



Gloucestershire Geology.

Having Special Reference to the Commercial Value of the County's Mineral Deposits.

(By L. Richardson, F.G.S., Hon. Secretary of the Cotteswold Naturalists' Field Club.)

THE geology of Gloucestershire presents so many points of interest that in the following brief notice but one aspect of the subject can be considered—the present and prospective commercial value of the county's mineral deposits. To describe at length the general geological characteristics of the county, and to investigate the causes which have given it a topography of so great a diversity and charm, would be far too alluring a theme to pursue in the limited space allowed me here.

Gloucestershire's quite remarkable achievements along industrial lines were no doubt owing, originally, to its wealth of timber, building-stone, iron, coal, and water power. Of these essential factors of production, timber and water power do not come within the scope of the present article; except it should be noted that the large forest reserve in the Forest of Dean and the considerable extent of wooded country on the Cotteswolds still supply in large part the material for a number of flourishing industries, such as the charcoal and chemical works at Lydbrook, the turned-wood works at Longhope, the stick factories in the Stroud valley, and the sawmills at various places throughout the county, and that the water power, which in other counties has been almost superseded by steam, is so abundant and so easily available that it is still one of our most valuable assets. Indeed, it may be said with entire accuracy that no other county in England possesses greater available water power; the configuration of Gloucestershire, arising from the sea-level to a height of nearly 1,100 feet, and being traversed from Meon Hill on the north to Lansdown on the south for a distance in a direct line of fifty-seven miles by the Cotteswolds, giving rise to scores of unfailing streams capable of turning innumerable wheels.

Of our mineral deposits iron was probably the first to form the basis of an extensive industry. It is well known that the Romans largely used Gloucestershire iron-ore, and that for several centuries subsequently its extraction and manipulation gave employment to a considerable number of men, particularly in the Forest of Dean district. However, owing to more extensive and more accessible deposits elsewhere, and the improved transportation which has made the new fields available, iron mining has become practically a lost industry in the county.

IRON.

The iron deposits in Gloucestershire cover an area of considerable extent. The Gothite and brown Hæmatite ores occur in the carboniferous Limestone, Millstone and Pennant-grits, as well as Limonite; the clay-ironstone occurs in the Coal-Measures, especially in the Kingswood district, near Bristol; and Mr. R. Etheridge noted that along the Frampton Cotterell, Iron Acton, and Rangeworthy fault much ore occurred. Hæmatite also occurs in the Dolomitic Conglomerate, but as the thickness of this deposit is so very variable any iron mining in connection with it is uncertain. It may be that in the future a growing scarcity elsewhere, or the application of more scientific methods, will again make iron mining and smelting a profitable industry in the county.

COAL.

The Gloucestershire coal deposits occur near Bristol and in the Forest of Dean. Professor E. Hull stated that the area of the Forest of Dean Coalfield is 34 square miles. The Coal-Measures attain a thickness of 2,765 feet, and contain 15 seams, of which eight are of a thickness of 2 feet or more, the thickest seam being about 5 feet. The structure of this coalfield is very simple, being a complete "basin." The Bristol coalfield is a pear-shaped basin, having the broad end to the south. In places it is much affected by faults, and is traversed by an anticline near the southern end. Resting upon the Millstone-grit are the Lower Coal-Measures; then comes about 1,000 feet of Pennant-grit, succeeded by the Upper Coal-Measures. Writing about the year 1865, Mr. R. Etheridge stated:—"This lower series of coals, etc., as they occur at Kingswood, St. George's, etc., are a marked and grand feature in the structure and economical value of the district, there being no less than 18 seams of coal, possessing a united thickness of 42 feet of workable coal." In the Pennant-grit are three or four workable seams, nearly all in the lower portion. Owing to the thickness of the grit no shaft has as yet been sunk through it to the Lower Coal-Measures, the beds being only worked where they come to the surface near the sides of the basin. According to Mr. H. B. Woodward, these Coal-Measures "yield but four workable veins." Of the 150 square

miles which Professor Hull stated is the extent of this basin only 45 are not concealed by newer formations, such as the Trias. Under the upper part of the Severn estuary and east of Chepstow, Coal-Measures have been proved by borings, but it is uncertain to what extent they are coal-bearing.

The last published census gives the number of employees engaged in mining coal and shale as 8,420. It should be added that, owing to the nature of the Coal-Measures, the collieries are almost entirely free from fire-damp and other objectionable features. Several of the collieries—notably in the Forest of Dean district—use electricity both as a motive power and for lighting purposes.

BUILDING-STONES.

As regards building-stones, Gloucestershire may be fairly said to be better off than the adjoining counties, because the extent of the Pennant-grit, the "yellow-beds" of the North Cotteswolds, and the freestone (such as is quarried at Leckhampton Hill) near Cheltenham is very considerable and easy to open out. In Somerset there is an equal variety, if not more, of workable stone, but the respective deposits do not extend over very large areas. The following partial enumeration will give some idea of the diversity and character of the principal building-stones in the county.

"Millstone-grit," or firestone—an exceedingly hard, tough rock, composed of grains of sand cemented by a siliceous cement—is found. A cubic foot of the rock, according to Professor C. Lloyd Morgan, weighs about 161·11 lbs. Subjected to crushing tests in the testing machine in the University College, Bristol, a cubic inch of a close-grained variety of this rock began to split at 10·17 tons, and broke down at 13 tons. The extreme hardness of the rock renders it difficult to work, and therefore expensive in construction, nor can blocks of any size be obtained. It is, however, an exceedingly durable stone, and its rich, red colour, and somewhat rough facing, is not unpleasing to the eye.

"Pennant-sandstone" is the favourite building-stone of modern Clifton, but it does not appear to be very desirable for ecclesiastical structures. It is largely quarried at Hanham, Fishponds, and Stapleton, near Bristol. It is a coarser-grained rock than Millstone-grit and a denser stone, but much less hard and durable. The colour is greenish-grey, bluish-grey, or red. For house-building it is now generally regarded as the best stone, and it is also a good paving-stone. This Pennant-grit is a deposit which comes between the Lower and Upper Coal-Measures. Whilst dealing with sandstones mention must be made of the Old Red Sandstone, a rock often seen in buildings near Bristol, but which is not a good weatherstone.

"Mountain Limestone"—the rock so well exposed in the gorge of the Bristol Avon at Clifton—is much used in that neighbourhood, and, indeed, wherever it is present, as at Wickwar, for rough walling and occasionally for houses. Fringing the Carboniferous or Mountain Limestone is a conglomerate known as the Dolomitic Conglomerate. The upper beds of it are usually of much finer texture than the lower, and such rock has been used in the construction of Clifton College and many walls in Clifton.

The "Liassic limestones," which occur at the base of the series, are poor in quality, and are seldom used except for common walling and for house walls when better material cannot be obtained. In the southern portion of the county are quarries at Horfield, Filton and Bitton; in the northern part, around Tewkesbury and at Elmore. While in South Gloucestershire the chief building-stone is Pennant-grit, in North Gloucestershire its place is taken by the freestone obtained from the Inferior Oolite.

Between Cleeve Hill and Stroud the best freestone comes just above a deposit called "Pea-grit," which is made up of small concretions resembling flattened peas. But in the North Cotteswolds the equivalent of this Pea-grit is the most important stone. The freestone of the Cheltenham district is of a yellowish-white colour, and is quarried at Cleeve Hill, Brockhampton, Whittington, Leckhampton Hill, Cowley, Cooper's Hill, Painswick, Scotsquar Hill, and the Frith Quarry; while it is also worked at Uley Bury, Selsley Hill, Nailsworth, and Stroud. Southwards it gradually thins out. In the North Cotteswolds the chief building-stone is a yellowish-brown stone, known as the "yellow-bed." It takes an easy dressing, and large blocks about 40 cubic feet in size are to be obtained, weighing 16 cubic feet to the ton. There are quarries at Westington Hill near Chipping Campden, Ebrington Hill, Bourton-on-the-Hill, Saintbury Hill, and Temple Guiting. A flaggy oolite known as the "tilestone" has been used locally for roofing purposes. "Ragstone-beds" are also worked locally for road-metal. With regard to working the Cotteswold freestones, such as those at Leckhampton Hill, there is one point which may be mentioned, and that is that the stone should be cut into the required shapes as soon after it is quarried as possible, because afterwards the water formerly absorbed exudes, and upon evaporation leaves a coating of carbonate of lime over the freshly-cut surfaces, which forms a protective covering. If the stone be cut or scraped afterwards, when dry it will be seen that it cannot be expected to withstand atmospheric ravages to the same extent.



The "Stonesfield Slate," which occurs at the base of the Great Oolite, furnishes good "slates" in places, such as have been used in the roofing of St. Matthew's Church at Cheltenham. It has been largely worked in the past on Sevenhampton Common and Eyeford Hill, and one quarry is now open at the former locality and two at the latter. These beds have been opened out at Througham, near Bisley, Stroud.

The "Great Oolite" has been extensively worked for a long time on Minchinhampton Common. As Mr. H. B. Woodward has observed: "The Weatherstone is a hard oolitic and shelly limestone, of coarse aspect and sandy in places, but very durable when dried by exposure to the sun. The stone does not readily absorb water, and consequently it resists the action of frost. A careful selection is, however, necessary." The Great Oolite is useful for road-metal when other stone cannot be obtained, and the same may be said of the Forest Marble. Both these stones are also useful for walls. The Forest Marble is worked at Ampney Crucis, near Cirencester.

From the foregoing brief reference it will be seen that the county contains the most valuable building-stones, exhibiting almost every variety of colour and texture, and, for the most part, easily quarried. The number of men engaged in quarrying, cutting and dressing stones in the county is nearly 2,000, as given in the last census.

CLAYS.

Clays suitable for making bricks and shaped ware are found in Gloucestershire chiefly in two deposits, known to geologists as Alluvium and Lias. The former deposit borders the Severn and Bristol Avon at various parts of their course. The Alluvium, or mud, brought down by the rivers is usually loamy, although, of course, its composition depends mainly upon the nature of the rocks traversed by the rivers higher up. The most extensive deposits occur near the Severn, and cover a larger area between Purton Passage and Avonmouth than between the Passage and Tewkesbury, although more use has been made of the deposit in the latter district, no doubt owing to the fact that the pits are nearer means of communication with the markets than are those in the southern portion of the county. In the past many pits have been opened out on the banks of the Severn, as the numerous old excavations testify, and there are now pits open at the Upper and Lower Lodes, Tewkesbury, and near Gloucester. There are many places left, however, where pits might be opened out to advantage. Near the river-side at Gloucester the loamy soil appears to be close upon 10 feet in thickness, but it soon thins out as the river is left. Between Oldbury and Berkeley there is a tract of Alluvium, and again between Aust and Avonmouth, aggregating nearly 25 square miles in extent. Unfortunately these tracts are somewhat difficult of access, but this will be remedied when the line from Avonmouth to Pilning is completed.

The other deposit which is valuable for brick-making purposes is the Lias. As the maps at the disposal of the agriculturist and others are those published by the Government Geological Survey, it is necessary to adopt their nomenclature; and for economic purposes, certainly in North Gloucestershire, this is the most suitable. According to the interpretation of that body, the clays found in the vales of Gloucestershire and Evesham belong to the Lower Lias, and the junction of this stage with the middle is near the foot of the Cotteswold escarpment, and is usually indicated by the outburst of springs and damp ground. In the southern portion of the county the Lower Lias does not cover a large area, and the clay-beds are thinner, although there are deposits which might be worked. In North Gloucestershire the clays are of considerable thickness, though it is doubtful if as much is usually thought. However, each zone of deposit has a considerable superficial extent, and this fact is important. Also, in most of these beds which are worked for clay, fossils are of small size—another point for consideration. Several pits are now being worked at different places, and other deposits are available.

About the best place to open a pit is at the junctions of the Middle and Lower Lias. Here the clay is more loamy, and the beds are, therefore, better adapted for brick-making. One or two matters may be mentioned to serve as a guide to locating this deposit. The Middle Lias is composed of this sandy shale and a "rock-bed" or Marlstone above. As the Marlstone is harder than the sub- and superjacent deposits, naturally it constitutes a feature in the Cotteswold escarpment, and on the outliers such as Alderton and Dumbleton, Oxenton,

Bredon, Churchdown, and Robins' Wood Hills. Below it there are the sandy clays, or shales, and their base is indicated by the outburst of springs and wet ground. Gorse-bushes, being particularly fond of a sandy soil, are also frequently useful in indicating its presence; indeed, in the North Cotteswolds this phenomenon is most noticeable. North of Stroud these beds and the succeeding stage, the Upper Lias, occur at rather too high an elevation to be profitably worked; but at Stroud, owing to various causes, the beds are at a lower contour, and accordingly pits have been opened out both here and at Stonehouse, the fine works of the Stonehouse Brick and Tile Company being located at the latter place. At Pilley, Cheltenham, beds containing some impure limestone bands are worked, but the rock and ironstone-nodules have to be picked out of the clay. At Robins' Wood Hill the same and higher beds (almost up to the Marlstone) are worked, and the clay obtained is excellent for brick-making. The south side of Churchdown Hill would be a good site for a clay-pit. In the valley of Cranham is a pit, presumably in Upper Lias clay, which has been worked since the time of Queen Elizabeth, if not earlier. Flower-pots, pans, drain-pipes, etc., are manufactured here.

OTHER MINERALS.

At Wick Rocks, near Mangotsfield, pits have been sunk in the Keuper Marls for ochre, which is ground at the rolling-mills near at hand. In 1890 the ochreous rock was about 4 feet thick, and occurred about 8 feet below the surface.

Celestine, or Strontium, is largely worked at Yate and Wickwar. It occurs in the Keuper Marls, and is found at several places in the Bristol area. It is exported to Germany for use in the refining of beet sugar. Gypsum also occurs somewhat abundantly in the Keuper Marls at Aust Cliff, near Pilning.

DEPOSITS OF SAND AND GRAVEL.

Deposits of "gravel" and sand—the Superficial Deposits—cover a very considerable part of Gloucestershire, especially the low-lying areas. Stretching down the central portion of the Lower Severn Valley is the accumulation of pebbles of quartzite and other hard rocks known to geologists as the "Northern Drift." It has been found a useful "gravel" for drives and mending the local roads, and pits have been opened out in it at Bredon, Shuthonger Common, and Twynning Green; while in the past it has been worked on Sandhurst Hill—perhaps better known as Wainlode Hill. A similar deposit covers much of the Vale of Moreton. Sometimes sand predominates, sometimes pebbles. Deposits of sand are fairly thick in places. According to Dr. Wright, a trial-boring at Hopwood's Nurseries proved as much as 40 feet. Certainly it covers a large area around Cheltenham, but sometimes much "gravel," composed of fragments of limestone from the Cotteswold Hills, are found mixed with it. Pits may be seen near Overbury, Prestbury, Charlton Kings, and Barnwood. Indeed, there are very many localities where it might be worked. Nearer the hills, of course, the "gravel" is mainly composed of the rocks which are exposed in the escarpment, and the deposit frequently furnishes a very good gravel for paths. In the southern portion of the county gravel deposits are rare. There were formerly workings near Bitton. One of the sub-divisions of the Inferior Oolite is a sand-deposit. It occupies a considerable area on the Cleeve Hill plateau, and was once dug for use in the Staffordshire potteries.

MINERAL SPRINGS.

It may be proper to add a word as to the mineral and hot springs to be found in the county. Four groups (saline and chalybeate) exist at Cheltenham, the chief spa; hot springs occur at Clifton, and petrifying springs at Kemerton; and warm saline springs occur at Gloucester, Newent and Ambleton. In 1839 Sir Roderick Murchison called attention to the fact that "at the new Spa near Tewkesbury the water, though very slightly saline near the surface, was found to be much more impregnated with salt as the sinking was carried downwards," and he had no doubt that "similar results would follow by deepening any of the mineral sources which are so numerous in the vale of Gloucester—those of Walton, the bottom of Churchdown Hill, etc., for instance."

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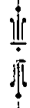
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