THE BUILDER

The Builder August 30, 1862 – Box Hill And Its Bath Stone Quarries

The Builder October 1, 1864 – Bath Freestone

The Builder April 13, 1895 – The Stone-Producing Areas

The Builder April 20, 1895 – Bath Stone II – Analysis Of Thickness Of Beds

The above articles are referenced in several publications relating to Bath Stone Mining.

They have been transcribed for easier reference.

Alan Gray

February 2025

NOTE – Pages 26 and 27 – Some of the information (highlighted in green) is "hidden" in the crease of the book.

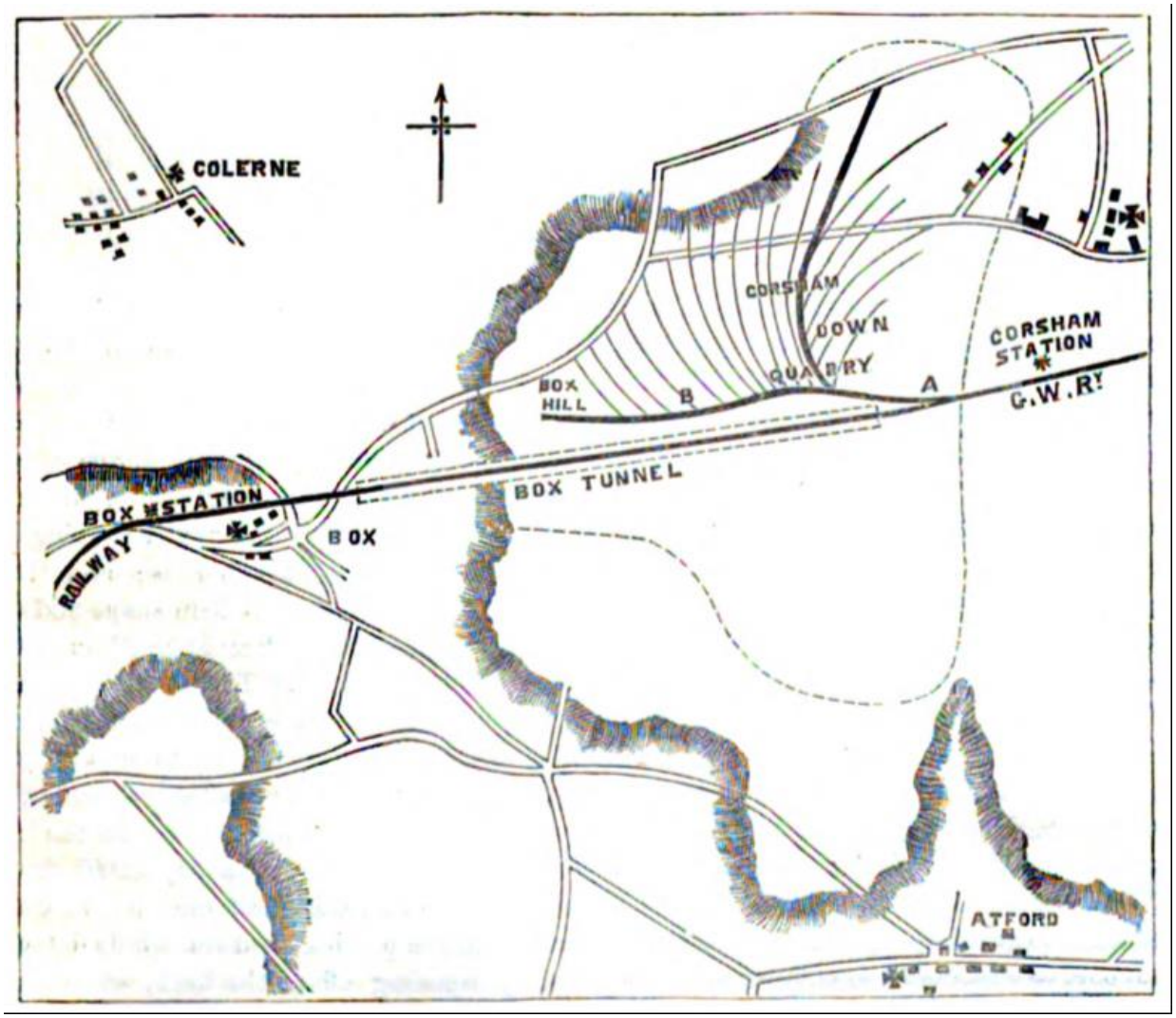
The Builder August 30, 1862

BOX HILL AND ITS BATH STONE QUARRIES

Box Tunnel, that great supererogatory work of Brunel, cuts a straight line, running nearly due east and west, through one of the most important members of the Jurassic group of strata in England, geologically named the Lower Oolite, but here more commonly known as Bath or Free Stone. Box-Hill itself forms the centre of the oolitic district, roughly triangular in outline, and comprising an area of about three square miles. Many parts of this and the neighbouring locality have been worked for stone, with more or less activity, from a very early date ; but, though quarries were opened here as many as 300 years ago, it was not until after Brunell's tunnelling operations had demonstrated how large an amount of good material might be got out of the district, that the workings began to receive any adequate development. The construction of the Great Western Railroad, however, gave a great impulse to this previously limited industry, and the remarkable facilities for transit which its completion afforded soon attracted the attention of practical men. Indeed, it could hardly have been otherwise : here was an almost unlimited supply of a material whose usefulness for many constructional purpose had been established by use; and cutting almost through the site of future workings was thig great broad gauge line. The present proprietors of the Box and Corsham Quarries, Messrs. Randell & Saunders, were not long in seizing upon the opportunity which these circumstances appeared to offer for the establishment of a large trade, and in the year 1816 they commenced the undertaking which has since attained its present large proportions. Having recently paid a visit to these quarries, where we spent some pleasant hours watching the work and investigating the methods in use for getting out the stone, we to describe what we saw, and explain to all whom it may interest the manner in which this building material is obtained. Nothing can be more unlike the ordinary experiences of mining excursions than a visit to the Corsham Quarries. Those who, like ourselves, have suffered in various parts of the country from hot, damp, and dirty scrambles through underground passages, whose narrowness and darkness were both alike incapable of the slightest alleviation, either by persevering stooping, or liberal illumination, will have a sense of surprise and pleasure when they first set foot within the wide, lofty, and well-ventilated roads which ramify for miles through the bowels of Box hill.

Before conducting our readers into the working, however, we will drat examine a little into their general lie and disposition by the aid of the accompanying map, a few minutes' attention to which will probably save us, by and bye, from that feeling of utter bewilderment too often the visitor's only companion in the subterranean regions given over to the miner's craft. All the workings which have yet been opened are situate on the northern side of the tunnel. They are divided into two districts, called the Corsham Down and Box-hill quarries, the former occupying the eastern, and the latter the western, side of the hill. Entrance to both of these is obtained at the Corsham end, where the main road (A) joins the Great Western Railway on a level; a communication between the two sides being by means of the road (B), along which all the Box stone is hauled to the railway trucks. Both these roads run parallel with the tunnel, the former debouching, as we have seen, upon the main line, and puzzling visitors strange to the locality with the apparently anomalous phenomenon of a double entrance to Mr. Brunel's great work. The dimensions of this approach almost rival those of its neighbour, permitting the ingress of two rows of wagons for some distance, but presently narrowing to one line of broad gauge rails, which are continued as far as the first of the Corsham workings, where they terminate opposite the discharging platform, to be more fully described hereafter. Greatly as these ample roads contrast with the straitened passages of ordinary mines, their size is not only convenient, but profitable. Unlike coal or other similar minerals, there is no object here in keeping the within the narrowest possible limits. All the material taken out is commercially valuable, and hence the wealth of space throughout the whole quarries so pleasantly surprising

to those whose underground experiences have previously been confined to some less favoured locality. From the main roads the workings spread northwards and westwards, as shown upon the plan, into complex reticulations of great and yearly-increasing extent, all of which communicate by means of gently-falling tramways with the discharging-platform. The utilization of gravity as a means of locomotion is carried out with much completeness throughout the works. In drawing from the Box side horses are employed to haul the stone only through a portion of the distance ; more than half of it being accomplished by gradients. The natural disposition of the strata has greatly assisted in laying out the quarry thus ; and nature is supplemented by art in the arrangements for economising horse-traction, wherever such economy is at all practicable.



We shall make no attempt to follow the windings of all the workings shown upon our map, since the methods employed for getting stone are everywhere similar, and we shall learn more by confining our attention to one spot than by rambling with desultory aimlessness through the whole of the quarry. Changing our point of view, then, from one of general observation only, let us enter the right-hand one of the two tunnel mouths which meet us on our walk down the main line from Corsham. Pausing inside for a few minutes to go through the preliminary ceremony of lighting candles and tallowing our fingers—melancholy rites only too painfully characteristic of all subterranean explorations—we presently get our eyesight, and are able, without risk of stumbling, to step out on our journey.

A hundred paces along the main road suffice to dispel any apprehensions of discomfort that we may have anticipated from ordinary mining misery. The path is dry enough, wide enough ; and,

above all, there is air enough, and to spare. Instead of the sluggish current of hot and carbonised air with which one for breath among the stalls or headings of a coal-pit, there is here a cool breeze flying past us at a great rate on its way to the distant workings towards which we are progressing. Those of our readers who are not acquainted with the methods commonly in use for the ventilation of underground works will probably be glad of such an explanation of the first principles on which these depend as will enable them to understand the reasons for the efficiency of the process in action here.

The well-known difference in the gravities of warm and cold air is made use of in all mines for the production of a current through their workings. Thus, if two pits be sunk at some distance apart, and then connected at the bottom by a passage, any rise in the temperature of one shaft will be followed by an upward movement of the air contained within it, and a corresponding downward flow in the other, through which the colder atmosphere rushes to supply the partial vacuum that would otherwise be formed by the ascent of the rarefied column in the upcast. Now, if we suppose all the workings of a mine to be situate somewhere between an upcast and a downcast shaft, this simple principle can be made sufficient to keep the workmen well supplied with oxygen. In all collieries the natural warmth within the pits generates a current of more or less intensity, though this is seldom strong enough to fulfil the requirements of good ventilation without artificial assistance. Hence it is usual to beat the upcast by means of fires, which, increasing the volume and decreasing the weight of the atmospheric column within it, assists in producing a sufficient draught. At Box, however, no artificial stimulus is needed to keep up the circulation. The down. cast shaft being here by a wide and lofty road entering the hill upon level, admits air so readily, that few "upcasts," here and there communicating with the surface, suffice to establish an abundant current. Nowhere throughout the whole quarries is there anything approaching to a scant supply of oxygen; and the visitor is never conscious of breathing under conditions at all different from those of ordinary life, though he is often likely to be made aware of the rapidity with which the wind traverses these subterranean passages by the coolness of his person, and the difficulty he will sometimes find (in the larger roads especially) to keep his candle from being blown out by the draught.

A walk of about a furlong brings us opposite the point where the stone taken out is loaded into railway trucks, a process effected with great simplicity and economy. The single line of broad gauge rails which we have hitherto followed stops here, but it met and accompanied through the last few hundred yards of its length by a narrow tramroad about 2½ feet gauge, running parallel with the main line, but laid at such a level as to bring the little trollies forming its "rolling stock" to the game height as the larger wagons, into which the blocks are readily shifted by means of two powerful cranes, without any lifting whatever. By this a large amount of work is got through in the course of a day, one crane alone being capable of loading up some 6,000 feet of stone, or nearly 400 tons in ten hours. This discharging-platform, we have previously named it, is in direct communication with the whole of the workings every one of which has its own branch of narrow-gauge rails; and along some of these feeder lines the small trucks are constantly with their burdens. Immediately opposite where we now stand is an entrance to the first of the Corsham side workings, lying little off the main road, and approached by a narrower passage cut almost at right angles to it. Turning into this, we shortly find ourselves in a large open space, lighted with tolerable brilliance by many candles, and occupied by a group of workmen all busily engaged in various quarrying operations—some sawing, others hoisting; some prizing great blocks on rollers towards the trollies in waiting, and others manning the handles of crane occupying the centre of this little amphitheatre. We will make this working our pattern card; in describing it we describe all its fellows, and there is no reason to prolong our walk for the of seeking information which can be had here for the asking. One uniform system of getting stone prevails, suggested and occasionally slightly modified by the natural peculiarities of the rock itself, which it will be necessary to understand before we

can gain any notion of the object to be attained by the different processes we see going on around us.

Like almost all other stratified deposits, Bath oolite lies in “beds,” as they are named both by geologists and quarrymen. In other words, the total depth of the stratum is made up of many successive layers of stone, varying very much in their respective thickness and separated from each other by natural joints or “partings.” In oolite these partings are extremely thin; they appear as if marking certain periods in the formation of the rock, daring which the process of deposition was arrested, and the stone allowed to harden fresh accumulations of sediment were thrown down upon it. Out of the whole man of freestone forming the core of Box hill, only those beds are quarried which are known to produce good stone. The number, lie, and position of these were ascertained with considerable accuracy during the progress of the tunnel, whose shafts, penetrating through the whole formation, afforded the best possible opportunity for an examination of constituent members. The average depth of the workable beds varies from 8 feet to 30 feet, and respective thickness range from 6 feet to 1 foot. The uppermost of them is only about 10 inches through, and is called the “picking bed,” for a reason will become clearer as we proceed. The actual getting of all minerals differs greatly with the character of the materials to be dealt with, depending of course upon their respective hardness, softness, toughness, or friability. Granite, for example, is torn by main force of gunpowder from the parent rock; while coal is won by the pricker and the pick. Portland stone—a harder form of oolite—is blasted out, like granite, in masses, which are afterwards reduced to form by the chisel and bar ; but the freestone, from its soft nature and the regular occurrence of the joints, to which we have alluded, permits a very different mode of treatment. Those of our readers who are acquainted with the methods ordinarily employed by colliers will understand our description the better for being told these processes represent an almost exact inversion of those in use at Box and Corsham. In the former every successive measure is thrown down from above by continued at the floor lever of the mine, which, removing the support from one mass of mineral after another, suffers each to separate itself by its own gravity from the over lying strata at one of the partings, which characterises the carboniferous equally with oolitic formation. In the latter, “undercutting” is replaced by what, we might aptly designate “overcutting;" and operations precisely similar in principle, though different in detail to those employed in the winning of coal, are commenced at the roof instead of at the floor of the mine. The accompanying sketches will help to render our more intelligible.

Here Figs. 1 and 2 the section and elevation of working recently opened; its various beds of stone being shown at A, B, C, D, E, F. In the uppermost of these previously denominated the picking bed, an excavation is made, as indicated by the shaded portion of the sketch throughout the whole width of the working, a distance averaging from 18 feet to 30 feet : a dimension wholly dependent on the nature of the overlying stratum or “ceiling,” the strength of which regulates the size of opening that may be worked without fear of settlement. In these quarries the roof is generally very strong, and the system of commencing to excavate in the topmost member of the beds affords an absolute security from falls—that most common and fatal of the miner's many dangers. The removal of only 9 10 inches of material beneath the ceiling deprives the overlying strata of support as effectually as cutting away all the stone from roof to floor would do; hence, should there be any tendency to settle, it is always shown at a period human life not exposed to its influence, and when an actual drop could do no possible injury to the workman.

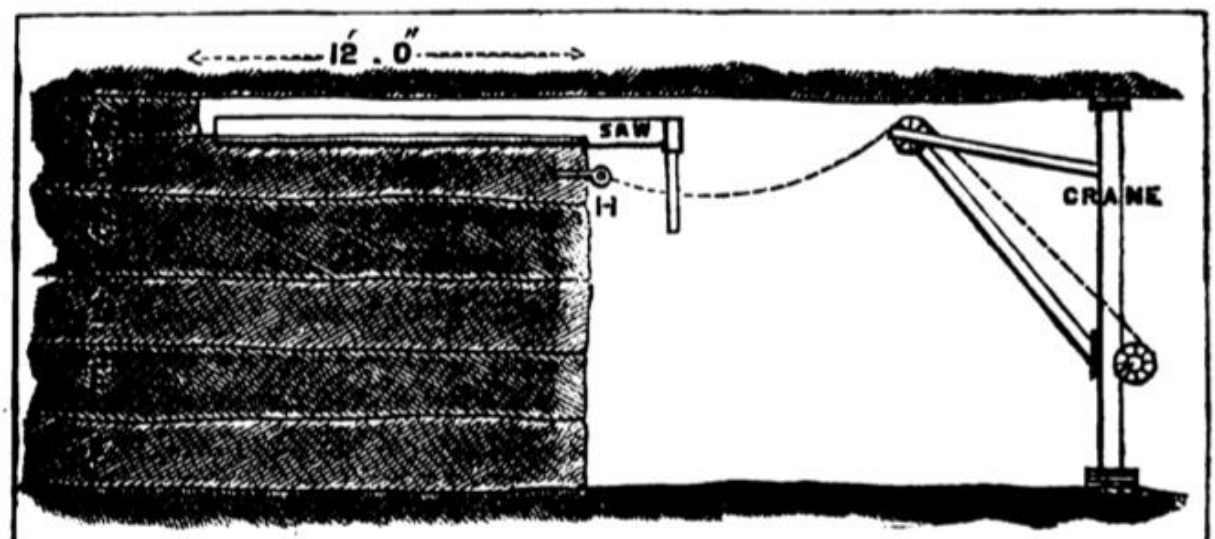


FIG. 1. SECTION OF WORKING.

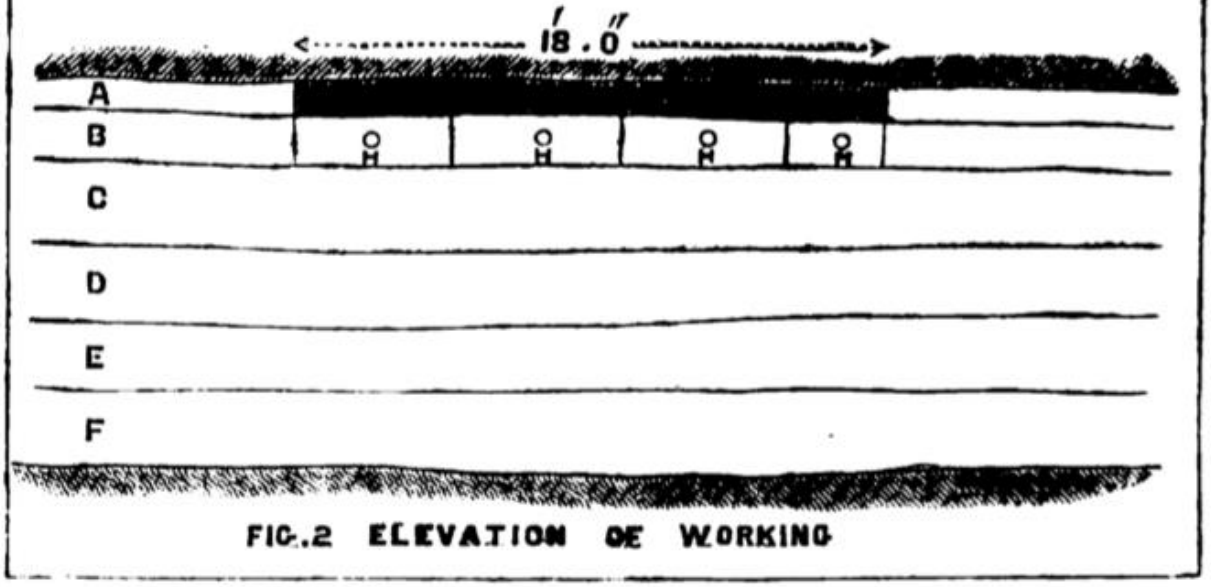
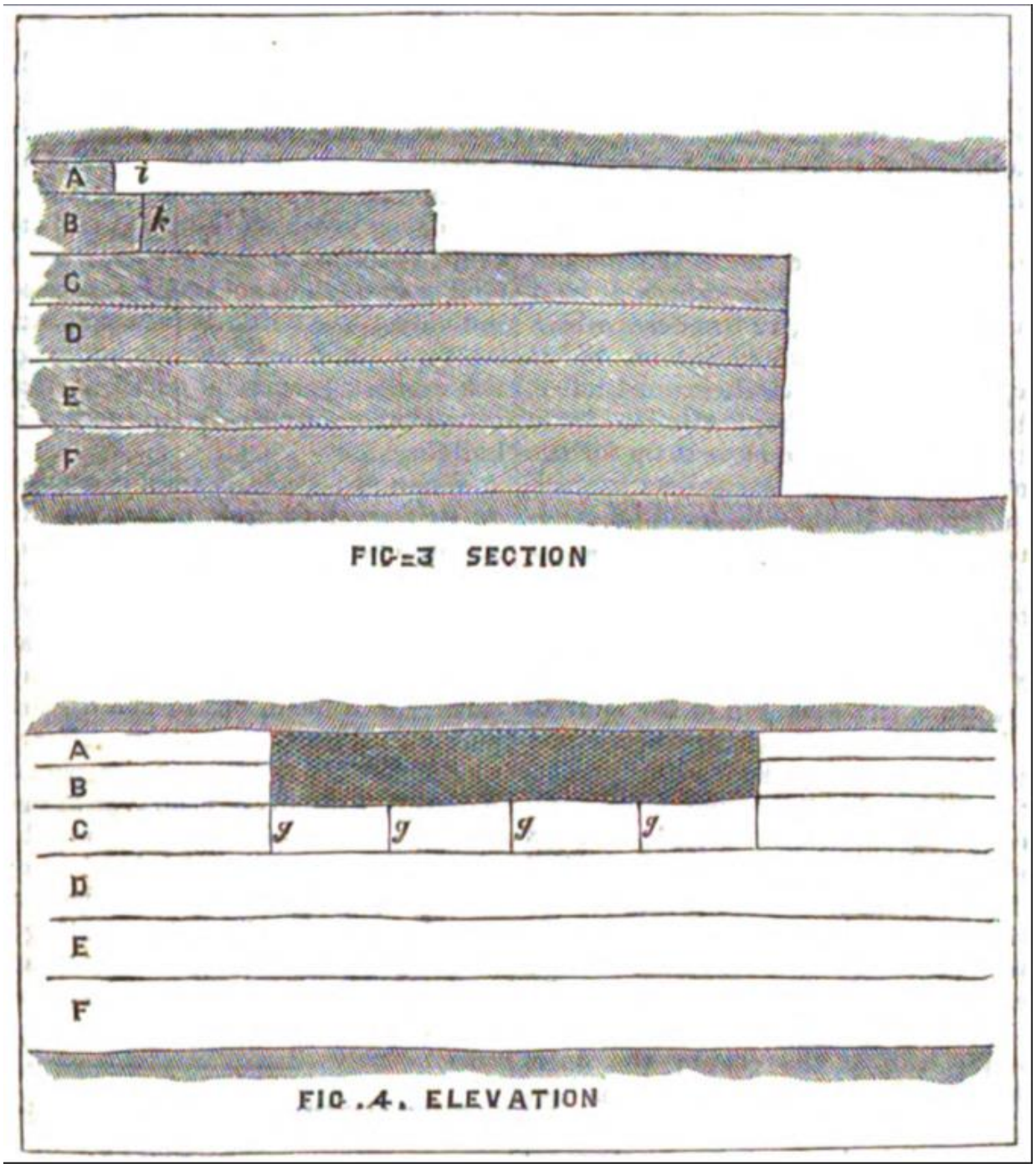


FIG. 2 ELEVATION OF WORKING

The picking is effected by means of tools shaped something like an adze, the heads of which can be shifter on to longer handles as the work gets out of reach ; and thus the men carry the narrow hole shown upon the section a distance of about 12 feet into the roof. This completes the first process; and an entirely new agency now comes into action for the removal of the blocks.

Everyone at all acquainted with Bath stone that it be readily cut up by means of an ordinary saw. This is the case, even after its whole substance has become hardened by exposure to the air ; but it is specially so in the quarry, where the stone is rendered softer by the large amount moisture diffused throughout the beds. The front elevation, Fig. 2, shows a number of thickish black lines extending downwards from the pick-hole to the next recurring "parting." These represent saw cuts; and they are made by a tool differing little in shape and appearance from an ordinary "cross cut," but having a handle at one end only. The position of this saw during work is shown upon the section; and no further explanation is needed to make its operation clear to

the most unmechanical reader. After the bed has been divided down to the natural joint, and the blocks thus separated from the parent rock on all side but one, levers are introduced into the parting, and the whole detached by forcibly breaking off at the back, when the stone is ready for immediate removal to the discharging platform. We have already mentioned that a branch of line runs through each of the workings, connecting them with the railway wagons; and it is now time to speak of the manner in which stone is loaded on the trollies after being quarried. Immediately after opening out a face of work, a five or ten ton crane is erected in such a position to sweep it all over. One of these is shown in Fig. 1, fixed in bearings let into both roof and floor. These cranes are ingeniously contrived to suit variations in headway, such as are



caused by differences in the depths of the valuable beds. The post is telescopic, being capable either of sliding out to the loftiest, or contracting to the lowest space afforded. A large expense in continual alterations is thus avoided, and the periodical shifts from worked, out to new localities is made without trouble or loss of time. After the blocks have been loosened a Lewis

bolt is let into the face of each at H, and the chain of the crane made fast to it: one piece after another is thus dragged out, assisted by the crowbars of the men, and falls to the floor, whence it is soon conveyed by the trollies to the discharging-platform. The next and all the remaining beds are taken out by a modification of the which we have just described. By the removal of the layer immediately below the picking bed sufficient space is obtained to allow the workmen an entrance under the roof; and Figs. 3 and 4 show the manner in which they make use of this advantage. Vertical cuts (g, g, g) are again carried down to the next succeeding parting ; but, as there is now room at i to work the saw transversely as well, another cut (k) is made, which, separating the blocks from their hinder attachment, renders any further breaking off behind unnecessary. Meanwhile the cutting is continued in the picking-bed, and stone got out in layer a, just in the same way as before; everything below this point, however, is quarried with all sides sawn excepting those abutting on the natural joints. Hence there is very little or waste; each piece comes out square, finished, and ready to pass at once into the hands of the dealer or builder. Continued repetitions of these several operations produce a terraced profile in the workings ; and this is the form in which they are usually found by the visitor. At such times their aspect is quite picturesque. On all sides there are lights, which, unlike those of the dim colliery lamp, whose rays are all absorbed by the black mineral they vainly strive to reveal, are reflected from the white surfaces of stone, and give a really respectable amount of illumination.

Each of the platforms is occupied by groups of men, all healthy, cleanly, and cheerful-looking fellows, busily occupied either with pick, crow-bar, or and shouting occasional directions one to another in a tongue whose determined provincialism none but a born Wiltshire man could hope to interpret. Piecework prevails throughout the quarries ; every crane being let to a ganger, who contracts with the proprietors to supply stone at a given price per foot delivered into the trucks. Each ganger pays his own men, generally by the piece also; and when tolerably in the lie and nature of the stone, all the workmen make good wages, earning enough to enable those who are careful to put by something for a rainy day, after paying for the support of themselves and their families. Accidents to life and limb are almost unknown throughout the works: a few casualties have occurred since they were first opened ; but these are unimportant in comparison with the large quantity of material which is got out yearly in safety. The two special perils of minors are entirely absent. Gas, of course, there is none ; and falls of roof are prevented, as we have seen, by the methods employed in working. When we remember that in the subterranean world of Staffordshire, Lancashire, or Wales, some three-fourths of the disasters of which we hear so much every now and then are directly due to one of two agencies, we shall cease to be surprised at the wide differences exhibited in thig respect by two classes of works apparently so similar in everything except the character of the mineral with which they deal.

Several of the ventilating shafts serving to produce a circulation of air through the workings rise to the surface of the ground by a tolerably gentle ascent, and are furnished with from top to bottom. These are made use of by the workmen for to the quarries, and they form a designedly valuable arrangement for their health and comfort, bringing the men by short cuts to and from their work in the morning and evening.

The average daily produce of stone from these quarries is about 150 tons, being nearly double the quantity got out from all the other Bath-stone quarries taken together. The length of underground tramways leading to the several workings, exclusive of those which have been worked out and abandoned, is over five miles ; and the direct line running east and west through the length of the quarry is very nearly two miles. The number of cranes in constant use at the several workings is about fifty, each one of which keeps two or three of the narrow-gauge trollies fully employed ; while the rolling stock comprises forty-six broad-gauge wagons actually belonging to the quarries. and exclusive of the Great Western Railway trucks, in which a large part of the traffic is carried on. The busy time extends from May to Christmas, though

stone is got out for stock throughout the whole of the year ; and the quarrymen are thus seldom thrown out of employ at a time when they most require work and wages.

Having by this time gained all the information which is likely to interest us, it will be well, while our candles are burning closer and closer to our fingers, to return once more along the ample subterranean roads to open air and daylight : feeling glad, at the same time, to know of one branch of industry at least whose operations, necessarily conducted under ground, are free from imminent risk to the workman's health and life, and yet not therefore unprofitable to its conductors.

The Builder October 1, 1864.

BATH FREESTONE

By Mr. Randall. Read at the Bath Meeting of the British Association for Science.

The paper which have the honour to lay before you has reference to two subjects, both of equal local one in an economical and commercial point of view, and the other bearing upon the scientific conditions, both as regards the mode of working and geological position of those beds in the great or Bath oolites which may be called the "quarry-stone," and which are so extensively worked in the Bath district. I purpose, therefore, to divide my paper into two sections, or arrange the materials into a short and yet, I hope, sufficiently detailed manner, under two heads: first, to determine the true horizon or geological position of the workable beds of this valuable freestone in the series termed the great oolite ; secondly, to enter upon the mode of working and getting " this extensively used and valuable building stone.

Geological Position.—Nowhere, I believe, in Great Britain (indeed, in Europe) are the lower members of the Jurassic group of rocks so extensively developed as in the Bath district, where each group seems to have attained its fullest recognised development : nowhere can the whole Jurassic series be so readily studied ; nowhere so easily understood ; and this applies to the lias itself in its three divisions. The Fullers' earth (here extensively employed), and the member of the Lower Oolitic under consideration, viz., the Bath, or Great Oolite, is distinguished here for its economical value, and at Minchinhampton and other places for its fine and typical organic remains. Above this series, but intimately associated with it, the forest marble and cornbrash are highly and typically developed; succeeded by the Oxfordian and Kimmeridge groups; not omitting even the Portlandian, at Swindon, and the Purbecks of the Vale of Wardour. To each of these may be appended important notes bearing upon their high importance, economically considered, and which are extensively developed in the district ; but I purpose drawing the attention of the members of this section to the Bath oolite only, determining the position of that zone from which the freestone is extracted, and on which the wealth and comfort of the population of this neighbourhood, engaged in quarrying operations, so much depend. I have also endeavoured to fix, by detailed and measured sections, the workable beds of the district ; I and to correlate them over a considerable area, useful, it is hoped, both to the man of business and the geologist. These sections, which I may here refer to, are all coloured the same in their respective zones; show the importance of carefully determining the place or position of the workable beds, prior to any outlay of capital ; and however difficult, indeed impossible, it may be to diagnose the quality of the freestone beds in depth, there can be no doubt as to their position and probable condition ; and, when it is known that uniformity of condition over any large area is of extreme uncertainty, and knowing as we do that the thinning out of the unmarketable beds of freestone in this district, like the great oolite en masse on the line of deposition and dip, is a fact now well understood, it becomes a matter of high importance to the capitalist to be assured and confirmed as to the chances of success in opening one or developing a new district. The natural grouping of the beds constituting the great oolite series in this district fall under three well-marked divisions, all well exhibited in the sections exposed at Murhill, Westwood, and Farleydown, Combe and Hampton Downs, Box and Corsham workings, &c., Indeed, generally, where conditions have exposed them, and reading downwards from the surface, we meet with, over the Bath area, immediately below the forest marble (where present), the following groupings :—

1. The Upper Ragstones; 2. The Fine Freestones or Building Bed; 3. The Lower Ragstones. These constitute a series from 60 to 120 ft. in thickness, depending upon local circumstances and conditions during deposition, and, perhaps, subsequent denudation.

The Upper Ragstones.—This series consists of (in the upper part) coarse, shelly, and irregularly bedded limestones, with usually few underlying beds of white, fine-grained limestones, possessing a distinctly and well-defined oolitic structure and finely comminuted shells. These are again succeeded by tough argillaceous beds of limestone, usually pale brown in colour, and smooth in texture, the whole ranging in thickness from 23 ft. to about 50 ft. No beds of workable value occur in this upper series.

The Fine Freestone, or Building Beds, in the Bath Stone Series.—Succeeding the upper ragstone are the Bath freestone, or fine-grained building beds, which vary in the number and thickness of the various beds comprising the series, and also economically distinguished from each other by their structural condition, the size and structure of the oolitic grains, the presence or absence of silicious particles or finely-divided shelly matters; each of which may materially affect the limestone during the process of working, or influence them after being placed in position, and subject to weathering under atmospheric changes. In some localities the beds assume an earthy structure, indistinct in texture, smooth, and close-grained, and hold more moisture.

The Lower Ragstone.—Below the fine building beds, or freestone series, are the lower ragstones, which appear to be persistent everywhere over the entire area, and resting upon the Fuller's earth. They consist of numerous und generally well-defined beds of a coarse shelly texture, and hard crystalline limestone, exhibiting much false bedding, especially near the base. Many species of mollusca occur in the bottom beds, such as Ostrea accuminata, Terebratula, Ornithocepthla, Rhynchonella, Trikitis, Concinna, and Tancredia. These lower ragstones, as before mentioned, rest immediately upon the Fuller's earth; but this member of the oolitic series concerns us only by position, and is in this district west of Corsham and Bradford, a most persistent and important zone, between the inferior oolite beds below and the lower ragstones of the great oolite above, and, in some places, very fossiliferous, and varies in thickness from 150 ft. to 200 ft. Taking, therefore, as our guide in this district, the above three divisions of the great oolite, we are enabled to construct vertical sections to aid in our determinations as to the position and condition of the few feet, of stone profitable to work in the series, or the “freestone beds” – at all times an anxious and important question when seeking for and developing ground. In this paper I deal chiefly with facts, and therefore give detailed and measured sections of type localities, from which may be determined by comparison the probable conditions under which the beds may occur at intermediate and unexplored stations or localities on the tablelands behind such outstanding mineral precipices as Farley, Murhill, Box, on the eastern side of the Bradford and Slaughterford valleys; or on the elevated downs at Claverton, Combe, Hampton, Freshford, &c., to the south of Bath, and west of the Bradford Valley, and on the receding flats to the east of Monklow, Farleigh, and Bradford, &c., conspicuous for the numerous quarries opened in the cornbrash and forest marble, the latter of which occurs in detached patches or continuous lines, stretching from Malmesbnry on the north, to Chippenham, Bradford, and other localities, to the east of Bath, and especially conspicuous near Corsham, Chapel Korap, South Wraxall, and on to Melksham. The most complete section, and which may be regarded as a typical one of the great oolite and forest marble beds of the Bath district, is that of the Box-hill and Corsham Quarry workings; No. 1 showing those beds not usually seen or exposed, but which were cut through by the construction of the Box Tunnel, and which we are now extensively working in that neighbourhood. Another exposition of the series is shown at Murhill, on the eastern side of the Bradford Valley, where the three divisions into which the series group themselves may be studied in situ. Also at Upper Westwood, on the opposite or west side of the valley, other sections occur tending to show the same facts ; and the variable condition and thinning out of the same beds upon the line of Diss, even at this short distance. Believing, therefore, that I shall convey more information by giving detailed sections, showing the divisions of the three series, with special references to the building freestones, I have endeavoured to lay before this assembly somewhat detailed measured sections of the more

important localities where the beds of the three series are exposed, and at such distances as will show the attenuation of the fine building stones to the south east, and will tend to show how much the irregularly bedded and coarse shelly limestones in the upper and lower ragstones vary in different localities, thereby leading us to thoroughly acquaint ourselves with those necessary details which it is most desirable should be understood before large operations are commenced or capital sunk.

The Sections. —The shafts which are constructed along the line of the Box Tunnel, on the Great Western Railway, afford at the several points where they are carried through the beds of the great oolite, accurate data for the construction of sections and clear evidence of the succession of the strata, comprising the three divisions, I have endeavoured to maintain, as occurring through this district, and being situate considerably to the eastward of the Bath Valley escarpments, a large area, or the productiveness of that arca is estimated by the lie position and condition of the building freestones, supposed to occupy the summit of the table-land, stretching from the eastern escarpment of the Bradford, Box, and Slaughterford valleys to Yatten Kennell, Biddestone, and Corsham. The section No. 1 gives accurate measurement and sufficient details to enable a practical observer to determine the series of beds at almost any point over the area above indicated, or even between the westerly extension of the Oxford Clay Linc, from Malmsbury to Corsham and Melksham, and the valley escarpments before mentioned. It is not necessary to notice the forest marble, or corn brash, which is foreign to my paper, and which, although usually present, may or may not occur on any special arca above the great oolite proper, local conditions, during depositions or subsequent denudations, having removed one or the other, or both; but everywhere, so far as I know, over the whole table-land do we find the coarse shelly limestones, and some finely grained oolite beds belonging to the upper ragstones or highest members of the great oolite. In the typical section No. 1, taken at No. 7 shaft, Box Tunnel, also at the shafts 4, 5, 6, these beds occur, and were cut through when sinking, and were found to be from 20 ft. to 35 ft. in thickness, before proving the " capping " to the building or " fine beds" below. At Murhill, near Winsley, these upper ragstone-beds are about 20 ft. in thickness, and are hard, coarse, and fine shelly limestones, highly comminuted in structure, and occasionally oolitic. In some of the localities, many of the beds are of considerable thickness, and of regular and even texture; still they are too hard for those purpose for which the softer fine-grained, whiter, and more easily worked architectural stones below (in the second series) are sought for, and to which they are applied; and, again, they are not good weather stones, but rapidly fall to decay on exposure to severe changes of weather. At Upper Westwood, on the south side of the Bradford Valley, opposite Winsley and Murhill, the beds comprising this upper series are thicker and of more even texture, but, as weather stones, are of little or no value. At Farley Down (Section 3), overhanging Bathford, this upper series is nearly 30 ft. in thickness, composed of coarse shelly limestones at the top, with hard and soft ragstones down to the capping of the fine " building beds " below. At Combe Down and Odd Down the beds closely resemble those of Farley and Box, and approximate in thickness. Thus we may examine detailed sections of this upper series at Murhill, Farley, Westwood, Combe, and Odd Down, and the Box district generally; the beds at neither locality arc deemed of sufficient value to work for transit as a building stone. This series is coloured grey in the sections Nos. I, 3, 4., 5, G.

The Second or Middle Series.—Succeeding the ragstones above mentioned, and commencing the second series, there appears to be everywhere a peculiar bed extending over a large area, termed the "cover," or capping, varying in thickness, but generally hard in texture : this forms the roof, or ceiling, to the fine economical building freestones below, and over which it lies, and is a marked feature in extensive underground workings, both for its horizontal extent, application, and importance as protection to the workmen, and as commencing the second series, or middle beds, which occur between the "upper and lower ragstones." At Bradford, Westwood, and Murhill, this bed is a coarse, shelly, hard limestone; at Corsham and Box a

closer grained and tough rock. I associate it with the building freestone, or fine beds below it, rather than with the ragstone above, from its persistency and the constancy of its conditions. Succeeding this is the true Bath stone, or fine freestones, and which 1 believe occupy, with minor differences, the same position or horizon over the whole of the Bath district. This second, middle, or freestone series, are as a group from 20 ft. to 30 ft. in thickness, and are coloured chrome-yellow in all sections, and those beds worked for transit are usually evenly grained in texture, regularly bedded, yield well to the saw, are non-fossiliferous, and give evident proof of having been accumulated or deposited in a somewhat deep and tranquil sea, or away from any litoral [*coast]* or wave disturbance, and which the almost total absence of organic remains still further tends to confirm or demonstrate. It appears from observation, and the correlation of measured sections, and conditions observable underground, that these fine-grained regular beds thin away in a south-easterly direction, or upon the line of their general dip, a fact clearly determinable on examining the sections exposed in the valleys. Indeed, it cannot be doubted but, that the great or Bath oolite as a group, in this neighbourhood, exists under extremely irregular conditions, and dies out and disappears in the form of a lenticular or wedge-shaped mass, to the east and south-east. This circumstance, causing the building freestones to thus vary in their relative thickness as we proceed from the western part of the area to the east and south-east, and the removing of much of the exposed belt comprising the oolitic series between Bath and Bradford, on the line of their strike, north-east and south-west, caused, it would appear, by the extreme denudation of the Bath and Bradford valleys, and the westerly extension of the cretaceous scries from Melksham to Westbury, Frome, and Warminster, are due, perhaps, to physical conditions connected with the eastward extension of the Mendip axis, and the little understood, deeply-seated, but undoubted position of the palæozoic series, between Frome on the south, and Bath and Wickwar on the north, or along the eastern edge of the Bristol coalfield; but under any circumstances the extension or invasion of the cretaceous series to the east, the narrowing of the exposed oolitic series above mentioned, and the mechanical arrangement of the rock structures themselves, evince and determine local deposition to have gone on under continued oscillation of the land at the time of the deposition of the great oolite series. It is to this second grouping, therefore, or the middle series, which exist between the upper and lower ragstones, that we must assign the workable beds of freestone now extensively quarried in the Bath district.

The Lower Ragstones – These are an extensive series of rather fine and hard, as well as coarse and shelly, limestones. The lowest beds of this series are usually finer in texture than the upper, and when exposed, are generally from 30 to 40 ft. in thickness. Nowhere in this neighbourhood are finer sections to be seen than at Murhill, on the north side of the Bradford Valley, and Upper Westwood, on the south side. The beds comprising this division usually occur, or are exposed in the escarpments of the denuded valleys, or the projecting downs above. Masses of the thicker and fine-grain beds, frequently occur on the inclined slopes of the valleys, owing to, or arising from, frequent slips or slides over the fullers' earth upon which these lower ragstones immediately rest, It is, therefore, in the narrowing of the valleys and abrupt cliffs that, this serios of the great oolite are best exposed. The chief economical value of those beds is confined to local purposes, being utterly unfit for architectural work, or exposure to atmospheric influences. The stone used in the construction of the aqueduct conveying the canal over the river Avon, at Avon Cliff, came from the beds of this series at the Westwood Quarry, and although in situ the stone appears of a fine texture and quality, yet it rapidly decomposes on exposure, and the stonework of the Avon Cliff aqueduct is a perishing evidence of its nondurability. At the Box and Corsham quarries those lower beds, though not observable at the surface, are, nevertheless, 43 ft. in thickness, and are chiefly composed of fine textured oolitic limestones ; but arc not worked, as they are of no value in a commercial point of view.

On the Mode of Working the Bath Freestones – Having endeavoured to determine the horizon of the workable beds of oolitic, and the relations they hold to the ragstones, or shelly series,

recognised above and below these freestones, with the permission of this section of the British Association, I will endeavour to describe shortly the mode of opening, working, and extracting the rock; a matter you will see to be of no little importance when I inform you that more than 100,000 tons of the Bath freestone are annually removed from their original position in this neighbourhood, and forwarded to various parts of the United Kingdom. In working for stone, the first question to determine is, whether the stone shall be reached by open or underground workings; and this must depend upon the presence and conditions of the upper ragstones (and forest marbles, where they exist), as they must of necessity be passed through, unless the stone can be reached by tunnelling on the face of an escarpment where the beds are vertically exposed, or by driving a level to cut the beds; but, if the desired beds are not too much covered, open workings are resorted to. Few persons travelling from London to the West of England, via the Great Western Railway, through the Box tunnel, have any conception, on passing through it, that around and over them are large and extensively worked mines, from which the well known Corsham and Box freestones are taken; or, as they shoot from the tunnel-mouth into the Bath-hampton, Bath-Easton, and Bradford valleys, that it is the seat of so much quarry industry, having for its object the working of the Bath freestone. In describing the particular mode of getting the stone, I will, with your permission, take for my type the Corsham Down and Box Hill workings. I do so, because these mines have had more thought and attention bestowed on them than any others in this neighbourhood, and because they are the most extensively developed. It is believed that the Box and Corsham locality has been worked for stone, with more or less activity, for three centuries, but it was not demonstrated that so large an amount of good workable freestone existed in the district until the fact was evidenced by the cutting of the Box tunnel, at once exposed the beds, and showed that to the north and north-west of the tunnel on the strike of the beds there existed what we may practically call an inexhaustible supply of valuable freestone. The cutting of the Box tunnel having opened to view this fact, gave an impulse to the previously limited mining operations of the district. The plans and maps

I have the pleasure of placing before yon will illustrate the position of the workings. You will see the chief operations are situate on the north side of the tunnel : the reason of this is that the rock is found sounder in this direction, and the stone more even in colour, and more regular in quality and texture, than to the south or dip of the stone. The entrance to these workings is driven from the Corsham or eastern cut, immediately contiguous to the mouth of the Box tunnel; and it is here that the railways of the underground workings join the Great Western railway on the same level. The chief or main road through the workings is carried from this point due west, in a direct line towards the Box hill escarpment, a distance of 1 mile and 6-8ths, rising with the strata, for tbc purpose of keeping on the floor of the workable beds; thus making an incline to the west of about 1 in 40; and as the rise to the north is about 1 in 60, advantage has been taken of this, and the works so laid out, that much of the stone can he run on trollies without draught power, that is to say, by gravitation, to the loading platform, where it is transferred from the quarry trollies into the railway trucks, which are taken into the mine to receive it : to economise and facilitate the operation of loading, this platform stands on a level a few inches higher than the sides of the railway truck, into which the stone has to be loaded, and by the upper level narrow gauge tramways this platform is placed in direct connexion with the whole of the headings or workings ; and by its lower level broad gauge railway it is connected with the Great Western Railway. By this loading arrangement, we are enabled to load off into railway trucks from thirty to forty tons in the hour. One uniform system of getting or working the stone prevails throughout the quarries, and this system is an inversion of the mode of working coal. The coal miner undercuts bis coal, that the mass may fall and break; but, building-stone so worked would make a valueless rubbish-heap. The freestone miner or quarryman has to commence his operations at the roof of the stone. This picking operation is effected by means of adze. shaped on the heads of which longer handles are inserted, as the work proceeds, and the men thus make their driving a distance of six or seven feet back into the rock. The width or span of these stalls must, of course depend on the soundness of the rock. In

the Corsham workings they can, without danger, be driven a width of from 25 ft. to 35 ft. In the Box quarries, where the rock is not so sound, and the capping bed, before referred to, not so regular, the drivings are limited to from 12 ft. to 20 ft. This is, of course, regulated by the space that may be safely opened without danger to the working beneath. It must be evident, to yon, that the removal of eight or nine inches of the rock immediately under the ceiling deprives the overlaying strata of the support, of this area of stone as effectually as its removal throughout, from roof to floor, would do, and any tendency to settle or drop is at once determined, and any risk of life thus guarded against. Another process, by a fresh agency, is now called into exercise, for the cutting of the rock into blocks of required dimensions; for this, one-handled saw is used. These saws are worked in lengths of four, five, six, and seven feet, and are made broad, rather, I should say, deep, at the head or extreme point, so as to ensure the saw sinking to its work at that point. The saw is worked in first horizontally dropping a little as the cut goes on, and after the rock is thus opened down to the next natural parting, and the block thus separated laterally from the parent rock, levers are introduced into the bed or parting at the bottom of the block, and these levers are weighted and shaken till the block is forcibly detached at the back. It is then drawn down by crane power, and the broken end and the bed dressed with the axe, so as to make the block shapely; it is then placed on a trolley, and allowed to run to the loading platform. After the first block is removed, it will be evident to yon that the workmen have then access by that opening to the back of the bank of stone, and they avail themselves of this to work the saw transversely, which, separating the block from its back or hinder attachment, renders all further breaking off unnecessary, so the first block of each face is the only stone broken from the rock. To each face or heading of work: a crane is erected in such position as to command the whole face. These cranes are now constructed telescopically, so as to accommodate them to slight variations in the headings, arising from differences in the depths of the valuable beds, and the expense otherwise attendant on frequent alterations of the crane is thus avoided, and the periodical shifts from old worked out to new localities are effected with less trouble and loss of time. Sometimes after a block of freestone has been loosened in situ, a Lewis bolt is let into the face of the block, the chain of the crane attached to it, and the block is then drawn out horizontally. By the removal of the first stratum a sufficient space is obtained to allow the workmen an entrance under the roof; and vertical cuts are again carried down through the next bed to the parting below, and transverse cuts readily made. Meanwhile, the cutting is continued in the picking bed, the upper layer removed as before, everything below this point quarried away, with all the sides of the block sawn, except the bed on which it has rested, and those abutting on the natural joints hence each block comes out ready to pass into the hands of the builder, sculptor, or dealer, and this with much less cost, and less loss in waste, than formerly attended blasting, and other powerful but rough modes of extraction. The continued repetition of these several operations produces a terrace or step-like profile in the workings, extending from the highest to the lowest of the beds worked on, and thus they present themselves to the view.

Professor Ansted said the Bath stone, when it was carried for building purposes to a distance, was exposed to rapid destruction by the action of the atmosphere. He attributed this to the manner in which the stone was quarried. It had been observed that this did not occur with the stone that was used in the immediate neighbourhood of Bath. This, no doubt, was attributable to the fact that the stone was not taken away from its own atmosphere. He would suggest, therefore, to the quarry owners, that all the stone to be sent to a distance should be exposed to its own atmosphere for some considerable time, until it had become seasoned, as it were. He believed that if this were done, the stone would be as durable everywhere as it was in the immediate neighbourhood of Bath.

THE STONE-PRODUCING AREAS

The large district drawn upon in exploiting Bath stone may be judged from the accompanying sketch-map (fig. 1), for the particulars on which we are entirely responsible, except in so far as the geological boundary-lines and railways are concerned. These latter are inserted from the official geological map of the district. The position of each quarry(in the sense presently to be defined is marked thereon, from our own observations. It will be noticed that the workings are situated near Corsham, and between that village and Box, at Hartham Park, Monk's Park, Kingsdown, Monkton Farleigh, Bradford-on-Avon, Westwood, Winsley, Limpley Stoke, Bathampton, Coombe Down, and Odd Down. The most important local areas are the Box-Corsham, Monk's Park, and Farleigh groups. The Monk's Park and Hartham quarries are farthest from Bath, being about nine miles distant to the north-east; those at Bradford-on-Avon and Westwood are about six miles from the city in a south-easterly direction. It is noteworthy that no large workings are open to the north of the London railway line, except in the Box - Corsham - Hartham areas; and none are found to the west of Bath. The whole of the stone-producing areas may be divided into two parts : one to the south, south-east, and east of Bath, occupying an area of about sixteen square miles ; the other, to the north- east, having an area of about nine square miles ; so that Bath stone is raised over a district comprised within twenty-five square miles.

GEOLOGICAL POSITION.

A glance at the map (fig. 1) suffices to show that all the quarries are situated in the geological formation known as the Great or Bath Oolite, a member of the Jurassic series which also yields good building-stones in the southern part of the Cotswolds, to the north of the area depicted on the map.

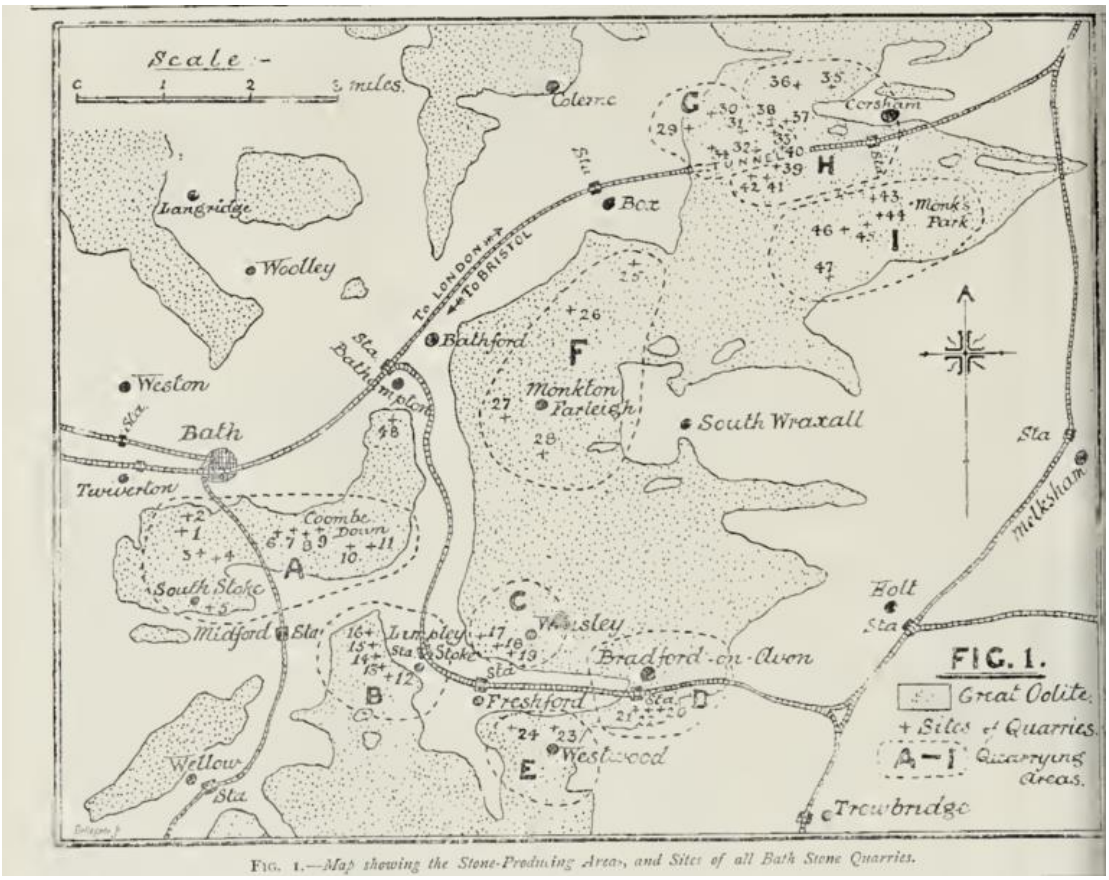


FIG. 1.—*Map shewing the Stone-Producing Areas, and Sites of all Bath Stone Quarries.*

It will also be noticed that enormous outcrops of that formation occur, on which no important quarries are situated. On the main mass, north of Bradford-on-Avon, and beyond South Wraxhall, it seems tolerably clear that enormous quantities of stone exist. On the hills to the south of Limpley Stoke, the formation is also well represented. The large tracts to the north, near Langridge and Colerne, however, would have to be studied in more minute detail than has hitherto been done to prove the existence of anything like extensive beds of good building stone there. It may be taken for granted that there is enough stone "in sight'' at the various quarries to last for many years to come, and there is nothing from a geological point of view, likely to arise to interfere with the workings. The sites for new quarries will have to be largely controlled by the proximity or otherwise of easy carriage.

THE QUARRIES.

For convenience sake we have divided the Bath district into several areas, the designations of which correspond as nearly as may be with the names usually borne by the different kinds of stone in the market. They are indicated on the map (fig. 1), and are as follow :

A—Bath area (Odd Down and Coombe Down stone).
B—Limpley Stoke area (Stoke ground stone).
C—Winsley area (Winsley ground stone).
D—Bradford-on-Avon area.
E—Westwood area (Westwood groundstone).
F—Monkton Farleigh area (Farleigh Down stone, Kingsdown).
G—Box area (Box ground stone).
H—Corsham area (Corsham Down, Corngrit, and Hartham Park stones).
I—Monk's Park area (Monk's Park, Ridge Corsham, and Park Lane stones).

In going round the workings we were met with a difficulty at the outset as to what should constitute a separate quarry. With the exception of those on Odd Down, the majority on Coombe Down, those at Winsley, and one in the Box area, all the workings are underground, and should therefore be called stone-mines. Many of these mines are close together, and communicate with each other underground. The difficulty was to define the limits of each mine. Nearly all have several distinct headings ; a number of these constitute a "quarry." The method we have adopted is to give each quarry or separate mine a distinctive number, and the various headings examined are distinguished by adding a letter. For example, No. 30 denotes the Clift quarry at Box Hill, and points 30^{a}, 30^{b}, 30^{c}, 30^{d}, 30^{e} indicate separate headings visited in that quarry.

A.—BATH AREA.

Starting from Bath, and passing by a large disused quarry en route, we arrive on Odd Down, at

Quarry No. 1.—An open working showing 6 ft. of overburden and 12 ft. of building stone in eight beds. Sample No. 1 was obtained from the third bed from the top of the latter series ; it is of a brownish yellow colour, and composed of fragments of shelly matter and oolitic granules bound together by a hard crystalline matrix, the latter forming a large proportion of the stone. The oolitic granules are not so crystalline as the matrix, and are more absorbent. It would appear as though they were much decomposed, and many are reduced to mere nuclei between which and the matrix is a free, porous space. The vertical joints in the quarry are very irregular, and the stone generally is much broken up, but large blocks are here and there seen. We

observed one which measured 5 ft. 11 in. by 3 ft. 3 in. by 2 ft. 11 in. Although raised by Odd Down the material is known in the market as Coombe Down stone.

Quarry No. 2.—A very small open working, not differing materially from No. 1.

Quarry No. 3.—An open working with about 3 ft. of tile-like rubble overbearing and 9 ft. of rather rough-looking stone, with very few regular beds, and much cut up jointing.

Quarry, No. 4.—Another small open working with 6 ft. of overburden, and 20 ft. building-stone running in thick beds. Large blocks were obtainable, but many were much discoloured. There was a small "cliff gully'' penetrating the stone, from the surface of the ground, to which some of the discolouration is due.

Quarry No. 5.—An unimportant working at South Stoke.

Quarry No. 6.—A large open working in Coombe Down, from which enormous quantities of stone were evidently abstracted in former days. It is in the form of a long sinuous wall stretching for several hundred yards. At a point now being worked it measured the following section (fig. 2)

Sample No. 6, obtained from a point indicated in the above section may be readily distinguished by its lighter tint, somewhat finer grain, more open texture, and by it having so much shelly matter. It seems; to take a sharp arris. In the quarry it appears to be clean, and to possess minute cracks filled with calcite, which render it sound than would otherwise be the

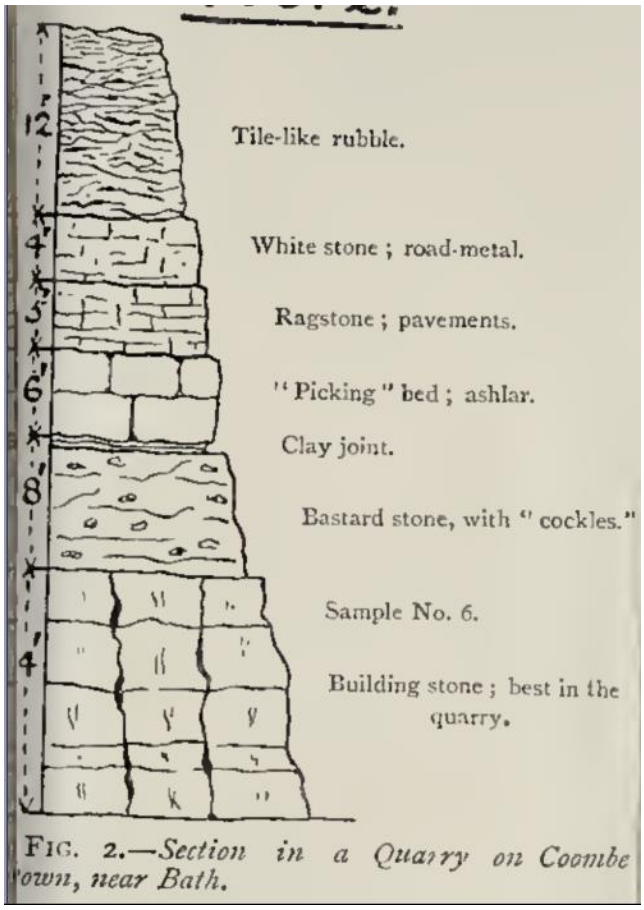


FIG. 2.—*Section in a Quarry on Coombe own, near Bath.*

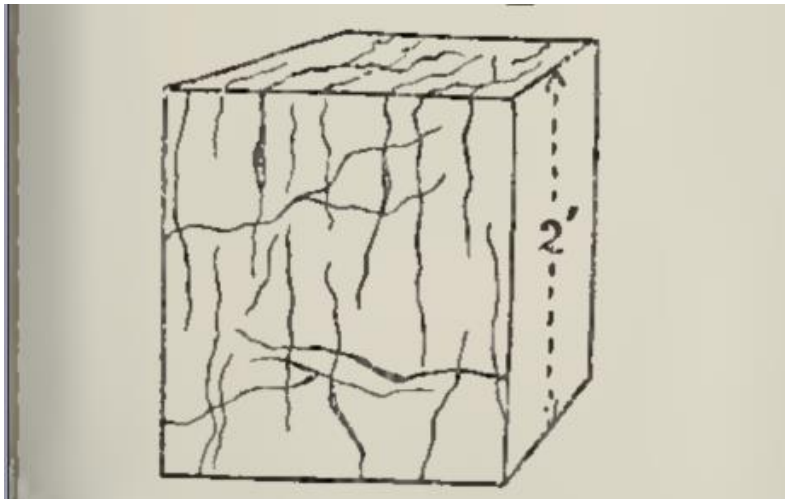
case. The bed, called "bastard" stone is peculiar; it contains what the quarrymen call " cockles

we examined a number of these, expecting from the description, to find the remains of fossil molluscs, or corals. They were, however, mere cavities, lined in some cases fine crystals of calcite, and no doubt originally contained fossils which have since been decomposed, and removed in solution by water. We state this to show the kind of action to which the Coombe Down stone has been subjected, by which its original character has become much modified. Continuing along the face of this quarry we noticed a species of wedge - bedding, phenomenon illustrated in fig. 5, though the latter refers to another working. We ascertained that the false-bedding, or wedge bedding did not affect the quality of the stone in any way.

Quarry No. 7.—An open working known Prior Park quarry, consisting of 8 ft. rubble, 8 ft. of useless stone in four beds, two of which are much iron-stained, beneath which is a variable thickness of building sone, from 4 ft. to 7 ft. deep. The quality of the stone is not bad, but the joints are rather close together, and only small blocks could be obtained at the time of our visit The lower portion is slightly false-bedded. The stone is of a yellowish-brown tint, compact with many shells, and several earthy oolitic granules.

Quarry No. 8.:—Small open working, with 8 ft. of overburden, and 7 ft. of building-stone the latter are in very thin beds, six being opposed vertical joints irregular, so that only small blocks were procurable. It is lighter in tint than that from No. 7 quarry, and contains a number of small porous cavities which immediately distinguishes it from others.

Quarry No. 9.—An open working, with 3 ft. overburden, and 10 ft. to 11 ft. of building stone, in rather thick beds for Coombe Down stone. One measured 2 ft. 9 in. on the bed. This is much used as sawn ashlar, and the blocks present a peculiar appearance. Over the face of the stone, as will be seen in the following sketch (fig. 3), a number of veins of calcite make their appearance.



3. 3.—*Block of Coombe Down stone, showing minute calcite veins.*

The width of some of these was as much as 1 mm., and using a lens, extremely minute ones, and very close together, were observable. This structure is peculiar to certain kinds of Bath stone, and although they must be, to some extent, a hindrance to the free working, or masoning of the material, they will be found to be characteristic of the most durable varieties.

Quarry No. 10.—A large open working, known as Mount Pleasant quarry, with a considerable thickness of overburden, made up of 16 ft. of tile-like rubble with coarse stone at the base, underneath which is a bed of ragstone 7 ft. in thickness; then follows the building-stone in beds

of 4 ft. 6 in., 2 ft. 6 in., 4ft.*, 10 in., 11 in., and 9 in. The stone is finely oolitic and shelly, with a hard crystalline matrix, but its most durable part is the shell constituent. Thin calcite veins are frequent.

Quarry No. 11.—Part of this working is in the open, and part underground ; it is the only stone mine on Coombe Down. The section in the heading showed four beds, having the following thicknesses respectively : 3 ft.*, 3 ft. 6 in.*, 4 ft. 6 in.*, and 2 ft. 6 in. The stone is fine-grained, and mainly composed of minute oolitic granules.

B.—LIMPLEY STOKE AREA.

All the workings in this area are mines. They are situated near the summit of a hill above the village of Limpley Stoke, the material for the most part being carted to the railway station near at hand. All the sections visited showed but one bed of building-stone, known in the market as "Stoke Ground."

Quarry No. 12.—Thickness of bed 5 ft. 9in.* The stone is of a brownish cream tint, medium-fine grain, not very uniform, and compact. It is composed of rather earthy oolitic granules, with occasional large pieces of shells bound together by an abundant calcite matrix. The last mentioned is the most characteristic and distinguishing feature in the Stoke ground stones, which are all very homogeneous in tint and appearance.

Quarry No. 13.—The section here shows a bed 6 ft.- 3 in.* in thickness. The oolitic granules are slightly more earthy.

Quarry No. 14. — This communicates underground with the last mentioned working. The building-stone bed is 7 ft. 6 in.* in thickness. It is locally harder than any other in the area, a phenomenon produced by the occurrence of small concretionary patches, in the vicinity of which the whole stone seems to be better in quality than elsewhere. It is probably the most durable of the stones in the Stoke area. In walking underground we noticed two faults which seem to have been a considerable hindrance in the working. The following diagram (fig. 4) shows the effect. A section of the stone, at *b*, about 50 ft. in length, after having been dislocated

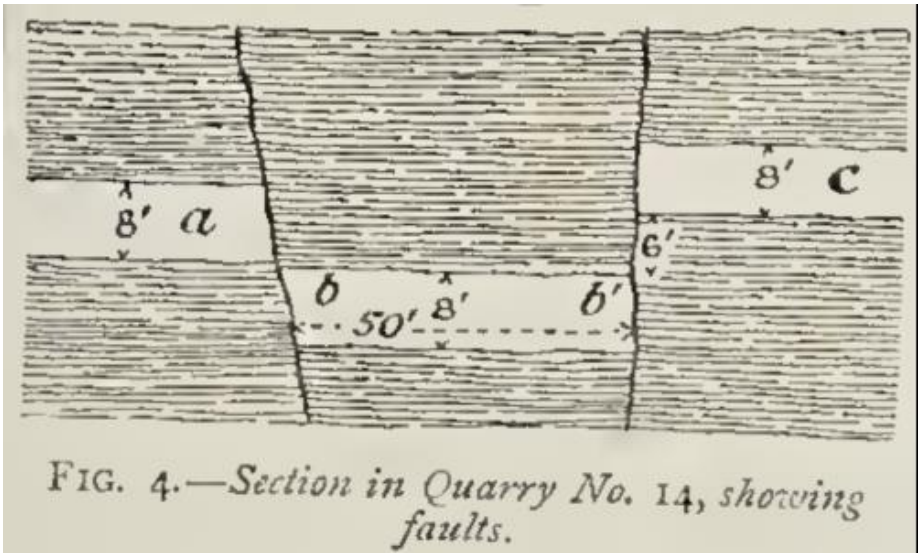


FIG. 4.—*Section in Quarry No.* 14, *showing faults.*

has dropped about 8 ft. from the gallery at a, whilst the continuation at c has been elevated about 6 ft., at least, that is the net result of the movement. It was not difficult for the quarrymen in a to find b, but it must have required some tact, after arriving at the wall b1where the stone suddenly gave out, to ascertain the whereabouts of the continuation at c. They were, no doubt,

facilitated by the soft ferruginous earth filling up the fault, which permitted of tolerably easy access in either direction.

* An asterisk following the thickness of a bed denotes that a sample which may, or may not, be described, although carefully examined, was obtained from that bed

Quarry No. 15.—Situated farther along underground, in a lateral prolongation of the faulted mass B, shown in fig. 4. The stone is 8 ft.* in thickness, and does not differ materially from that last described, except that the small concretions are missing.

Quarry No. 16.— Thickness of bed, 7 ft. 6 in.*; stone similar to that from last quarry. At the point of junction with the bed below (not used) numerous small cavities exist, doubtless due to the action of percolating water.

C.—WINSLEY AREA.

This is the least important of the stone-quarrying areas in the Bath district. Were it not that the material raised is warmer in tint than other kinds, and that certain architects have a preference for it in consequence, it is probable that the quarries would be closed. The amount of overburden to be removed before the stone is obtainable, together with the circumstance that the workable beds are only about 5 ft. to 6 ft. in thickness, render the exploitation of the "Winsley Ground" stone, a rather costly affair, and this is no doubt responsible for its being so little used. Yet in former times enormous quantities must have been raised thereabouts, and many buildings erected of Bath stone from fifty to a hundred years since derived the material from the old Murhill quarries, a visit to which is instructive as showing old methods of working.

Quarry No. 17.—The old Murhill workings
referred to. The quarries, which form along open face, have about 20 ft. of over-burden, beneath which are two beds of building-stone, 3 ft. and 2 ft. in thickness respectively. The face is interesting as showing the old method of quarrying with picks, instead of one-handled saws. The material appears to have been mostly sent away by canal, for the remains of old-fashioned rails down an inclined plane to the waterway which runs along the side of the hill, may yet be seen. Hard by is a small abandoned stone mine, at a lower level.

Quarry No. 18.—A small open working, showing 20 ft. of overburden, mainly composed of rubble, brown clay, and ragstone, beneath which are two beds of freestone 3 ft. 5 in.*, and 2 ft. in thickness respectively. The stone, both in this and the next quarry to be described, was much iron-stained, and appeared to require careful selection. It is a yellowish-brown, fine-grained shelly oolite, the granules being the least crystalline portion of the stone. Its deep colour at once distinguishes it from other Bath stones.

Quarry No. 19.—Very close to the last-mentioned, and the section and stone are similar. The ragstone has many " cockles " and cavities in it, and might do for burning into lime.

D.— BRADFORD-ON-AVON AREA.

Although raised in larger quantities than at Winsley, the stone is of more interest locally than from a general standpoint, inasmuch as it is chiefly used in the immediate vicinity of the town.

Quarry No. 20.—This is the largest working in the area, and is known as Woodside quarry, close to the canal. The freestone beds are of variable thickness, measuring in the aggregate

from 10 ft. to 15 ft., the roof and floor being of ragstone. The material itself is a light cream-coloured oolite, uniform in grain, and not very fossiliferous.

Quarries Nos. 21 and 22.—Mines known as Poulton quarries, both very small, the material being used locally.

E.—WESTWOOD AREA.

The workings in this area are mines of great size. In some respects the disposition of the stone is very remarkable. One may walk for long distances underground and find that the stone does not vary more than an inch or two in thickness the whole way. With few exceptions, presently to be noted it is in one bed only, which is about 8 ft. in thickness, but occasionally it "heaves" in the middle — i.e., a weak plane is developed along which the stone has a tendency to split.

The most curious point, however, is that the vertical joints are very far apart—in some instances 20 yds. to 25 yds. We were told, and are quite prepared to believe it, that in these quarries gangs of men work for months on one large block of stone before coming upon any joints. The softness of the material in the quarry enables it to be readily cut, otherwise the absence of joints would render it very difficult to get.

Quarry No. 23.—We visited ten headings, but as each one showed a thickness of stone of 8 ft.*, and were similar in other respects, they need not be separately referred to. In one part of the quarry the freestone was 7 ft. 6 in.* in thickness, resting on a hard bed containing blocks sometimes sawn into slabs for paving purposes. This latter stone cannot, of course, be considered in the same light as the freestone.

Quarry No. 24-—Known, like the preceding, as Westwood quarry, and adjoining it. It is a very large quarry. Amongst the headings visited we noticed three, in which the stone was—point 24^{a}, 7 ft.* in thickness; point 24^{b}, 5 ft.* and 3 ft. 6 in ; and point 24^{c} 6 ft.* and 3 ft. 6 in. One of the peculiarities noted was that no matter in what direction one penetrated from the entrance, it was very wet for a certain distance, and then the galleries became suddenly dry. The Great Oolite formation at this spot is partly covered by clay, which prevents the free percolation of water, so that where the oolite is protected by the clay the ground is dry. This is an interesting fact, amongst many others, gleaned during this visit from the point of view of water-supply. In some of the quarries we were able to ascertain the rate of percolation from the surface, the results being of much use in another connexion. The "Westwood Ground" stone itself may be described as a shelly oolite, in which the shelly constituent is the predominant, and the granules larger than in most other kinds of Bath stone ; the matrix is not very crystalline, though abundant.

F.—MONKTON FARLEIGH AREA.

The stone mines in this area may be divided into two sections—those near the village of Monkton Farleigh, which are the more important, and those between that place and Box on Kingsdown. Dealing with the latter first, we come to

Quarry No. 25.—Longsplatt quarry, Kingsdown. It is a mine showing a great thickness of stone at the headings, cut up into several beds, in descending order as follow :
Useless stone, 2 ft. ; soft, fine-grained oolite, 1 ft. 6 in. and 1 ft. 6in.*; "fine-bed," 1 ft. 6 in., 2 ft., 2 ft., 2 ft., and 2 ft. 6 in. ; "oaty bed weather" stone, 2 ft.*; "fine-bed" (of the same character as that above the " oaty" bed), 3 ft., 3 ft.*, and 4 ft. It is difficult to satisfactorily classify any of these beds; some of them partake of the character of Farleigh stone, whilst others remind one of

the Box ground. In reality the “fine-beds" constitute a distinct variety of Bath stone. The material is fine-grained, contains an abundant matrix, and although distinctly a shelly oolite, the granules are not very conspicuous unless seen under the microscope. The “oaty” bed contains small local patches of concretionary origin, at which places the stone is much harder than at others.

Quarry No. 26.— Kingsdown quarry, situated about half-way between the Longsplatt and Farleigh groups ; it is not important. At one point underground (No. 26[a]) there were eight beds as follow:—2 ft., 1 ft., 1 ft. 6 in.* 1 ft., 2 ft. 8 in., 2 ft., 2 ft. 2 in., and 3 ft. At the time of our visit the material, much cut up by jointing, was very rough. At another point (26[b]) there were nine beds— 1 ft. 6 in., 1 ft. 7 in., 1 ft. 8 in., 1 ft. 4 in., 2 ft. 4 in.*, 2 ft. 10 in., 1 ft. 4 in., 2 ft. 5 in., and 4 ft. 3 in. Here, also, joints were frequent, but the quality of the stone did not seem to be impaired. At a third point (26[c]) the face of stone was so much cut up, both by bedding and jointing, that it hardly seemed worth working.

Quarry No. 27.—This is by far the most important mine in the Farleigh district, and yields, together with that next to be described, practically all the “ Farleigh Down stone, properly so called. The quarry masters allude to each heading (or local groups of two or three headings) as a separate quarry, but we have not adopted this course. The stone, as a whole, may be described as being a light cream oolite, fine grained, compact and uniform, shelly matter not being abundant. It is very variable in character at the different headings, and whilst much cannot be said to be of a durable description, yet here and there a fairly good stone is obtainable. A special feature of the bottom beds was the occurrence of large pieces of fossil wood, which we should not notice here, except that they produce soft places, and sometimes holes. In many of the other quarries similar pieces of fossil wood were found, but not in such abundance as in No. 27. The following headings were visited, and are far removed from one another :

Point 27[a].—Beds 2 ft. 6 in., 1 ft. 3 in., 1 ft. 7 in., 1 ft. 10 in , 10 in., l ft. 6 in.*, 1 ft., 1 ft., 1 ft., and 2 ft. 6 in.
Point 27[b] .—Beds 2 ft. 6 in., 1 ft. 3 in., 3 ft. 3 in., 1 ft. 3 in., 4 ft.*, 3 ft., and 3 ft. 6 in.
Point 27[c]—Beds 2 ft, 1 ft. 8 in., 1 ft. 4 in., 2 ft. 7 in., 2 ft. 2 in., 2 ft. 10 in., 2 ft. 8 in., 2 ft. 10 in., and 5 ft.*
Point 27[d].—Beds 2 ft., 2 ft. 8 in., 3 ft. 4 in., 1 ft. 4 in.*, I ft.. 1 ft. 8 in., and 3 ft. 8 in.
Point 27[e]—Beds 2 ft. 4 in., 1 ft. 10 in., I ft. 7 in., 4 ft 8 in., 4 ft.*, and 5 ft.

The 5 ft. bed from which the sample from point 27[c] was obtained is of a reddish-brown tint, and is sold for outdoor work more particularly. It is certainly the most durable of the “Farleigh Down” stones. When dry it is not so deeply coloured as that from Winsley.

Quarry No. 28.—South Farleigh quarry. The disposition of the stone underground is rather peculiar ; it represents wedge-bedding on a large scale, but the strata are of regular thickness throughout, and present the normal features of dipping. At one heading, point 28[a], the following thicknesses of beds were shown :—2 ft., 1 ft. 9 in., 1 ft. 6 in., 1 ft., 2 ft., 1 ft., 8 in., 2 ft.*, 2 ft., 1 ft. 3 in., and 1 ft. 5 in.; at another point, 28[b], they were, 1 ft. 10 in., 1 ft., 1 ft. 2 in., 6 in.*, 1 ft. 2 in., 1 ft., I ft. 4 in., 1 ft. 8 in., 2 ft., and 2 ft.

G.— BOX AREA.

The enormous workings between Box Hill and the end of the railway tunnel towards Corsham form the largest stone mine in the United Kingdom, and probably in the world; they are reached by several entrances. The area occupied is irregularly oval in form, about two miles in length and one mile in width, a system of light railways, and a siding from the G.W.R. at the Corsham end, serving to haul the stone out of the quarries. About two-thirds of this area, towards the

west, furnishes the "Box ground" stone; the remaining one-third being exploited for divers kinds of Corsham stone. Outside this immense mine, to the north and south, are other and independent quarries also furnishing Corsham stone. In the maze of galleries and tunnels it is not easy to work out the precise lie of the beds, and so to ascertain the relative positions of the Box ground and Corsham stones, but we offer a solution in the sequel, based on a general survey of the points examined, and are tolerably sure that it is, in the main, correct.

Quarry No. 29.—This is the only open working in the area, and is not important ; at the time of our visit it was being converted into a mine. One open face gave the following remarkable detail (fig. 5). We observe that in the upper part of this section the beds are horizontal, under which is a series wedge-bedded, followed by another horizontal parting, the base showing wedge- bedding in the opposite direction. Underground we measured the following beds :

2 ft. 4 in., 4 ft.*, and 4 ft. The stone is of a cream tint with light brown specks, and is of

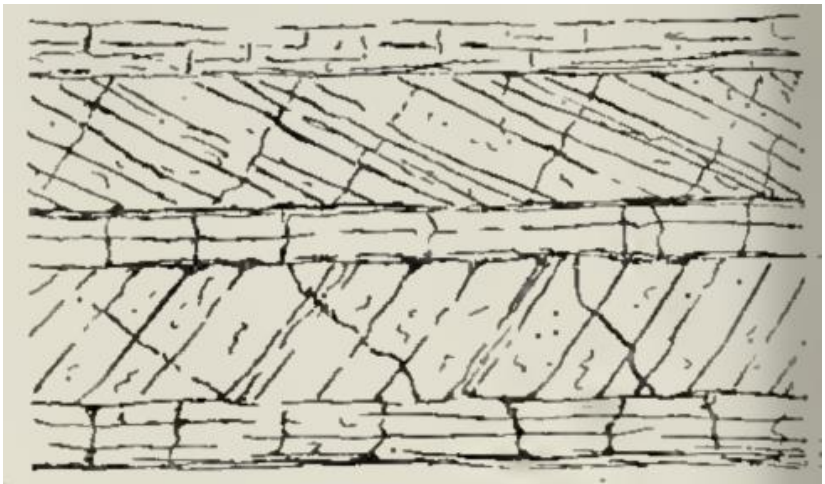


FIG. 5.—*Section of open working showing wedge-bedding in two directions, Box Hill.*

medium grain. Shelly matter is plentiful, oolitic granules very minute, the crystalline matrix not being abundant.

Quarry No. 30.— Clift quarry, from these entrance of which the whole of the remaining workings yielding " Box Ground " stone may be reached. It is perhaps the best show quarry in the Bath district, the antique and fearful-looking engine running in and out having attracted considerable attention. One may here walk underground for miles, the headings are innumerable, and we elected to examine only a few at sufficient distances apart. It may be worth mentioning, that after a storm on Box Hill, it takes from thirty-six to forty hours for the rain-water to percolate from the surface to the working underground—a depth of about 110 ft., made up of alternating beds of "rag" and soft: stone of no commercial value. Heading yielded the following thicknesses of stone :-
Point 30[a] Beds 2 ft., 3 ft., 3 ft. 4 in. ; 2 ft. 4 in., 2 ft., 1 ft. 6 in., and 2 ft. 9 in.
Point 30[b] Beds 3 ft. 3 in., 3 ft.*, 3 ft. 9 in.; 2 ft. 3 in., 3 ft., and 3 ft.
Point 30[c] Beds 5 ft., 3 ft. 4 in.'3 ft. 10 in., 4 ft., and 3 ft. 2 in.
Point 30[d] Beds 2 ft. 4 in., 3 ft., 5 ft. 2 in. ; 4 ft., and 1 ft. 10 in.

At the heading point 30c we saw a block quarried measuring 10 ft. x 4 ft. x 3 ft. 3i An old working, known as the "Cathedral" near this point will be adverted to in on remarks on the methods of quarrying the stone in olden times. All we need now saw in reference to this is that then the material was obtained from three distinct levels by means of galleries. That quarried

from the uppermost gallery was called “Box Scallett”; from the middle, “Box Corngrit,’’ and from the lowest level, “Box Ground,” which latter is the only variety now exploited.

Quarry No. 31.—Known as No. 4 Box quarry, from its proximity to shaft no 4; the Box tunnel on the Great Western Railway. A heading showed beds as follows
2 ft., 3 ft. 6 in., I ft. 10 in.*, 5 ft., and 4. The stone is a rather coarse-grained shell oolite with sparse crystalline matrix. ,

Quarry No. 32.—Tyning quarry. A heading gave 2 ft., 2 ft. 6 in., 2 ft. 2 in., 2 ft. 9 in- and 4 ft., as the thickness of beds.

Quarry No. 33.—This, the most easterly of "the Box Ground group is called “No. 6 Box” quarry. It is close to those yielding Corsham stone. Two headings examined gave :—Point 33[a], 3 ft. 8 in., 1 ft. 2 in., and 2 ft. 10 in.*, and point 33[b], 4 ft.*, at, 4 ft. 4 in.

Quarry No. 34.—This embraces a number of headings known as the “ Lower Hill Box Quarries, which we did not visit. The stone is practically the same as that from the Clift quarry near by.

H.—CORSHAM AREA.

[*The highlighted words or numbers indicate that the word obscured when the magazine was bound and is not readable*]

The stones obtained from this are following the several varieties, are known by the following names in the market : Corsham, Corsham Down, Corngrain Hartham Park Corsham, Hartham Park Ground, Scallett, and Corsham Blue.

Quarry No. 35.—This working and the next, known as Hartham No. 2 and No. 1 quarries respectively, are the most northerly the Bath district, and are, to a certain extent, isolated from the main Corsham quarrying area. A number of different kinds of stone are raised, and we think the quarry masters are judicious in giving some of them distinctive names, as in certain respects they are peculiar. There are several headings; a typical one gave the following :

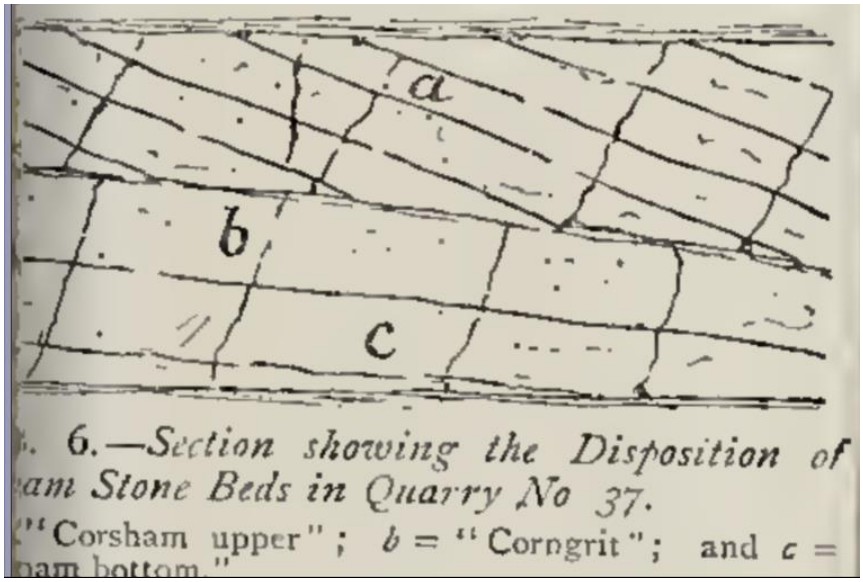
llett, 2 ft. 6 in.* ; Hartham Park Corsham, x ft. 6 in., 1 ft. 6 in., 1 ft. 6 in., 2 ft., and x*; Hartham Park Ground, 2 ft. 6 in., x ft. 6 in.*, 2 ft. 8 in., and 4 ft.—a total thickness of 23 ft. 8 in. The vertical joints are few and far between—some from 30 ft. o ft. apart—though occasionally a “blind” rift, running through two or three beds, may, occurs between. Speaking in general these may be classed amongst the er kinds of Corsham stones; the “Scallett ” bed is a very fine-grained true te, the Hartham Park Corsham has to a e extent been derived from pre-existing ly oolites, and has a finely-granular matrix, whilst the Ground stone is chacterised by its sparse matrix. They are of a light yellow tint.

Quarry No. 36.—This was not being so largely exploited as the last- mentioned king at the time of our visit; the section character of the stone are similar to it. efore stated, it is known as the Hartham No. 1 Quarry.

Quarry No. 37.—Opened about 50 years ago and called Corsham Down Quarry. As indicated on the map (Fig. 1), it forms part e large Box-Corsham Mine. The stone discovered during the construction of Box Tunnel on the Great Western Railway, and there is a railway siding running in the quarry underground. The workings are divided into two parts, according as they are situated north or south of the railway *.

Three kinds of stone are recognised : Corsham Down “bottom bed (2) Corngrit and (3) Corsham Down “fine upper”

There are sixteen headings, most of which we visited, and measured the follow-—Point 37[a].—“Corsham Down upper,” ft. 6 in.. 2 ft.*, 1 ft. 8 in., 2 ft. 6 in., and ft. 6 in. ; Corngrit, 2 ft. 6 in.* ; and Corsham Down bottom,” 4 ft. 6 in.*, and ft. 6 in.* The beds in this quarry are :r curiously disposed, as will be gleaned from the following diagram (fig. 6). Those are wedge - bedded, and dip S.E. * rate of 4 ft. in 17 yards, and rest on * dipping slightly to the south; whilst to a certain extent, follows b. From this * be perceived that the Corsham Down “finer " stone is worked along several adjacent beds, as the constantly recurring f the wedge-bedding brings them into * in the process of quarrying. The * dipping so slightly, however, and the * running chiefly east and west, there * so many beds as at first sight might * to be the case. At point 37[b]



6.—*Section showing the Disposition of ham Stone Beds in Quarry No 37.*
"Corsham upper"; *b* = "Corngrit"; and *c* = ham bottom."

the following section was seen: — Corsham Down “upper beds" 1 ft. 7 in.* and 3 ft. , and Corngrit I ft. 8 in.* This section he north of point and we notice that the beds are much attenuated. Some- the Corngrit occurs in two beds ; on og to the south of the tunnel the lower becomes thin and hard—in fact, there it oecies of ragstone of no use for build purposes. The term Corngrit is derived from the speckled appearance assumed by the stone. It is extremely variable in structure, however, and in certain places resembles the Corsham Down beds. On the average it is lighter in colour and harder than they, and the concretionary patches forming the speckles alluded to are very characteristic. Of the Corsham Down beds, there does not seem to be much difference between them, but of the two horizons the upper would, no doubt, prove the more durable. They are true oolites, with very little foreign matter.

Quarry No. 38.—Huddswell quarry, and the stone is known by that name, or as “Corsham.” Sections yielded—point 38[a], 1 ft. 4 in., 3 ft. 6 in., and 2 ft. 4 in. ; the bed below this is a modified Corngrit, 2 ft. in thickness; point 38[b], 1 ft.*, 3 ft., 1 ft. 10 in., and 1 ft. 4 in.

Quarry No. 39. — "Stone’s No. 6 Corsham” ; it is exploited both north and south of the railway tunnel, and is very straggling. The following occurs in the northern portion, point 39[a], Corsham stone, 1 ft. 6 in., 2 ft., 2 ft. 10 in., 2 ft. 3 in., and 2ft.; Corngrit, 2 ft. 10 in.* ; and Corsham “bottom,” 4 ft. and 2 ft.* In the southern portion we have—point 39[b], 1 ft. 10 in., 1 ft. 10 in., 3 ft., 2 ft.*, 2 ft. 4 in., and 2 ft. 6 in. ; point 39[c], 1 ft. 2 in., 1 ft. 9 in., 1 ft. 3 in., 2 ft. 6 in.*, 1 ft. 10 in., 1 ft. 10 in., 2 ft., and 1 ft. 6 in. ; point 39[d], 1 ft. 8 in., 9 in., 1 ft. 10 in.*, 1 ft. 9 in., 1 ft. 5 in., 1 ft. 5 in., 1 ft. 2 in., 1 ft. 8 in., 10 in., and 2 ft., all of which beds are known as Corsham stone. A fault, with a drop of 9 ft., occurs in one part of the working, and on nearing the Box Ground

stone, close by, we observed the following section (fig. 7), which shows the relation existing

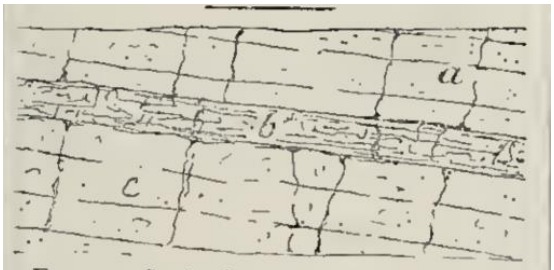


FIG. 7.—*Section between quarries Nos. 33 and 39, showing relation of "Corsham" to "Box Ground" stone.*

a = Corsham stone; *b* = Bastard stone; *c* = Box Ground stone.

between the Corsham and Box stones. The beds dip to the S.E. at about 4 ft. 3 in. in 18 yards.
Quarry No. 40.—"Pictor's No. 6 Corsham" quarry. The beds all dip slightly to the S.E., and are as follow ft. 10 in.*, 1 ft. 6 in., 1 ft. 8 in., 3 ft. 6 in., 2 ft. 2 in., and 2 ft.; point 40[a], 2 ft., 2 ft., 2 ft., 1 ft., 2 ft. and 2 ft. 6 in.*

Quarry No. 41 "No. 7 Corsham," "Spring," or "Waterhole " quarry, yielding beds as follow : - 1ft. 6 in., 1 ft. 10 in., 2 ft., 2 ft., 2 ft. 6in.*, 1 ft. 6in. and 3ft.* The lowest beds here are remarkable as yielding a blue stone ; it occurs in the manner indicated in fig 8. As will be seen, this material is not found in any large quantity, it has been used principally in churches and for columns. The existence of the bed is not generally known.

On the bank of the quarry above ground we examined in detail the various kinds of Corsham stone in process of "seasoning" i.e., left in the open-air to dry. There is nothing worth recording respecting this, except in reference to the Corngrit. The majority of the blocks of this material

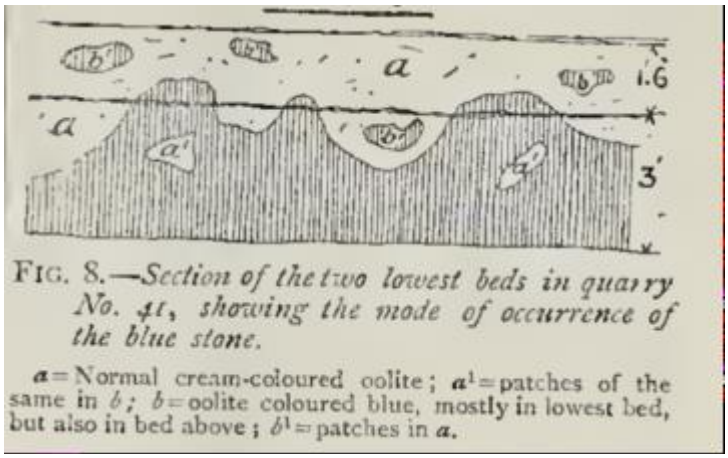


FIG. 8.—*Section of the two lowest beds in quarry No. 41, showing the mode of occurrence of the blue stone.*

a = Normal cream-coloured oolite; a^1 = patches of the same in *b*; *b* = oolite coloured blue, mostly in lowest bed, but also in bed above; b^1 = patches in *a*.

were found to have hard calcite veins running through them, and always in one direction, at right-angles to the bedding-planes. These appear to hinder the penetration of water through the stone, as will be seen in fig. 9.

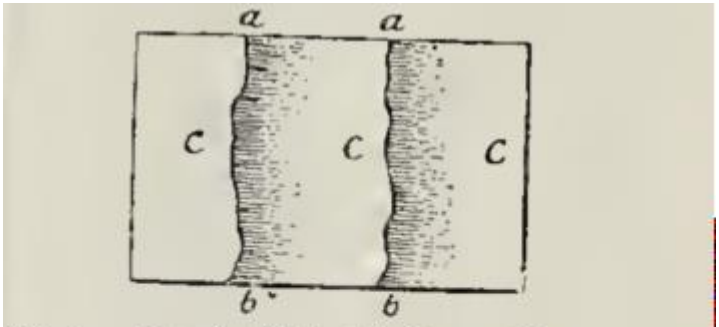


FIG. 9.—*Face of a block of "Corngrit," showing calcite veins acting as damp-courses.*

a = Hard calcite veins running through the stone; *b* = Moisture in the stone arrested by *a*; *c* = Comparatively dry areas.

On building the material into walls, if the stone is turned up on its bed—and in the case of this particular kind of Bath stone, which exhibits hardly any trace of bedding, this would not facilitate weathering—the thin calcite veins a could not fail to act as damp courses.

Quarry No. 42. —As will be seen by referring to the map (fig. 1), this is not connected with the Box-Corsham stone mine, but is so close to it that the produce is practically the same. It is known as Sands, or Westwell's quarry, and is a comparatively new working. A heading yielded the following beds, all called Corsham stone— 2 ft., 1 ft., 3 ft.*, 4 ft., 2 ft.,' and 2 ft. These thicknesses vary, however, within very short distances, for the bedding-planes are not regular, even for a few yards. At the time of our visit one of the headings was not in good condition, though such an occurrence is, of course, liable to take place in any quarry.

From data derived during our examination, and for the most part given in the foregoing observations on the Box and Corsham areas, we are enabled to present the following as a general section (fig. 10),

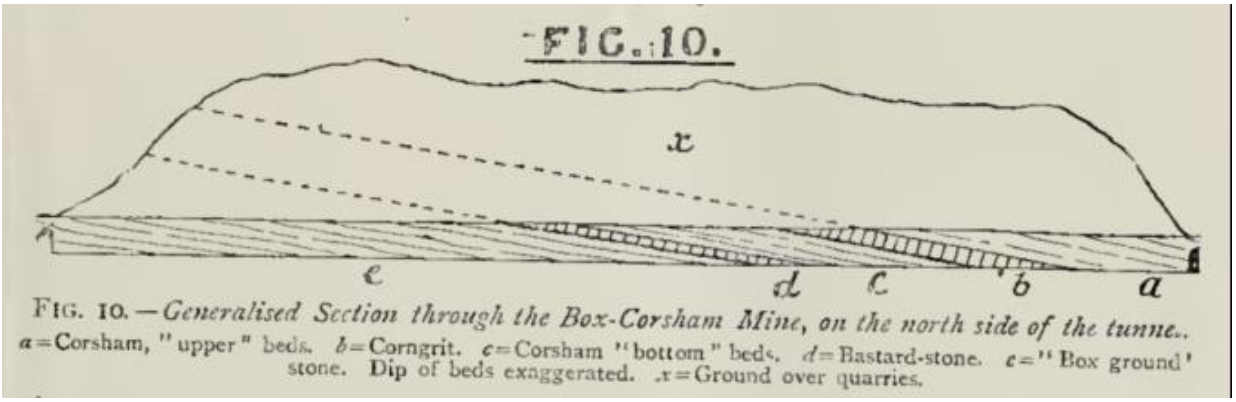


FIG. 10.—*Generalised Section through the Box-Corsham Mine, on the north side of the tunne..*

a = Corsham, "upper" beds. *b* = Corngrit. *c* = Corsham "bottom" beds. *d* = Bastard-stone. *e* = "Box ground' stone. Dip of beds exaggerated. *x* = Ground over quarries.

through the large mine. The bed c is not important as a building-stone in some parts of the mine, and very likely merges into d or b. The Box Ground stone thins out on approaching Corsham, or, at least, becomes so modified in structure that it ceases to be of any value for building purposes beyond the point shown. The base line drawn, which indicates the floor of the present workings along the line of section, is said by all concerned to mark the inferior limit of the good stone, though we had no means of proving this. The best store is found only in the position between the parallel lines indicating the floor and ceiling of the quarries. The phenomenon of wedge-bedding accompanying the regular dip rendered it very difficult to make precise observations on these points. From the evidence afforded by the section in the shaft at

the " Cathedral " (part of Quarry No. 30) to the west of the area, it seems tolerably clear that the Corngrit and Corsham beds, in a modified form, occur in the ground over that portion of the quarries, and their approximate position is dotted in accordingly. That there are no really good beds of building-stone in the 100 ft. odd above the mine, is rendered certain in the details afforded by the vertical ventilating shafts both in the mine and tunnel, though here and there, at different levels, the material looked promising.

I.— Monk's Park Area.

We have grouped the following quarries under this heading more from their geographical position than from any peculiar features presented. Generically the stone is related to the true Corsham, both structurally and physically, and it is, indeed, often called " Monk's Park Corsham " stone. Then, again, certain kinds are known as "Ridge Corsham" and "Park Lane Corsham." All the workings are mines.

Quarry No. 43.—Monk's Park northern quarry ; three headings examined gave—
Point 43^a, 1 ft. 7 in., 1 ft. 6 in., 1 ft. 10 in., 1 ft. 5 in., 3 ft., 4 ft.*, and 3 ft. 6 in. ; point 43^b. 2 ft. 5 in., 1 ft. 4in., 1 ft. 4 in., 2 ft., 3 ft. 3 in., 2 ft. 2 in., 3 ft. 3 in., and 3 ft.; point 43^c, 2 ft. 9 in., 2 ft. 9 in., 2 ft. 6 in., 1 ft., 2 ft. 6 in., 3 ft., 2 ft. 6 in.*, and 2 ft. Certain beds had calcite veins running through them, with results similar to those already described (fig. 9); these are, no doubt, the best "weather" beds.

Quarry No. 44.—Eastern Monk's Park quarry ; three headings yielded beds as follow :—Point 44_a, 1 ft. 2 in., 2 ft., 2 ft., 1 ft. 3 in., 2 ft. 6 in.*, 3 ft. 6 in., and 3 ft. 9 in. ; point 44^b, 4 ft., 2 ft. 3 in., 1 ft., 1 ft. 8 in., 2 ft. 10 in.*, and 4 ft. ; point 44^c, 2 ft., 1 ft. 8 in.. 1 ft. 3 in., 2 ft., 1 ft.*, 3 ft., 2 ft. 10 in., and 4 ft.

Quarry No. 45.—Western Monks Park Quarry a quantity of the material was cut up and decomposed, so much so that it was difficult to work, and the proportion of bad to good stone was very considerable. It is some distance from the last – mentioned quarry, and the produce is known as "Ridge Corsham." Three headings measured gave — Point 45_a, 2 ft., 1 ft. 10 in., 2 ft. 8 in., 1 ft. 5 in., 1 ft. 9 in., 2 ft. 9 in., 1 ft. 10 in. , 2 ft., 3 ft., and 1 ft. ; point 45^b, 1 ft. 7 in., 1 ft. 3 in., 1 ft. 8 in.*, 8 in., 3 ft. 6 in., 1 ft. 10 in., 1 ft. 9 in., 1 ft., and 3 ft. ; point 45^c 1 ft. 8 in., 2 ft. 6 in., 1 ft. 10 in., 1 ft. 8 in., 1 ft. 5 in. *1 ft. 7 in., 10 in., and 3 ft. Between the first and second points there was a fault running E.N.E., with a downthrow of 7 ft.

Quarry No. 46.—" Ridge " Quarry; close to that last described, but the average quality of the stone was much better, and compared favourably with the true Corsham, in every respect. The material is known both as "Ridge Corsham" and "Corsham Down." A heading gave 1 ft. 6 in., 1 ft. 6 in., 1 ft. 6 in., 2 ft., 2 ft., 2 ft. 6 in.*, and 2 ft. 6 in. ; but in this instance the thicknesses varied within short distances. It will be noticed that the beds are thin, but we measured one block drawn out of the quarry which was 2 ft. 10 in. on the bed, and were informed that occasionally 4 ft. stones could be procured. An interesting case of step-faulting occurred here, which will be alluded to in describing the methods adopted in quarrying Bath stone.

Quarry No. 47.—Park Lane Quarry; situated about half a mile S.W. of the last mentioned. Sections—point 47^a, 2 ft.4 in.,1 ft. 7 in., I ft. 5 in., 1 ft. 9 in., 3 ft*. 2 ft., 2 ft., and 2 ft. ; point 47^b, 3 ft. 10 in., 1 ft. 1 in., 2 ft., 3 ft. 2 in.", 2 ft. 6 in., 3 ft. 3 in., and 3 ft.; point 47^c , 2 ft., 1 ft. 2 in., 1 ft. 5 in., 2 ft. 4 in., 2 ft. 6 in.*, 2 ft. 6 in., 3 ft. 3 in., and 3 ft. 8 in., all known as Corsham stone.

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Quarry No. 48.—Old workings above Bathampton, from which enormous quantities of Bath stone have been extracted.

The Builder April 20, 1895.

BATH STONE—II.

ANALYSIS OF THICKNESS OF BEDS

Considerable doubt has hitherto prevailed as to the capabilities of the different Bath stone quarries of producing blocks of large size, and it has been more than once hinted that, whet' the better quality of stone falls short in that respect, inferior kinds are substituted. This we shalt prove, by the following analysis, to be utterly without foundation. The thickness of each bed is measured as it stood in the quarry, so that allowances have to be made for shaping and getting the blocks ready for market. This, in general, would mean a reduction in thickness of from 3 in. to 4 in. from each bed. It must, of course, be remembered that the depth of beds, except in such areas as that at Westwood and Limpley Stoke, quarries as the stone is dug into. All the same, it is believed that we have made a sufficient number of measurements in each area to warrant us in arriving at definite results in regard to the present and ultimate capabilities of each area: In this connection it may be remarked that the 403 measurements shown as actually having been made do not represent all that were taken, as, where two headings, close together, were inspected and were obviously alike, we made one measurement do for both. In the table (Table No. 1) on the next page the numbers in the columns refer to the number of beds in the quarry thus, in Quarry No.1 there are six beds below 2ft. 6 in thickness, one bed between 1ft. and 1 ft. 6 in. in thickness and one bed between 2 ft. 6 in. and 3 ft. in thickness.

From the foregoing summary it will be observed that for beds of great thickness, between 6 ft. and 8 ft., the only areas available are Westwood and Limpley Stoke, and there is plenty of stone in both. This thickness is, of course, much in excess of ordinary requirements. It is noteworthy that in the Box area the majority of the beds are of medium thickness, from 2 ft. to 4 ft. In the Corsham area a large proportion are under 2ft., the general range being from 1ft. 6 in. to 2 ft. 6 in. ; at the same time, beds over 4 ft. occur and practically the same may be said of the Monk's Park area, though the extreme irregularity of the beds in certain of the quarries in the latter renders the average size of blocks a matter of uncertainty at times. A large number of the beds at Farleigh are under 2 ft., but here. again. we see an occasional thickness sufficient for all practical purposes. The stone runs very thin in the surface quarries of the Bath area, whilst the absence of beds of less than 3 ft. in thickness is conspicuous in the Westwood and Limpley Stoke areas. Taking these last two facts together it would seem that where the Bath stone has a tendency to run in thick beds these are not accompanied by a corresponding series of thin ones ; in other words, we do not find really thick beds in the same quarries as the thin ones, or even in the same areas. If now we compare the summary with the map (fig. 1), we observe that the thickest beds are to the south in the areas B, E, C; whilst there is, roughly speaking, a progression in thickness from the area A to the north-east, through the areas F and H. It is remarkable that on a broad scale there is an apparent connection between structure and thickness of beds of Bath stone, and we regret that we cannot enlarge on this at the moment. A general impression exists in the district that the thickness of beds increases with depth of working but although we are prepared to concede that this is the case with some other districts. it does not appear to hold good for the area under consideration, as will be seen on reference to our figures. Of course. if we consider the open quarries only, there is the normal passage from soil, through rubble stone and odd and thin - coursed material, down into the more solid building stone beds whilst these latter on cropping out at the surface are much more broken up than when found beneath a thickness of overburden.

METHOD OF QUARRYING

Dealing first with the method of quarrying in the open works, the following diagram (fig. 11), suffices to indicate the general plan adopted. As the overburden is removed, it is thrown behind the workers, at a sufficient distance from the face of stone to permit of the easy passage of horses and carts for carrying away the blocks as quarried.

In regard to the actual "getting," it may be premised that the rubble and hard useless stone constituting overburden are blasted with rock powder; the building stone is never raised in this way, inasmuch as apart from the waste attending the shaping of blocks due to the irregularity of the cracks produced, blasting has a tendency to shatter" the stone, creating minute hair-line cracks. At the same time, a "tight place" in the open is occasionally relieved by "shot. Hole" blasting. The ordinary method of quarrying the building stone beds is illustrated in the following reproduction from a photograph (fig. 12). We notice that after the removal of the closely-bedded stone and rubble forming the overburden, advantage has been taken of a wide joint in getting out the building blocks. The material is sawn in situ by means of a one-handled

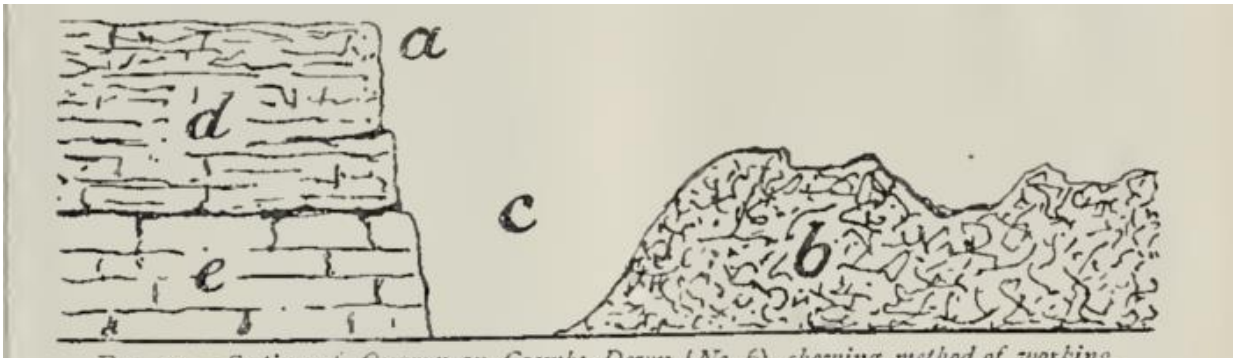

FIG. 11.—*Section of Quarry on Coombe Down (No. 6), showing method of working.*

a = Present face of quarry. *b* = Rubbish heaps derived from waste of former workings, and thrown behind as the face was quarried into. *c* = Space left between *a* and *b* to admit the passage of vehicles for carting away the stone as quarried. *d* = Overburden. *e* = Building stone to be quarried.

saw, down to the bedding-plane on which the man is standing. After this cut, another is made in the same manner at right-angles thereto, and the block is then lifted from its bed with the aid of iron bars. Subsequently, any rough surfaces on the stone are shaped by means of a two-edged stone axe, such as is seen in the illustration (tig. 12) resting on the unquarried mass of stone to the right of the sawyer. It may be remarked that but few building stones are capable of being quarried in such an easy manner as this, whereby at least two even surfaces are produced on the block, so that work and waste are reduced to a minimum. An obsolete method of "getting" the stone is well exemplified in the old workings at Murhill (Quarry No. 17), near Winsley, and in the district, where, before the introduction of the one-handled saw, picks were employed; the marks of these latter, producing a peculiar effect, are quite clear to the present day.

FIG. 12.—"*Getting*" *Bath Stone, at Mount Pleasant Quarry, Combe Down.*

Turning now to the method of quarrying Bath stone underground, which is a very different affair, we may first allude to the opening up of the mine. The stone mines in the district have been opened on three different plans, (1) horizontally, running into the side of a hill ; (2) tunnels constructed at a high inclination ; and (3) vertical shafts. Those of the first—mentioned type—tunnels driven into a hill by following up and excavating in the building-stone bed, are limited in numbers, and may be sufficiently. understood without further description. The second type is that most commonly adopted in the district under consideration, and refers to nearly all the mines in areas B, F, and I, the majority in G, and H, and to one each in A, and in E (See map in last issue), short, to nearly an the principal quarries. It will be easily understood, on reference to figs. 13 and 14, as also will the means of drawing stone out of the mine. The third type—obtaining the Stone by means of a vertical shaft-—requires no explanation. Quarry No. 35 furnishes the best example of it in the district. The haulage above ground is by steam-power or by horses and winch.

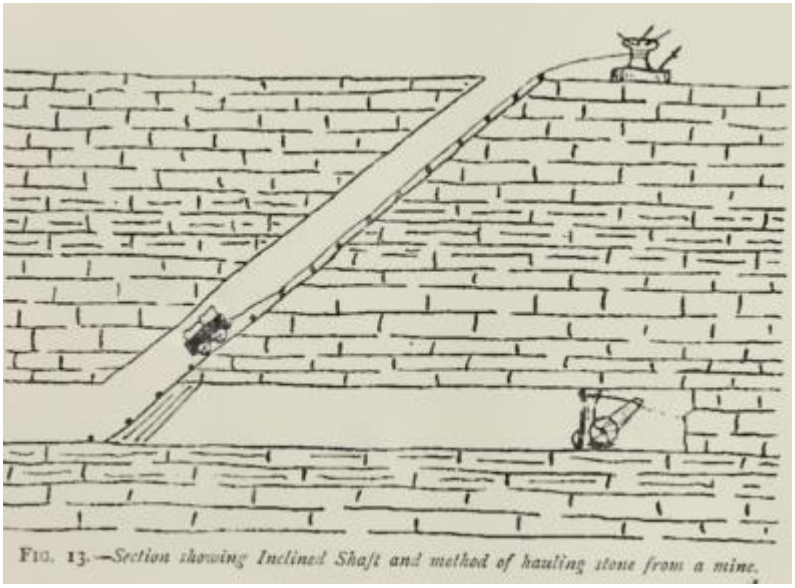

FIG. 13.—*Section showing Inclined Shaft and method of hauling stone from a mine.*

As will have been surmised from the legend attached to fig. 14, the stone is transferred from the various headings to the bottom of the inclined shaft in truck running on tram-rails. In the majority of the workings the haulage underground is effected by means of horses, but in the case of the Clift Quarry (No. 30) in the Box area; and some other workings connected therewith, the stone is drawn out on the flat by means of a steam engine. That from Corsham Down Quarry (No. 37) is placed in railway trucks underground, communicating directly with the Great Western Railway system. In a few of the smaller quarries, or where no tram lines are laid down, the stone is drawn out on the flat in wagons, by horse-teams.

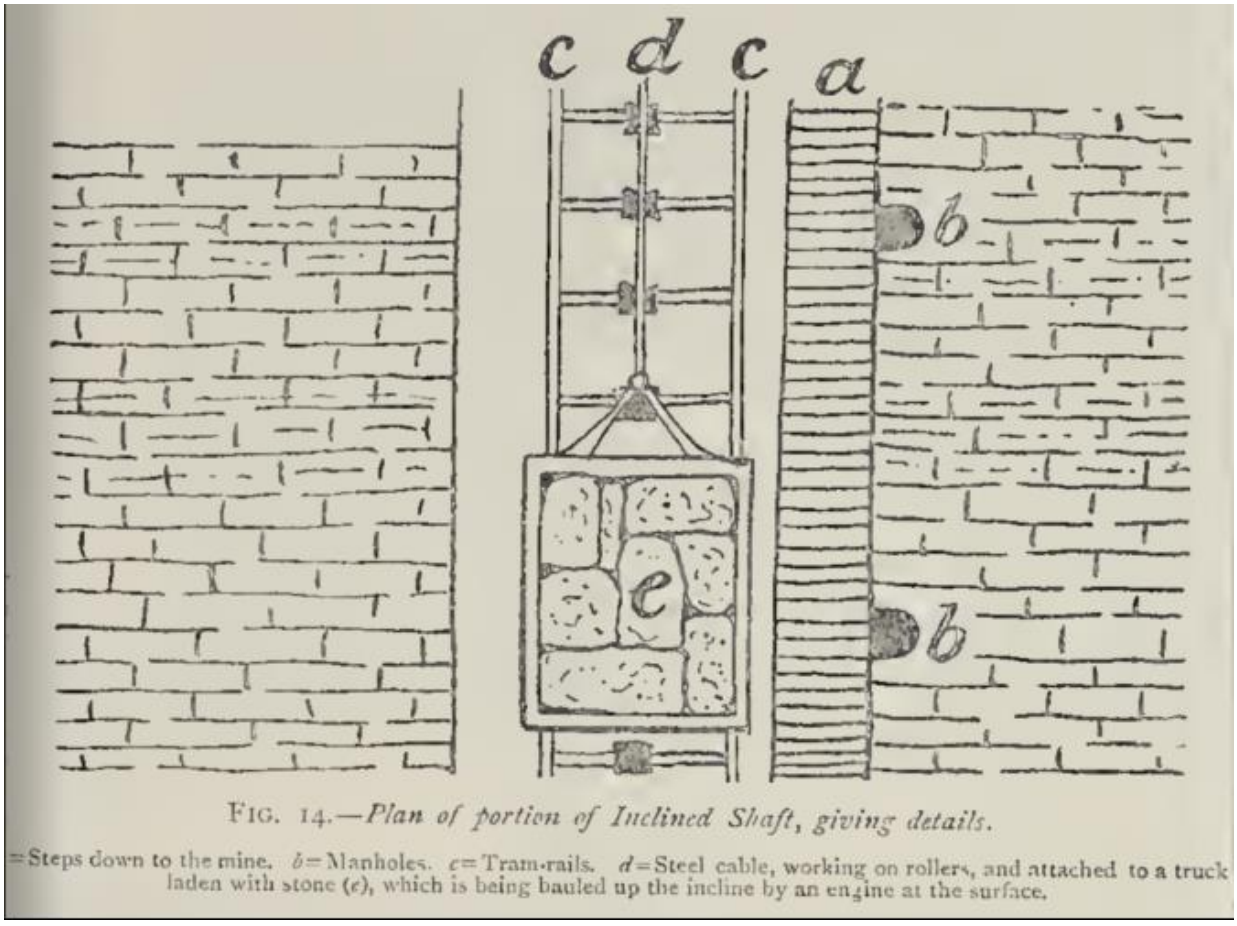

FIG. 14.—*Plan of portion of Inclined Shaft, giving details.*

=Steps down to the mine. *b*=Manholes. *c*=Tram-rails. *d*=Steel cable, working on rollers, and attached to a truck laden with stone (*e*), which is being hauled up the incline by an engine at the surface.

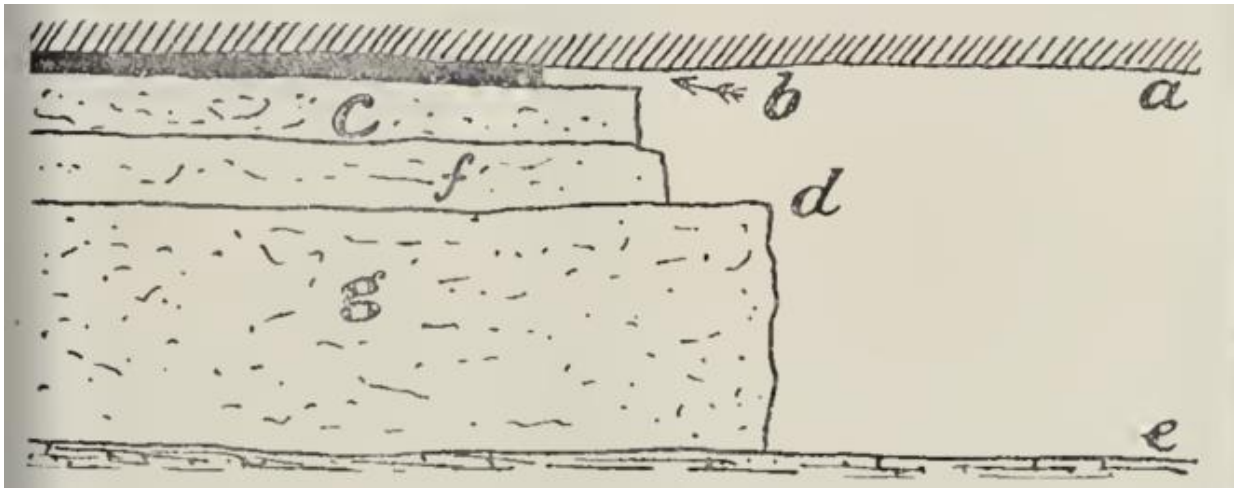

FIG. 15.—*Section of heading underground, showing method of quarrying Bath stone.*

a = Roof of working. *b* = Jad. *c* = Picking bed. *d* = Picking standing. *e* = Bottom of quarry. *f*, *g* = Blocks about to be quarried.

In regard to the actual method of "getting" underground, we would direct attention to fig. 15. The first operation in driving the heading is to remove two or three inches of the stone immediately under the roof, by means of picks; the part thus to be remove

TABLE NO. 1.—*Thickness of Bath Stone Beds.*

Quarry, or Point.	ft. in. Below 1 0	ft. in. 1 0 to 1 6	ft. in. 1 6 to 2 0	ft. in. 2 0 to 2 6	ft. in. 2 6 to 3 0	ft. in. 3 0 to 3 6	ft. in. 3 6 to 4 0	ft. in. 4 0 to 4 6	ft. in. 4 6 to 5 0	ft. in. 5 0 to 5 6	ft. in. 5 6 to 6 0	ft. in. 6 0 to 6 6	ft. in. 6 6 to 7 0	ft. in. 7 0 to 8 0
No. 1	6	1	...	...	1	...	...	...	.	...	. .	. .	...	.
,, 3	6	1	1		...	..	...	...	...	.	...	.	...	...
,, 4	2	..	3	2	2	1	1	...	...	...	. .	...	...	...
,, 6	1	1	...	2	2	...	...	1	...	...	...	...	...	...
,, 7	3	4	4	...	...	...	...	...	...	...	...	...	...	...
,, 8	8	...	1	...	...	...	...	...	...	...	..	...	...	...
,, 9	...	3	...	1	1	...	...	...	...	...	...	...	...	. .
,, 10	3	...	...	1	. .	..	1	1	...	...	...	...	...	...
,, 11	...	...		1	1	1	...	1	...	...	...	...	...	...
Bath area	29	10	9	7	7	2	2	3	...	...	...	...	...	. .
No. 12	...	...	...	...	...	...	...	...	...	...	1	...	...	...
,, 13	...	...	...	...	...	...	...	...	...	...	...	1	...	...
,, 14	...	...	. .	...	...	...	. .	...	...	. .	...	...	...	1
,, 15	...	...	...	...	. .	...	...	...	...	...	...	...	...	1
,, 16	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Limpley Stoke area	...	...	...	...	...	...	...	...	...	...	1	1	...	3
No. 17	...	...	1	...	1	...	. .	...	...	...	...	...	...	...
,, 18	...	...	1	...	...	1	. .	...	...	...	...	...	...	...
,, 19	.	.	1	...	...	1	. .	...	...	...	...	...	...	...
Winsley area	. .	...	3	.	1	2	...	...	...	...	..	...	...	...
No. 23	...	. .	...	...	...	...	...	...	...	...	...	...	...	1
,, 24*a*	.	...	...	...	...	. .	...	...	...	...	...	...	1	...
,, 24*b*	...	...	...	...	...	1	...	...	1	...	...	...	...	...
,, 24*c*	.	...	...	...	.	1	...	...	...	...	1	...	. .	...
Westwood area		...	..	...	.	2	...	...	1	. .	1	. .	1	1

No. 25		3	5	1	2		1	...	...	...	...	...	..	...
,, 26*a*	2	1	2	1	2	...	..	...	...	..	...	...	...	...
,, 26*b*	..	3	2	2	1	.	...	1	..	...	..	...	...	...
,, 27*a*	4	2	2	2	...		.	...	...	...	...	..	..	...
,, 27*b*	...	2	...	1	1	2	1	..	...	...	...	..	..	...
,, 27*c*	...	1	2	1	4	.	...	...	1	..	..	...	...	...
,, 27*d*	1	1	2	.	1	1	1	...	...	...	...	...	...	...
,, 27*e*	.	...	2	1	...	...	1	...	2	...	...	...	...	...
,, 28*a*	3	3	5	.	...	...	...	...	..	...	...	...	...	...
,, 28*b*	3	3	4	...	..	.	.	...	..	...	...	...	...	...
Farleigh area	13	19	26	9	11	3	4	1	3	...	...	...	...	...
No. 29	...	...	...	1	...	...	2	...	...	...	.		...	...
,, 30*a*	...	1	2	1	2	1	.	...	..	...	..		...	...
,, 30*b* .	...	...	...	1	3	1	1	...		...	...		...	...
,, 30*c*	.	...	...	.	...	2	2	...	1	...	.	.	...	...
,, 30*d*	.	.	1	1	1	...	1	...	..	1		.	...	...
,, 31	.	...	2	..	...	1	1	..	1	...	.	...	...	...
,, 32		...	1	2	1	...	1		...	...	.	..	...	...
,, 33*a*		1	...	..	1	...	1	..	..	...		..		...
,, 33*b*	...	...	...	..	...	...	1	1	...	...	..	...	...	..
Box area		2	6	6	8	5	10	1	2	1		.	..	.

No. 35	...	2	2	4	1	...	1	...	...	...	.		...	...
,, 37*a*	...	...	2	2	...	3	.	1	...	...			...	...
,, 37*b*	..	...	2	...	..	..	1	...	...	..		.	...	...
,, 38*a*	...	1	1	1	...	1	...	..	...	..		..	.	...
,, 38*b*	1	1	1	...	1	...	...	...	...	...		.	.	...
,, 39*a*	...	1	3	1	2	...	1	...	...	...			..	...
,, 39*b*	...	...	3	2	1	...	...	..	...	...			. .	...
,, 39*c*	...	3	4	1	...	...	...	.	.	...	.		...	..
,, 39*d*	2	3	5	.	...	...	...	.	...	.		...	. .	...
,, 40*a*	...	1	3	1	...	1		...	...	...		...	...	...
,, 40*b*	1	...	4	1	..	. .	.		...	...	.	.	...	...
,, 41	...	2	3	1	1	. .	.	...	...	.			...	...
,, 42	1	...	3	...	1		1			...		.	. .	...
Corsham area	5	14	36	14	7	5	4	1	...	...	. .	.	...	...

Quarry, or Point.	ft. in. Below 1 0	ft. in. 1 0 to 1 6	ft. in. 1 6 to 2 0	ft. in. 2 0 to 2 6	ft. in. 2 6 to 3 0	ft. in. 3 0 to 3 6	ft. in. 3 6 to 4 0	ft. in. 4 0 to 4 6	ft. in. 4 6 to 5 0	ft. in. 5 0 to 5 6	ft. in. 5 6 to 6 0	ft. in. 6 0 to 6 6	ft. in. 6 6 to 7 0	ft. in. 7 0 to 8 0
No. 43*a*	...	2	2	..	1	1	1	...	...	...	...	...	.	..
,, 43*b*	..	2	1	2	1	2	...	...	.	. .	...	...	...	...
,, 43*c*	1	...	1	3	3	...	...	..	...	...	...		. .	...
,, 44*a*	...	2	2	1	...	1	1	...	...	...	...	...	.	...
,, 44*b*	1	.	1	1	1	...	2	...	...	...	...	...	.	...
,, 44*c*	1	1	3	...	2	...	1	...	...	. .	. .	. .	...	...
,, 45*a*	1	1	5	..	3	...	...	.	...	...	...	..	...	...
,, 45*b*	2	1	4	...	1	1	...	.	...	...	...	..	...	.
,, 45*c*	1	1	4	1	1	...	...	. .	...	.	. .	.	...	...
,, 46	...	3	2	2	...	...	...	...	...	. .	...	...	...	...
,, 47*a*	..	1	5	1	1	...	. .	..	...	...	...	...	.	...
,, 47*b*	...	1	1	1	1	2	1	...	...	...	...	...	...	...
,, 47*c*	. .	2	1	3	...	1	1	...	...	...		...	...	...
Monk's Park area	7	17	32	15	15	8	7	...	...	...		...	. .	...

Areas. — *Summary.*

Bath	29	10	9	7	7	2	2	3	...	...	...	...	...	...
Limpley Stoke	...	...	...	...	...	...	...	..	...	...	1	1	...	3
Winsley	...	...	3	..	1	2	...	...	...	...	. .	.	. .	...
Westwood	...	...	...	...	...	2	...	...	1	...	1		1	1
Farleigh	13	19	26	9	11	3	4	1	3	. .	.		...	...
Box	...	2	6	6	8	5	10	1	2	1		. .	...	...
Corsham	5	14	36	14	7	5	4	1	...	...	.	.	...	...
Monk's Park	7	17	32	15	15	8	7	...	...	. .		.	...	. .
Totals	54	62	112	51	49	27	27	6	6	1	2	1	1	4

is called the “jad,” or “picking jad " (b) creating this space the quarrymen are enabled to insect tools to loosen the blocks below but in order to do this more effectually a third bed (c), known as the “picking bed," is also taken out, both this and the jad being reached from a ledge called the “picking” standing's (d) whereon the picker stands. Plenty of room having now been obtained, the one handled saw is called into requisition, and with this, and subsequently iron bars, the blocks are removed. A hand-crane is use at every heading to assist in the work.

Under certain circumstances a “lewis” is inserted into the face of the block, and this being attached to the crane, either directly or indirectly, is utilised for dislodging the blocks from position. At point b in the Clift quarry (No. 30) the “jad” was being picked from scaffolding .In sawing underground, water is always used, not So much that it makes the stone softer along the line of cutting, but because it washes out the dirt made during the operation, and thus frees the cut of obstruction. The roofs of the workings vary considerably, some being very sound, others permeated by innumerable cracks. The general method of keeping up the roofs in driving ahead is to leave pillars of the stone at intervals. Where the roof is good these are left far from each other, when bad they are arranged close together, or the bad places may be strutted up by timbering. The term “breach” is applied to the width from pillar to pillar and a “wrist” is the taper-shaped (smaller at back than front) stone first pulled out from under the jad in working ahead.

The locality in the Box Ground group is known as the “Cathedral,” is interesting, as showing the method of obtaining stone from mines years ago. Here a vertical shaft was sunk, which on reaching the building stone, levels widened out in the form of a gigantic bell, or a dome with a hole in its roof, up which the stone was lifted by chain and horse-gearing. The walls are scored by pick marks, as in the open working at Murhill.

The disposition of the strata, known as “wedge bedding,” is a great nuisance to quarrymen, creating, as it does, sloping beds and, near the roof, tapering blocks leading to much waste. Faults, naturally, are not regarded with much favour, seeing that they disturb the general regularity of the beds and often lead to a considerable amount of unremunerative work. Fig. 16 shows how step-faults are dealt with.

Quarrying is also occasionally impeded by wide joints containing ferruginous clay (“barrs”) which discolours stone in the vicinity, and in former geological times allowed the free percolation of water, with subsequent regional decomposition.

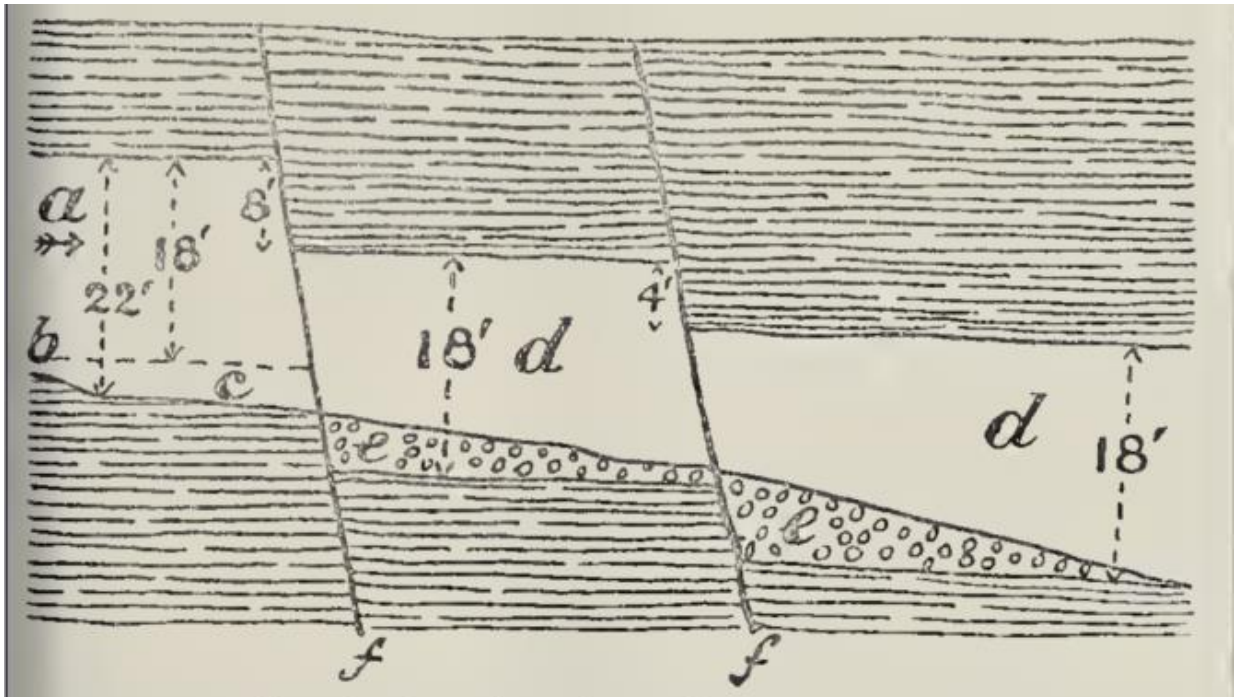

FIG. 16.—*Quarrying underground through step-faults.*

f, *f*=Faults. *a*=Gallery worked in the direction of the arrow, in good stone. *b*=Floor at that time. *c*=Useless stone blasted away, lowering floor to assist in working out faulted stone at *d*, *d*. *e*, *e*=Rubble filled in (after abstraction of stone) to level of floor at *c*.

IG. 17.—*Method of conveying stone from Park Lane Quarry* (*No.* 47) *to the Corsham railway station.*

=Trucks being pulled up incline by the stationary engine *b*. *c*=Truck running down inclined plane to railway station yard *d*. *x*=Entrance to quarry.

SEASONING.

We have very little to say in regard to this. At many quarries the stone was either being converted on the spot immediately after it was extracted, or was being despatched to various "jobs." In such cases seasoning was, of course, not possible. in saying this we convey no imputation against the quarry owners, inasmuch as many architects and builders prefer not to have the stone seasoned. That process hardens the material, and in consequence increases the cost of labour, and there being a demand for the unseasoned stone, it is, naturally, supplied. At the same time, we could not help feeling that amongst certain of the smaller quarry-owners no serious attempt was being made to weather " or season the stone, even where it might have been desired. The case was different with larger firms, at whose quarries immense stacks of stone were often found. When stacked above ground to "weather" in winter time much of the, material is liable to deteriorate, so that, the stone quarried in mines during that season of the year is either stored in the spacious galleries underground, or sent off at once to the building. Having said this, we leave our readers to imagine what may happen to some of it when drawn from the quarry during winter and used at once for exteriors. The material stored underground is taken above during the early spring, is then stacked, and being exposed to the air is allowed

to season in summer-time, after which it is not so liable to decay. A great deal has been made in the past of the improvement effected in “weathering” such stones as that from Bath before using them. We do not desire to make any further comment than to remind who attach such great importance to this, that no amount of seasoning can render a really bad block of stone good. From the manner in which some people allude to the beneficial effects of seasoning one would be led to imagine that any rotten, worthless kind of stone is converted into a good one by being simply placed out in the wind for a season. The stone must be good in the first instance, and it will then most probably be improved by being allowed to weather," but that depends entirely on the particular kind of stone. We cannot now discuss the desirability, or other-wise, of always building Bath stone “on its natural bed,” but we may remark in this connection that in order to facilitate masons in ascertaining the direction of the bedding- planes, much of the material is marked before leaving the quarries.

CARRIAGE OF STONE.

Bath stone is taken from the quarries either by horse-teams, traction engines, railway direct, or a system of inclined planes. We may only refer to the last-mentioned, which is adopted principally in area I, and in the western part of G. The following diagram (fig. 17) shows that between the Park Lane Quarry and Corsham Station a low ridge intervenes. Instead, therefore. of starting the loaded trucks down an incline direct to the station, as is done from the Clift Quarry to Box, an engine (b) is stationed at the summit of the ridge which pulls the trucks (a) from the entrance of the quarry to the top of the hill. Then (each truck being in charge of a breaksman) they are permitted to accomplish the remainder of the journey to Corsham Station by gravitation, with a little occasional assistance from a horse. The quarries in the southern part of the Bath district are fed partly by a canal, whilst railways, as will be seen on referring to fig. 1, run through the whole system.

MICRO-STRUCTURE.

This has been fully described and illustrated in our columns on a former occasion (The Builder, January—June, 1894, pp. 354, 372) and the reader is requested to consider what we then said with reference to what follows.

CHEMICAL COMPOSITION.

We have not thought it worth while to make independent chemical analyses of Bath stone, seeing that its properties in this respect are not important as throwing any light on the quality of the material, and may be sufficiently gleaned from what we have already said concerning its micro-structure. At the same time, as a matter of general interest we may quote the following :-

	Coombe Down stone.*	
	I.	II.
Water	·88	·74
Silica	·42	·85
Protoxide of iron	1·22	1·04
Alumina	·46	·61
Carbonate of lime	95·14	95·74
Carbonate of soda	·71	·71
Magnesia	·32	·23
Chloride of sodium	·05	·05
	99·20	99·97

	Monk's Park stone.†	Box Ground stone.‡
Carbonate of lime	97·2	94·52
Oxide of iron and alumina	1·6	1·20
Silica	1 0	—
Carbonate of magnesia	·2	2·50
Water and loss	—	1·78
Bitumen	—	trace

* Ransome and Cooper, "Mem. Geol. Surv. Gt. Brit.," Vol. ii., Pt. 2 (1848), p. 691.
† Analyses made by Professor Attfield.
‡ Daniell and Wbeatstone, "Commissioners' Report" (1839), p. 30.

STRENGTH.

We give the following particulars (Table No. 2) concerning the strength of the different varieties of Bath stone in order that their general resistance to crushing maybe under- stood .—

TABLE NO. 2.—*Strength of Bath Stone.*

Name of Stone.	Size of Cube.	Cracked. Tons per sq. foot.	Crushed. Tons per sq. foot.	Test made by
	in.	Minimum. Maximum.	Minimum. Maximum.	
Corsham Down ("fine upper" bed)	12	64·4	83·7	Kirkaldy.
,, ,, (bottom bed)	12	75·1	102·8	,,
,, ,, ,, ,,	1½	—	87·4 | 97·7	Poole & Son.
,, ,, ,, ,,	3	—	185·1	,,
,, ,, ,, ,,	3	61·7 | 87·4	74·3 | 87·4	,,
,, ,, ,, ,,	2¼	—	70·1 | 128·6	Beare.
Corngrit	12	84·1	116·3	Kirkaldy.
,,	2¼	—	107·3 | 172·4	Beare.
Box Ground	1½	—	76·3	Poole & Son.
,, ,,	1½	66·0	73·7	,,
,, ,,	3	—	133·7	,,
,, ,,	3	43·7 | 48·8	54·0 | 54·0	,,
,, ,,	2	—	95·0	Roy. Com.
,, ,,	2¼	—	81·9 | 126·1	Beare.
Monk's Park	6	150·8 | 193·6	172·6 | 210·9	Kirkaldy.
,, ,,	2¼	—	112·8 | 172·0	Beare.
Farleigh Down	2¼	—	58·1 | 69·3	,,
Coombe Down	2¼	—	93·3 | 151·2	,,
Stoke Ground	2¼	—	70·4 | 106·7	,,
Winsley Ground	2¼	—	85·2 | 114·9	,,
Westwood Ground	2¼	—	89·7 | 140·4	,,

TABLE No. 3.—*Experiments on some Physical Properties of Bath Stone.*

Name of Area.	No. of qu'ry, or point.	Specific Gravity.		Weight per cubic foot in lbs.		Absorption of Water—per cent.					Remarks.
		True.	Particles	Dry.	Wet.	1 sec.	1 min.	30 min	1 day.	1 week	
Bath.	1	2·04	2·54	127·3	158·5	1·45	4·13	8·27	8·75	9·48	Odd Down.
	6	1·92	2·55	119·8	159·1	2·33	6·43	10·52	11·11	12·86	Coombe Down.
	7	2·10	2·61	131·0	162·9	1·69	4·36	7·76	8·25	9·22	"
	8	1·77	2·49	110·4	155·4	2·63	7·00	12·57	13·15	16·37	"
	10	2·10	2·43	131·0	151·6	·73	2·44	5·62	5·86	6·35	"
Limpley Stoke	11	1·90	2·40	118·5	149·8	2·00	5·00	8·50	9·00	11·00	Third bed from top.
	12	1·95	2·58	121·7	161·0	2·31	6·18	10·30	11·08	12·37	
	13	1·89	2·57	117·9	160·4	3·06	8·16	12·24	12·75	14·03	
	14	2·10	2·60	131·0	162·2	1·35	4·05	8·37	8·64	9·18	
	15	1·96	2·65	122·3	165·4	2·58	7·29	11·52	12·00	13·17	
Winsley	18	2·04	2·57	127·3	160·4	1·62	4·17	9·28	9·74	10·20	
Westwood	23	2·09	2·64	130·4	164·7	1·49	4·47	8·70	9·20	9·95	
	23	2·07	2·39	129·2	149·1	·86	2·15	5·59	6·02	6·45	Paving Bed.
	24[a]	2·02	2·63	126·0	164·1	1·96	5·55	10·13	10·45	11·43	
	24[b]	2·06	2·59	128·5	161·6	1·86	4·90	8·41	9·11	9·80	
	24[c]	2·04	2·57	127·3	160·4	1·61	4·31	8·34	8·89	9·97	
Farleigh and Kingsdown.	25	2·00	2·61	124·8	162·9	1·76	5·58	10·29	10·58	11·76	" Oaty " bed.
	25	1·84	2·65	114·8	165·4	4·33	13·66	15·33	15·33	16·66	" Fine grained " bed.
	25	2·06	2·69	128·5	167·9	2·26	7·80	10·07	10·57	11·33	" Fine " bed.
	27[a]	1·88	2·61	117·3	162·9	2·65	8·77	11·70	11·96	14·62	
	27[c]	2·09	2·65	130·4	165·4	2·35	7·06	8·44	8·70	10·11	Red bed.
	27[e]	1·88	2·62	117·3	163·5	3·21	10·45	12·86	13·13	15·00	
	28[a]	2·02	2·67	126·0	166·6	2·56	7·69	10·76	11·02	12·05	
	29	1·91	2·55	119·2	159·1	2·82	7·96	11·05	11·56	13·11	
Box.	30[a]	1·95	2·47	121·7	154·1	2·07	5·44	9·06	9·58	10·62	
	30[b]	2·01	2·57	125·4	160·4	1·75	5·52	9·04	9·54	11·04	
	30[c]	1·89	2·42	117·9	151·0	2·14	6·16	9·38	9·65	11·52	
	30[d]	2·06	2·51	128·5	156·6	1·73	3·72	6·70	6·94	8·68	
	31	2·03	2·52	126·7	157·2	2·41	5·55	7·48	7·97	9·42	
	32	1·98	2·54	123·5	158·5	2·07	4·43	8·58	8·87	10·94	
Corsham.	35	2·05	2·68	127·9	167·2	1·93	6·03	10·38	10·62	11·35	Hartham Corsham.
	35	2·04	2·66	127·3	166·0	2·25	7·51	10·27	10·77	11·52	" ground.
	35	2·08	2·67	129·8	166·6	1·55	5·95	9·32	9·84	10·62	" " Scallett."
	37[a]	1·95	2·68	121·7	167·2	3·16	8·97	12·92	13·19	13·98	Bottom bed.
	"	1·96	2·69	122·3	167·9	2·45	7·66	11·93	12·57	13·80	"
	"	2·09	2·67	130·4	166·6	1·47	4·66	9·09	9·58	10·29	Corngrit.'
	"	2·00	2·63	124·8	164·1	2·38	7·16	10·14	10·74	11·94	Upper bed.
	37[b]	2·03	2·67	126·7	166·6	1·94	6·55	9·95	10·67	11·89	"
	38[b]	1·90	2·67	118·5	166·6	2·84	8·26	13·10	13·67	15·10	Huddswell.
	39[a]	2·07	2·65	129·2	165·4	1·40	4·47	9·17	9·88	10·58	Corngrit.
	39[b]	1·93	2·65	120·4	165·4	2·37	8·44	11·87	12·13	13·98	
	40[b]	1·93	2·66	120·4	166·0	1·71	8·60	12·76	13·26	14·00	
	41	1·92	2·70	119·8	168·5	2·81	8·80	13·63	13·63	15·05	
	41	2·06	2·62	128·5	163·5	1·82	5·18	9·75	9·75	10·37	Blue bed.
Monk's Park	43[b]	2·15	2·66	134·2	166·0	1·14	4·21	8·05	8·05	8·81	
	43[c]	2·03	2·70	126·7	168·5	2·00	7·00	10·50	10·50	12·25	
	44[b]	2·10	2·67	131·0	166·6	1·87	5·86	8·92	9·15	10·09	
	46	1·98	2·68	123·5	167·2	3·49	9·94	11·55	11·82	12·90	Ridge Corsham.
	47[a]	2·02	2·68	126·0	167·2	2·56	7·92	11·18	11·42	12·12	Park Lane.
	47[b]	1·99	2·67	124·2	166·6	2·82	8·74	11·82	11·82	12·85	"

Analysing these, we find that the Box Ground stone is credited with the lowest crushing weight, namely: 54 tons per square foot, whilst the highest is the Monk's Park: with 210.9 tons per square foot. The sample, of Box Ground tested, however, must have been very abnormal, for the other results on the same stone come out at a much higher figure. The experiments of Professor Beare are the most recent, and probably apply to the materials as at present quarried it is to he regretted that the experimenter did not himself select the samples in the quarries.

OTHER PHYSICAL PROPERTIES

This section is, perhaps, the most important contribution we have to offer in regard to knowledge of Bath stone. The reader is requested to interpret the results recorded in the following table (Table No. 3) in the light of our observations " On the Structure and Physical Properties of Building Stones," contained in a series of articles published in the Builder. January—June: last year.

In regard to these experiments it may be noted that they are, every one original, and were carried out by ourselves on samples during our visit to the district. Moreover, we have recorded the results afforded by every sample dealt with. It appears that the stone which absorbed the least amount of water during one week immersion is from the Mount Pleasant quarry (No. 10), on Coombe Dowa, which only imbibed (935 per cent. of its bulk. The Westwood Ground paving bed (quarry No. 23), runs it very close with 6.45 per cent but this latter is not, strictly speaking, building stone, as previously remarked. The sample absorbing the most water was from Longsplatt quarry (No. 25): Kingsdown—the uppermost "fine-grained" bed, third being from the top. It is noteworthy, however that the stone from Quarry No. 8 on Coombe Down should have taken in as much as 16.37 per cent, so that almost the highest and lowest results on absorption should be obtained from one area. We could not adduce a more striking illustration of the extreme variability of Bath stone in point of openness and general quality even in restricted portions of the district and the necessity of careful selection is at once apparent. The stone from the last-mentioned quarry has also the lowest specific gravity (1.77). One of the most striking facts ascertained by the absorption experiments that all Bath stones imbibe nearly as much water in half-an-hour as they do in one week in which respect they somewhat resemble Portland, though the latter stone as a whole is far less absorbent. Again, the differences in the results for 30 min. and the day on Bath stone are very slight ; in some cases absorption during immersion beyond 30 min. and up to one day was absolutely arrested, after which we notice an increase in the amount at the end of a week. This shows beyond the shadow of a doubt, that some agent was at work in opening up the pores of the stone, or rendering it more absorbent, during the final six days of the experiments. We have been at much pain to ascertain the cause of this and beg to offer the following explanation, It was observed that after being in the water a few minutes the majority of the stones commenced to disintegrate slightly ; but there was no material increase in the amount disintegrated after that, for some 3 or 4 days. On the expiration of that period, however: it would appear that the rate of wasting became slightly accelerated but after the sixth day it ceased. We are speaking now as to the general effects produced : certain samples were not subject to this peculiarity and constitute remarkable exceptions to the general rule. Some of the salts in the stone are soluble in water and it may be that they had as far as possible, to be removed before maximum absorption could be arrived at. Itis probable that in some instances progressive absorption may account for the phenomena but this cannot apply to many samples. The rate of absorption was, in other respects very peculiar: and it will be seen on a casual inspection of the table that the results obtained on the first dip (1 second) are by no means indicative of what will take place during a week—except, of course in a general way. To this there are a few notable exceptions. On studying the table, several other points may be brought out: but we think the results, toa large extent, explain themselves

CONCLUSION

In concluding this somewhat lengthy article we may observe that the Bath stone as now used is different to most of that worked at the commencement of the century or even seventy years ago. It was therefore with great reluctance that we brought our selves to quote the chemical analyses of Coombe Down stone made in 1848, or those by Daniell and Wheatstone in 1839. We admitted them only after satisfying ourselves that the Coombe Down stone referred to must, of necessity, have been exploited very close to the present workings and also the Box Ground stone dealt with most probably was obtained from the Cathedral (Quarry No. 30)1 or near by. Bath stone has been raised in enormous quantities from Bathampton Down, and the remains of the inclined plane to the valley below, as at Murhill, may also be seen. On Combe Down, also, many large abandoned quarries exist.