ON JET MINING.

BY CHARLES PARKIN.

It may appear at first that such a purely ornamental material as jet is hardly a suitable subject to bring before the notice of the members of this Institute, but the fact that it is sought for and wrought at considerable personal risk to the miner, and that the mining for it is subject to the Coal Mines Regulation Act, suggests the idea that a few remarks on the question may not be, after all, inappropriate; and although this mineral has been worked for many years, yet so little is known of the method of obtaining it—except to those closely interested in the trade—that the writer hopes a brief description of its geological position and the mode of working it will not be out of place in the Transactions of the Institute.

GEOLOGICAL DESCRIPTION.

In Dr. Page's Handbook of Geological Terms it is stated that the word "jet" is derived from Jayet, or Gagites, terms in their turn derived from Gaga, the name of a river in Asia Minor, and that he considers jet to be more of the nature of amber than of coal, stating that in Prussia it is known as "black amber."

Young and Bird in their survey relate that in front of the cliff north of Haiburn Wyke, near Whitby, was found the petrified stump of a tree in an erect position, three feet high, and fifteen inches across, having the root—consisting of coaly jet—in a bed of shale, whilst the trunk in the sandstone was partly of petrified and partly of decayed sooty wood.

Phillips, in his Geology of Yorkshire, states that "jet is simply a coniferous wood, and in thin sections clearly shows the characteristic structure, frequently resinous masses of oval figure enveloping larger tissue than occurs elsewhere appear under the microscope," and also "that impressions of ammonites and other fossils appear on surfaces of jet, proving that it has passed through a condition of softness."

The best jet is usually found in the largest quantities towards the base of the upper lias or alum shale stratum, and this portion is generally known as the jet rock; a softer jet is obtained also throughout the shales above, in

the oolite series, but in less quantity. The jet rock is about 18 feet thick, lying a few fathoms above the Cleveland main bed of ironstone, but below the top seam, which is worked in the Rosedale Abbey and Grosmont district known as the oolite ironstone. The shale is bituminous, and a thin piece when lighted will burn by itself; on being exposed to the atmosphere it sometimes takes fire, when it assumes a reddish hue, due no doubt to the iron which it contains; water flowing through this shale leaves it impregnated with alum, and destroys vegetation. An instance of this may be seen at the Slapewath old Alum Works, near Guisbro'. The jet deposits vary in size, and although when found are termed seams by the miners, yet this term is not a correct one, the jet lying irregularly through the whole depth of the shale, ranging from a wafer to 5 or 6 inches in thickness; and in length up to several feet, the breadth of the deposit being only a few inches.

Mr. Matthew Snowdon, of Whitby, in a letter to the writer, remarks: —"We have often got large quantities of jet down here in working the oolite ironstone seam, and in one instance, at Port Mulgrave, we found a deposit for which I had £700 offered. We came across it between the oolite ironstone seam and the freestone." The shape of the deposit was like that shown in the woodcut.

MODE OF WORKING.

The number of men actually employed in jet mining would be somewhat difficult to arrive at, for no accurate record is kept (to the writer's knowledge) either of the men employed or the quantity of material worked per annum. Slight accidents have been of frequent occurrence; and in 1873, a jet miner was reported to have been killed by a fall of shale, owing no doubt to the careless way in which the operations were carried on.

The search is always commenced at the outcrop of the alum shale, two or four men forming a company. Shafts are not sunk, either to win or to work it. A drift 6 feet high by 3 or 4 feet wide is driven in from the outcrop, when these drifts are advanced a few yards; side excavations are made, and the systematic search for jet commenced. The shale over the roof of the side drifts is hewn or wedged down, serving as a platform to work on, and the whole thickness of the shale is then explored in a fashion somewhat resembling a combination of longwall in coal work, and of stopeing in lead and other metalliferous mines. While the preparatory drifts are being driven, the shale has to be conveyed outside, but in the

regular course of working most of it is tossed back, and as little taken out of the mines as possible, horses or lads hardly ever being required. When a discovery is made, the deposit is carefully followed up and excavated in as large pieces as possible; sometimes weeks will elapse and no jet be found, while occasionally exceptional luck is met with, and a great quantity got in a few days. On such occasions the so-called seam is very seldom left until all is extracted, and the miners work night and day. The reason for this caution is obvious, for should it become known that a good deposit has been met with, if the mine was left, the jet might be stolen and carried away during the night.

The workings seldom extend beyond a hundred yards at the most from the drift mouth, the shale becoming much more difficult to work as operations are extended from the outcrop.

MEANS OF VENTILATION.

If when a drift is driven in for some distance the prospect is found to be cheering, another drift is commenced running parallel with, and at a distance of about five yards from the main one, and the two connected in order to secure ventilation, but the plan more generally adopted at the present time is that of allowing the roof to fall away to the surface when explorations are being made near the top of the jet rock.

An explosion of gas is reported to have taken place some years ago in a jet mine, which was probably due to the oily vapours exuding from the shale; and in the ironstone mines of the district explosions have occurred probably from the same cause. The writer would here acknowledge his indebtedness to a letter which appeared in the *Mining Journal* for this fact and some other particulars contained in this paper.

TIMBERING AND BLASTING.

Very little timber is required in these drifts, as the jet-bearing rock is of a very tough character, and no gunpowder or other explosive is necessary in working the shale, the nature of it being opposed to successful blasting, which would moreover injure any jet lying near.

ROYALTY CHARGES, YEARLY PRODUCTION, AND COMMERCIAL VALUE.

Owing to the uncertain character of the speculation it is a very difficult matter to fix upon an equitable and reasonable royalty charge, and in most leases or agreements granted for the working of ironstone and other minerals, when jet is included, the terms for working it are embodied in

the unsatisfactory words of "a rent to be agreed upon, or, failing agreement, to be determined by arbitration." But it is customary to arrange the matter by a payment varying from 2s. 6d. up to 3s. 6d. per week for each miner employed.

The quantity of English jet used per annum at present only amounts to three or four tons, its value varying from £300 to £1,300 per ton, whilst the quantity imported from France and Spain is over 100 tons per year, the foreign supply being so much cheaper, that from France costing the manufacturers only about £30 per ton, and the Spanish from £60 to £140 per ton. The English jet, however, is superior to that obtained from abroad, which is much more liable to fall to pieces on sudden exposure to the sun or other sources of heat.

LOCALITY OF MINES.

The Yorkshire jet mines are situated in the North Riding, and are to be found principally within a few miles of Stokesley, at Swainby, Bilsdale, Rosedale Abbey, and neighbouring district. Jet is also wrought from the sea cliffs, in open quarries in the neighbourhood of Whitby, the supplies from Kettleness having been very large. The Eston range of hills has also yielded a good deal of jet in years past. Operations are at the present time going on at Swainby and Bilsdale, where Mr. Hall, of Whitby, is working; and on the west side of Rosedale, on Gillbank Farm, where the results are turning out very encouraging; and it is anticipated that other parts of the dale will be explored, the jet from Gillbank having proved to be of superior quality.

MANUFACTURE.

That jet manufacture is of ancient date is evident from the fact of it being on record that from the Sands-End cliffs it was procured and used in making ornaments by the Romans at their station of "Dinum Sinus" (Dunsley Bay). The writer has himself seen a fourteenth century jet ornament.

"Whitby Jet" is a term which seems now to be accepted as a guarantee of the good and genuine quality of the articles manufactured out of this mineral, and the town is justly famed for this branch of industry, for considerable ability and ingenuity is shown in the bracelets, necklaces, ear-rings, brooches, watch-chains, and other fancy articles made. Upwards of 400 men and boys are employed in the Whitby manufacturing trade, who work nine hours per day. The men are paid about 25s. per week, and the lads from 6s. to 10s. per week.

Mr. Thomas Boyan, one of the principal manufacturers in Whitby, has

been kind enough to allow an inspection of his works, which enables the writer to briefly describe the process through which this mineral has to go.

The first process in the manufacture is stripping the skin off the jet (this skin is of a blue colour in that obtained from the alum rock in the cliffs near Whitby, and of a brown colour in that obtained from the jet rock proper in the mines further inland); this operation is done by workmen chipping off the outside with a short chisel; the substance is then passed on to be sawn into various thicknesses and sizes. In this process the greatest economy is observed, and the apparently useless fragments are made up into beads and small ornaments according to their size and shape. The cut pieces are then put into the hands of workers, who with foot-treadle grindstones take off all the sharp edges and bring them into oval, circular, or other geometrical shapes required. In the next stage it passes into the hands of the carvers and turners, the former with knives, chisels, and gouges, bringing the pieces into beautiful designs, with a degree of accuracy and rapidity that could hardly be credited. From the carving department the work is transferred to the polishers, who first treat the rough work on polishing boards having a surface of rotten stone and oil, and after this treatment comes the finishing polish, or, as it is termed, "rougeing," which is accomplished by holding the article against a quickly revolving wheel covered with walrus hide for the broad surfaces, and strips of list fixed on end for the indented or carved portions, or against a revolving brush wheel, all of which are covered with rouge. This rouge consists of a red oxide of iron powder and water. It then only remains to fix the article into its setting to become ready for sale.

Ammonites (molusca shells), commonly known as snake stones, are richly polished and inserted into many of the ornamental articles, and these are obtained in great abundance in the alum shale, and on the sea-shore scar at Whitby.

There are reasons to believe that the trade will receive a great impetus from the introduction of jet into the enamelling art. Mr. Charles Armfield, Diocesan Surveyor, York, writes to the *Builder* to call attention to a new means of decoration. It is the invention of Mr. Godfrey Hirst, of Whitby, and consists of a combination of enamel with jet. Mr. Armfield states that, from specimens of the work he has seen, he believes it will form a very valuable artistic addition to the legitimate means of decorating furniture, pulpits, reredoses, etc. It is well known that jet is capable of a very high and endurable polish, and he (Mr. Armfield) has seen a thirteenth-century jet cross, found buried on the site of Grosmont Priory, near Whitby, which is still in a perfect state of polish. It may not be

generally known that it possesses, in a unique degree, the power of absorbing the radiations of adjacent colours, so that when used with any other colour than yellow, it produces a wonderfully soft effect, and gives a richness of tone which no other black material is capable of producing. That gentleman further states that he has used jet instead of crystals or sham pearls for jewelling embroidered altar frontals, and was astonished on his first essay with the materials to find that the jet bosses, worked on a deep crimson ground, at ten yards distance, looked like carbuncles. At first he thought it was the result of reflection upon the rounded surface of the boss, but a little more thought soon made it apparent that this was not the case, and an experiment with a flat disc of jet, on a similar ground, gave a clue to the real cause. This valuable quality of radiation absorption showed itself very strong on the blue, but less on the red, grounds.

In connection with this subject, it seems worthy of consideration that, if the shale excavated from the mines could be utilized—and, it must be remembered that it contains both alum and oil—this, in conjunction with the working of jet, might make it a subject more worthy the attention of capitalists.

Phillips says: "The petroleum generally sought for is usually found in most quantity above the jet rock. It is found in the joints of the rocks, in the cells of ammonites, and in other situations which seems on the whole suggestive of a process of distillation from carboniferous compounds in the shales above;" and in many of the Cleveland mines the smell of it is very perceptible.

It is asserted that Sir Thomas Chaloner established the first Alum Works in England, at Bellman Bank, near Guisbro', in the year 1600; these were vigorously worked until the year 1792, and in 1852, they were re-opened after having laid idle for sixty years. The Guisbro' works proving so successful, other speculators were induced to embark in these undertakings, and about the year 1615, works were opened at Lofthouse, Boulby, Kettleness, Sandsend, and Saltwick, near Whitby, all of which were supplied from the Sea-cliff quarries of alum rock, within ten miles north, to about seven miles south of Whitby. The Lofthouse and Boulby Works, were the most extensive in the kingdom, and the New Boulby Works belonging to a Mr. Baker, in the year 1858, employed about 100 hands. The alum trade, doubtless, laid the foundation of the future importance of Whitby. The number of inhabitants of the town in 1610, was 1500, whilst in 1650, the number had increased to 2500, due entirely, it is said, to the introduction of the alum trade to the district. The

shipments from all the works were made here, and exported to France, Holland, and other Continental places, but after some time the demand from abroad began to fall off, until the trade gradually became confined to the home market, supplied through the ports of London and Hull, and of late years nothing has been done at these works, most of which have been permanently closed for some time past.

It is very evident, however, that a large business has been carried on for more than two centuries, which points to the conclusion that the speculation proved to be a remunerative one, and the writer is led to consider it a question worthy of investigation, as to how far it would be practicable to combine jet mining, with the working and manufacture of alum or shale oil. With regard to the resources of alum shale now available, they may be considered as practically inexhaustible.

The PRESIDENT said, Mr. Parkin need not have apologized for his paper, which all would consider a very interesting one, whether looked at in regard to jet itself, or in regard to alum works. He was afraid alum works were among the dead industries of the country. He had been connected with them, but the market for alum was gone, and that substance was superseded by other chemical substances.

Professor LEBOUR exhibited a few specimens, which he thought might illustrate some of Mr. Parkin's remarks. There were, he said, specimens of Whitby jet, and among the others were the chief varieties of asphalt and mineral bitumen found elsewhere; and they would see that there was some connexion between all of the specimens. As to the word "jet," Mr. Parkin quoted a derivation from the river Jayet. The same derivation was given for agate. Those substances were not the same things, and yet the same derivation was given for each. One must be wrong. Jet was found in the upper and middle lias of England, also in the Kimmeridgian beds on both sides of the Pyrenees, but chiefly on the south or Spanish side. It was of the same character as the English jet, but was not of such good value for commercial purposes. The optical character of jet mentioned by Mr. Parkin was quite new to him; that, he thought, was the most important part of the paper; and, in addition to being a subject of interest to capitalists, it was also a subject of interest to physicists. Mr. Parkin had quoted Professor Phillips' description of jet as showing in microscopical sections distinct signs of tissue, so that he looked upon jet as simply altered wood. He (Professor Lebour) had no doubt that Professor Phillips was right as to the sections which he happened to observe, but Professor Phillips' day was not the

day of microscopic sections. He (Professor Lebour) had no hesitation in saying that in many sections of jet no tissues of that kind would be observed.

Mr. PARKIN said, he had seen on the surface of jet the impression of something like a fern, but he had not the specimen to show to the members.

Professor LEBOUR—That was extremely likely. Anything like jet or asphalt, when in a soft condition, would be just the matter to retain the impression of vegetable matter in perfection.

Mr. BOYD said, it might be reasonable to conclude that the impressions of fossils on jet would be the remains from inland waters, and not from sea deposits.

Professor LEBOUR—Yes, unless they are drifted.

The PRESIDENT moved a vote of thanks to Mr. Parkin, which was seconded by Professor Lebour, and unanimously carried, and the discussion was adjourned.

Professor LEBOUR, M.A., F.G.S., read the following paper on "The Present State of our Knowledge of Underground Temperature, with special reference to the Nature of the Experiments still required in order to improve that Knowledge :"—