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THE
MINERALOGY

OF

DERBYSHIRE:

WITH

A DESCRIPTION OF THE MOST INTERESTING

MINES

IN THE

North of England, in Scotland, and in Wales;

AND AN ANALYSIS OF MR. WILLIAMS'S WORK,

Intituled "The Mineral Kingdom."

SUBJOINED IS

A Glossary of the Terms and Phrases used by

MINERS IN DERBYSHIRE.

By JOHN MAWE.

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and by John Drury, in Derby.*

1802.



P R E F A C E.

DERBYSHIRE has ever been considered as one of the chief mining counties in the kingdom, and was known to produce lead ore at a very early period. Since the Roman invasion, its mines have supplied the greatest part of Europe with their produce. It appears that the Saxons introduced their method of working the
A 2 mines,

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mines, the riches of which recompenced their labour; and the present mineral laws, customs, and technical phrases are derived from them. Perhaps no country yet known produces so many veins as the mining tract of Derbyshire; and the number of mines that have been sunk in various parts is incredible. Being a native of the county, and having resided several years in the most interesting part, I was applied to by a Spanish gentleman to make surveys of the principal mines, to collect their various productions, and more particularly, specimens from each stratum, describing their thickness, situation, and position; in order to shew an exact representation of the mines, for the cabinet of his most Catholic Majesty at Madrid. To ascertain

tain a correct statement of the geology and mines of Derbyshire, is a work worthy of the patronage of a Prince who enjoys so great a share of the precious metals produced in South America: it may prove an example that may merit the attention of other potentates; for collections thus formed, displaying the strata and their products, may lead to a more minute investigation, where such strata may occur; the best means of forming opinions being by comparison, if similar mountains and strata are met with, it would be very natural to expect similar substances; these circumstances have unfortunately hitherto attracted little notice. The ancient method of dressing and smelting lead ore is here still continued, and though

new veins are frequently cut, no analysis is made of their produce; it is much to be wished sufficient encouragement was given in this science, to render it worth the attention of a person of abilities to analyze mineral substances, in order to convey mineralogical information to that part of the community that is so much interested in them. For such a purpose Castleton seems to be the best situation, where such a variety of strata, mines, and mineral productions occur as perhaps no situation in this kingdom can boast. The various mines and veins of ore are of the first consequence, while the mountains around present a variety of strata worthy the attention of the geologist.

Freyberg and Schemnitz, the present
theatres

theatres of mineralogical knowledge had beginnings; is it not to be regretted that no institution for such information is established in this kingdom, the riches of whose mines have so long been celebrated?

Students attend the mineralogical lectures at Freyberg and Schemnitz from all parts of the world, and they are as much famed for the study of mineralogy, as Rome was for the fine arts.

Having frequently visited most of the mines in this kingdom, I have been repeatedly solicited to publish the observations I have made, with a view to guide the traveller to the most interesting points, and to describe those objects to the mineralogist, as they are presented by nature; as an observer addicted to no theory, I leave the scientific to form opin-

ions agreeable to their own sentiments. I now beg leave to submit this essay towards a description of the mines in Derbyshire, &c. to the public inspection: conscious I am that the plainness of the language may not be well suited to the literary world, but I hope the candid reader will excuse it, trusting it is the best adapted to explain the subject on which I have treated, and fully acknowledging my want of abilities, as an author unaccustomed to composition. I am afraid it is impossible to avoid tautology in giving a description of mines and their concomitant circumstances, and in my endeavours to render them more easily understood, I may probably have had recourse to some degree of repetition; if so, it has been in order to explain my ideas with

with more precision, my sole view being to induce others to investigate this county more minutely.

It was my intention to have given a description of the mines in Cornwall and the west of England, and their products; but being engaged in other pursuits, I must defer it until a more favourable opportunity.

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—	51,	— 12,	— pyrites	— pyrites
—	58,	— 6,	— calcedoney	— calcedony
			— Fagus	— Faujas: <i>and</i>
			<i>omit the words, "Toad-stone con-</i>	
			<i>taining lead ore.</i>	
—	84,	— 9,	— Scarfdales	— Scarfdale
—	86,	— 2,	— lminated	— laminated
—	95,	— 6,	— pirites	— pyrites
—	96,	— 19,	— amorphus	— amorphous
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—	186,	— 12,	— supporting	— supposing
—	187,	— 12,	— Daven Jaur	— Davenfawr
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—	—	— 15,	— coal	— cone
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DERBYSHIRE,
shewing where
MINES & COLLIERIES
are Situated.



- A Mine .
- A Number of Mines .
- Collieries .

SECTION I.

*Curiosities of Derbyshire; particularly near
Castleton.*

ON approaching Derbyshire from the south, the eye of the traveller, fatigued with level uniformity, is agreeably relieved with the prospect of mountains. For here begins the chain which has been called the English Apennines; and which, forming, as it were, a root in Derbyshire and part of Cheshire, afterwards sends forth a trunk, which running

ning due north, branches into the mountains of Westmoreland, Cumberland, and Northumberland.

These mountains have been ably described by Dr. Aikin, Mr. Housman, and others; and these remarks shall be confined to their mineralogical productions; after a few general observations on some parts of Derbyshire, and in particular on the vicinity of Castleton.

Derby is situated in the southern part of the county, while the chief mountains, and Castleton, are in the north. The capital of the shire is a well built town, and of late has received considerable improvements. It is situated on the river Derwent, over which there is a new stone bridge. There are five parochial churches, of which All Saints, the principal, stands in the centre of the town; a handsome modern edifice, the roof being supported by elegant columns of the Doric order,

order, and of considerable size. But the tower is ancient Gothic, richly ornamented, and about 180 feet high. Here is the ancient burial place of the Devonshire family, and there are some good monuments of the house of Besborough. Derby has communications with many canals, and navigable rivers, and is founded on a stratum of grit stone; beds of gravel, composed of siliceous rounded pebbles, of various sizes, are frequently incumbent on it in the neighbourhood.

The silk mills, erected by Sir Thomas Lombe, are fine buildings of considerable extent, and giving employment to numbers of men, women, and children. The proprietor is always ready to impart information to the curious visitor. The first mill that was built for Sir Thomas is now converted into a manufactory for sawing, turning, and polishing the fluor spars; the whole of the

B 2 operations

operations being conducted by machinery, subservient to the power of water.

The porcelain manufactory, belonging to Messrs. Duesbury and Kean, is worthy of the patronage of the illustrious family who have honoured it with their approbation. Here the whole process of making what we call China may be seen; and the beautiful painting and gilding have conferred on this manufacture a great reputation.

There are also many cotton mills, the principal belonging to Messrs. Strutts: and a rowling and flitting mill, where iron plate is tinned; with a manufactory of white lead, and one of red lead at Darley near Derby.

On the road to Matlock, four miles from Derby, is the magnificent seat of Lord Scarsdale, called Kedleston Hall, with a park, wood, and gardens, which are deservedly admired. Matlock, a bathing place,

is

is celebrated for its romantic situation. Dovedale, near Ashborne, is a beautiful valley, through which runs the rapid river Dove, among rocks and woods, uncommonly striking and picturesque.

Buxton is well known by its hot baths, and the beautiful crescent, built for the public accommodation by the duke of Devonshire.* This place is much frequented; and throughout the whole county the traveller may depend on good roads and excellent inns.

Chatsworth was once esteemed *among* the wonders of Derbyshire, being a summer residence of the duke of Devonshire; is very stately and spacious, with delightful gardens, pleasure grounds, and water works.

Other curiosities of Derbyshire are the grand cavern called Peak's Hole, the Elden

* The traveller will be much surprised to see a building in this remote part of the kingdom that rivals the beauty of Palmyra.

Hole in the Peak forest, and the ebbing and flowing well near Castleton. Monfaldale, near Ashford, is a beautiful small valley, where nature seems to have exerted herself, to contrast and diversify the scenery, so as to equal any thing of the kind in the kingdom.

Proceeding north to Castleton, the most striking object is the castle, which by the Romans was called *arx diaboli*; it stands on a rock of limestone, inaccessible in every direction, except to the south. The buildings enclose an area of larger extent than would be expected; and from the foot of the hill extends on each side a ditch which surrounds part of the town, being three yards wide and two deep. Heads of arrows are frequently found; and also Roman coins. I have in my possession a Roman celt of brass found here, about five inches in length, weighing about a pound. It is evident that the Romans worked the lead
mines

mines here, as a bar of lead was found marked with the name of one of the emperors; and which I believe is now in the museum of Mr. Green at Litchfield. Near Castleton are many fine springs of water; and in the neighbourhood of Bradwell is a warm salt spring, which has not yet been analysed.

About five miles from Castleton, and on the road to *Chapel en le Frith*, is the ebbing and flowing well, at the bottom of a limestone hill, and several yards in circumference. After it ebbs there is scarce any water, except at the sides which first begin to flow. In wet weather it flows and ebbs several times in an hour: while it flows the water boils up with great violence, in a number of places, for five or six minutes; then it ceases, the water runs off, and after about ten minutes it begins to flow again. In dry weather it does not flow so often.

Proceeding a mile further, and at the town end of *Chapel en le Fritb*, is a new piece of mechanism, called the inclined plane, a name which explains its nature. It is formed on the side of a mountain, in order to convey limestone to the Manchester canal. The carts hold about three tons each, and their velocity is regulated by mechanical principles. While the loaded carts descend, the empty ones ascend to be filled again. This limestone forms a considerable article of commerce, being transported many miles, and esteemed of a very superior quality. The noted cavern of Peak's hole has been so often described that any further account would be superfluous: but a short description may be allowed of another wonder of the Peak, not so generally known, concerning which marvellous stories have been told, and this plain account may at least save the reader from imposition. Elden
hole,

hole in Peak forest, is a chasm or fissure on the side of a limestone mountain, about 30 yards in length, and from 7 to 9 yards wide. The form is irregular, the depth about 60 yards, the stratum separating at the bottom, with some communications of inconsiderable extent. Any miner could go down with ease, for a small compensation; he would call it a *shake*, *swallow*, or *opening*, as shall afterwards be explained.

SECTION

SECTION II.

Account of the Strata in Derbyshire.

HAVING thus given a cursory idea of some interesting objects on the surface of Derbyshire, let me next be permitted to accompany the reader under ground, and to explain the general formation of the strata, supposing a mountain to be vertically divided. This appearance will best be understood by referring to the annexed plate, which I shall proceed to illustrate, after observing that the strata in Derbyshire are singularly curious, and perhaps unlike any thing to be found on the continent, being considered by foreign mineralogists as often presenting exceptions from the general rules observable in continental mines.

No.

No. 1. represents the summit of a hill. *A* is argillaceous grit: *a* shews irregular beds of argillaceous and fulphureous iron ores attendant on coal: *b* is coal lying in laminæ under the argillaceous grit. The depth of these strata is as follows.

Although argillaceous grit is generally above coal in this county, it is not to be understood that it is invariable so; for a variety of substances which frequently appear in great confusion sometimes are superincumbent: as vegetable earth, gravel or rubble, composed of quartzose pebbles, clay, and pieces of argillaceous sandstone. Indurated clay; a species of shistus sand stone in laminæ, blue clay; semi-indurated black earth or smut; argillaceous iron ore; and thin beds of prites and shistus. These substances have frequently various names, as metal, bind, rachel, clunch, &c. They at all times indicate coal; and though coal is found

found under, and in a variety of strata in other parts of Europe, yet in this county it has been hitherto confined to the argillaceous.

No. 2. Siliceous grit, forming a stratum of unequal thickness, sometimes exceeding 120 yards.

No. 3. Shale or shistus, appearing like an indurated clay, of various thickness, sometimes equal to No. 2.

No. 4. Limestone of various thickness, from four fathoms to more than 200, and not cut through.

No. 5. Toadstone, which frequently divides the limestone.

No. 6. Limestone, beyond which no mine in Derbyshire has penetrated.

Each stratum is separated by a small seam of clay, or marl, differing in thickness from two or three inches to two feet; and of various colours, from the ochre yellow to the

the brown, and ash green. It is worthy of notice that whatever stratum appears the uppermost, this representation will shew the subsequent arrangement; a circumstance deserving attention in mining countries: for by the knowledge of the upper stratum the skilful miner is enabled to form an idea of what may be found underneath; whether coal, iron, &c. &c.

The surface of the valley of Castleton is rubble, composed of broken fragments of various substances, some as small as coarse gravel, reaching to the depth of a few fathoms, as represented in the plate.

I shall now proceed to examine the substances that compose each stratum, and thus endeavour to point out the use of mineralogical knowledge, as many gentlemen for want of receiving some information on that interesting science, have been exposed to the arts of their agents, and have suffered
great

great impositions and loss. But now that mineralogy is becoming a fashionable study, we may expect to see great improvements in this important branch of natural history.

Let us now return to a more minute consideration of the strata above delineated.*

No. 1. Argillaceous grit forms the uppermost stratum, and is more or less thick, as the surface is more or less uneven. It is an assemblage of sand, and adventitious matter, in a base of argil; *fracture* granular; of a dull colour; smell earthy when breathed on: does not effervesce with acids; does not take a polish; may be easily scraped with a knife; has often brownish red veins; and is sometimes ferruginous, which renders it heavier. By exposure to the atmosphere it decomposes.

* Tablets, composed of the substances themselves, in their natural order, may be had of the author, forming a portable and interesting picture of the geology of Derbyshire.

This

This stratum generally indicates iron ore, which is frequently found under it in laminæ and nodules. The argillaceous iron ore is the most common: *a* represents a thin bed of it, of a brown colour, and compact nature; smell earthy; yields about 30 per cent. seldom more. Nodules of this ore are frequently found, which easily divide, and shew very fine impressions of plants, flowers, coralloids, and shells. The strata of argillaceous grit and iron are generally incumbent on coal, as at *b*, which represents coal lying in laminæ, unequal in quality and thickness. It frequently abounds with pyrites or sulphuret of iron, and argillaceous iron ore in nodules: fracture generally splintery, laminated, sometimes regular, with a bright gloss, and very brittle: contains much sulphur and petroleum.

Coal is found at Newhall, about ten miles south of Derby; it is there covered
with

with a variety of earthy substances, the strata being of various thickness, in different situations where the mine is sunk. First vegetable earth a few inches, then 12 feet argillaceous blueish earthy matter, 44 to 50 feet decomposed black earthy shistus, a bed of 6 feet of shistose hard coal, under which is a stratum of argillaceous indurated clay, from 10 to 12 feet, which is incumbent on a bed of fine coal, 8 to 10 feet thick.

In the neighbourhood, to the north east, is a large mountain of limestone, containing a considerable portion of magnesian earth, at Breedon, on the edge of Leicestershire, used for land and building purposes; its colour being redish grey: in it are sparry veins, and sometimes small strings of galena. Proceeding north, the coal does not make its appearance until you arrive north east of Derby, a distance of twelve to fourteen miles; here a large tract of country is enriched

enriched by this valuable commodity, as at Morley, Hallam, Smalley, Denby, Heynor, Pentridge, Alfreton, Chesterfield, Baslow, and many other places, amongst which are some iron works.

The coal is found at various depths; and where a horizontal gallery can be driven into the coal, it is certainly much more convenient and less expensive than the general mode of sinking shafts.

The national benefit arising from this article is beyond estimation; canals are cut to transport it into those districts in which no coal is found, by which many thousands find employment. Coals may be bought at the mine for 5s. 6d. per ton, or at 10s. per ton conveyed a few miles.

The great improvement which the iron manufactories of this country have received by charring or coaking the coal, now frequently adopted, gives reason to hope that

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they will soon rival those of Sweden and Ruffia. The English iron, twenty years ago, scarcely deserved the name, as it could not be worked into any article of fineness; but such is the improvement, that we now have but small demand for foreign iron.

• It is not an easy matter to determine the extent of this improvement, as iron works are so considerably increasing all over the kingdom; and at some distant period we probably may possess our mines of coal when the forests of the northern powers may perhaps be consumed: such is the possibility of affairs; nor is it extremely improbable but this country may at some future period export her iron to the nations that half a century ago exclusively supplied us.

Our iron bridges are a species of architecture of which this empire alone can boast. Iron in its various states is so applicable to the use of man, that it would be
 daily

difficult to form limits to its application ; and I am credibly informed that the demand daily increases. We have a few works in this kingdom in which charcoal is used in the making of iron ; the iron thus produced is equal to the best Swedish, and probably we soon shall procure from it as fine steel.

Coal frequently emits while burning a liquid bituminous matter ; and shistus is frequently so penetrated with asphalt as to burn until the inflammable matter is volatilized. In this country pieces of coal may be got very large, weighing more than three or four hundred pounds. Veins of sulphate of iron frequently occur ; and in two or three instances lead ore has been found in it. When the sulphate of iron has appeared in abundance, and the situation convenient, copperas works have been established.

The culm, or small coal, is in many cases of no value, and may be taken away from the mine gratis.

Coal presents several varieties, and is more or less interesting; some are shiftose, hard and sulphureous; others are soft, and quickly consume.

The best coal is generally of the least specific gravity, and of the brightest black colour, finely laminated, and on burning leaves the least ashes.

The cannel or candle coal is very compact; fracture splintery; it is lighter than the other variety, and is sonorous when struck; frequently explodes when heated, and burns with a luminous flame; its colour is jet black; it is capable of a fine polish; it seems to contain more carbon and less sulphur; it is sometimes found under and in connection with the common varieties.

Coal is sometimes in contact with asphalt and indurated bitumen.

Coal mines are of various depths; and coal often bassets* out to the grass. The

* See the glossary at the end.

stratum

stratum is frequently broken, when the workmen meet with a fault, *near*, or *lum*, which is a cavern filled up with clay, or rubble, dislocating the stratum of coal. In such case the coal is sometimes lifted up, ten or twenty yards; or as much thrown down. See the coal stratum at B, (see plate 1.) and the fissure at F where the coal is thrown down at D. In searching for coal, streams of water, after heavy rains, should be examined; and when it is found, the most easy method of working should be adopted, that an article of such general use may be rendered as cheap as possible. It is the grand source and root of all our manufactures, and of the first national consequence; whence too much encouragement cannot be given to search for this necessary article, where it has not yet been found. It would prove an inexhaustible source of wealth in the Highlands of Scotland: agriculture would flourish,

flourish, the arts and manufactures would be extended; and from its appearance might be dated the riches of that country.

Coal is frequently found under a variety of substances, commonly appearing in the form of strata, and called by the colliers *under-soil, gravel, bind, clutch, bardstone, metal, plate, &c.* as has been before mentioned, which are sometimes only a few inches thick, in others several feet; but generally the grit is superincumbent.

No. 2. (see plate 1.) The stratum of coarse siliceous grit, extending at the most about 120 yards, and variable in its appearance and texture. It forms the uppermost stratum in Wirksworth Moor, Cromford Moor near Winster, the East Moor, Birchover, Matlock town, the Edge side Hills, from Eam to Castleton, of Mam Tor, and in many other places.

It is an assemblage of coarse quartz pebbles

pebbles of various sizes, seldom exceeding a quarter of an inch diameter; some are in part crystallized with sharp angles, others are rounded; it is very friable near the surface, and sometimes contains adventitious matter: it is not stratified. It gives fire with steel; resists acids; and is often coloured by iron: fracture irregular, and does not take a polish. In this stratum are varieties of grit stone in laminæ; some are called freestone, and used in buildings; others called millstone grit, and used for millstones. A particular variety is laminated with mica, being an excellent substitute for slate, and used in forming the roofs of buildings; whence it is an article of commerce. This variety is somewhat elastic, and easily divides with a knife. Frequently it contains crystallized fluor, and barytes, and is incumbent on shistus or shale, from which it is separated by a thin seam of clay.

In general it is rare to find veins in this second stratum, but there are some instances of lead ore being found in it.

No. 3. The stratum of shale or *shistus* is not stratified; it sometimes is 120 yards in thickness; and is the uppermost stratum in many of the valleys, where the mountains on one side are grit, and on the other limestone: the shale betwixt the two entering the edge of the limestone, and passing under the grit. The hot waters of Buxton are found in this substance.

It is of a dark brown or blackish colour, bituminous, and appears much like an indurated clay: it does not contain vegetable impressions, though sometimes impressions of marine substances are found in it much impregnated with pyrites. It is not generally considered as a stratum fertile in veins of lead ore, though sometimes that substance is found in it, for being incum-
bent

bent on limestone, the veins strike from it into the shale, and carry lead ore with them to some distance. In its sparry veins are frequently cavities, called *locks* by the miners, which are incrusted with fine and rare crystallizations of calcareous spar in great variety.

By exposure to the atmosphere, this shale decomposes in *laminæ*: its fracture is dull: it absorbs moisture: contains sulphur burning with a blue flame, and becoming of a redish brown colour: frequently resists acids, but sometimes effervesces slowly: contains nodules and thin beds of pyrites. The waters passing through it are chalybeate, and frequently warm. It is incumbent on limestone, and is separated from it by a thin bed of clay. When it approaches the limestone, it of course effervesces with acids; in some cases even containing a
 large

large portion of calcareous earth ; the limestone in return partaking of its dark colour several feet from where they are in contact,

SECTION

SECTION III.

The subject continued. Further account of the Strata of Derbyshire, particularly of the Limestone and Toadstone.

HAVING thus discussed the superior strata, I shall next proceed to others which are more interesting to the miner and geologist.

No. 4. (see plate 1.) The first stratum of limestone is regularly stratified, and varies considerably in depth, being in some places thin, while in others, as already mentioned, it is extended to more than two hundred fathom. It forms the uppermost stratum east of Wirksworth, at Matlock, at Winster, Ashford, Eyam, Buxton hills, Monyash, and south of Castleton. It lies in laminæ, more

OR

or less thick, and is frequently separated at irregular distances of seven or five fathom, &c. by a marl containing adventitious substances, and in some places only a few inches thick, while in others the marl is two feet.* The whole of this stratum is composed of marine exuvia, which shew it not to be what is understood by primitive limestone. On the surface of this stratum is sometimes found rotten stone, particularly near Wardlow Mire and Ashford, which appears a decomposed argillaceous substance containing oxyd of iron. It feels smooth, and is much used for polishing brass in the manufactories at Sheffield.

This stratum abounds with a variety of shells, entrochi, coralloids, madrepores, &c. The vallies often contain ratchell or rubble,

* If more notice were taken of the divisions in the limestone, by the marl and adventitious matter interposing, probably the formation of calcareous earth might be better explained.

a con-

a confused mass of various substances, of different sizes, collected by their rolling from the mountains at various periods. Sometimes the hills on one side are limestone, and on the other grit or shistus. For instance, the limestone, which to the south west of Castleton is uppermost, is 300 yards below, under the opposite mountains, which are of grit, incumbent on shale. As neither the strata of shale nor grit make their appearance on that of limestone, to the south west of Castleton, nor in many other parts of this country, it was the opinion of Mr. Whitehurst, that such strata were dislocated and thrown into confusion.

The limestone forms a variety of beautiful marbles; near Wicksworth some are found in thin strata, of a light stone colour, full of marine remains, and used for paving, flooring, &c. called Hopton stone. Near Monyash, and at Eoolow, a beautiful variety is found

found in a considerable quantity, of a cheerful colour, inclining to the brown red, and full of large marine figures in all directions, which on being cut appear white, and afford a pleasing contrast. This beautiful marble is used for chimney pieces, and other ornaments. Near Wetton, a variety is found, of a darker colour, and presenting very small figures, whence it is called bird's eye marble.

In various parts black marble is found in laminae, being coloured by iron and petroleum, which is frequently found to pervade the mass. It burns to a white lime, which forms a strong cement. All the varieties are foetid when rubbed with a harder substance. The coralloids that are found in the black marble have a very pretty starry or stellated appearance, but such pieces are not common.

A filiceous substance called chert, used
by

by the potters, is found in the limestone stratum, in large detached masses and thin strata, near Castleton, at Dirlow, at Bradwell, in Middleton dale, in Peak forest, Matlock, and various other places. This substance is full of marine figures, and animal remains; in which respect it resembles the limestone, as though it had undergone a transition into petrosilex, or what the French call keralite. I have specimens, partly siliceous, and partly calcareous. The shells in this substance, and in the limestone, are full of calcareous crystallizations, and sometimes contain bitumen.

In this large calcareous stratum are many caverns, particularly that wonderful work of nature, Peak's Hole.

The limestone in the Peak forest is the best: the fracture scaly bright; it is compact; and sonorous when struck. It burns to a fine white lime, losing about thirty per cent.

of

of the carbonic gas during the operation, which occupies about thirty hours of a strong fire. It is burnt in conical kilns of various sizes. Irregular masses of limestone, consisting of fragments cemented together by infiltrated water, are sometimes found, with crystallized calcareous spar, &c. in the interstices.

This stratum is the most interesting to the mineralogist, for in it are found the principal veins, containing galena, sulphuret and native oxyd of zinc, a variety of ochres, fluors, barytes, calcareous crystallizations, pyrites, &c.*

I may here be permitted to give a short account of the metallic veins, as they occur in Derbyshire. They are chiefly divided into two varieties, *rake* or perpendicular

* The great copper mine at Ecton is in this stratum; and in other parts of England I have seen copper ore and iron ores, in considerable quantity, in the limestone.

veins,

veins, as at R; and *pipe* or flat veins as at P. The rake veins are in different directions. Near Castleton they generally run from east to west, and are traced, or discovered, from the surface. They are not exactly perpendicular; but *bade*, or incline, about one foot in ten, sometimes to the north, and sometimes to the south. There are veins that have a more northerly or southerly direction, and are then called *cross veins*. Sometimes they intersect each other; and where they unite they are generally very rich. Small veins, usually called *strings* or *scrins*, often extend from the rake, and take various directions. All are worked as long as they are found profitable: and the intermediate substances that divide them are called *riders*. (see r.)

The rakes generally form a strait line, and very rarely assume a bent direction. When separated, which is sometimes the
D case,

case, by *clay*, *bind*, or *toadstone*, they are observed (upon being again discovered below) not to be perpendicular, but to be thrown to one side, according to the *bade* of the vein, and the distance of separation, and are thence said to *leap*. From this observation it does not appear adviseable to sink a shaft or sump perpendicular from where the vein was cut off, in order to find it again, but to make a cross cut for some fathoms that way which forms an obtuse angle with the vein; by that mean you will be certain on sinking, after cutting across a proper distance, to find the vein again. Sometimes one part of a vein will hade, and another part stand perpendicular, as in Mandel mine, near Sheldon. The rakes differ much in size, in the same vein, and are subject to *twitches*.

The principal veins near Wirksworth are called *Yolk cliff rake*, *Hollyhole vein*,
Rantor

Rantor Tor, Orchard, Ratchwood, Pen's rake, Grey Mare, Samuel rake, and many others: some range north and south, and others east and west; and sometimes several veins unite, and form a very large one: besides which there are many other veins in the neighbourhood of Matlock, Bonsal, Winster, Elton, Youlgrave, and other places.

Near Castleton, the most northerly vein of lead ore in the county is Oden, a large work. A number of veins of less note, are in a mountain called the Long Cliff (and a strong pipe vein) which extends to the Red Seats and Mr. Eyre's Park, Dirtlow and Pindar; and south is Moss rake, Hell rake, Shuttle rake, Hucklow and Tidflow rake; Seedlow rake; at Wardlow is Longfon edge vein, and Bright side at Calver.

The pipe veins, or flat works, as at P. form another variety. They do not follow

any regularity, or inclination of the stratum, but fill up fissures; having found rock for *roofs* and *soles*, the vein running more or less horizontally. They are sometimes of great magnitude, twenty or thirty yards wide, and sometimes so slender as not to exceed two inches.

Pipe veins are always attended with a considerable portion of clay, which, when the vein becomes imperceptible, will be a sure guide to follow; and from the appearance of a few inches of clay only, pursuing it a few feet, the vein has been found of considerable extent. Such is the irregularity of pipe veins. The gangart of the pipe is different from that of the rakes, and they most commonly have the toadstone in the vicinity, either above or below.

The principal pipe veins are Yate stoop, near Winster; Hubberdale, near Money-ash;

ash; Watergrove, Millermine, and Lanehead at Castleton.

In the neighbourhood of Wirksworth, Matlock, Bonsal, Castleton, &c. are many veins containing blende or black jack, sulphuret of zinc; calamine, lapis calaminaris, or native oxyd of zinc; barytes, calcareous spar, &c.

At Brassington Moor, north west of Wirksworth, are carbonates of lead, irons, steatite, calamine, and blende. The white lead ore is commonly in *lums*. These minerals are chiefly found under loose sandy adventitious matter, which might deserve the attention of the geologist. Black wad, an ore of manganese, is found near Youlgrave. The fluor spar mines at Castleton are interesting to curiosity, as they shew such a variety of *lums*, or broken strata, filled up with adventitious matter, as are perhaps no

where else to be met with; and produce the greatest variety of fluors in the world.

In this limestone stratum are frequently found openings or caverns, which are commonly called *shakes*, or *swallows*. They are large fissures, the depth and communications of which cannot be ascertained, but they are of great service in several mines, as receptacles for the *deads*, or rubbish, and as aqueducts to carry off the water.

I now come to a stratum which has excited great attention among geologists and mineralogists, foreign and domestic. No. 5. represents *Toadstone*, by which name various substances have been denominated, some having the appearance of basalt, with equal hardness; while others are of various colours, full of holes and quite soft. When a substance is met with, intervening the limestone stratum, but different in colour and texture from the generality of limestone;

stone; it is here generally called *cat dirt*, *channel*, or *toadstone*. How far they may prove to be what is generally understood by the name of toadstone, the reader will determine.

This stratum is very irregular in its appearance, thickness, and direction. In the neighbourhood of Wormhill, Ashover, Buxton, Castleton, and various other places, it appears at the surface, being the uppermost stratum. It is generally of a dark brown colour, with a greenish tinge, superficially full of holes; but at a greater depth it is more compact, and the holes seem to have been filled with calcareous spar, and sometimes with green globules. Fracture irregular; easily scraped with a knife; but this soft variety appears to me to be in a state of decomposition.

The harder variety is found in an irregu-

lar column, in the *cave** at Castleton. This is as hard as any basalt I have seen; is compact; contains hornblende; and some patches or streaks of red jasper. This sort is also found near Buxton, containing zeolite and calcedony. In no instance does it present veins of lead ore, or any mineral substance, at least in Derbyshire. The appearance of this variety assumes so many different characters, according to its state of decomposition, that it is very difficult to trace its origin. The basalts I met with at Salisbury craggs, near Edinburgh, also near Glasgow, in the island of Mull, and in Staffa, when in decomposition, have every appearance and exterior characteristic of some of the varieties of the Derbyshire amygdaloid.

It has not any appearance of stratification.

* This is a deep ravine at the back of the castle; and must not be confounded with the cavern at Peak's hole.

It

It resists acids. No vegetable nor marine figures have been found in it; nor any characteristic mark to evidence that it was formed at the same time, or by the same means, as the limestone stratum which it divides. The exterior, or what has been exposed to the atmosphere, resembles a scoria or vitrified mass; but this appearance may proceed from its containing oxyd of iron: and it absorbs moisture. The fracture of a dull colour; earthy smell when breathed on. It certainly contains iron in a large proportion, which is easily attracted by the magnet after torrefaction. It divides the limestone stratum, intersecting and cutting off the veins of ore, as at H, which are again found by cutting through it to G. It frequently fills up fissures of great depth, as at O, while at a small distance from such fissures, it is only a few fathoms in thickness.

A de-

A description of a substance called *chan-
nel*, or *cat dirt*, or *toadstone*, containing lead
ore, and mentioned by Faujas de St. Fond,
Werner, Kirwan, &c. shall be given in its
proper place; and on examination it will
prove to be another substance. Miners call
every substance in the limestone stratum,
differing in colour, &c. by those names;
and travellers too frequently adopt their
language, and rely on their information,
without examining the substances them-
selves.

No. 6. is another stratum of limestone,
resembling No. 4 in every particular, which
render a description unnecessary.

This brief account will give the reader
an idea of the general produce of Derby-
shire. The miners have laws peculiar to
themselves, of ancient date, and rigidly ob-
served. The lead ore throughout Derbyshire
is supposed to be what is called potter's
ore.

ore. There is not one refining furnace. The reverberating furnace is in most general use.

The calamine and blend are got in abundance at Bonsal, Wirksworth, Matlock, Castleton, &c. being bought by the brass founders. There is a house where it is calcined at Cromford, whence it is conveyed to Stone, in Staffordshire, &c. The iron works are small, and not numerous, though there be several at Chesterfield.

The mines throughout the county were formerly much richer than they are now, and produced the finest crystallizations.*

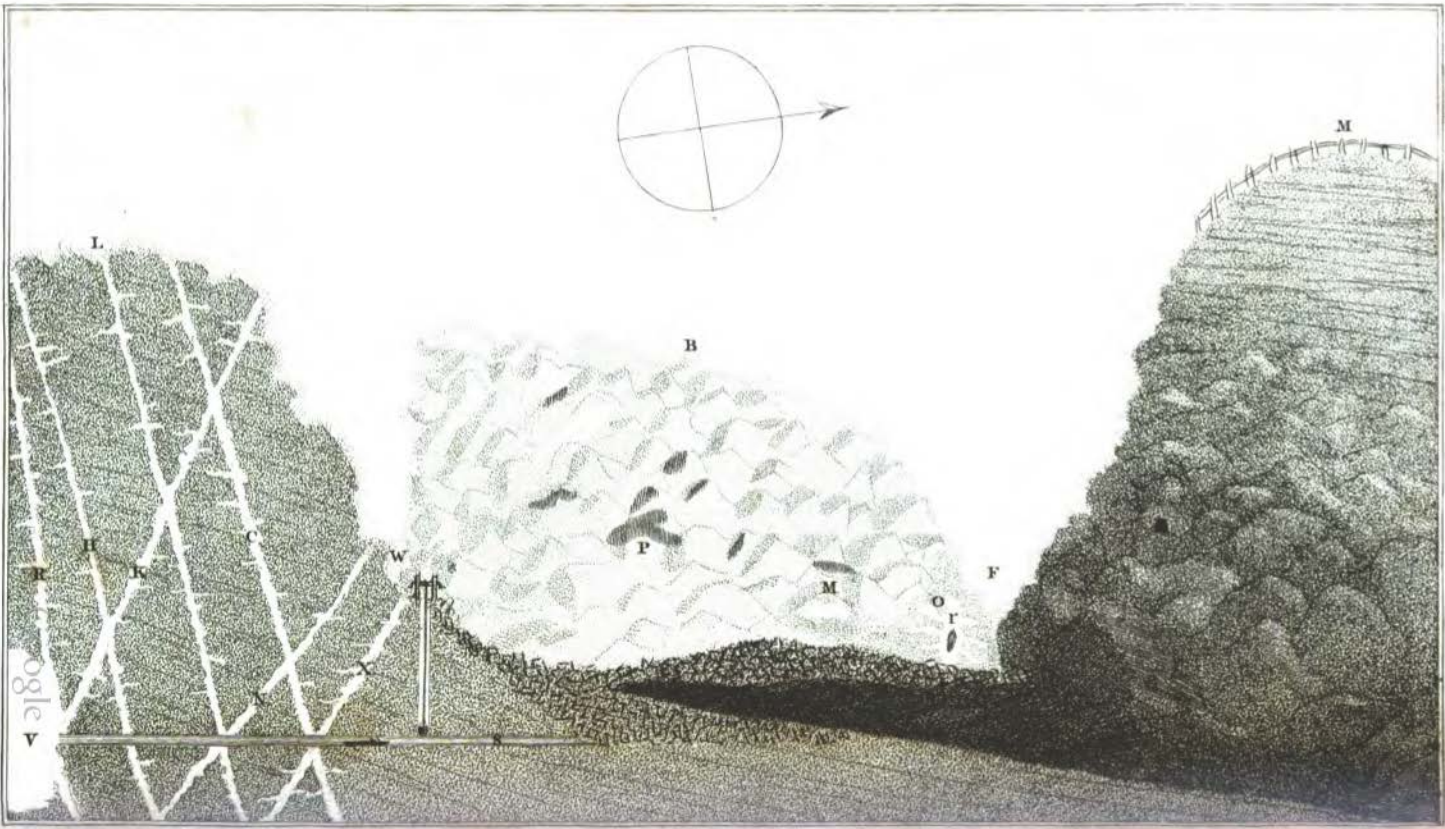
Near

* It is worthy of observation, that the veins are poorer, in general, the deeper they are worked, which may serve to support the opinion that veins are not formed deeper than the crust of the earth; but that remains speculative at present, as does the manner in which they are filled, more especially when we know some of them are worked under an immense stratum, that does not even bear any kind of vein. Veins, although they appear at the surface, yet they are seldom rich until they get a considerable depth, and where the stratum forms

Near the New Haven, on the road from Ashburn to Buxton, is a vein of argillaceous carbonate of lead, called the Wheat stone, and also some good white clay.

forms a rock of the greatest solidity. The almost continual attendant on large veins of ore, of every description, is a considerable quantity of water, and scarce is any good mine worked that does not suffer inconvenience from it.

SECTION



SECTION IV.

*Strata of the Mountains to the west of
Castleton.*

(See Plate 2.)

IF we suppose these mountains vertically divided, from the surface to the bottom, M will represent the mountain of Mam Tor. F is the fissure that separates it from the limestone mountain B, where the blue fluor is found. W is the fissure, where is the road called the Winnets; and L the mountains that compose the Long Cliff.*

Mam Tor, which is said to signify Mother Rock, presents on one side a bare stratum of 130 yards in perpendicular height, being composed of micaceous grit, in small

* Tablets of these strata may also be had, shewing the direction of the veins, caverns, &c.

and

and thin beds, intervened with *shistus*. The latter is acted on by the atmosphere, and from its exposed situation, soon decomposes, and falls in great quantities, whence Mam Tør has been called the shivering mountain. The inclination is about one foot in fifteen to the south.

The stratum of shale, or *shistus* makes its appearance underneath the grit; and at the north end of the mountain B is a vein of ore called Oden, a mine as represented at O. This is a long rake vein of lead ore, running from west to east, and underlying or *bading* south. It is said to be a very ancient mine worked by the Saxons. The operations are conducted horizontally, the ore being cut out more than a mile from the entrance; in some places 60 yards below the level or horizontal entrance, and in some places as much above it. This vein is of various thickness, sometimes eight feet,

feet, at others not above four inches, when it is divided by a *rider*, as at *r*. Lead ore in great quantities, with many fine crystallizations of blende, barytes, fluor, calcareous spar, selenite, &c.

The entrance of this mine is in the limestone; and the strength of the vein extends it into the shale, which it soon leaves, and then comes into the limestone again. The vein is in some places divided by the hard limestone called *rider*: in which case the miners, following the divided veins, work by each side of the rider, perhaps more than a hundred yards, till the veins again unite. The lead ore produces about 60 per cent; and the mine employs about 100 people, who chiefly reside in Castleton, and are, in general, intelligent men. It is easy of access, and the manager is always anxious to satisfy the curiosity of those who wish to visit

visit it, by rendering them every civility in his power.

Here is found that singular variety of lead ore, called *slickenside*. This galena presents a smooth surface, as if plated. Sometimes it forms the sides of cavities, and on being pierced with the miners tool, rends with violence, and explodes with a crackling noise. The cause of this phenomenon has not been fully explained. I have seen a man, when he came out of the mine, only a few minutes after the explosion, who, regardless of the danger, had pierced the sides of this substance, and was much hurt, and cut violently, as if stabbed about the neck and other places with a chisel, whence he was unable to return to the mines for two weeks.

The section under the letter L represents part of a mountain, called the Long Cliff, forming awful rock scenery along the road
to

to Manchester. This mountain is chiefly of limestone; and that marked B has every appearance of having been separated from it. Here is the Speedwell, or navigation mine, driven north and south, as at S, to cut across the veins of ore, which generally run east and west. It has not proved successful though excavated for half a mile, and connected with immense openings, as at V. Its waters are collected, and boats float from the entrance to the *Forefield*.

In this mountain are several small rake veins, containing lead ore, barytes, fluor, carbonates of lime, pyrites, rose-coloured calcareous spar, blende, &c. X is a rake vein running nearly south east by east, and north west by west; it is called Little Winter, and there are several shafts on it, which are above twenty fathoms deep. N represents Long Cliff rakes, on which there are a few shafts.

E

H represents

H represents a small rake, or *scrin*, of lead ore, running nearly east and west. It ranges up the side of the mountain, and on it are a few shafts, thirty fathoms deep. It is worked open from the surface for a small distance. K is a rake vein larger than the others, called Faucet, or fore-side rake, which has a direction south, by $67^{\circ} 30'$ east, and north by $67^{\circ} 30'$ west: it ranges from the top of the Long Cliff, to and across the Castle hill. A stratum of basalt and toadstone openly appears, about one hundred yards to the north of the rake K, at a place called Little Banks; and I regret that it cannot be represented in the section. R is a small rake, or cross vein, or *scrin*, called Rock Pipe; which, however, takes the usual direction of pipe veins. C is Long Cliff Pipe, a small rake *scrin*, but in a pipe direction. Many small veins cross the mountain, several of which are cut across by the

Speedwell

Speedwell mine, as may be seen in the plate.

The veins of ore in this mountain range under the toadstone. On the surface of the limestone are frequently found quartz crystals detached, some pyramidal with prisms. They are called Derbyshire diamonds.

In the cave, or ravine, south of the castle, on Cawler Hill, is an irregular basaltic column, appearing like a detached mass; and from it I have broken pieces containing jasper, calcedoney, and quartz. The outside is decomposed. Adjoining is a stratum of toadstone, which is also decomposed; it appears like indurated clay, full of holes, with green globules, spar, &c. This stratum ranges to the east and south, and is of considerable extent.

SECTION V.

Account of the Adits or Galleries.

IN Derbyshire there are many levels, adits, or galleries, to free the mines from water, which are often admired by foreigners. One of the most considerable is at Wirksworth, called Cromford Sough, relieving an extensive mineral tract of its water, to the depth of the drain. This *sough* passes from the north east to the south west, and is full two miles in length. The adventurers, with a laudable spirit, expended 30,000*l.* in its completion, and the mines pay a proportion of lead ore to the proprietors of this grand drain. Yet the mines about Wirksworth
are

are now beneath the level; and it is rendered of no farther use.*

Another *fough* has been driven from a lower level, that of the Derwent, at a great expence, and is called Wirksworth moor fough. It is to the east of that town; and is near three miles in length. This level will lay the mines dry for several fathoms, but it is not yet settled what contribution is to be made from the miners to the proprietors. It is singular that a low level in the limestone lays a great course of country dry, all the waters falling into it for a considerable distance.

At Youlgrave is one of the longest levels

* The relieving of the mines at Wirksworth, by the spirited enterprize of driving the level, is become only a secondary object; for the water delivered by it at Cromford, has proved of amazing value, and was the first stream employed by the late Sir R. Arkwright, to work his cotton mill. This water continues to work one of the largest cotton mills in the kingdom, and has the great advantages of not being subject either to considerable increase or diminution.

in this country, running from the Derwent to Alport, and called the Helcarr *fough*. The length is near four miles, and it cost upwards of 50,000*l*. It is driven through a variety of strata, and relieves a considerable number of mines. At Stoke Hall is an adit, driven up to relieve the Edge-Side mines, near Foolow, exceeding a mile and half in length.

In Derbyshire there are many other levels, extending a considerable length, but there are few steam engines, except on the coal mines.

The manor of Castleton has a royalty, called the King's Field, enjoying ancient and peculiar customs and privileges. Any person who discovers a vein of metal may take possession of it, and upon application to the bar master, after proving that a small portion of lead ore has been obtained, a piece of ground is granted, and the mine
and

and its produce become the legal property of the discoverer, who then generally sinks a shaft, or takes the most easy method, conformable to the laws and customs, to excavate the vein, and bring the produce to the surface. The mass containing parts of lead ore, spar, &c. as cut from the vein, is called *bowse*: when drawn out of the mine it is broken small; the lead ore is separated from the sparry matter, by various operations, as washing, sifting, &c. and brought to a proper size; after which it is measured by the *Bar* master, who takes a certain quantity as *lot*, or duty, for the king, and for tythe. It is then conveyed to the furnace, where it is smelted into lead. The duke of Devonshire has a lease of the duty from the crown.

Calamine, blende, &c. &c. pay no duty; but they cannot be taken off the ground

until the land owner be satisfied, he having the prior claim.

This county is extremely full of small veins, almost every miner possessing more or less. Such are seldom rich in produce, and indeed they have been rarely analysed; but were the produce of every new vein submitted to analysis, it might lead to many advantages.

SECTION

SECTION VI.

Observations on Cat Dirt.

IT has already been observed in the end of Section IV, that there sometimes occurs in the Derbyshire mines a stratum of decomposed toadstone, with the appearance of indurated clay, full of holes, containing green globules, spar, &c. Having been informed that lead ore had sometimes appeared in this substance, and afterwards seeing it mentioned by Werner (on the information of a Derbyshire gentleman), and from him by Mr. Kirwan, in his *Geological Essays*, p. 288, I became anxious to discover the truth of this matter. This desire was increased by the recent work of Faujas de St. Fond, entitled *Travels in England and Scotland*,

Scotland, from which I shall beg leave to select the most essential passages on this subject; particularly those pages where he informs the reader that galena has been worked in the toadstone stratum.

Fagus de St. Fond, p. 328, says, ‘ Toadstone containing lead ore, Mr. Whitehurst, and Mr. Ferber affirm, that in all the mines which have yet been opened, the vein of ore is found exclusively in the limestone,* and disappears so completely on reaching the bed of toadstone, that not the smallest vestige of it is discoverable in the latter: but that on piercing through the toadstone, however thick, the vein as certainly makes its reappearance; and this fact, they affirm, holds good through every vein of strata, to any depth. This disposition, however,

* This is not exactly correct, as before stated in this work. It will be found that the lead ore is frequent in the schistus, and sometimes in the coal.

‘ astonishing,

' astonishing, is in general true ; and thence
 ' Mr. Whitehurst conceived the opinion
 ' that the toadstone which thus separates the
 ' calcareous strata, and interrupts the course
 ' of the ore, must be the result of different
 ' currents of lava. My thoughts on this
 ' subject have been already explained, but
 ' if there should remain any doubt that the
 ' toadstone is not a product of volcanic fire,
 ' the fact which I am now going to state
 ' will be sufficient to remove them.

' Doctor Pearson having spoken to me,
 ' at Castleton, of a miner who sold select
 ' specimens for the cabinet, we went to pay
 ' him a visit. I purchased from him a col-
 ' lection of the most interesting minerals of
 ' Derbyshire, and some fine pieces of fluor
 ' spar, the crystals of which were in the
 ' most perfect preservation.

' In the course of conversation with him,
 ' I asked whether it was true that no vein
 ' of

' of ore was ever found in the toadstone ?
 ' he replied, that such had uniformly been
 ' the fact hereto, and though long employ-
 ' ed in the mining business, he had never
 ' heard that the slightest trace of lead ore
 ' had been discovered in that stone, but
 ' that he had just learned to his cost, that
 ' the rule was not without exception, if not
 ' in respect to toadstone, at least as to the
 ' cat dirt or channel.

' On requesting a further explanation, he
 ' told me he had been ruined by working,
 ' on his own account, a vein, which at first
 ' had the most promising appearance, but
 ' which, after opening a deep gallery, at a
 ' great expense, was lost in a bed of chan-
 ' nel, where, however, it was again re-
 ' covered, but in too poor a state to indem-
 ' nify him. As the mine was but a little
 ' way off, he offered to shew it to us,
 ' especially when he perceived I doubted
 ' his

' his account: providing himself therefore
 ' with some mining implements, he desired
 ' us to follow him, and we willingly com-
 ' plied. We directed our steps about a mile
 ' to the east of Castleton, along the steep
 ' side of a mountain which fronts it, and
 ' upon a narrow road about 200 feet above
 ' the subsequent plain. The mountain is cal-
 ' careous; and in some parts exhibit traces
 ' of strata, but its general disposition presents
 ' a uniform and continuous mass, like most
 ' calcareous rocks of great elevation. Marine
 ' bodies are not very abundant here; I ob-
 ' served however a few fragments of en-
 ' trochi, and some terebratula. Several
 ' lead mines have been opened in it, and it
 ' also affords calamine in an ochreous form.
 ' We soon reached the entrance of the
 ' gallery, which penetrates in an horizontal
 ' direction, and opens in the stratified part
 ' of the calcareous rock, in a seam of white
 ' calcareous

' calcareous spar, which presents a small but
 ' very distinct vein of galena, intermixed
 ' with fluor spar.

' This indication, which was regarded as
 ' very promising in a mountain which con-
 ' tained several other lead mines, determined
 ' E. Pedley, and his associates, to commence
 ' their operation; but scarcely had they
 ' reached the depth of twelve feet, when
 ' the limestone terminated, and they had
 ' the misfortune to meet with the channel.
 ' As till then there had never been any in-
 ' stance of the most slender veins of metals
 ' being found in this unproductive stone,
 ' they would immediately have discontinued
 ' their labours, had not the same vein of
 ' galena, which they traced through the
 ' limestone, continued its course in the
 ' channel or trapp. This appearance was
 ' so extraordinary and novel, that, seduced
 ' by it, the miners pursued the ore in the
 ' channel

' channel to the horizontal depth of ninety
 ' feet, in the constant hope that the vein,
 ' which never exceeded an inch in thick-
 ' ness, would soon enlarge its dimensions.
 ' But the farther they proceeded, the trapp
 ' became so hard, and it required so much
 ' labour and expense to cut through it, that
 ' Elias Pedley told us he was on the point
 ' of altogether abandoning the work. This
 ' bed of trapp was little more than seven
 ' feet thick, but it is very probable it ex-
 ' tends a great way into the mountain, when
 ' it is considered that the gallery has already
 ' been carried ninety feet in an horizontal
 ' line, without discovering any appearance
 ' of alteration.

' This bed of channel, or cat dirt, is
 ' really a greenish trapp, very hard in the
 ' interior of the mine, but upon being taken
 ' out of the gallery, and exposed for some
 ' time to the atmosphere, it becomes friable,
 ' its

' its colour changes, and it passes into an
 ' earthy state. It is probable that this de-
 ' composition arises from some invisible
 ' particles of pyrites, which become efflores-
 ' cent, and cause the substance to fall into
 ' a detritus.

' Here then is a proof that galena has
 ' been found in a bed of channel, in which
 ' it has been traced in an uninterrupted line
 ' of 90 feet, accompanied with a small por-
 ' tion of calcareous and fluor spar. This
 ' instance exhibits a direct and unequivocal
 ' exception to the observations hereto made
 ' respecting the mines of Derbyshire. The
 ' existence of lead ore in the trapp is a cer-
 ' tain proof that it is not the product of
 ' fire.

' I know that those mineralogists who
 ' are conversant in the study of lithology,
 ' who have examined the trapp upon the
 ' spot, and are fully acquainted with that
 stone

' stone and all its varieties have no occasion
 ' for this proof. But the fact appeared of so
 ' much importance that I conceived it pro-
 ' per to mention it, to do away every
 ' doubt on the subject. This consideration
 ' therefore, will form my excuse to those
 ' who may be displeas'd at the minute and
 ' tedious details which I have been oblig'd
 ' to enter into, that I might place the
 ' question in the clearest possible point of
 ' view.'

I am sorry Monsr. Faujas de St. Fond
 did not examine this substance more mi-
 nutely, as well as the well-known moun-
 tain of Mam Tor.

He says, page 325 of his work, ' Several
 ' mines have been opened in the very steep
 ' calcareous mountain of Mam Tor.'

Its very appearance is the most opposite
 to calcareous mountains that can be con-
 ceived, and its component parts are mica-

F

ceous

aceous grit, laminated with argillaceous shif-
tus, and incumbent on the same stratum ;
as before mentioned.

It is by no means my wish to enter into
the examination of the works of literary
men with a view to confute them, I merely
wish to state facts as they appear, so as to
present the scientific with authentic ma-
terials.

The excellent Lord Bacon introduced
what is called the experimental philosophy,
in which facts alone are consulted ; and I
hope to be pardoned, if sacrificing for a
moment my veneration for those illustrious
characters, I state the plain facts with the
freedom of a practical man addicted to no
theory. I went into a mine called DIRT-
LOW, about a mile east of Castleton, where
it is said that the vein of lead ore migrates
into cat dirt, or toadstone ; and indeed the
mine itself took its name from this cat dirt.

In

In a shaft, on the left of the road going to Bradwell, which proceeds from a large rake vein, I went down about 40 fathom. One side of the vein consisted of what the miners called *channel*, *cat dirt*, or *toadstone*; and a part of the vein was full of that substance. I cut out some pieces myself, and directed others to be cut, all which I took with me. Upon examination, this substance was of a brownish green colour, interspersed with green earth, soft, and porous. It was by no means so hard as the generality of limestone, and appeared on the contrary to be in a state of decomposition. It effervesced strongly with acids, and on putting a piece in a heated crucible, I immediately perceived a strong smell of sulphur. In the dark it emitted a blue flame, and burnt to a dirty red. On applying it to the tongue, it was caustic, and greedily absorbed moisture.

It seemed to me to be a question, whether this substance be not a limestone, strongly impregnated with pyrites, which are in a decomposing state; the green earthy matter I suspect to be chlorite.

At Pindar and on Tideswell Moor, where the lead ore is also said to occur in this substance, I examined another variety of it, but found it essentially to agree with the former. I therefore conceive that the confused terms of miners have misled the very respectable authors before mentioned, who had not sufficient time nor opportunity to institute a strict enquiry. In truth, the miners have applied the same name of toadstone, or cat dirt, to substances extremely remote, and which have only a partial resemblance in exterior appearance.

SECTION

SECTION VII.

Account of the Fluor Mine, and of the manner of working that mineral.

IN the fourth section of this work, I have already explained the appearance of several Derbyshire strata. The reader will now forgive my proceeding to some, in which I am myself much interested. The mountain B, (see plate 2.) appears an assemblage of vast rocks of limestone, without connection or regularity, and is full of openings or caverns of immense depth, fissures, &c. In this mountain are the two mines that produce the beautiful compact fluor*, here called Blue John, which is found in *pipe*

* This substance acts as a speedy flux to metals, owing to its peculiar acid, whence the name of *fluor*.

veins of various directions, as represented at P. In these mines it is necessary to arch the roads with stone; for after long rains, wood is not capable of sustaining the weight. The fluor in various places appears to have been formed on the limestone; for it frequently has that substance for a nucleus, around which it seems first to have chrystallized, till it had greatly increased by accumulation. Frequently, however, the centre is hollow.

In various parts of the mine, in caves filled with clay and loose adventitious matter, the fluor appears in detached masses, bearing every appearance of having been broken from the limestone, on which it seems to have been originally formed; for every piece, in one part or other, seems to have adhered to something, and to have been broken off. These caverns are frequently

quently beset with beautiful calcareous stalactites, of a large size.

It is impossible to account for the prodigious variety, and singular disposition of the veins, and sudden contrasts of the finest colours, which occur in this substance. Some of the pieces of fluor are a foot in thickness, and have four or five different and distinct veins; but such large pieces are very rare. In general they are only about three or four inches thick; and some present one strong vein, while others shew many smaller. Such as display a geographical figure, like a coloured map, are most rare, and valuable. Some varieties are much more loose in their texture than others. The colouring matter has been generally thought to be iron, but I suspect it to be asphalt, which may perhaps contain pyrites in a decomposed state; but there are many singular varieties which have not undergone any analysis. The

fluoric acid is easily obtained by pulverizing the fluor, and putting it in a leaden retort, to which add its weight of any of the mineral acids. Apply a gentle heat, and the fluoric acid will appear as gas, which may be caught in a vessel of the same materials with the retort. Its peculiar property of corroding glass and siliceous substances, is well known, and has been employed in France in engraving glass plates of singular beauty. It is also a noted flux for the lead ore, its very name being derived from its being so ready a mean of accelerating fusion.

Faujas de St. Fond has pronounced this substance to be the most beautiful in the mineral kingdom; and has particularly praised the elegance of the manufacture.

In the loose earth of the caverns are found rounded nodules of lead ore, sometimes called potatoe ore; and there is in the same mountain a pipe vein of calcareous spar,
one

one of which contained lead ore, which was worked as at M, called the Miller mine. The limestone that composes the whole is full of marine exuvix. This mountain, as I before observed, reaches southward to the Winnets, where it is separated from the Long Cliff by a deep ravine, in which is the road to Manchester.

The rocks on the side of the road are stupendous, and in many places perpendicular, running in all directions, and forming immense caverns. The mines of this mountain afford the greatest variety of mineralogical information of any which I have yet seen. The veins themselves, the frequent obstruction of their directions, and the dislocation of the strata, with the heterogenous substances found in the immense caverns; present matter for great study, and curious observation.

The access into the mine of fluor is tolerably

ably easy, descending about 60 yards down steps, amid limestone. Proceeding about 30 yards deeper, by an easy route, you arrive at a most beautiful cavern, beset with delicate white stalactite, which, to the imagination, assumes a variety of figures. At a small distance further, you are led into a cavern yet more grand, in which some stalactites, hanging perpendicularly from the roof of the projecting rock, form a striking semicircle; the black walls of the mine contrast with the snow white stalactites, and constitute a scene surpassing description. Hence you are led into a variety of interesting caverns, veins, &c. and the guide will be ready to give every information to the curious visitor, without any wish to delude him by fabulous wonders, or interested error.

I shall now proceed to give a short account of the chief varieties of fluor, and of the

the method employed in their manufacture. Fluor, or *fluatē of lime*, generally crystallizes in the cube and its modifications, rarely in the octaedral, and still more rarely in the dodecaedral form. The chief varieties are the following :

Water coloured crystals of cubic fluor, studded with bright pyrites. The accumulation of crystals frequently covers the pyrites with a pretty effect.

Very large and transparent cubes of fluor, with pyrites in the inside, accompanied with blende and lead ore.

Blue fluor, of a violet colour, in perfect cubes, with cubes in the interior.

Amythistine and topazine fluors. The latter is of a fine yellow, with internal crystals of pyrites.

Dark blue fluor, with the edges bevelled on each side.

Blue

Blue fluor, with one bevelled edge, or a plane on each edge.

Blue fluor, with four sided pyramids on each face.

Blue fluor, indented and perforated.

Fragments of octaedral fluor.

Ruby coloured fluor, in perfect cubes, on limestone.

Granulated, or sandy fluor, of a rose colour.

Compact fluor, in masses, formed on limestone, or in nodules. This seems an accumulation of cube upon cube, forming prisms, the surface of which is crystallized. Some of these masses, which are seven or eight inches thick, are separated in two or three places with a very thin joint of clay, scarcely thicker than paper. This variety is composed of very fine veins, and sudden contrasts of blue.

Another variety in masses, full of holes, containing

containing decomposed calcareous spar, in the form of brown pearl spar. This variety is lightly veined with blue; and the bottom, or part next the rock, which is called the root, is wholly blue, and transparent, but not so dark or so finely figured as the veins.

Another variety, harder than the former, the ground clear white, but tinged like the *lichen geographicus*. This never forms veins.

A variety having five regular veins of fine blue. This stone is much looser in its texture: and where cut across its crystallization, it presents a beautiful honeycomb appearance. There is another variety more regularly divided into three veins.

The dark blue, approaching to black, is perhaps of all others the most rich and beautiful, and displays a variety of pentagonal figures, and is bituminous.

The

The variety, which is of a dark purple, pervading the whole mass, is loose and friable.

That of one strong blue vein is much harder, very rich, and transparent.

Fluor in detached cubes, in the limestone, appearing a little decomposed.

Fluor with metallic veins.

Fluor decomposing.

Fluor of a fine green tinge.

Of a blue colour, in a mass of crystallized cubes, with elastic or indurated bitumen.

Fluor in compact limestone with galena, in veins and small particles, filling up interstices.

Fluor crystallized in cubes, upon hornstone or petrosilex.

Fluor in the cavities of coralloids.

Fluor with barytes, commonly called tyger stone, being opaque, and full of dirty brown spots.

Having

Having thus given an account of the chief varieties of fluor, I shall describe the art of working it.

When it is intended to be worked into a vase, or the like article, a piece is selected fit for the purpose; and if after minute examination it be found free from defects, it is carved with a mallet and chissel into a spherical form, and then fixed on a *chock* with an exceedingly strong cement. The chock is then screwed on the lath, a slow motion is produced, and water continually drops on the stone, to keep the tool cold, which is at first applied with great care. This tool is a piece of the best steel, about two feet long, and half an inch square: it is reduced to a point at each end, and tempered to suit the work. As the surface becomes smoother, the tool is applied more boldly, and the motion much quickened,
till

till the piece of fluor be reduced to its intended form.

The laths worked by machinery possess a great advantage, the tool being applied with more delicacy, from the body not being in motion, as in turning the foot laths. Another great advantage is, that any motion is procured by a touch; as in some cases a very quick motion is required, and in others very slow.

The piece being thus formed, and rendered smooth by the steel instruments, in order to render it fit to receive a polish, a coarse stone is applied with water, so long as the smoothness is improved by these means. Then finer grit stone, pumice, &c. till the piece be sufficiently smooth to receive coarse emery, and afterwards fine emery.

If with the latter it appear of a good shining gloss, then the finest putty is employed for a considerable length of time,
till

till the polish be as bright as possible, which is known by throwing water on it. If the part thus watered appear higher polished than the rest, the polishing is continued till water will not heighten the appearance.

The advantage of the lath, worked by water, is particularly conspicuous in forming delicate hollow vases, &c. for by the use of the foot lath, the fluor was frequently broken, and its laminated texture at all times disturbed; but the use of the water lath, by its steadiness, prevents these inconveniences.

The first mill that was built for Sir Thomas Lombe, at Derby, is now converted into a manufactory for this purpose, as mentioned in the first section. This beautiful production of nature is here formed into elegant urns, vases, columns, &c. giving employment to a number of families,

o

and

and forming an interesting article of commerce.*

* Messrs. Brown and Co. the proprietors, are happy to shew travellers their manufactory, and give them every information. Their wholesale warehouse in Tavistock-street, Covent-garden, exhibits the greatest variety of elegant urns, vases, &c. formed of this beautiful stone, at the same price as at the manufactory; also the most splendid and extensive collection of minerals in the kingdom.

SECTION

SECTION VIII.

*Account of other Minerals found in
Derbyshire.*

THE gypsum or alabaster, naturally arises to observation, after the fluor, as being employed in works of similar elegance. This substance is found in large masses, filling up cavities or insulated places in the argillaceous grit, near Derby; as at Elvaston, Chellaston, and Tetbury. It never forms a stratum, but is generally attended with gravel, strong red clay, and an earthy covering, in which are frequently innumerable shells.

The gypsum is generally veined with red, and frequently with a dirty blue. No mineral, or marine substances, are found in it.

Gypsum or alabaster, is generally so soft as to be scraped with the nail; but some sorts are much harder than others, and of a closer texture. Near the surface it is striated and sometimes crystallized; below it is much more compact, and is frequently used for architectural purposes, forming elegant columns, pilastres, &c. of which those in the hall of Lord Scarfdales, at Kedleston, stand unrivalled. When crystallized it is called selenite. It is easily calcined, and then forms what is called plaister of Paris, which greedily absorbs water, and is cast into various figures, as imitations of the antique statues, &c. It is likewise used for moulds, for floors in houses and other economical purposes. It forms an article of trade, and considerable quantities are sent to London.

The chief varieties of this substance are capillary gypsum, in delicate silky filaments, three or four inches long, so tender as to render it impossible to procure it perfect.

Plumose

Plumose gypsum, like white feathers, elegantly curled, on limestone.

Green selenite, extremely rare.

Scelenite in transparent prisms and rhombs.

Gypsum, rock alabaster. Striated silky alabaster.

Compact white; semi-transparent; red veined; variegated, &c.

I shall now give a short detail of the other minerals and metals found in Derbyshire.

In the siliceous order may first be mentioned topazine and rose coloured quartz, in hexagonal prisms, with double pyramids detached.

Amethystine quartz finely tinged; with perfect hexagonal prisms, also with double pyramids detached.

Clear colourless quartz in fragments, and the same enclosing bitumen: these varieties are loose in the limestone.

Chert, hornstone, or petrosilex, forming thin laminated beds, near Bradwell, Buxton, Middleton, &c. &c.*

The same substance is also found exhibiting entrochi, coralloids, &c. in which case it seems the secondary petrosilex of Sauffure.

Of the barytic order the most general is the substance called cawk, from its resembling chalk, (which is not found in the north.) It occurs in great quantities, being the common attendant on lead ore. The colour is often white, but more frequently a greyish white, inclining to the cream

* Dr. Smith in his travels, vol. I. p. 176, mentions a stratum of flint running horizontally through the limestone by the rock house, at Cromford near Matlock. Mr. Kirwan in his geological essays says, that it is found in strata 12 feet thick in Derbyshire. For this he quotes the philosophical transactions. In Peak forest are a variety of chert beds of various thicknesses, some are in contact with the granulated limestone, although limestone full of shells is above it and below it; its colour is of the dove blue, it adheres to the chert, and is softer than the other variety,

tinge,

tinge; which sometimes rises to the ochre yellow. It is soft but ponderous: fracture earthy, sometimes scaly. It often contains small veins of lead ore, as thin as threads; and sometimes small veins of fluor and blende.

Barytes occasionally occurs crystallized in tabulated rhombs, on grit stone; but more generally in delicate tabulated crystals, which by combination, form spherical balls. One variety is stalactitic, sometimes with transparent crystals, and native sulphur.

The arborescent barytes is composed of ligaments of various colours, interveining each other, appearing somewhat like branches with foliage. A piece now before me is polished, and exhibits dark brown and lilac figures, beautifully interspersed with blue in a geographic form, or like a coloured map, and affording beautiful contrasts.

Barytes in tabulated crystals, opaque white,

G 4

half

half an inch in diameter, but as thin as leaf gold, on a cellular gypseous matrix, with native sulphur.

Barytes having a plumose appearance, when covered with transparent crystals of fluor. Barytes in fluor forms a pretty variety.

Barytes has lately been found confusedly crystallized, of a sky blue colour: the fracture foliated.

But what the chymists call carbonates of lime, and mineralogists calcareous spar, &c. afford an amazing variety of colours and crystallizations. This substance is apt to be confounded with fluor, from which it essentially differs; the fluoric acid being of a peculiar nature, and very different from the carbonic, not to mention other distinctions. The calcareous spar here appears in its most usual shape of the rhomb, and its modifications, macles, &c.

The

The primitive rhomb is rarely found. It is generally on a dark bituminous limestone with pearl spar and selenite: the primitive rhomb passing into a variety of modifications.

Lenticular crystals, on dark limestone, blende, &c.

The dogs tooth spar, forming double hexagonal pyramids, joined at the basis.

Hexagonal crystals of calcareous spar, rarely terminating with pyramids of the primitive rhomb.

Hexagonal crystals terminating with the primitive rhomb truncated.

Hexagonal crystals terminating with the lenticular pyramid.

Hexagonal crystals with a variety of terminations forming pyramids, with three, six, twelve, fifteen, and more facets.

Hexagonal prisms of a high topaz colour, with various terminations.

Fibrous,

Fibrous calcareous spar. Calcareous spar appearing mamellated.

Macles, or twin crystals; some exceedingly rare, and in great variety.

Opake snow white calcareous spar, crystallized in double hexagonal pyramids, joined at their bases.

Stalactites forming a variety of beautiful colours, with the appearance of agate vein.

Stalactites, the terminations crystallized.

Green stalactites, very rare.

Granulated calcareous spar, or in masses, composed of grains.

Rose coloured calcareous spar, amorphous.

To this order also belongs a great variety of marbles. The upper surface of the limestone is frequently nearly white, probably from being bleached by the weather; it is perfectly hard; a variety of it is found at Lover's Leap, near Buxton.

Of

Of a fine stone colour, near Hopton.

Fine red brown, near Ashford, full of large marine remains.

Fine black is found at Ashford, Matlock, Monfaldale, and various places.

Coralloid marbles exhibiting a variety of madrepores, are found in laminæ in various parts of the stratum.

Dark coloured limestone, full of marine exuvia, in large figures.

Dark coloured limestone in very minute figures at Wetton. Frequently in the stratum of limestone are decomposing green globules, and small green veins with decomposing pirites. This substance is soft, and of a fine light green colour.

Before proceeding to the metallic ores, a few of the inflammables may be mentioned. Among these the most peculiar and remarkable is the elastic bitumen, in its various states, (or mineral cahoutchou) a recent discovery.

discovery. It is generally found between the stratum of shistus and the limestone, rarely in small cavities adhering to the *gangart*, and sometimes containing lead ore, fluor, &c. When first detached the taste is very styptic, as if blended with decomposed pyrites. It varies in colour from the blackish or greenish brown to the light red brown, and is easily compressed; but sometimes the same piece is less elastic in one part than in another. On burning it the smell is rather pleasant.

A piece of the elastic bitumen, of a reddish brown colour, now before me, contains nodules of indurated shining black bitumen, resembling jet. This kind is very rare.

Another variety, the only piece I have seen, is in a *marine shell*, in a piece of limestone.

The elastic bitumen of a dull red, and
transparent,

transparent, in crystallized fluor, extremely rare.

A variety, yet more scarce, but less elastic, appears to be composed of filaments, and has a singular acid taste. The characteristics are very different from any other sort; and might probably, if investigated, account for the origin of this substance. On cutting, and in other circumstances, it resembles soft cawk, or old bark from a tan-yard.

Indurated bitumen, appearing like jet, in amorphous masses, and globules of a shining black, but sometimes liver-coloured. This kind is electric when rubbed; and is sometimes found in barytes.

Elastic bitumen with asphalt, containing lead ore. The same in long filaments, almost as fine as wire.

Sulphur (native) in the cellular parts of barofelenite on limestone.

That

That essential mineral, Coal, which gives birth and support to many of our manufactures, appears in different parts of this country. It is found in the greatest plenty in the north east, as has been before mentioned. Towards the north west of Derbyshire it is found again near Buxton, as at Coit Moss, on the edge of Cheshire. In various places, for the distance of several miles from east to west, neither the stratum of argillaceous grit, nor the coal, have appeared.

Coit Moss is a considerable mountain 3 or 4 miles west of Buxton, composed of argillaceous grit; at the depth of 30 or 40 fathoms, beds of coal are found.

There appears a ferruginous shistus-like substance, several feet thick, incumbent on the coal, which decomposes by exposure; its basis is argil with oxyde of iron.

The

The coal is a great relief to this mountainous and cold country, and its effects are conspicuously seen in a variety of objects.

*Sulphur combined with Iron, or Martial
Pirites.*

IN enumerating the metallic ores, I shall first mention iron, which appears in the form of sulphuret or pyrites in various states, but generally crystallized in the octaedron, cube, dodecahedron, &c. is frequently marmelated, elliptical, arborefcnt, and kidney form; colour fhining bright yellow, sometimes inclining to brown; very brittle; gives fire freely, and when conflicted has a very sulphureous fmell; it is frequently compact, forming a vein.

Hematites,

Hematites, or liver stone, is sometimes found incumbent on a solid mass of ball pyrites, about a quarter of an inch in thickness, the interior brass yellow, diverging from a centre.

The argillaceous iron ore is in the most general use in the iron works. It forms a thin stratum in the coal countries, sometimes enclosing shells and coralloids. It frequently occurs in nodules above coal, containing vegetable impressions. It is sometimes mixed with a proportion of Lancashire ore; which by using a proper quantity of limestone as a flux, is found to be a considerable improvement.

Calcareous or sparry iron ores, are of a fine brownish red colour, sometimes bright yellow, scaly, and dirty brown, found in amorphous masses near the surface, and filling insulated places. The calcareous matter
seems

seems predominant, the crystallization is frequently preserved, and it appears in different stages of decomposition; it is very useful to mix with other iron ores, and is said to make a good iron for converting into steel.

Manganese appears in the shape of *black wad*; formerly supposed to be an iron ore, in earthy masses, crumbling to powder on exposure to the atmosphere, being very loose and friable. These black lumps are not unlike hard balls of soot, but when broken, capillary veins appear somewhat of a metallic lustre.

Black wad must not be confounded with *black jack*, which is a blende or sulphuret of zinc, or pseudo galena, found in amorphous masses, frequently crystallized, and generally accompanying fluor and barites. The colour is a blackish brown, inclining to a metallic lustre, and a little transparent.

H

A variety,

A variety, called ruby blende, is crystallized on calcareous spar, and is of a beautiful transparent red.

Another variety is called pigeon necked blende, from its iridescent hues.

Red blende, minutely crystallized on fluor.

The blendes generally produce above forty per cent of zinc, sometimes with iron, lead, or copper, and are frequently in Hungary and other places, auriferous.

Zinc* is also found in the form of lapis calaminaris. This native oxyd occurs of various colours, brown, reddish, and bluish brown, yellow, waxy, green, white, stalactitic, porous, &c. It is found in nodules, and often clothes calcareous spar, which it

* Native zinc is said to have occurred once: but after making every inquiry, and not having been able to see the specimen, I feel warranted in concluding, from an intimate acquaintance with the mine which is said to have produced it, that it is improbable, and wholly a mistake.

foon

soon decomposes. I have seen fragments of calcareous spar, coated with calamine: a sufficient proof of the recent formation of the latter.

It is sometimes in an ochreous state, combined with ferruginous matter, but the compact is the best; and it is most esteemed when of a waxy colour. Sometimes there are transparent tabulated crystals, and it is frequently botroidal, or in the form of grapes, and also stalactitic. The snow white is mamellated, and is extremely rare. It seldom occurs coating fluor, but often decomposing calcareous spar, and is frequently attendant on blende.

Calamine generally contains *above* sixty per cent of zinc, with some iron; and assumes various appearances, sometimes effervescing with acids, and phosphorescent.

To the east of Castleton is the place called Red Seats, where are several fake veins containing

containing blende, calamine, and small quantities of lead ore, with barytes, calcareous spar, and fluors. Here are several shafts of no great depth. In the vicinity are several masses of limestone, consisting of small pieces, or angular fragments, cemented by the water filtering through the mass, and precipitating its earthy particles, which constitute a stactitic matter pervading the interstices.

SECTION

SECTION IX.

Of the Lead Ores,

THOUGH lead ores generally contain silver, none in Derbyshire, yet analysed, yield any portion of that precious metal, sufficient to defray the expences necessarily attendant on the separation of it.

The most common lead ore is galena, or sulphuret of lead, which generally lies in larger or smaller veins and masses; frequently in nodules, with cawk, a name here used for barytes. Galena is frequently crystallized in cubes, with the angles truncated, also in the octaedron and its modifications. It is of a bright lustre, and flaky fracture.

fracture. Another variety, when broken, is remarkably bright and foliated ; by exposure it becomes tarnished and decomposes.

Another kind of galena is called the steel grained lead ore ; being very hard, and the granulated appearance, when broken, resembling the fracture of steel. This ore sometimes appears fibrous, not unlike the common compact ore of antimony.

Masses of galena frequently contain small holes, the surfaces of which, being nearly black, appear as if corroded. Sometimes carbonate of lead appears on it, in various states and forms ; some of the crystals having a semi-metallic appearance, others of a dirty white, and some transparent : the shape is chiefly the prism, and the double hexagonal pyramids joined at the base.

Two, three, or four veins of galena sometimes occur in barytes, the whole not broader than two and a half inches. These
veins

veins are perpendicular, and afford a pleasing image of the large veins of ore.

Spherical nodules of lead ore are not unfrequently found in caverns in the mines, whither they must have been conveyed by water. Some of them are hollow, and contain native sulphur.

A pulverulent black lead ore, sometimes disseminated on the matrix, appears to arise from the decomposition of the galena, owing probably to their super oxygenation.

Slackenfsde is a singular variety of galena, appearing of a bright metallic lustre, with a reflection approaching to that of a mirror. It is thin, as if it only plated on one side of a substance called *kevel*; and forms the side of a vein or of a cavity. When first pierced it cracks and flies with violence, as already mentioned. A new variety of *slackenfsde* of a metallic lustre, coated with blende of a light stone colour, sometimes dark brown

on a fine violet fluor matrix, has been recently found,

Masses of lead, perfectly malleable, but very much corroded, are sometimes, though very rarely, found in old mines. They appear stalactitic. At an early period the miners made fires in the mines to melt the lead ore in the veins, and this substance may probably have remained there ever since.

The antimoniated lead ore runs, like net work, in filaments curiously interwoven, and is sometimes accompanied with indurated bitumen. This kind is rarely iridescent.

A most beautiful iridescent variety is sometimes met with in octaedrons, the colours being very vivid at first; but they are subject to tarnish and lose their beauty, by exposure to the atmosphere. This variety is generally attended with crystallized fluor, affixed to its surface.

Sometimes

Sometimes a variety of carbonate of lead occurs, which does not adhere to the galena, Masses have been found of a horn colour, semi transparent, and finely crystallized on the surface,

Muriate of lead in perfect crystals of a beautiful transparent yellow colour.

What is called glass lead, *appears* as if it had undergone the action of fire; is transparent, and sometimes crystallized; but in other instances is of an opaque, waxy white. It is easily melted by the blow pipe.

Nodules of carbonated lead have also been found, formed by a combination of prisms, acicular, fibrous, and interwoven, sometimes of a considerable size in loose earth. Other carbonated nodules found in a loose ferruginous earth, granular, and of a shining micaceous fracture, and easily reduced

duced to a sandy powder. This variety may be termed sandy lead ore.

Crystals appearing semi-metallic: sometimes one part of the same crystal a dull blue colour, the other transparent horn colour.

A singular variety of carbonated lead occurs in ferruginous earth, in nodules, with hydrophanous steatite, &c. appearing like a decomposed breccia, in small semi-transparent veins.

These ores have hitherto attracted little notice; nor indeed, till within these few years, was it known that they contained lead.

An argillaceous variety, called wheat stone, is found in a large vein. It is of a light stone colour, very heavy, with black spots, and contains arsenic. It is not transparent: fracture earthy, with a few bright metallic

metallic scales, and sometimes traces of small semi-metallic veins. This variety is extremely easy of fusion, during which it emits a strong smell of sulphur and arsenic.

Phosphate of lead, of a leek green colour, in hexagonal prisms, is sometimes found on barytes, attached to sand-stone.

Molybdate of lead, of a fine yellow colour, approaching to orange, sometimes appears in the cavities of galena, and of carbonated lead. This variety I have seldom met with in this county.

Galena generally yields from 50 to 80 per cent. at the furnace; many arts are practised in the dressing, to make it appear clean and rich, in order to fetch a higher price, which are well known to the smelters or ore buyers.

The carbonates of lead are so full of heterogeneous matter, that they rarely yield

yield more than from 30 to 50 per cent,
and do not produce such ductile metal as
the galena.

SECTION



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Mawe del.

Maston sc.

SECTION X.

Account of the Ecton Copper Mine.

THE Ecton copper mine is the only one of any consequence in Derbyshire; to which though on the edge of Staffordshire, it is generally reputed to belong.

The general produce of this mine, is massive rich yellow copper ore, frequently in contact with galena and blende, but specimens occur of purple, steel-blue, brown, or brass-yellow colours. The ore yields from forty to sixty per cent. and is sometimes vitreous and black.

Sometimes, though rarely, it is crystallized in the cube, and its modifications.

No specimens whatever can exceed the beauty of some from this mine, consisting
of

of iridescent copper pyrites, on a white barytic gangart. The colours are beyond description; the topaz yellow and gold; the violet and azure, being blended in the brightest effulgence.

The calcareous spar of Ecton, is a singular modification of the rhomb, very transparent, sometimes of a rich topaz colour, and generally containing brilliant crystallized pyrites in the interior.

Fluor, water coloured or light blue, also appears, finely crystallized with galena.

By the decomposition of the copper pyrites on the calcareous spar, arises a beautiful green efflorescence, clothing the spar, and sometimes appearing to pass into pearl spar.

Ecton also produces mountain blue, and mountain green; the former approaching to azure, the latter to a light verdgris colour, the fracture of these substances is earthy

earthy and uneven. They absorb moisture, and appear to be composed of barytes, granulated calcareous spar, and clay, with iron, and green calx of copper.

The famous vein of copper ore called Ecton mine, lies near Hartington, being what the Germans call a *Stock work*, and the only one in this kingdom. It is situated from the surface to the bottom in a blackish brown limestone, the strata of which are in the greatest confusion, extremely irregular, and running in all directions, as the reader may judge from the annexed plate.

This mine was probably worked at a very early period; it is one of the deepest in Europe, and it is now worked to the depth of 220 fathoms or 1320 feet; during the time it produced the greatest quantity of ore, the profits were immense.

This work seems very different from the generality of veins; it has the appearance
of

of large cavities or openings in the stratum filled with copper ores, &c.

There are some few other mines in the neighbourhood of little consequence.

This mine was extremely productive, and at one time employed more than 1000 people; the rich ore was in amazing large heaps, being in some places 70 yards broad, in others not above ten. It was smelted at Cheadle, where coals are more plentiful; and the copper is greatly esteemed, and much in request for large boilers, &c. being more ductile than any other.

SECTION

SECTION XI.

*Description of the Surface of the Country in
Derbyshire.*

AFTER having premised the strata, it perhaps may not prove uninteresting to give a short description of the surface of this county. The substances found in each stratum have been before mentioned, nor have we any account on record, or proof, of other substances having been found in them.

To begin with that part of the country where the argillaceous grit appears at the surface, or under the vegetable earth, will be the most regular method; as it is
I considered

considered the uppermost stratum, and for a considerable distance presents more uniformity; the hills are more regular, and rise by easy inclination, forming vales of considerable extent. The soil above is generally inclinable to the red clay and vegetable earth, where it continues unimproved. A large tract of country around Derby, in a high state of cultivation, has led me to the observation. In this neighbourhood, the value of coal is most conspicuously seen in agriculture.

The effects of lime on these lands is tolerably ascertained, but in what manner it acts, has not perhaps been thoroughly examined. Incapable as I feel myself to investigate this subject, yet, if by any means I could contribute to the examination of one so interesting, and of so great public utility, I should consider myself as not doing my duty, did I omit to mention my ideas.

The

The varieties of limestone render it highly necessary, that its properties and different characters should be more generally known. Some sorts are more proper for the purposes of agriculture, while others claim the merit for architecture. Limestone containing manganese, iron pyrites, and earth of the magnesian genus, is destructive to vegetation, according to the proportion it contains, but these substances do not render it unfit for a cement. The lime that contains the largest portion of carbon, and free from metallic substances, is considered most proper to stimulate and increase vegetation. Lime on clay lands, probably acts as an absorbent, the vitriolic acid, which iron generally imparts to it, is in part disengaged; by which means a substance destructive to vegetation is destroyed. Lime also acts powerfully, by preventing large masses of earth from forming by adhesion, and

12

renders

renders these masses more friable where it enters, by filtering, as it were, through the soil at the surface. It may be of considerable use by so greedily absorbing moisture, dividing the earthy particles, and forming a thin stratum a few inches below ; and having regained a considerable part of the carbon, which was disengaged by burning, it probably imparts it to the young plants.*

To the learned Doctor Darwin, the public are much indebted for information on this head ; this truly great philosopher has clearly shewn, that carbon is the life of the vegetable creation. I hope the reader will pardon me for the digression, and trust my motive will prove a sufficient excuse.

* In many of the sparry limestones, that have been submitted to my examination, I found a considerable portion of the phosphoric acid, which may probably act as a great stimulant.

The

The face of the country, where the coarse gritstone makes its appearance on the surface, next strikes the attention.

This substance forms long and narrow mountains rather than hills; the soil above it; in most of the elevated situations, as the East Moor and Edgeside Hills in the neighbourhood of Castleton, Winhill, Lords Seats and others in the north, is very indifferent. On Cromford Moor it forms rude scenery, but more particularly so near Birchover, where immense masses lie in the rudest directions.

The mountains formed of the grit stone are the highest in the county, and have little depth of soil; but the land immediately below has more, and pays the cultivator for his improvement: decomposed vegetable matter forms the best soil, and is washed down by heavy rains. A large tract of country might be mentioned where

this stratum appears uppermost, but as it has the general character before described, it will be unnecessary.

The surface where the stratum of shale or shistus makes its appearance is next in succession. It most frequently appears uppermost in vallies formed by limestone mountains on one side, and grit stone on the other, where it is generally covered with loose irregular pieces of stoney matter, called ratchell, which has probably fallen from the adjoining mountains in the lapse of ages. Shale is subject to decompose by the action of the atmosphere, and where it is exposed, it falls into a black earthy matter; it is not considered as a substance friendly to vegetation, though when immediately in contact with limestone, its properties appear altered. In many places it is much impregnated with vitriol and martial pyrites. Lime acts very powerfully on it, and in many vallies it is well

well covered with vegetable earth, and forms good land.

The form and general appearance of limestone mountains next present themselves to view. In many parts they are perpendicular and overhanging, presenting bare rocks in a great variety of forms, with distinct marks, stratification, openings, or caverns, of which none of the preceding shew any character.

The appearances of dislocation and separation in these mountains, are evident marks of the violent efforts of nature. Limestone in the north and west, in this county, generally forms large tracts of mountains, rising to a considerable height from the valley to the summit; they then range more regularly to their furthest extent.

The lime generally used in the south of Derbyshire, is brought from Breedon, on

edge of Leicestershire, near Ticknall, and probably from some other places adjacent. North of Derby large mountains are formed in the neighbourhood of Wirksworth, Cromford, Matlock, Winster, Ashford, the banks of the river Wye, a large tract from Ashford to Buxton, in which is the beautiful valley of Monfaldale, Chee Tor, and a variety of places that present as fine rock scenery as almost any country can boast of, not forgetting in the more western part, the beautiful valley of Dovedale, where the rocks are singularly picturesque.

The wild scenery of Middleton dale, and the Winnets on approaching Castleton from the north, is the admiration of visitors, and the irregularity is beyond description. The mountains which form one side of the beautiful valley of Castleton, are called, Longcliff, Cawler, and the Red Seats: they are full of veins of lead ore, and range
from

from thence, south, 8 or 10 miles; south-west of Castleton, the limestone mountains range to Buxton, over Peak Forest, where is produced the finest lime.

The soil above this stratum is converted to all the purposes of agriculture; it affords most excellent pasture and grass lands, and produces fine crops of corn. The mountains are usually stored with cattle, being inconvenient for the purpose of tillage. Their stratification particularly engaged the late Mr. Whitehurst's attention, especially about the neighbourhood of Matlock, where he says (according to his ideas of the formation of the earth) they take an undulating form for a considerable distance, in which I conceive he was misled, by not more closely examining the substance. The stratification of the high Tor and adjoining mountains, inclines into the rock or to the east, probably as much as one foot in six, forming

forming an angle of 25 degrees. The face of these rocks is full of hollows, and very uneven, by parts projecting, which causes it when viewed at a distance to have an undulating appearance.

It will obviously strike the reader, that if a prominent part is marked by stratification, and a part annexed recedes twelve feet, it will appear when viewed in front at a distance, that the stratification of the projecting part, is two feet higher than the part which recedes. It in reality is so, therefore it is the uneven form of the mountain, that gives it the undulating character, which it does not possess.

There is one place exactly opposite Matlock bridge, that seems to have more of the undulating form; and though I convinced my friends of the error of their opinion in the mountain called the High Tor, yet they seemed confident I should agree with them

them in this instance, which I shall briefly describe.

The front of a bare rock presents itself of no considerable size; its form is broad at the bottom, narrowing to the summit; and the marks of stratification, rising from each side, meet in the centre, forming a short undulating appearance. This seemed to me contrary to any formation of limestone I had yet seen, and made me determine to examine it more minutely. On crossing the river I was close to the rock, and found a fissure or vein situated exactly in the centre, by which the stratum was broke and lifted up in the middle; consequently appearing as if thrown down on each side, which sufficiently accounts for the appearance.

As every circumstance attending the situation of objects is interesting to natural history, it may not be improper to give
a short

a short description of the form and appearance of the caverns, which are peculiar to this stratum in this county; and are objects of great curiosity and admiration.

The character and form of caverns have not been noticed by any to my knowledge. If they were more accurately noticed, it might probably be the means of throwing more light on their formation. The entrances into many caverns are spacious, the openings are large, more particularly those from the surface, as Peaks hole: while others are found by mining, consequently the entrance to them is no larger than necessary for the purposes of the miners. The entrance and roofs generally assume an arched appearance, and though the tops of the caverns are frequently irregular, they almost always form a segment of a circle; the sides generally rise nearly perpendicular, while the bottoms are
more

more flat. Large detached masses of limestone frequently lie at the bottom in rude forms: marine figures present themselves in abundance, projecting in many places above an inch from the rock; chert, or hornstone in nodules, and various forms, appears prominent in every direction. Caverns in the interior are frequently found above 200 feet high, and probably much higher, inclining to the form of an inverted cone. A prodigious variety of round or spherical holes occurs in the roofs, some two, three, four, and six feet diameter, and as deep; they preserve a very correct round form: and often smaller ones appear in them, as if formed by art. In various places the rock forms festoons, and where it hangs from the roof, it frequently is extremely thin (as if worn by water) and assumes the appearance of drapery. The sides and roof of caves are commonly covered

covered with stalactitic matter, and sometimes elegant stalactites are formed 3 or 4 feet long, and not more than one in diameter, quite transparent; when the infiltration of water is great, stalactites seldom appear, the rock being covered with a thick muddy marl; streams of water generally occur at the bottoms, and water frequently filters down some part or other. In the caverns are depositions of sand, earthy matter, and a variety of rounded stones, &c. which clearly prove, that water from a remote part has found a subterraneous course into these caverns, and probably was the principal agent at some period of their formation. Openings or swallows frequently occur of considerable depth, some are disclosed from the surface; as Eldon hole, others are found in mining: they are generally uneven at the surface, and the sides are commonly perpendicular; they appear to be a part
of

of the stratum funk, and to have filled some cavern below.

The limestone stratum is found frequently divided by the toadstone, which I shall now notice. It forms the surface in various parts of the county, beginning in the neighbourhood of Matlock, and dividing the limestone for a considerable distance near Buxton, and particularly at Wormhill; in that neighbourhood, it is of considerable extent, uneven, and rocky, but by no means so much so as the preceding stratum. This substance is singularly acted upon by the atmosphere, and puts on such a variety of appearances and difference of characters, as to render it difficult to know it in its various stages of decomposition; in some places it appears like basalt, or rather what is called whinstone; abounding with hornblende, and in it are found jasper and calcedony. At a small distance not exceeding 20 yards

yards, it migrates into a variety of amygdaloid, some dark green and hard, others ochre yellow, with globules of green earth; and is as soft as clay.

It is very probable this substance was at some early period equally hard; but from being so differently exposed to the action of the atmosphere, is in some places covered with vegetable earth, moss, &c. and in other places it may receive the filtrated water from the limestone stratum, which perhaps may, in some degree, be the cause of its various appearances.*

It is not considered as a stratum that admits of water filtrating through it, though for a small depth it is penetrated by it; springs

* This stratum is considered by the miners as very uneven; it by no means so frequently divides the limestone and veins of ore as is imagined; a number of mines from 50 to 80 fathom deep are situated in the limestone, where the toadstone has not been met with. In fact, it may be stated seldom to occur instead of generally.

often

often appear on its surface. To give an exact account of the variety of appearances this substance takes in the same stratum, would be too extensive for a work like this, neither is it to be supposed every place is mentioned, where it and the preceding strata, make their appearance. This is intended to give a concise description of those only that have been under my observation, more particularly in the neighbourhood of Castleton.

SECTION XII.

*Some account of the Mines north of
Derbyshire.*

HAVING thus briefly described the mines and mineral substances of this country, perhaps a short account of the mines further north may prove acceptable, and serve as a guide to those who wish to visit mineral countries; my wish being to impart such information, as may assist the progress of mineralogy.

The coal mines at Wiggan, about 16 miles north of Manchester, are worthy of notice; for here is found the noted *kennel* or candle coal.

Near

Near Chorley, 25 miles north of Wigan, are lead mines, not now worked; belonging to Sir F. Standish. These mines, which produced the witherite or aerated barytes, were sunk in the grit or sandstone; they ceased to be worked about 15 years ago, and are now filled up by the earth running in, or are full of water. It would be fortunate if their produce could be rendered more useful; and I have been informed, that the proprietor offers liberal terms to adventurers.

To the west of Lancaster, is Ulverston, remarkable for iron mines of rich hæmatites. One perpendicular vein of ore is thirty yards wide, in limestone; large nodules, some even weighing four cwt. of a kidney form, metallic lustre, and stellated fracture, are found in the loose ore. This iron is peculiarly ductile, when it is melted with charcoal; and it is used for making wire. Part of the ore is transported to Bunawe, in

the highlands of Scotland, where a company has established a foundery, fed with charcoal, small wood being plentiful near this distant establishment.

From Ulverston to Conniston; near which there is a copper mine of little consequence, and some small mines of lead. The mountains are chiefly of the blue argillaceous shistus.

Hence to Borrowdale, in which is the remarkable mountain containing what is understood by black lead, or as erroneously termed by the miners *black wad*; an important article of commerce, and which may be said to supply all Europe with the black lead pencils. This mine is situated on the summit of a granite mountain, high, and difficult of access; lower in the mountain is driven a short level.

The *wad* lies in what the miners call *locks* or small cavities; and forms an irregular

gular kind of pipe vein, attended by ochreous matter, calcareous spar, quartz, and more generally by a greenish, scaly, soft micaceous earth, appearing a little like a species of serpentine. This mine is only worked once in two or three years; a method which produces a sufficient supply for that space of time. The mine is carefully watched, and a house is built over the entrance. I believe that it is felony even to take specimens from the hillock. Plumbago, or black lead, contains about ninety per cent. of carbon, combined with one-tenth or one-eighth part of metallic iron.

From Borrowdale to Kendal, eight miles, a very mountainous country. Here is a very fine variety of green granite; an uncommon substance, also found in the county of Galway, in Ireland. It is sometimes used

for flooring: but the rocks are generally a kind of blue argillaceous shistus, which on exposure to the atmosphere, decomposes in thin laminæ. The geologist will find many interesting varieties of rock in this neighbourhood. At the bottom of Derwent water, the lake so called, are a few veins of quartz in the shistus mountains, containing lead ore; but the produce is small and of no moment. In the vicinity is a fine spring of salt water, not hitherto noticed. It will be worth while to visit Crosthwait's museum, where the traveller will meet with interesting subjects, and procure information with civility and attention.

From Keswick to Caldbeck are some mines which were formerly worked, but there is nothing interesting to stop the traveller. Hence to Carlisle; near which
place

place is a vein of antimony, and a mine worked for that substance, which I did not see.

SECTION XIII.

Account of some Mines in Scotland.

FROM Carlisle I passed to Moffat, noted for its baths and mineral springs. Hence to Elvanfoot bridge, and to Lead Hills, a mineral country belonging to Lord Hopton. The mountains are composed of what is improperly called whinstone, for it seems rather a siliceous schistus, or perhaps a kind of basalt; it is of a very dark brown colour and very close texture, smell earthy when breathed on, fracture splintery, and irregular; is very hard, gives fire with steel, and is very ponderous.

The

The veins of lead ore are in general large, and extremely rich. The fusanna vein is the admiration of travellers, being a great rake vein, which in some places has continued for a considerable way, 14 feet wide of solid ore. It is now full three feet wide; and an amazing quantity is before the miners. This mine is about 100 fathoms deep, with a fire engine, not now employed, a sufficient quantity of water having lately been procured to work the water engines, so as to keep the bottom dry. There are many other veins, and in general rich; in some parts are veins of a granitic varieties of a fresh red colour, containing cubic pyrites: they appear in all directions when they approach the veins of lead ore; they do not intersect or divide them, but continue their direction, forming the gangue on each side, they are from a few feet to 35 yards wide, intersecting

ing the whinstone; a singular circumstance which also occurs in Brown's vein, and the mines at Wanlock Head, &c.

The veins produce oxyd of copper, mountain cork, and great variety of carbonates, phosphates, and molybdates of lead, with quartz and calcareous spar; and sometimes barytes.

At Wanlock Head, distant two miles to the south, are some rich mines belonging to the Duke of Queensberry; the substances being much the same as at Lead Hills.

Near the latter mines native gold is procured in grains, by a simple, but interesting procedure. A person who understands the business, (and little art is required,) takes about 20 or 30 pounds of earthy matter, as near the solid rock as possible, and putting it in a trough, he proceeds to a rivulet. Filling the trough with water, he turns the earth a little with a small shovel, and places

places it in the current, which carries off the light earth; and the stones are thrown out. This process is repeated till little be left; which is turned again and again, in the running stream; till it diminishes to a few ounces, chiefly of lead ore and other heavy particles; among which, a few grains of gold are almost always discovered, their gravity precipitating them to the bottom.

On enquiring if it would be productive to conduct these operations on a large scale, I was answered in the negative. The smallness of the grains indeed afforded sufficient information; yet the certainty of finding gold, more or less, is strikingly singular. Pieces have been found above an ounce in weight, and I am informed, that Lord Hopton has a piece yet heavier in his possession. A company of Germans once worked here for gold; and the manager

nager is said to have made a large fortune ; but this may be a popular story. It is certain, that gold medals were struck from the produce, when Charles I. was crowned at Edinburgh.

The miners at Lead Hills are men of good morals, and excellent members of society. They have a pretty large circulating library, which they founded for their own amusement and instruction. The agents are men of science, who exert themselves to promote industry and happiness.

From Lead Hills I passed 50 miles to Glasgow, where there is plenty of coal found in the neighbourhood. Hence to Tyndrum, where there were considerable lead mines that produced vast quantities of lead ore, with a variety of other mineral substances, and used to employ a great many people. The veins are in a mountain of granite ;

granite; but the operations have ceased for some time.

From Tyndrum I went to Strontian, about 70 miles, over the black mountains, the Devil's staircase, and the grand *Glen Co*,* where there are many curious porphyries, and granites, and their varieties.

Near Ballyhulish is the largest and best slate quarry. I ever saw, in a mountain of micaceous schistus, with a seam of limestone in the vicinity. These slates form a considerable article of export, the limestone is burnt; but coal is so dear that the advantage cannot be general.

Strontian is situated in a fine valley, near the bottom of Loch Sunart. The mines are in the mountains, at the upper end of the vale, the rock being red granite; but the neighbourhood contains many va-

* *Glen Co*, near Loch Lung, contains micaceous schistus.

rieties

rieties of this stone, some very full of mica. The veins are what the miners call *rake*, and of considerable extent. Some of them have been worked about 100 fathoms sunk in the vein, without any perpendicular shaft. The companies that have hitherto worked these mines have always been unfortunate; and they are now full of water. Besides lead ore, was produced *frontian*, a rare and new variety of earth; with calcareous crystallizations, zeolite, staurolites, &c. but none of these substances are now to be found. I was there in July 1800, and could not procure one ounce of the frontianite; and was informed, that two or three people had, for more than a year, been employed in picking it up, wherever it could be found.

Ben Riffabel, in the statistic account of Scotland, Vol. XX. p. 289, it is called
 Ben

Ben Reifipoll, and the height is said to be 887 yards. A very high mountain of white granite, is about six miles to the west of Strontian; the summit presents a micaceous vein, containing large garnets.

I returned by Collendon to Stirling. In the neighbourhood of the latter place the Ochill Hills, especially near Alva, contain veins that produce silver, copper, cobalt, lead, &c. The mines are not now worked; but the naturalist who takes the trouble of picking the hillocks, and searching the mountain, will meet with some recompence for his labour. At Edinburgh is Weir's museum, where I hope to see mineralogy more noticed; the largest departments are the birds and the fish. Arthur's seat, and Salisbury Craigs, are of basalt, sometimes forming rude irregular pillars.

The

The whinstone, or basaltic mixture of quartz and hornblende, is uppermost; and under it is a seam of jasper, in some places curiously spotted with iron. Here also occur grit and limestone; with quartz and calcareous spar. When the whinstone is in decomposition, it appears like a lava that has been long exposed to the weather, and much resembles the Derbyshire toadstone. The Pentland hills produce *petunse*, or the decayed felspar used in making porcelain; and, according to some, adularia. Here are also considerable masses of argillaceous porphyry.

From Edinburgh I returned by Carlisle to Alston, where there are several mines belonging to Greenwich Hospital; from the trustees of which, they are rented by the Quaker company. They are chiefly in limestone; and are rake veins, producing

producing a great quantity of lead ore, with blende, calcareous spar, &c.

Garrigill gate, Tyne head, and Nent head, are considerable mineral countries. Coal Clough, a great mine, is worked in limestone, and in the grit sometimes called *bazel*; and also, which is singular, through a thin seam of coal. It produces large quantities of lead ore, fluor, &c. There is another considerable mine of the same substances at Allons Head; both of these mines, and many others, being the property of the worthy Colonel Beaumont. The mines in this quarter are conducted on the most scientific principles, which their rich produce can indeed well afford; and the agents are men of skill, and well versed in mechanics. On proceeding southward, a variety of mines appear in Weredale and Teesdale, about Middleham and Ark-

L

endale

endale in Yorkshire, and at Kettlewell in the vicinity; nor must I omit to mention those at Grassington and Paitley bridge.

SECTION

SECTION XIV.

Tour from Glasgow to Staffa.

SHOULD the traveller wish to visit the celebrated isle of Staffa, one of the western Hebrides, the following short account may perhaps prove interesting. I shall not attempt to delineate the vast extent of mountainous country I travelled over : that would require a work of time, and could not be accomplished in few words.

From Glasgow I determined to make a pedestrian tour to Staffa ; accordingly I set out for Dunbarton about 15 miles distance, good road ; the neighbouring rocks appear

a dark basalt; from Dunbarton I proceeded by Loch Lomond and Ben Lomond; excellent road and fine rock scenery to Lufs, and from thence to *Arrocher*, 22 miles. On the side of Loch Long a good inn; where I arrived about 6 o'clock in the evening. The day having been rainy, and the evening commencing with violent gales of wind, accompanied with heavy rain, caused me to determine to stay here until morning; having picked up a few fragments of rock specimens and carried them in my pocket, which I now began to unload and examine their merits, in order to throw away those which was least interesting. They chiefly consisted of basalts, argillaceous shistus, granites, and their varieties. The argillaceous shistus I found frequently in veins in the basalt; it appeared in various directions, and falling in laminae by decomposition; in it were many quartzose

zose veins, and patches of fine blue slate. A beautiful red granite, in which the felspar was of a high flesh colour, was amongst them; the felspar composed the greatest part of the specimen; in one or two pieces of granite, the mica composed three parts out of four of the whole.

I shall not attempt to amuse the reader by telling how I spent the evening, what I had to eat, &c. suffice it to say, the inn is a good one, and the hostess did credit to her house.

In the morning I arose at 5 o'clock, and immediately started for Cairndow, 12 miles distant. Having walked round the head of Loch Long, my mind was struck with awe at the approach of Glen Cro; the roads are excellent, and the traveller is amused almost every mile by an inscription engraved on the mile stone; by whom
 L 3 they

they were made, when they were erected, &c.

Glen Cro is a very deep ravine, furrounded with vast mountains extremely rugged. The morning was exceedingly rainy with a violent high wind; a rivulet runs through the Glen, which in wet weather, must be considerably increased from its rapid fall. Immense cascades are formed in heavy rains, precipitating large pieces of rock to the bottom, which lie in all directions,

The Glen is so much on the ascent, that there is not an acre of even ground in the distance of several miles. At the top is placed a stone, on which is engraved, "rest and be thankful:" certainly thankful for a good road, but the ascent is not so great to men accustomed to mountainous countries, as to be so much singularized. The rocks are chiefly a micaceous

aceous shifus, frequently containing large veins of quartz.

Onward I proceeded this unfavourable morning over a variety of mountains and glens; whose beauty was in most parts hid by the inclemency of the weather, until I arrived at Carndow, on the banks of Loch Fine, a delightful situation; I dried my clothes, breakfasted, and received every comfort a good inn could afford a wet traveller.

Being refreshed, I started at 11 o'clock for Inverary, distant about 12 miles, the weather still unfavourable. In mountainous countries, when it begins to rain, it frequently continues a long time; but in walking a few miles the atmosphere is commonly less agitated. If the traveller stops every day, he meets with bad weather, it will be long ere he accomplishes his journey in this country. Walking by the head of Loch Fine, I
picked

picked up many varieties of granite, which added considerably to my weight, and were very inconvenient to carry. I examined many fissures in Basaltic rocks as I passed, and found the sides corroded, and very full of holes. Arrived at Inverary, refreshed, and proceeded to Port Sonnochin, 12 miles distant. The Duke of Argyles' seat is delightfully situated, and happily adapted to its site and surrounding objects; the interior is elegant and magnificent. The castle is built of a singular kind of stone, I scarcely know by what name to call it; it appears a species of argillaceous pot stone; the magnesian earth seems predominant from its soap like feel. I was informed that it is found on the opposite side of the Loch. I proceeded to Port Sonnochin, over immense mountains immersed in the clouds; and was surprised to see such quantities of rounded pieces of granite, some

some of amazing size, detached on the summits.

Port Sonnochin is on the banks of Loch Awe, a fresh water lake well stored with salmon; I was ferried over about half a mile, and proceeded to Bunawe, distant about 10 miles. Having crossed the lake, the country opens, and the scenery is less wild; schistus and granite seem to compose the general range of mountains, which are here covered with small wood. At 9 o'clock arrived at a tolerable good inn, pleasantly situated, where I staid all night.

In the morning I was gratified with fine weather; set out for Oban, distance about 12 miles, a most excellent road and pleasant walk, by Loch Etive to Dunstaffnage.

Here the glens are more spacious and more cultivated, the mountains appear in general to be a bluish schistus and granite. At Bun Awe is a small iron work, situated
here

here for the convenience of small wood, which is converted into charcoal. On approaching Oban I met with a singular rock, presenting its bare perpendicular front on the road side, and of considerable extent; it appeared to be composed of an assemblage of large stones in all shapes and directions, cemented together by an earthy kind of matter; many detached pieces lay in the Glen, and it forms the bed of the water I crossed at the entrance of Oban. The stones that compose this rock are chiefly granites, shistus, and quartz, rounded in a pebble-like form; some are very large; the mountain may be called a species of pudding stone, though the cementing matter seemed to me to be very soft, in some places, decomposing and earthy.

This kind of pudding stone is in contact with shistus; in which last stratum good slate is found in the neighbourhood.

Near

Near Kerrara Ferry is a mountain of shistus containing veins very full of mica; on the summits of the rocks are many rounded pebbles, and near Oban are varieties of amygdaloids.

Next day crossed Conol Ferry, and visited Berigionium; near which place is a bare rock projecting on the road side, composed of the before-mentioned rounded stones in great variety.

Berigionium is a steep mountain, composed of quartzose shistus, situated on a large tract of low flat land, extremely boggy, from whence quantities of peats are cut for fuel.

The mountain is not large, but rather difficult of access; on its summit is a variety of scoria and pumice like matter, cementing fragments of granite, quartz, &c. some of which are covered with enamel and other evident marks of fusion. These
vitrified

vitrified substances appeared to lie in masses in different parts. This mountain has been represented as Volcanic, and these specimens (particularly those that resemble pumice) have been brought forward to substantiate the fact.

I should rather suppose large fires have been made on it as signals to the neighbouring isles and other purposes ; for which its situation is particularly convenient. It is near the sea, which throws up innumerable rounded stones, some of which I think most probably have been carried to the top of this mountain, to serve as a base or fire place.

It is also probable, that wood and weeds left by the tide, were gathered to burn as occasion required, which may in some degree account for the vitrification encompassing the rounded stones, more especially as they are only in small heaps. This mountain

tain has not the smallest vestige of any thing like volcanic origin ; at one end are a number of stones placed without order or regularity.

From Oban I hired a boat to the isle of Mull : and walked to Arros. In various directions I travelled about 50 miles on that island, and found it generally of basalt, in such various stages of decomposition, as to render its character lost in many instances, frequently migrating into a soft toadstone. On the west side of the island, the cliffs adjoining the sea have a columnar appearance.

I stopped at a house at Lagan, a tolerably good inn : they are very civil people, and the hostess spoke English : they rent the isle of Staffa, and accommodated me with a boat and necessaries for the voyage. In visiting Staffa, I did not perceive much danger, the westerly winds
often

often prevail and render it impossible for a boat to go, but in tolerable good weather (and surely nobody would go 10 miles to sea in bad weather on pleasure) a boat may approach it with safety.

I have visited Staffa several times, and never met with any thing like an accident; the landing is perfectly easy and safe, when conducted by the people accustomed to the island.

Staffa is a bold high islet, rising nearly perpendicular in many places; being about a mile long, and one eighth of a mile broad. It is almost surrounded by perfect basaltic columns in different directions, and of unequal magnitude; they are in general perfectly distinct and detached from each other. The more earthy parts in the hollows consist of a singular species of mandel stone, of a dark dirty brown colour, full of holes, many of which contain calcedony,

dony, zeolite, and olivine. Zeolite appeared very scarce, and I never found any deserving the name of a good specimen.

The summits of basaltic prisms appear above the grass in one part of the island. The boat generally lands you on basaltic columns, which are even with the water; from which you walk on others rising in regular succession and serving the purpose of steps, until you arrive at the height of the island.

Near the cave of Fingal the columns are of great height, some perpendicular, others bending. Opposite there is the island of Booshala, which is completely formed of columns in all directions; but less than those of Staffa, from which it is separated by a narrow sound, very deep, though not exceeding 10 yards wide.

The sea almost continually beating against the western end of the isle, may probably have

have formed the cave which is situated there; it may be entered with a boat in fine weather, the water in it is deep, and a great surf runs in high winds. The approach and entrance to the cave are by walking on basaltic columns, that also form a path to the end, which may be 60 or 70 yards.

Its breadth at the entrance about 12 or 15 yards, its height about 20 yards, depth of the water in the cave, from 10 to 15 feet.

The constant humidity of the cavern, causes the tops of the columns which form the path, to be extremely slippery; they are also at unequal distances, and unequal in height; some being a foot or more higher than others, and the width being only the diameter of a column which renders this not one of the safest roads for a traveller, as one slip would plunge him into 10 or 15 feet water, with the additional danger of a violent surf
that

would render swimming ufelefs. I would advife the visitor, whose curiofity may lead him to the far end, to take off his boots, by which he will have the ufe of his feet better, and be lefs liable to flip. This ifland, though bare of foil, produces good grafs, and is much efteemed for pafture; fometimes 20 or 30 head of cattle are feeding on it.

One family refides here to take care of them during the fummer. In the neighbourhood are feveral other interefting iflands, as Iona the luminary of the Eaft many centuries ago; here lie more than forty Scottifh, Irifh, Danifh, and Norwegian Kings or Chiefs; here are alfo the remains of many monuments and of a cathedral.

Dutchman's Cap is a fingular ifland, alfo Ulva and others adjoining to Mull.

M

SECTION

SECTION XV.

Salt Mine of Northwich.

ON proceeding from Kutsford to Northwich, the chief appearance is that of grit stone, with some nodules of granite and clay.

A small distance from Northwich I was lowered down into the salt work, about 110 yards, by a steam engine. The shafts are lined with wood; and the first bed of salt is about 40 yards thick, being excavated about ten feet in height, to an extent of 50 yards.

Descending about 60 yards further, you arrive at the bottom, which appears like a
grand

grand amphitheatre, about 120 yards long, 100 broad, and 15 feet high. Triangular pillars of a vast size support the roof, and every part being perfectly dry and clean, the effect is very pleasing.

They get the salt with long chissels, and by the blast, working from the solid rock at the sides.

The strata are extremely irregular. At the surface is a strong red clay, then a shiftose substance called *plate*, which is followed by a little layer of coarse grit; then a blue clay with gypsum, to which succeeds a substance called *metal*, being an indurated clay, in which are veins of rock salt. This clay is of great thickness, and is followed by a bed of rock salt, workable for perhaps 20 feet. Next is a stratum of clay, mixed with salt, about 30 yards thick, more or less impregnated, until it becomes a hard compact rock salt, which is generally of a

reddish brown, and sometimes in thin layers perfectly transparent. It is worked at an expence of about two shillings a ton.

To draw up the rock salt, they have fire engines, equal in power to three horses. It is chiefly exported under a heavy duty; and in the town are fifty or sixty officers of excise.

Common salt is procured by dissolving the rock salt, and if a fine sort be required, a strong fire is made under the brine, and the salt forming at the top, precipitates to the bottom. If stronger salt be wanted, as for fish, &c. the heat is administered slowly, when the salt crystallizes in large cubes.

The whole surrounding country is clay, and very coarse grit; and wherever a shaft is sunk in the neighbourhood, there is a certainty of finding salt.

The

The grit stone prevails as far as the town of Flint in the county so called ; and as no coal is found near Northwich, it is presumable that the salt is above it.

In the county of Flint, and near the capital of that name, are plenty of coal mines at various depths.

Towards Conway there is abundance of limestone, and at Newmarket I observed some heaps of green calamine.

Llandidno is situated on the top of a hill, and is a poor village. The copper mine is in limestone, and seems to occupy a large space ; the surface has sunk several yards, the bottom being soft, and containing caverns, with calcareous spar and copper.

This mine is said to have been worked by the Romans, and seems to lie in bunches. There are some curious calcareous spars ; and the limestone is very full of chert. Fine malactites, of the velvet kind, have
M. 3
been

been found here; and the sandy sort of copper ore.

From Conway to Beaumaris are chiefly blue schistus and granite; and near Bangor are good quarries of slate.

SECTION

SECTION XVI.

The Paris Mine.

BEING now arrived in the Island of Anglesea, I was anxious to see the celebrated mine in the mountain of Paris. The smelting works first attracted my observation, being superior to any I had seen, and containing 20 furnaces in a very extensive building.

The mine is on the top of a mountain of blue or perhaps quartzoze shistus, or perhaps some might call it a quartzoze shistus with serpentine; ranging from east to west, about 500 yards in length, while the breadth

M 4

is

is about 100 yards, and the depth nearly as much. The bottom is very irregular, masses of *rider* or vein stone interfering; while the richer copper ore runs into holes, and crevices, in strange and various directions. The shistus lies in irregular strata, and is covered with a bed of gravelly heterogeneous matter, full of chert.

Copper ore is got for about two shillings a ton, and is laid in heaps of five or six hundred tons; in the sides of which ovens or fires are placed, and the sulphur in the ore soon taking fire, it continues roasting for six or nine months, and is then forwarded for smelting. The produce of the mine is very poor, about seven and a half per cent. sometimes more, and sometimes so little as five per cent. Patches appear of fine cubic mundic.

Great quantities of sulphur are made. In the subliming houses the ore is covered

vered with earth, and brick tunnels are formed on the top or sides, to receive the sulphur.

On examining this immense mine, it does not appear like a vein. About 500 yards to the east, the Cornish Company have sunk a shaft of 40 fathom, but have only found small particles, and strings of ore. They have also driven north and south; but have not met with any vein.

In some places the ore rises within eight inches of the surface; and immediately above is a red crust, which has every appearance of vitrified scoriæ, has marks of fusion, being cellular, glazed, and like a feruginous pumice. It is sometimes a little irredifcent, has a styptic vitriolated earthy smell; and probably contains vitriolic acid, with iron and sometimes lead.

The area of ground, containing the whole works, is at least a square mile in compass.

The

The water, which is pumped from the works, is strongly impregnated with copper, and is received in dams and reservoirs constructed for the purpose, and in vats like the pits used by tanners. In these are placed plates of cast iron, on which the copper is precipitated, which is of the best quality. Of these pits there are some hundreds; and in the vicinity are ovens to dry the copper.

After the sulphur is refined, it is melted in iron vessels over a slow fire; and when liquid is cast into moulds, perhaps earthen boilers would improve the colour, which is far from good.

The Paris mine is worked at a considerable expence; and with the Mona mine, employs about 1,200 hands above ground. The greater number are occupied in sorting, dressing, washing, &c. while few are employed under ground, the deepest shaft being about 40 yards.

The

The copper ore is extremely full of sulphur and iron. About four hours are employed in reducing it to a regulus. The metallic substance running chiefly into the first pig, which is richer than the rest, the regulus sinking from its superior weight. The second is tolerable; but the others are thrown aside, and form an article of sale for mending roads. Formerly conical kilns were used, but they were found too expensive.

The smelting house is about 80 yards in length, by 18 in breadth, and about 6 yards high.

The harbour is safe and convenient; but a bar seems wanted to break the surf.

The surrounding mountains appear to be all formed of siliceous schistus; with a kind of serpentine, which cleaves and decomposes,

The

The chief minerals I observed here are as follows:

A kind of lead ore resembling clay.

Sandy lead ore.

Yellow copper ore.

Black ditto.

Iridescent ditto.

Varieties of mundic.

Copper formed by cementation.

Native vitriol.

Ochres.

Lead ore sulphuric.

Steel grained galena.

A shistus serpentine, with asbestos.

Green semi-transparent asbestos.

A quartzy shistus, full of veins of white quartz.

Many varieties of chert, with veins of copper in them, forming a part of the riders in the mine.

Allum

Allum is also prepared here, from shistus laid on the roasting copper ore, where it absorbs the vitriolic acid. The pans used are of lead.

SECTION

SECTION XVII.

Some other Observations in Wales.

RETURNING by Conway, I inspected the mines in that neighbourhood, but found nothing worthy of notice. Their matrix is chiefly chert, a species of black hornstone; and there is a black flinty stone with white quartz.

The vale of Conway is extremely picturesque, and full of rich scenery, the rock and waterfalls conducing greatly to the effect.

Near Llanrust are some large veins of quartz, which are worked for the porcelain

lain mill, near Bangor; and I should have mentioned, that near Conway are some masses of chert, in a black siliceous mountain, which are found nearly as well adapted for mill stones as the French *burr*: and a lady obtained the premium of 100 guineas, from the society of Arts, for the discovery.

The mountains near Llanrust are of granites, porphyry, and shistus, with a great deal of black chert, in which are veins of lead ore, quartz, &c. but there are no lead mines of any consequence.

I re-visited Llandidno, and went down the mine. There are veins of copper ore, which sometimes present that substance, and at others masses of limestone. Here is a vast *lum*, filled with loose earthy matter, dislocating the strata.

SECTION

SECTION XVIII.

*An account of Mr. Williams's Book, called
the Mineral Kingdom,*

Edinburgh 1789, 2 Vols. 8vo.

Vol. I. 450, p. p. Vol. II. 531.

THIS work is written in so singularly prolix and confused a manner, that an analysis of it may be useful to those who possess the work, and to those who do not, may afford an instructive account of its contents.

The title page expresses that it is divided into three parts :

“PART I. Of the strata of coal, and the concomitant strata.”

“PART

PART II. Mineral veins and other beds, and repositories of the precious and useful metals.

PART III. Of the prevailing strata, and of the principal, and most interesting phenomena upon and within the surface of our globe.

Of these Part II. which occupies about a third part of the first volume, is the most curious and interesting; but like the rest, disgusts by its tedious prolixity, and want of scientific arrangement.

At the end of the second volume is a table of contents which ought to have been prefixed to the work. There are neither chapters nor sections, so that the reader is bewildered in a vast mass of matter; and this neglect has led the author into many repetitions.

In the preface, the author explains the importance of our coal and other mines to the manufactures and commerce of the na-

N

tion;

tion; and the consequent importance of acquiring mineralogical knowledge. He shews that many manufactures of the greatest consequence depend entirely on mineralogy, and in page xxiii. begins a confutation of the Huttonian system, which continues to the end of the preface, p. lxii. A chief end of this analysis, is to select the real facts and observations, which in this work, are buried in a mass of idle declamation. Such is that, p. xlix. that the rich vein of lead at Llangunog in Montgomeryshire; which was five yards wide of solid ore, was found suddenly cut off by a deep bed of shistus. This preface concludes with a prayer, the author being a very good christian.

PART

PART I.

The strata of Coal and its Attendants.

THE author first investigates the regularity and inclination of coal strata. The incumbent substance is called the roof, while that below the coal is termed the pavement, which generally proceeds in a manner surprisingly regular, except when interrupted by *troubles*. These consist of slips, dykes, gashes, and other circumstances. The most common is the slip of the English colliers, the dyke of the Scotch, in which the strata are broken asunder, and thrown up or down on the other side of the slip. Parallel slips

cut the strata in their inclination, which is generally from north east to south west. Oblique slips pass across the slope. Direct slips cut the strata right across. All these slips would be called by naturalists, perpendicular fissures, and by miners, rake veins. A hitch is a small slip only affecting part of the coal; his other remarks on this subject, must be interesting to coal proprietors.

The next interruption is that properly called the dyke, consisting of hard stone, commonly called whinstone, of softer stone, clay, gravel, or sand; the name seems to arise from its resemblance to a wall in the north, called a dyke. The softer and looser sorts produce much water, which renders them difficult to be penetrated. The *gash* or *gall* is very frequent, being a crack or chasm in the coal, and its concomitant strata; and when wide, it is sometimes full of loose

loose matter, so as to partake of the nature of the dyke.

The shake affects the coal and strata, so as to break them and throw them into confusion, and when large, the best expedient is to sink a shaft upon the other side.

Mr. Williams then proceeds to give some account of the coal strata to the east of Edinburgh; particularly those near the Temple Mill, which present four seams of coal. The author then gives some account of Arthur's Seat, and Salisbury Craigs, &c. and of the great regularity of strata on the coast of Caithness. The author thinks, that most caverns, have been mineral veins.

Among the regular strata, Mr. W. classes coal; argillite and mountain rock among the irregular mountain limestone, which Mr. Kirwan supposes to be primitive limestone. Among substances seldom stratified, he men-

tions granite, of which a mountain may appear as compact as a small piece.

He then returns to coal, and mentions many instructive particulars which need not here be repeated. The roofs of coal or incumbent strata, he divides into basalt, as at Hill House, a mile south of Linlithgow limestone, poft stone, or sandstone, doggerband or strata, in balls of iron stone, blaes, or black shistus, also form a common roof; but his further remarks on this subject become scarcely intelligible from the imperfection of his mineralogical knowledge and vocabulary. The extent of the adit at Kilmarton, which intersects above 60 beds of coal, with different intervening strata, is particularly displayed.

Our author then enlarges on the declination of the coal strata, and the various accidents to which they are subject, particularly their running sometimes like waves
but

but many of his remarks are very local and minute.

He then proceeds to examine the extent of coal fields which he finds do not pass through mountains, but on the contrary, sometimes terminate at some distance from them. The coal field to the S. E. of Edinburgh, extends about sixteen miles from Duddington to New Hall, where it terminates at the bridge of Carlops, where the river Esk leaves the Pentland Hills; and the seams of coal, instead of passing under the hills, basset or rise up in great confusion. He concludes, p. 141, that the coal fields do not stretch under the mountains, but are patches of different dimensions like fields of corn or grass. That of Mid Lothian is about fifteen miles in every direction, the fourth forming the northern boundary.

After several repetitions which might have been avoided by a proper distribu-

tion and subdivision of his subject; he observes, that hills of whin or other concomitants of coal, are not to be considered as intersecting the strata. The coal field in Fife (he says,) reaches from Stirling to St. Andrews; and is in some places about 10 miles broad. He then explains how coal may be exhausted; and observes, that this substance is first mentioned in English records of the year 1234, and in Scottish 1291. Some remarks follow on the state of coal at Newcastle, Whitehaven, and in South Wales, from which last, the mines of Cornwall are supplied. Further observations follow on the coal trade, and on the supposed existence of large beds of coal in the island called Cape Breton. Nothing can exceed the prolixity of his declamations on this subject, which rarely present one ray of solid information.

La

In p. 207, Mr. Williams proceeds to give some instructions to landed gentlemen, on the real and fallacious appearances of coal, and p. 233, he particularly considers petroleum; which he says is often found in stratified limestone at a great distance from coal. He afterwards delivers his opinion, that coal consists of antedeluvian timber.

He then, p. 242, &c. enumerates six kinds of coal. 1. Caking coal, such as that of Newcastle, but scarcely known in Scotland. 2. Rough or rock coal, as that of Lothian and Shropshire.* 3. Stone or splent coal of a flaty texture; common in Lothian Fife, Ayrshire, and in some parts of England, (I believe that of Kingswood, near Bristol is of this kind.) 4. Cannel or parrot coal, as that of Wiggan, and also found near Edinburgh. 5. Culm or blind coal

* This kind seems always to border on primeval hills of porphyry, &c. as the first on limestone.

which

which neither emits smoke nor flame, but burns like charcoal. 6. Jet, which he says is found in England and other parts in detached and separate masses; he then compares the different kinds of coal with the different kinds of wood, and points out p. 254, the extraordinary appearance of coal at Castle Lead, in the east of Roxshire, where it assumes the form of rake veins, and as he afterwards explains in granite. He also found coal in the isle of Mull; he returns to shew the absurdity of supposing that petroleum and far less ochre, are any indications of coal.

PART

PART II.

Mineral veins and other Beds, and Repositories of the precious and useful Metals.

HE divides mineral veins into four kinds, 1. rake, 2. pipe, 3. flat or dilated, 4. accumulated. He observes, p. 271, that the vein at Strontian may be called a gash, and that it is in grey granite, in which he is mistaken or inaccurate, faults too common in this work, for it is in red granite. In p. 274, he again returns to Llangunog, and afterwards gives an account of the lead mine at Daven Jaur in Cardiganshire, and of mineral veins on the Scottish shores.

In

In his account of irregular rake veins, Mr. W. observes, that the best concomitants of ore are the spars, and vein stones or riders. His account of the spars is pretty accurate, considered as calcareous, as cawk or barytes, and quartz. In p. 288, he gives a curious account of lochs or the cavities in mines, and the beautiful specimens of copper found at Colvend in Galloway. He then enumerates the soft substances found in veins, particularly that resembling spuff, or the guhr of the Germans. Other circumstances attending veins are enumerated with care, and in general this second part of his work is by far the most precise and instructive; but cannot pretend to any praise of arrangement.

In p. 314, he describes a beautiful ore of the Lead Hills, being a yellow efflorescence near an inch deep, of a fibrous or columnar texture upon the blue galena.

After

After a full account of the rake or perpendicular vein, because it is the most common, he proceeds p. 321 to consider the pipe vein. The mining field of Illy, he says, consists of string veins, and subjoins some account of them. The pipe vein he describes p. 331, as varying from the horizontal to the declination of 45° or more. He observes that the lochs are open spaces, and more frequent in the pipe veins.

The flat or dilated vein or streak, lie between strata like seams of coal, and commonly occur in argillaceous strata.

The accumulated vein, commonly resembles a coal direct or inverted, and is usually the richest of any.

Mr. W. then proceeds to explain the various slips, troubles, and other incidents which occur in metallic veins; and observes that ore is sometimes found interwoven as if it were with the rock, yet worth

worth working, of which he gives an instance at Cwmystwith in Cardiganshire; metallic ore also occurs in the puddingstone at Gourock, near Greenock, and in a singular stone near Loffymouth, which he describes as a compound of many fine stones of beautiful colours.* He then treats of float or shoad ore and indications of metal, on which subject he is practically instructive. The rachel or broken rock, called broil by the Cornish miners, he considers as worthy of particular attention; but he is led into some repetitions concerning the soft mineral soils, and what the miners call *mother chun* or *gubr*. He then combats the opinion, that metallic veins are peculiar to mountains. Among the most productive strata, he enumerates lime-

* From specimens it is now found, that this rock consists of petrosilex, with some galena and quartz crystal, so that Mr. W. has here indulged his imagination only.

stone,

stone, and what he calls the indurated argillaceous mountain rocks and granite; but he looks upon the second as the most abundant, as affording the rich mines of Lead Hills, Tyndrum, and others in Scotland; those of Cardiganfhire, of Yorkshire, Westmoreland, and many parts of the north and south of England.

He now falls into several repetitions concerning slips, &c. and in p. 408, describes the various kinds of lead ore, afterwards proceeding to those of copper and iron. Some of the miscellaneous remarks here introduced are curious, such as that p. 411 concerning the Roman works at Darenvawr, and the richness of the lead of Cardigan; that concerning the veins of copper near Old Wick in Caithness; and that found in limestone at Loch Kiffern, upon the west coast of Rosshire, opposite to the isle of Rasay; that concerning the copper, silver,
lead,

lead, and cobalt found in the Ochil Hills, near the bridge of Allan, with the copper found at Curry, in Lothian; and Colvend, in Galloway. The irons he considers as of two kinds, iron ore and iron stone: of the latter, he describes a stratum as of a reddish brown colour, and it is also found in nodules in the argillaceous strata, which accompany coal.

PART

PART III.

Of the prevailing Strata, and of the principal and most interesting phenomena upon and within the surface of our Globe.

THIS third part occupies the whole of the second volume, and is discussed in a very prolix and declamatory manner.

The first topic is a general view of the prevailing rocks and strata in Great Britain. He first mentions the regularly stratified mountain rock, as whin and argillite, among the latter, the fine blue slate of Eisdale and Ballachylish, in the islands of Scotland, that of Stobo in Tweed-dale, and
 o the

the purple slate near Tombay, above Calender. After describing shiftus, he proceeds to the granatic rocks, on which subject he displays little knowledge. The peasy whin is found in Galway, consisting of black and white grains of the size of small peas. He returns to the rock at Loffymouth, and then proceeds to speak of limestone. The mountain kind he has seen in the islands resembling Parian marbles, "and some of it composed of fine glittering spangles as large as the scales of fishes." The ash-coloured mountain limestone with small grains he observed in the isle of Ilay, and in the country of Assynt, to assume the exterior appearance of sharp jaggs about a foot long. He then describes the white statuary marble of Assynt, and some other kinds. He mistakes the serpentine of Portsoy for Jasper, and a hill
of

of quartz, near Rothes, for agate.* The granite of Ben Nevis he here calls porphyry; but he adds, that about three quarters of the way up this mountain, upon the N.W. side, there is found a porphyry of a greenish colour, with a tinge of brownish red spotted with white angular specks. He then returns to granite, and afterwards mentions basalt. Next are marl and chalk, and micaceous shistus; then a more ample account of basalts.

He proceeds p. 49, to breccia or pudding-stone, and p. 52, to the mountains of quartz in Ross and Invernesshire. Next are the strata of sandstone, particular those of Caithness.

He then enters the wide field of the stratification of this globe, and mentions p. 63, the prodigious mass of granite which

* From the specimens it is a white quartz, in some parts crystallized and tinged red with iron.

composes Ben Nevis, which he seems to describe as being four miles in length. It is unnecessary to follow him through the mazes of theory; suffice it to remark, that he supposes veins and faults to be fissures occasioned by heat, and afterwards filled by depositions from water. He examines at some length the system of Buffon, which he considers as impious and chimerical. He afterwards investigates the structure of mountains, and points out a valuable mill stone rock near Loch Broom. One of his most singular remarks p. 152, &c. relates to the pudding rock, which he traces in Sutherland, Ross, and Inverness, &c. in the north of Scotland, and from Monteath to Stonehaven in the south; and in p. 156, that it is also found to the west of Thurso in Caithness, and the vitrified forts, as he says only occur upon this kind of rock, the account of which he amplifies p. 158,

as

as stretching along the S. E. side of the Grampian Hills, by Kinfauns in Perthshire, and into Dunbartonshire, crossing the Clyde to Ayrshire, where it finally enters the estuary of that river. Some also appears in the neighbourhood of Dumfries, and it seems palpably to have been washed down from the highest mountains.

In the confusion of his arrangement, he next describes talc and mica, and in his account of quartz and felspar, he blends and confounds those different substances. He mentions p. 175, a singular amethystine sand on the river Aldgrant, in the east of Roxshire,* but this is probably as imaginary as his rocks at Loffymouth and Rothes. Of shill or shorl he also gives an imperfect account.

He afterwards particularly examines the

* He calls it the river Allgrade, and says it runs into Moray Firth, instead of the Firth of Cromarty.

strata of coal, and on this subject falls into many repetitions. His theory of antediluvian tides corresponds in some degree with Mr. Kirwan's geological essays; but his idea of antediluvian strata, consisting of uniform mica, uniform quartz, uniform diamond, &c. deserves little attention, and his theory is deservedly forgotten among many others. The population and natural history of America, form a long and tedious digression.

At p. 319, we find what he calls *tracts* on several subjects relating to the *mineral kingdom*. The first of these *tracts* is on volcanoes, and here again we find many repetitions concerning veins, &c. nor does this theoretical essay throw any striking light on the subject. He denies, p. 374, that basalt is volcanic, and with his usual confusion he subjoins an account of tufa and stalactite.

His

His new title of tracts on several subjects, &c. is abandoned at p. 410, where he assumes another title, that of *singular observations and improvements*, many of which are in fact idle theories, and none of them having any connection with mineralogy; it is unnecessary to give any detail of these heterogeneous digressions.

G L O S S A R Y

OF THE TERMS USED BY

MINERS IN DERBYSHIRE.

A

ADIT. A level. See Sough.

Arched. Arched. The roads in a mine when built with stone, are generally arched.

B

Bar-Master. An officer who superintends the miners.

Barmote. A hall or court in which trials relative to miners are held.

Basset. When a substance as coal appears at the surface, it is said to basset.

Belland.

- Belland.** Dusty lead ore.
- Bit.** A piece of steel placed on the end of the borer.
- Bind.** A name given by miners to any indurated argillaceous substance.
- Binghole.** A hole through which the ore is thrown.
- Bingplace.** Where is laid the ore ready for smelting and measuring.
- Blast.** When a hole is made with a borer of sufficient depth, it is filled with gunpowder to force off the rock, and the process is called blasting.
- Borer.** A round piece of iron three quarters of an inch in diameter, and two feet long, steeled at one end with a short flat edge.
- Bowfe.** Lead ore, as cut from the vein.
- Bucker.** A piece of iron about six pound weight, with a wooden handle, used for breaking the bowfe.
- Buddle.** A frame made of wood and filled with water.
- Budfing.** Washing inferior lead ore, to free it from extraneous matter.
- Bunding.** Wood placed to throw the refused cuttings on, or deads.

C

- Catdirt.** A substance sometimes called toadstone, being sometimes a variolite, at others a kind of limestone.

Cart.

- Cart.** A machine used to draw ore, &c. out of the mine.
- Chair.** Used in drawing up ore or coal.
- Cleaner.** A wire used after boring, to clear the hole.
- Clevis.** An iron at the end of the engine rope, on which the bucket is hung.
- Coffeads.** A small building.
- Copa.** To agree to get ore, at a fixed sum per dish, or measure.
- Coper.** One who agrees to take or make a bargain to get ore.
- Corf.** A kind of sledge used to carry ore from the miners at work, to the drawing shaft foot.
- Cross veins.** Veins that cross each other.
- Cross Cuts.** Are driven diametrically across the range of the vein.
- Crosses and Holes.** When a person discovers a vein, and has no means to possess it for want of stowces, he marks the ground with crosses and holes, by which means he possesses it until he can procure stowces.

D

- Deads.** Cuttings of stone of no use.
- Dial.** A compass.
- Dialing.** The taking the different bearings of the various ways, gates, &c. in a mine, in order to sink a shaft from the surface on any particular spot with exactness.
- Dish.**

- Dish.** A measure containing 15 pints Winchester measure.
- Due.** The same as lot.
- Door.** A cross cut for a door is sometimes used to open and shut, to increase the circulation of air.
- Drift.** The place the miner excavates to make a road.
- Driving.** Cutting and blasting horizontally.
- Ditch.** A drain made at the surface to carry water off.

F

- Fang.** A case made of wood, &c. to convey wind into the mine.
- Fausted.** Refuse lead ore, to be dressed finer.
- Fault.** A fissure which breaks the stratum.
- Feigh.** The refuse washed from the lead ore.
- Flat.** Flat work, when a vein, &c. is horizontal.
- Forks.** Pieces of wood, used to keep the side up in soft places.
- Founder mere.** The first 32 yards of ground worked.
- Founder shaft.** The first shaft that is sunk.
- Forefield.** The face, or vein worked,
- Freeing.** Entering a mine or vein in the bar-masters book.
- Fuzze.** Straws, or hollow briars, reeds, &c. filled with powder.
- Fuzze-borer.** An iron made red hot to bore a fuzze to hold powder.

G.

G

Gallery. A drift or level.

Gate. The fame.

Gears. Ufed to the cart, a kind of harnets for the men that draw ore out.

Grove. A mine.

Gingonin. Walling up a shaft instead of timbering, to keep the loofe earth from falling.

H

Hade. The underlaying or inclination of the vein.

Hadings. When fome parts of the vein incline, and others are perpendicular.

Hangbench. Part of the stowces.

Hangingfide. The fide a vein hangs to.

Horsehead. A large opening made of wood, to turn and put on to a fang or trunk, to convey wind from day-light.

J

Jig Pin. A pin ufed to ftop the machine in drawing when neceffary.

Jumper.

Jumper. Borer, an iron instrument from a foot to three feet long, one end of which is steeled and worked to an edge.

K

Kevel. A sparry substance found in the vein, composed of calcareous spar, fluor, and barytes.

Kibble. A bucket used for drawing up ore out of the mine.

Kit. A wood vessel of any size.

Knits. Small particles of lead ore.

Knockings. Lead ore, with sparry matter as cut from the vein.

Knockstone. A stone used to break the ore on, but sometimes it is a piece of cast iron.

L

Leap. The vein is said to leap when a substance intersects it, and it is found again, a few feet from the perpendicular.

Leadings. Small sparry veins in the rock.

Level. An Adit, gallery, or fough.

Limp. An iron plate used to strike the refuse from the sieve in washing lead ore.

Loch. A cavity in a vein.

Lot. A certain proportion taken for the lord of the manor.

M.

M

- Maul.** A large hammer.
- Mear.** Thirty-two yards of ground on the vein.
- Metal.** A word sometimes used to express an indurated clay above salt and coal.

N

- Noger, or Jumper.** See jumper or borer.

O

- Old man.** Places worked centuries ago, or in former ages.
- O'erlayer.** A piece of wood used to place the sieve on, after washing the ore in a vat.
- Opens.** Large caverns.
- Opencast.** When a vein is worked open from the *day*.
- Ore.** The mineral as produced in a mine.

P

- Pee.** A piece of lead ore.
- Pipe.** A vein running unlike a rake, having a **rock roof** and **sole**.
- Plumb.** A line and lead to measure depth.

Possession.

Poffession. When stowces or wooden frames are placed on a vein, it is said to be in poffession.

Pricker. A thin piece of iron used to make a hole for the fuzze to fire a blast.

Primgap. A variable distance, between two poffessions.

Poling A plank or piece of wood, to prevent earth or stone from falling.

R

Rake, A perpendicular vein.

Ratchell. Loofe stones.

Rider. A rocky substance that divides the vein.

Rifing. A man working above his head in the roof, is said to be rifing.

Roof. The part above the miners head.

Rubble. Same as ratchell.

Run. When the earth falls, and fills up shafts or works, it is said to run.

S

Scaffold. In a mine, a platform, made where some miners work above the heads of others.

Scrin. A small vein.

Shot. Blasting.

Sled. A sledge to draw ore without wheels.

Scraper. A small iron used to scrape the ore, a kind of rake.

Shakes.

- Shakes.** Fissures in the earth.
- Shift.** The time a miner works.
- Shaft.** A perpendicular hole cut to get up the ore.
- Sinking.** Working deeper.
- Smelting.** Reducing the ore to metal.
- Smitham.** Small lead ore, dust.
- Smut.** Decomposed dark earthy shiftus.
- Sole.** The bottom of the mine.
- Sole Tree.** A piece of wood belonging to stowces, to draw ore up, from the mine.
- Sough.** An adit or level.
- Spindle.** A part of the drawing stowces.
- Stickings.** Narrow veins of ore.
- Stimmer.** A piece of iron used to ram the powder with, when a blast is intended.
- Stemples.** Wood placed to go up and down the mine instead of steps.
- Strings.** Small veins of ore.
- Stope.** A piece of mineral ground to be worked.
- Stopeing.** Cutting mineral ground with a pick.
- Stowces.** Drawing stowce, a small windlass.
- Stowces.** Pieces of wood of particular forms and constructions placed together, by which the possession of mines is marked—a pair of stowces possess a mear of ground.
- Sump.** A shaft or perpendicular hole under ground.
- Swallows.** Caverns or openings where the water loses itself.

T

- Trogues.** Wooden drains like troughs.
- Troubles.** Faults or interruptions in the stratum.
- Trunks.** Wooden spouts to convey wind or water.
- Turntree.** A part of the drawing stowces or windlafs.

U

- Underlay.** When a vein hades or inclines from a perpendicular line, it is said to underlay.

V

- Vein.** Any substance different from the rock, a rake vein is perpendicular, a pipe nearly horizontal.
- Vat.** A wooden tub used to wash ore and mineral substances.

W

- Walling.** When the roads in the mine, are made with stone, it is called walling. The sides of the mine or gangart; is frequently called the wall.
- Wash-hole.** Where the refuse is thrown.
- Water-holes.** Places where the water stands.

Weighboard.

- Weighboard.** Clay intersecting the vein.
- Wedge.** An iron tool to get ore, split rocks, &c.
- Wim.** An engine or machine to draw ore worked by horses.
- Wind-holes.** Shafts or fumps, sunk to convey wind or air.
- Windlafs.** A well-known machine used to draw up ore.
See **Stowces**, by which name it is commonly called.
- Windlefs.** A place in a mine where the air is bad or short, it is then said to be windlefs.

Y

- Yokings.** Pieces of wood ascertaining possession. **Stowces.**

THE END.

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