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THE DIAMOND MINES OF KIMBERLEY.

BY

GARDNER F. WILLIAMS, General Manager, De Beers Consolidated Mines, Ltd.

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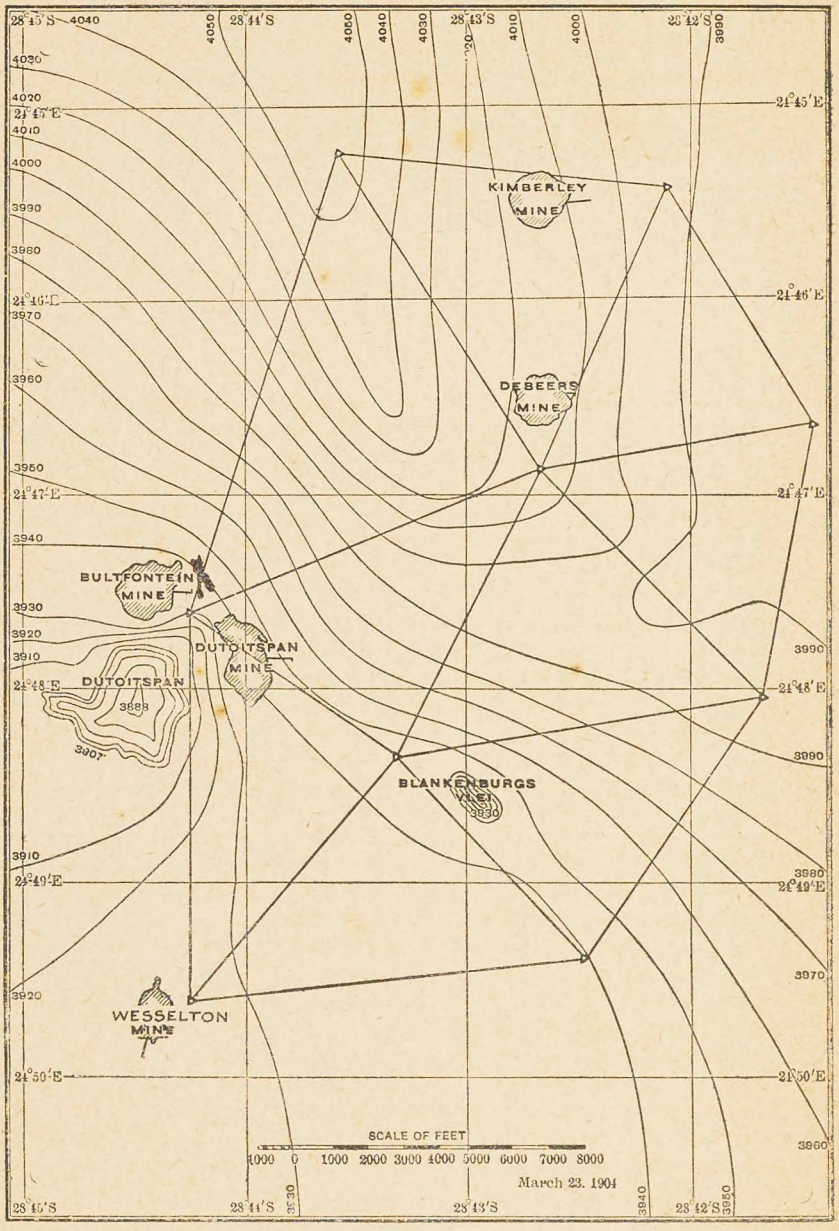
It is not my intention to go into the history of the discovery of diamonds in the alluvial soil along the Vaal river followed by the finding of diamonds in the "dry" mines, as the discoveries at Kimberley were called. The history of these mines has been written and re-written, besides the space allotted for this article is too small to give more than a cursory sketch of the formation of the mines and the occurrence of diamonds.

The mines are situate between longitudes 24° 45′—24° 50′ E. and between latitudes 28° 42′—28° 45′ S., and are distant by rail 647 miles from Cape Town and 485 miles from Port Elizabeth. The elevation of De Beers and Kimberley mines is about 4,000 feet above tide level, and the elevations of Dutoitspan, Bultfontein and Wesselton mines are 3,975, 3,958 and 3,936 feet respectively.

The geological sections of the rocks through which the diamond-bearing pipes pass are as follows:—The surface is covered with either a few feet of red soil or of calcareous tufa. Underlying these we find diabases and basalts which are, in places, worn away down to the shale. There is no great difference between these two rocks; some are diabasic in structure, some are olivine, others quartz diabases. The basalt varies in thickness from a few feet to a little more than 100 feet. It rests upon bituminous shale, which is from 200 to 280 feet in thickness. The constituents of the shale are small clastic grains of feldspar and quartz and much opaque or dark brown translucent material, probably of organic origin. The minerals of secondary development are kaolin, serpentine, white mica, and calcite. This is known as the Kimberley shale. Below the shale and resting on an amygdaloidal rock is a layer of small angular, or more or less rounded boulders, known as the Dwyka or glacial conglomerate, which varies from 3 to 10 feet in thickness as determined in various shafts in the Kimberley mines. It is composed of fragments of quartz, feldspar, chert, shale, quartzite, quartz, porphyry, and other rocks. The amygdaloidal rock is melaphyre (or olivine-diabase of Stelzner) and is about 400 feet thick.

* Author of "The Diamond Mines of South Africa," New York, The Macmillan Co.; London, The Macmillan Co., Ltd., 1902. Revised edition, New York, B. F. Buch & Company, 1905.



RELATIVE POSITION OF DE BEERS COMPANY'S MINES.

The amygdules are filled with granular and chalcedonic quartz. The malaphyre rests upon quartzite, which is 722 feet thick where De Beers mine rock shaft passes through it. The constituents of the quartzite are partly rounded or subangular grains of quartz, microcline and other plagioclastic feldspars and chert. The cement consists of shreds of sericite together with calcite in places. Some of the feldspars are replaced by calcite and a little pyrite. The quartzite was evidently derived from a granite by rapid erosion, for, if it had been by slow disintegration, the feldspars would be decomposed. The Kimberley mine rock shaft was sunk through about 400 feet of quartzite and 260 feet of mixed quartzite and shaly material, some pieces of which show organic matter. Underlying the quartzite is quartz porphyry, which has been proved to the depth of 2,600 feet.

Upon the information at hand it may be assumed that all diamonds found prior to the discovery of the Kimberley pipes, or craters, came from alluvial deposits.

In the case of the Kimberley mines, the diamond-bearing rock or blue ground has been forced up through the geological strata mentioned above. This rock was described by Professor Henry Carvill Lewis as "a phorphyritic volcanic peridotite of basaltic structure," which he named kimberlite*—a name now generally accepted by geologists.

In De Beers mine a dyke of igneous rock appeared and, owing to its taking a serpentine course across the mine, it received the local name of "snake." It stands like a vein, nearly vertical, varying in thickness from 2 to 7 feet. No diamonds have been found in it, yet investigations show that its composition is substantially the same as the surrounding diamond-bearing rock. The late Dr. Stelzner described the blue ground and snake as follows :—

> "The main body of the blue ground is entirely analogous to the snake rock, naturally more decomposed ; but in essential points the microscopic features of blue ground and snake (not taking into consideration the numerous little slate fragments in the blue ground) are in an extraordinary degree alike. It therefore impresses upon one's mind that the 'snake' is a younger eruption formation coming from the same volcanic source as the blue ground."†

The blue ground must be designated as a breccia. There is no doubt that it is of volcanic origin, and was forced up from below ; it consists of olivine with fragments of other rocks. The writer has lately had slides made of pieces of blue ground from the several mines. These show it to be very similar in all the five mines. It consists of a clastic mass of rounded and angular olivine which is

*"The Matrix of the Diamond," Henry Carvill Lewis, M.A., F.G.S., Professor of Mineralogy in the Academy of Natural Sciences, Philadelphia, U.S.A., at meeting of the British Association at Manchester, August and September, 1887.

†Dr. A. W. Stelzner, Professor of Geology at the Freiberg, Saxony, Mining Academy, in a letter to the writer.

almost entirely converted to serpentine. This alteration appears to have taken place down to the lowest depths from which the samples were taken, *i.e.*, 2,520 feet. The following minerals are to be found in the blue ground : augite, biotite, bronzite, calcite, chlorite, chrom-iron, cyanite, garnet, hornblende, magnesite, magnetite, mica, olivine, perofskite, smaragdite, titanic iron (ilmenite or menaccanite), and zircon.* Corundum is said to have been found in Jagersfontein mine, in the Orange River Colony, and in the Frank Smith mine, situated about 50 miles west of Kimberley. Iron pyrites and barite are found in the deposit resulting from the washing of the blue ground. The pyrites come, for the most part, from the country rocks, which become more or less mixed with the blue ground during the process of mining. The barite is a secondary formation of small veins in the blue ground at its junction with the country rock. Beautiful crystals of doubly refracting or Iceland spar are occasionally found also near the boundary of the blue ground. The shale fragments which are contained in the blue ground are altered very little, in fact most of them are unaltered. The pieces of shale, which show any alteration, have probably been changed by recrystallization to minerals of a micaceous or calcareous character. There is not the slightest evidence that the carbon of the shale has crystallized to diamonds.*

As to the origin of the diamond-bearing pipes themselves, I have always held that they were filled by aqueous rather than igneous agencies, possibly by something of the nature of mud-volcanoes.

It is a noteworthy fact that all the craters are filled just even with, or slightly above the surface of the surrounding country. Would this have been the case if the pipes were of igneous origin ? I think not. It has been claimed that the surface of the country, as it existed when the craters were filled with the diamond-bearing breccia, was not the same as at present, but that it has been denuded or washed away. There is not the least particle of evidence to bear out such a contention. If the country rock and diamond-bearing ground had been washed away, then diamonds would have been found in the " wash " or in ravines and water-courses in the vicinity of the mines. Such is not the case ; no diamonds have been found in alluvial soil nearer than the Vaal river, some 20 miles distant, and these diamonds are totally different in character from the Kimberley stones. The Kimberley mines lie in basins from which no water flows into any stream, but runs into pans or vleis where it evaporates or is used for mining purposes.

In this connection it may be stated that Dutoitspan mine is situate within a few hundred feet of Du Toit's pan, a pond, which is fed by small water courses during the rainy season. The bottom of the pan was probably 30 feet lower than the edge of the mine, where the yellow diamond-bearing ground joined the basalt, yet it is a significant fact that no diamonds have been found in the pan.

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*Waldemar Lindgren, U.S. Geological Survey, in a letter to the writer Dec., 1904.

Bultfontein mine is also quite as near this pan and lies at a considerable elevation above it.

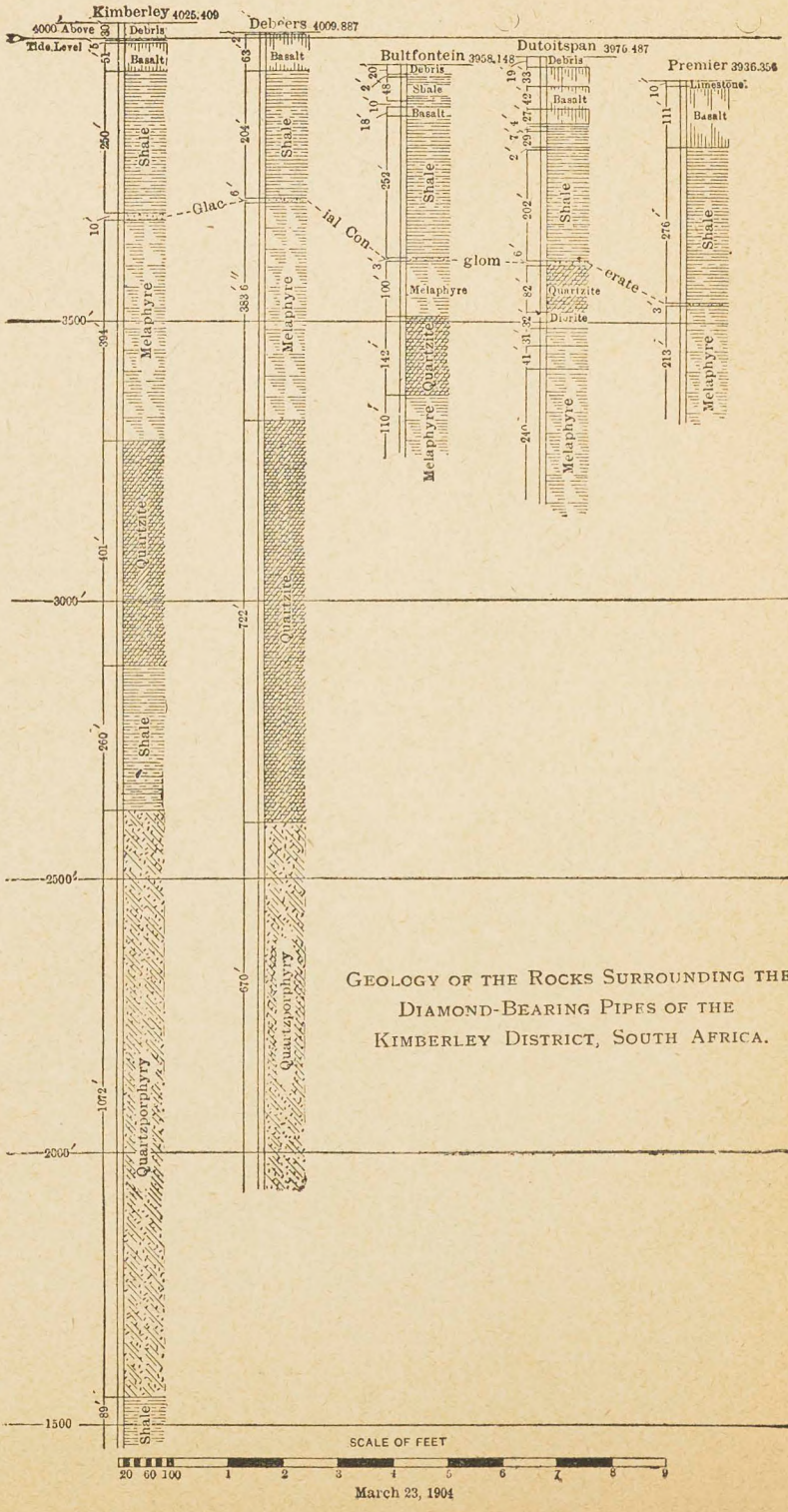
At Kimberley and De Beers mines the same conditions exist, but the drainage from these mines is to the north into Diebel's Vlei, which is one hundred or more feet below the mines and nearly 4 miles distant therefrom. No diamonds have been found between the mines and the vlei nor in the vlei itself, and I repeat that this is a significant fact. By what laws of nature would it be possible to obliterate a large section of these mines and leave no diamonds behind in these depressions. In case the depressions have been made since the formation of the pipes, would it not be reasonable to expect that the forces that made them would have washed a portion of the diamond pipes into them ?

I have given these facts at considerable length because my contention that these are the craters, and not simply the necks, of mud volcanoes has been questioned. It is contended that the craters have been washed away, but this is hardly borne out by local observations. The tops of these craters are bell-shaped as is the case of ordinary volcanoes. I cannot conceive how these craters could have been just filled to the level of the surface of the surrounding country except that the material which filled them came up as mud highly charged with gases which escaped in the air on nearing the surface and allowed the mass of mud to subside. There must have been some such process to incorporate the shales, which lie near the surface, so thoroughly with the eruptive mass.

If, as contended, a few thousand or even a few hundred feet of the tops of these mines have been washed away, where are the rich places which contain this marvellous store of diamond, richer than the soil along the banks of the Kistna and Godavari rivers, where the Golconda of tradition outstretched, and richer than the cascalho of Brazil ? A story is told of the climbing of Zulmat by the great Alexander, to the rim of an inaccessible valley, where, beneath sheer precipices, glistened a coverlet of the stones of fire. There was no way of winning the diamonds that glowed so temptingly except by flinging down masses of flesh and waiting for swooping eagles to bear the lumps up to their perches on the mountains with the precious stones sticking in the meat.*

Sindbad the sailor had this tale in mind in his second voyage. It will be remembered that he was stranded by shipwreck on a desert island and was carried away by the flight of a gigantic rukh to the top of a distant mountain. From this mountain he descended into a neighbouring " valley," exceeding great and wide and deep and bounded by vast mountains that spired high in the air. Walking along the wady, he found that " its soil was of diamond, the stone wherewith they pierce minerals and precious stones and porcelain and the onyx, for that it is a dense stone and a stubborn, whereon neither iron or hard head hath effect, neither

* " Oriental Accounts of Precious Minerals," Journal of Asiatic Society of Bengal, August, 1832.



GEOLOGY OF THE ROCKS SURROUNDING THE DIAMOND-BEARING PIPES OF THE KIMBERLEY DISTRICT, SOUTH AFRICA.

March 23, 1904

can we cut off aught therefrom, nor break it save by means of lead stone." The sailor soon bethought himself of the old story of the valley from which diamond-studded meat was "plucked by eagles." So he quickly filled his pockets and shawl girdle and turban with the choicest diamonds. Then he put a piece of raw meat on his breast and lay down on his back. Soon a big eagle swooped down into the valley, clutched the meat in his talons and flew up to a mountain above, "where, dropping the carcass, he fell to rending it," leaving the lucky sailor to scramble off with his booty.*

These amazing stories are less teeming with interest than they were in the days when they were first told. If from the mines of Kimberley huge masses of diamond-bearing earth have been washed away there must be a massing of these diamonds in the valleys of the Vaal and Orange rivers awaiting the coming of some lucky Aladdin which will make the discoveries of Alexander and Sindbad look insignificant. Personally, I do not believe that toilsome searches for these masses of precious stones from the craters of Kimberley will ever be rewarded.

I cannot conceive of any denudation of the tops of volcanic craters which would not have left behind some trace, even more than a trace, some concentration of diamonds and the heavy minerals which are associated with them. In the machines in use on the Diamond Fields we imitate nature in concentrating the heavy minerals. The light particles are washed away leaving the concentrates behind.

In the case of the Kimberley diamond mines there was no richer ground on surface than that found below it. In the Transvaal Premier mine the conditions seem to have been different. There a concentrating process seems to have gone on for ages. These concentrates have not been swept away into unknown quarters, but have simply sunk down as the upper part of the mine was disintegrated and the lighter material was washed away. It is true that a portion of this concentrated mass finally found its way into the alluvial deposits below, but the diamonds appear to be found at no considerable distance from their source.

The evidence of the movement of the diamond-bearing rock after solidifying is indicated by the slickensides and striated surfaces of the country-rocks at their junctions or contacts with the kimberlite. Large sheets of calcite are frequently found at the junction of these rocks, which have taken the form of the striæ. Beautiful calcite crystals and transparent pieces of doubly-refracting, or Iceland spar, are of frequent occurrence.

There is conclusive proof that the diamonds in the South African mines are not found in their original place of crystallisation, as, for example, the frequent occurrence of broken crystals, embedded in the hard kimberlite.

Concerning the discussion of the genesis of the diamond, Sir Isaac Newton's opinion was that it was of vegetable origin and

* Arabian Nights, Lady Burton's edition, Vol. III., pp. 476—482.

combustible ; but it was not until 1694 that the combustibility of the diamond was actually proved by the famous burning-glass experiment of the academicians of Cimento.

Lavoisier, Guyton de Morveau, and others determined that the diamond was converted into carbonic dioxide by burning. The experiments of Sir Humphrey Davy, in 1816, showed that the diamond was almost pure carbon. These experiments have been confirmed by Dumas, Stas, Friedel, Roscoe and other eminent chemists, who have fixed with extreme precision the composition of the diamond to be pure carbon in crystalline form. The late Dr. W. Guybon Atherstone was one of the first scientists to deal with the occurrence and genesis of the diamond in the Kimberley mines. Being a resident of the Cape Colony he made frequent visits to the diamond fields and made personal investigations.*

Professor Lewis alleged that the diamond is the result of the intrusion of igneous rocks into and through the carbonaceous shales. He says :

> " The kimberlite is shared by no other terrestrial rock. In structure it resembles meteorites of similar composition. If the ground-mass of kimberlite were replaced by native iron it would be nearly allied in both structure and composition with meteorites known as chrondrites. . . . . Perhaps the most interesting chemical observation concerning the blue ground was that made by Sir H. E. Roscoe. He found that on treating it with hot water an aromatic hydrocarbon could be extracted. By digesting the blue ground with ether, and allowing the solution to evaporate, this hydrocarbon was separated and found to be crystalline, strongly aromatic, volatile, burning with a smoky flame and melting at 50 ° C. . . . . That the rock was a true lava and not a mud or ash is indicated by the fact that the minerals and their associations are those characteristic of eruptive ultra-basic rocks."†

Professor Lewis advanced the theory that probably the diamonds came from the hydrocarbon which was contained in the fragments of carbonaceous shales distributed through the blue ground, but the inclusion of carbonaceous shales in the blue ground can hardly be reconciled with Professor Lewis's conclusion " that the rock was a true lava."

If the diamond is the result of the intrusion of igneous rocks into and through the carbonaceous shales, why do not all pipes composed of kimberlite contain diamonds ? And why do diamonds exist in some mines, such as those in the Pretoria district, where no carbonaceous shales are to be found ?

Professor Molengraaff,‡ formerly State Mineralogist to the South African Republic, discusses the genesis of the diamond, and says

*Geological Magazine, Vol. VI., p. 208, May, 1889.

†The Matrix of the Diamond. Professor Henry Carvill Lewis, p. 52.

‡ A Monograph on the Diamonds at Rietfontein, near Pretoria, in the Transvaal.

that the theory of the formation of diamonds during the ascension of the blue ground from carbon borrowed from the carbonaceous shales was, in his opinion, weak.

> "In the Pretorian beds, as well as in the formations underlying these, strata containing any notable quantities of carbon were nowhere to be found in the Transvaal; so that the conclusion might safely be drawn that the igneous blue ground, in forcing its way from great depths towards the place where it was found, could not borrow any carbon from the surrounding strata in order to convert it into diamonds."

In Bohemia a rock occurs which contains every mineral known in the blue ground of Kimberley, except diamonds. On my visit to the Mining Academy at Freiberg, Saxony, a few years ago, Dr. Stelzner, Professor of Geology, showed me two cases containing these minerals, and in every instance the Bohemian minerals corresponded with those from Kimberley, except that the case of Kimberley minerals contained a few small diamonds, which had been presented to the Academy.

It is reported by Mr. G. F. Kunz that diamonds have been found in Bohemia, but they did not occur in the rock mentioned above.

Both the aqueous and igneous theories of the origin of the kimberlite have had able supporters, among the former being Stanislas Meunier,* M. Chaper,† and, later, Professor Garnier and Sir William Crookes.‡ The igneous theory is strongly supported by Professors Lewis,§ Molengraaff|| and Stelzner.** My own opinion is that the aqueous theory is the less assailable.

Concerning the origin of the blue ground, assuming that it is not the original matrix of the diamond, I find the following weak points in the igneous theory.

1. As already observed, it is impossible to account by the igneous theory for the water-worn boulders found in the blue ground, and the presence of carbonaceous shale fragments.

2. The experiments of Herr W. Luzi,†† of Liepsic, in the production of artificial figures of corrosion upon the surfaces of rough diamonds, are most interesting in the light which they throw on the crystallisation and the probable matrix and genesis of the diamond. Until lately the only appearance of corrosion upon the surface of

* "Composition et origine du sable diamantifère du Toits Pan, Afrique Australe"—Comptes rendus de l'Academie des Sciences de Paris, Vol. LXXXIV., No. 6, p. 250. "Examen mineralogique des roches qui accompagnet le diamant dans les mines du Cap de Bonne Experance"—Bulletins de l'Academie Royale de Belgique, 3d. series, Vol. III., No. 4.

† "Note sur la région diamantifère de l'Afrique Australe," Paris, 1880.

‡ Lecture before the Royal Institute of Great Britain, June 11th, 1897.

§ The matrix of the Diamond—Henry Carvill Lewis at a Meeting of the British Association at Manchester, August, 1887.

|| The Occurrence of Diamonds at Rietfontein, G. A. P. Molengraaff.

** A lecture by A. W. Stelzner before the Isis Society, in Dresden, Saxony April 20th, 1893.

†† Artificial Figures of Corrosion on Rough Diamonds, Berichte der Deutschen Chemischen Gesdleschaft, 1892.

rough diamonds was the regular, triangular negative pyramids which were produced through heating the diamond in the open air or under the oxygen flame.

Herr Luzi discovered that the breccia (kimberlite) from the South African mines, when in a molten condition, possesses the property of absorbing the diamond or of changing its shape.

He describes his experiment as follows :—

> " A small quantity of blue ground was melted in a crucible placed in a Fourquinon-Leclerq furnace at a temperature of 1770 ° R., which was the highest temperature attainable. A diamond with perfectly smooth, natural faces was submerged in this molten mass. A further quantity of blue ground was added to the contents of the crucible until it was completely filled. A tightly-fitting cover was placed on the crucible, which was again exposed for thirty minutes to the greatest heat attainable. When the crucible was cooled the diamond was removed and found to be covered with irregular oval and half-round grooves of various depths. In one experiment the diamond was found to be deeply eaten away on one side."

Some of these partly-absorbed diamonds, upon which Herr Luzi experimented are deposited in the mineralogical museum of Leipsic University.

Owing to the cost of the material to be experimented upon, however, Herr Luzi was unable to determine positively what chemical action took place during the time the diamonds were heated in the complicated silica flux. The fact that diamonds can be absorbed by being placed in molten blue ground tends to prove that the blue ground was not thrust up through the earth's crust in a molten state.

If the diamond is unable to withstand the corroding influence of the silica magma at the comparatively low temperature given above how could it possibly have retained its forms of crystallisation and perfect faces at the temperature and pressure which must have existed under the igneous theory ?

3. Some years ago a diamond weighing 28·5 carats, found at Kimberley, attracted the attention of the valuator. Its external surface was smooth and crystallised, showing no other mineral except the diamond itself, but the interior was white and not transparent. Noticing this peculiar appearance the valuator broke the stone in order to satisfy his curiosity, and found that a small, perfect octahedral diamond was enclosed in the centre of the larger stone. Nor was this all. There were flakes of a white mineral, not diamond, attached to the fragments of the broken diamond. In appearance the flakes were white, translucent and crystalline, and about as hard as steel. When heated in a closed tube moisture was given off. It fused readily on platinum wire to a white bead. A few grains of this white mineral were collected, and by analysis it proved to be apophyllite, a silicate of lime and potash with 16 per cent. of water.

If a mineral which is fusible at the ordinary temperature obtained with a blow-pipe, and which contains 16 per cent. of water, was formed at the same time that the diamond crystallised, it is certain that this did not take place under an enormously high temperature. How, then, one may ask, did the apophyllite become a part of this diamond ?

Herr von Tschudi* describes a beautiful crystallised Brazilian diamond in the centre of which was a leaf of gold. He obtained the information from Dr. Mills Franco, who claimed that there was no doubt or deception as to the identification of the gold.

Occurrences of this nature tend to veil in additional mystery the genesis of the diamond.

Professor T. G. Bonney,† at a meeting of the Royal Society, presented the following conclusions in reference to the origin of the diamond :—

> "The blue ground is not the birthplace, either of the diamond or of the garnets, pyroxenes, olivine and other minerals —more or less fragmental—which it incorporates. The diamond is a constituent of the eclogite, just as much as a zircon may be a constituent of a granite or a syenite." . . . "I had always expected a peridotite (as supposed by Professor Lewis), if not a material yet more basic, would prove to be the birthplace of the diamond.
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> "Can it possibly be a derivative mineral, even in the eclogite ? Had it crystallised out of a more basic magma, which, however, was still molten when one acid more was injected, and the mixture became such as to form eclogite ? But I content myself with indicating a difficulty and suggesting a possibility ; the fact itself is indisputable : that the diamond occurs, though rather sporadically, as a constituent of an eclogite, which rock, according to the ordinary rules of inference, would be regarded as its birthplace."

Professor Bonney's statement that diamonds occur in the eclogite of the Newlands mine caused me to examine the eclogite (?) which is found in all the mines at Kimberley, and has always been treated as waste rock and thrown away. There are tons of it lying about the Kimberley mines. I have examined hundreds of pieces of this rock, but never found a diamond ; nor have I ever heard of a diamond being found in it by any one during the many years that these fields have been worked. I caused about twenty tons to be collected and sent to a test-plant, where it was crushed and afterwards jigged ; but it contained no diamonds.

Mr. Waldemar Lindgren, who is connected with the United States Geological Survey, has had an opportunity of studying the blue ground and the minerals contained therein from samples

* Travels in South America, by J. J. von Tschudi.

† The Parent Rock of the Diamond in South African, Professor T. G. Bonney. Proceedings of the Royal Soc., Vol. LXV., July 27th, 1899.

supplied by the writer from which forty-five slides were made. His conclusions are as follows :—

> " In looking over the literature (on diamonds), especially the papers by Professors A. W. Stelzner and T. G. Bonney, it seems to me that the connection of the diamond with the garnet in the peridotite and pyroxenite has been satisfactorily proved. It is not possible to regard it as formed in the ' blue ground.' On the contrary it was evidently contained in the peridotite magma and crystallised with it."

A specimen of the rock, which I presume to be the same as the eclogite spoken of by Professor Bonney, taken from Dutoitspan mine, was handed to Dr. G. F. Becker, who had a slide made from it. He determines the rock to be lherzolite and says : " This composition shows that the rock is extremely analogous to kimberlite, in fact probably a sub-variety of it. Zirkel considers kimberlite as closely allied to lherzolite, while Rosenbush appears uncertain how to classify it." Dr. Becker is still of the opinion that diamonds ought to be found in the lherzolite in spite of the result of the test of twenty tons.

Quite a number of specimens of diamonds and garnets cemented together have been found, but in most specimens which have come under my observation the diamond has grown into the garnet. A diamond was found (January 9th, 1904) in Wesselton mine, Kimberley, which had a small garnet embedded in it. The diamond weighed 114 carats, and the garnet was estimated to weigh about half a carat. It appeared to fill the hole in which it was embedded. The diamond was of cubic crystallisation, with nearly half of the cube wanting. The part of the diamond in which the garnet was buried had numerous depressions similar to the one containing the garnet, and one is led to think that these depressions were also once filled with small garnets, or in other words the diamond crystallised upon a nest of garnets. It was of a peculiar plumbago colour and semi-transparent. All of the diamonds crystallised in cubic form which have been found of late in Wesselton mine were of this peculiar colour. Specimens have also been found where the diamond was embedded in olivine.

Sir William Crookes and others have mentioned diamonds which burst or explode on being brought to the surface ; and Sir William says it has been " conclusively proved that the diamond's genesis must have taken place at great depths under enormous pressure. The explosion of large diamonds on coming to the surface shows extreme tension."

Professor Lewis says that Kimberley diamonds have been found sometimes to have optical anomalies due to strain. Fizzan thought this strain to have been caused by the unequal distribution of heat during cooling ; but Jannettaz* holds that the strain is due to compressed gas in the interior of the crystal.

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* Bulletin de la Société Minerale de France, II., 1879, p. 124.

I have found that the light-brown, smoky diamonds are the ones which crack on being brought to the surface ; but even these remain intact if kept in a moist place. In the days of open-cut working, when a smoky or light-brown diamond was found, the digger placed it in his mouth, where he kept it until he offered it for sale. The buyer placed it in a raw potato, in which it was shipped to Europe. The temperature of the ground in which the stone was found would, as a rule, not exceed 70 ° F. The temperature of the diamond would be raised to 98 ° F. while in the digger's mouth. If, however, the stone was kept in a dry place, even at a lower temperature, it would crack in all directions. One might argue from this that it was not the expansion of gases by heat alone which caused the fractures. If these fractures were due to compressed gas, as contended by Jannettaz, one might expect this cracking to have occurred while the diamond and its contained gas were exposed to the enormous heat to which, according to the igneous theory, diamonds must have been subjected.

I had been led to believe that only light-brown or smoky stones cracked on being exposed to dry air, but I have lately been informed by one of the old diamond miners that he had seen white stones which showed the same phenomenon.

Sir William Crookes says that the ash left after burning a diamond invariably contains iron as its chief constituent, and the most common colours of diamonds, when most perfectly pellucid, shows various shades of brown and yellow from the palest " off-colour " to almost black. These variations, he declares, accord with the theory that the diamond has separated from molten iron.

I have made exhaustive tests in order to ascertain whether diamonds contain iron, oxidised or metallic. The experiments were made upon a magnetic separating-machine, the field-magnets of which attracted any mineral containing iron or iron oxides, except iron pyrites. Although some of these diamonds had the appearance of being coated with iron in some form, and others were coloured dark brown and deep yellow, they were in no way attracted by the magnet, even when excited by a strong electric current. These experiments do not, perhaps, disprove the existence of iron in the diamond, but they do establish the fact that the quantity is infinitesimally small. Further experiments in this direction ought to be made by those who have better facilities for such work than are at our disposal here in Kimberley. The experiments of Messrs. Hannay, Moissan, Friedel, Sir William Crookes and others all show that microscopical diamonds can be produced artificially ; but they throw very little light upon the question how the diamonds in the South African craters crystallised.

From what is known of the theory of crystallisation, one is inclined to the old Indian idea that diamonds grow like onions, though much less quickly. It is hardly conceivable that diamonds, such as the Koh-i-nûr, the Great Mogul, the Excelsior (a Jagersfontein, South African stone of 971 carats), and the two largest De Beers

diamonds (respectively of 503 and 428·5 carats) were formed, as the microscopical diamonds have been, in a moment of time during the sudden cooling of molten iron.

Is it not more reasonable to suppose that these enormous crystals grew little by little, and that nature has followed the same laws of crystallisation in the diamond as in other minerals ?