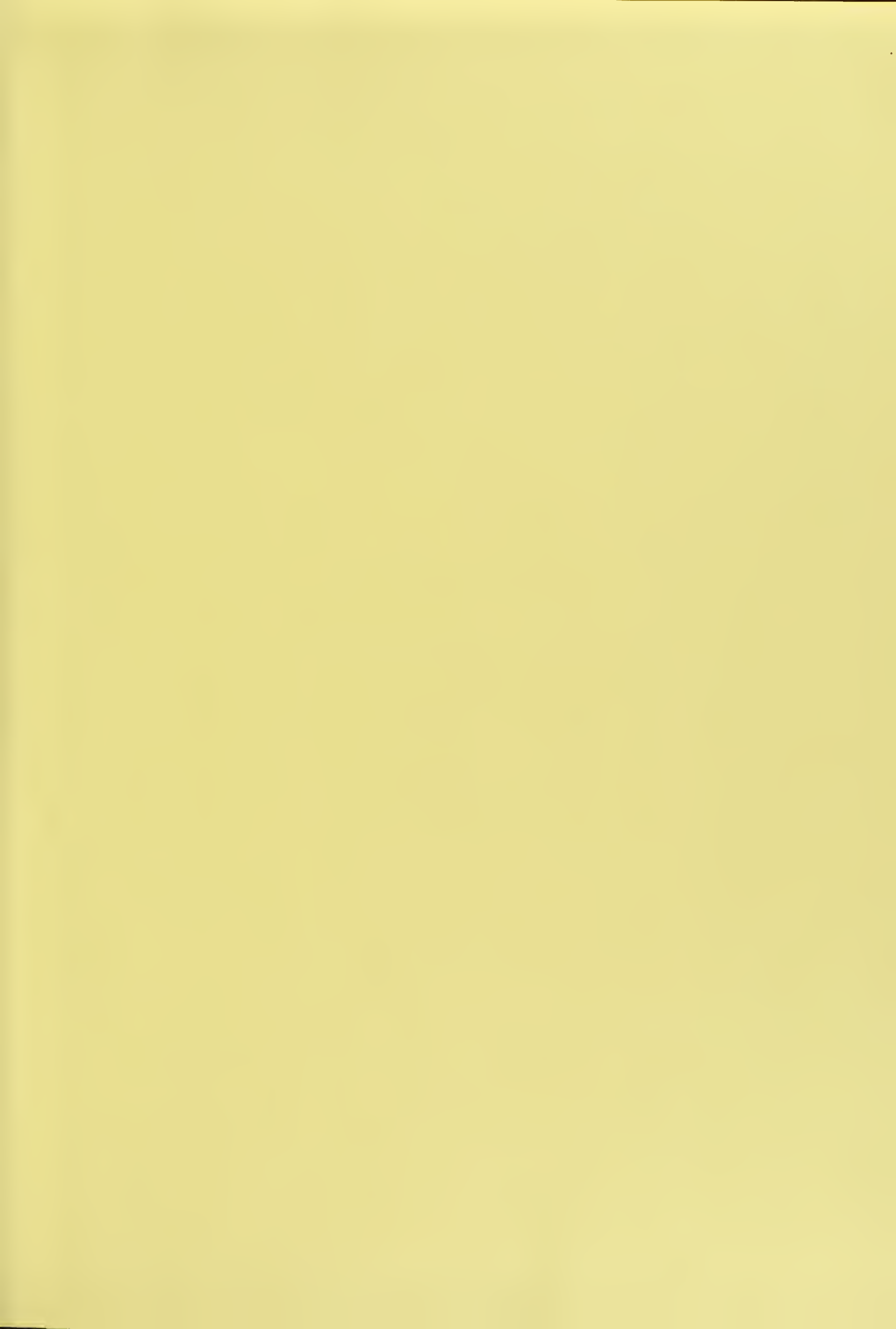


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N O R T H E R N O C E A N

ORKNEY ISLANDS

MAP OF SCOTLAND  
Engraved  
for the Outline of the  
Herminology  
OF THE SCOTTISH ISLES



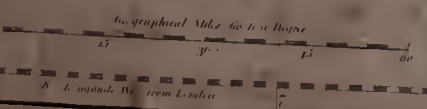
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By J. G. Bell, from London



# MINERALOGICAL TRAVELS

THROUGH THE

HEBRIDES, ORKNEY AND SHETLAND ISLANDS,

AND

MAINLAND OF SCOTLAND,

WITH

DISSERTATIONS UPON PEAT AND KELP.

IN TWO VOLUMES,

*ILLUSTRATED WITH MAPS AND PLATES.*

---

BY ROBERT JAMESON,

REGIUS PROFESSOR OF NATURAL HISTORY AND KEEPER OF THE MUSEUM, AND LECTURER ON  
MINERALOGY IN THE UNIVERSITY OF EDINBURGH, PRESIDENT OF THE WERNERIAN  
SOCIETY, FELLOW OF THE ROYAL SOCIETY OF EDINBURGH, AND OF THE  
LINNEAN SOCIETY OF LONDON, HONORARY MEMBER OF THE ROYAL  
IRISH ACADEMY, OF THE HONOURABLE DUBLIN SOCIETY, OF THE  
GEOLOGICAL SOCIETY OF LONDON, OF THE PHYSICAL  
AND MINERALOGICAL SOCIETIES OF JENA, &c.

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VOLUME I.

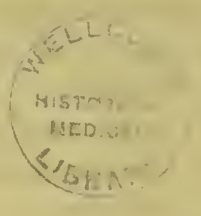
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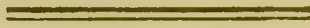
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Neill & Co. Printers,  
Edinburgh.

## ADVERTISEMENT.



*AT the suggestion of the Publishers of this Work, a new Title-Page, more descriptive of its nature and its contents than the original one, has been prefixed to the few copies still remaining on hand.*



## P R E F A C E.

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**I** UNDERTOOK the journeys, of which I now presume to lay the notes before the public, in order to acquire, from actual observation, a knowledge of the mineralogy of the Scottish Isles.

I have chosen the form of a journal, because I wished to convey the information I had gleaned in the stile of detailed observation, and in that order which the appearance of the country naturally suggested. But, in adopting this form, I am anxious to caution the reader against expecting that entertainment, and kind of information, which form the groundwork of the many journals through the more interesting parts of our island. If any one shall find this Outline of the mineralogy of these countries deficient in incident, in episodes and stories, and in descriptions of picturesque and romantic  
b scenery;

scenery; let him recollect, that to indulge in such descriptions was incompatible with the design of this work. I do not despise those ornaments; and I hope that I have not been insensible to the emotions which naturally arise from the retired and striking scenes which often burst upon me in the unfrequented tracts which my pursuits led me to explore: but I have thought it foreign to my purpose to obtrude these things upon the public.

Another resolution I had formed to myself, and which partly indeed led me to choose the form of a journal, was, to shun the fascinating evil of speculation and hypothesis, which mars all faithful observation. It would ill suit my talents to venture upon deep speculation, were I inclined; and perhaps the state of mineralogical knowledge forbids it. It is a fitter task for me to record faithfully what I have myself examined, and to give a fair report of the materials which were collected, than to expose myself, by the form or arrangement of the work, to the danger of having the facts twisted and perverted by hypothesis, the rage for which is as remarkable in this as in the other sciences.

While, in mineralogical pursuits, there is much to interest a philosophical mind, the object of true value is its application

to economical purposes. I fear that the theories of the formation of the earth, interesting as they are, often mislead the mind, and pervert the understanding; and those who yield to them, become so involved in delusive speculations, so blind to fact and experience, that, like Archimedes, they find but one thing wanting to raise worlds.

Of the utility of this science there can be no question; more particularly when it is freed from the vague suppositions of the theorist. It is a ground-work, without which the observations of the geologist, and the labours of the miner, will ever be uncertain, and of little utility. It is a science, the cultivation of which will raise a country to importance, by exciting new sources of industry, even in situations where the labours of the husbandman will be employed in vain. But, though I am well convinced that the importance of every thing in mineralogy is in proportion to its accuracy, I would not be understood to represent these notes as a complete account of the mineralogy of the countries of which they treat—I give them to the public as an imperfect outline. The mineralogical history of a country is to be accomplished only by studying at leisure all the varieties and disposition of the strata and veins, and the appearances of the mountains and valleys: an investigation which the utmost care, in a rapid survey, must leave in

many particulars imperfect, especially when the mineralogist is perplexed with the difficulties of travelling among unfrequented islands.

I have in this, as in a former work, separated the particular account of the strata and veins from that of the particular fossils; as the common method of conjoining them appears often to lead to confusion, and can never be sufficiently correct. In describing the fossils, the method and nomenclature of the best mineralogists has been followed. The chemical characters, which form even the foundation of many mineralogical systems, I have seldom employed; from a conviction that the chemical part of mineralogy, notwithstanding the late improvements in the art of analysis, is still to be considered as imperfect. We have only to observe the contradictory results obtained by the best chemists in decomposing the same fossil, to be convinced that the analysis of the present day, although much improved since the time of Bergman, is still of no very great utility in mineralogy.

The drawings of scenery, and the mineralogical plans, which accompany this work, were executed by the elegant pencil of my friend Mr. Charles Bell. In the views of scenery, he has happily expressed the different characters which the rocks assume from the effects of the weather; a circumstance which  
renders



renders them the more valuable. The mineralogical plans are of much consequence in elucidating several curious facts, which otherwise would with difficulty have been understood. These engravings are not to be judged of as picturesque representations—they were not intended as ornaments, nor were they selected as being the most beautiful: the design being to mark the characteristic features of the scene, not as a landscape, but as a mineralogical delineation.

C O N T

The first part of the report deals with the general situation of the country and the progress of the various branches of industry and commerce. It is followed by a detailed account of the operations of the different departments of the government, and a summary of the state of the public finances. The report concludes with a series of recommendations for the improvement of the administration and the promotion of the general welfare of the country.

103

The second part of the report deals with the operations of the different departments of the government. It is followed by a summary of the state of the public finances. The report concludes with a series of recommendations for the improvement of the administration and the promotion of the general welfare of the country.

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# INTRODUCTION,

CONTAINING

*An Abstract of the Wernerian Account of the different Kinds of Mountain Rocks; with Geognostic Observations on the Strata of the Scottish Isles, and such parts of the Mainland as are mentioned in this Work.*

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AS I shall frequently have occasion to mention in this work the division of rocks into Primary, Transition, and Stratified, it may be useful to many to know the characters by which these different rocks are distinguished. I am the more anxious to do this, as we have not, as yet, in any English publication, an account of the division. To this I shall add a few geognostic observations upon the different rocks to be found in the Scottish  
c isles,

isles, and in those parts of the Mainland which are mentioned in the following Outline.

According to the latest observations, all the strata, of which our globe is composed, may be arranged under the following classes: The Primary, (Urgebürge); the Transition, (Übergangsgebürge); the Stratified, which comprehends what are called the secondary strata, (Flötzgebürge); and the Volcanic, Alluvial, (Aufgeschwemmte.)

I shall now mention the distinction between these different kinds of strata; and, first, of the

#### PRIMITIVE.

These strata are characterised by their never containing the remains of animals or vegetables, nor alternating with such strata as contain these relics. Humboldt has also observed that the primitive strata in Europe are always inclined towards the N. E., while the strata of the secondary mountains dip towards the S. E.

It is to the celebrated mineralogist John Gottlob Lehman  
that

that we are indebted for the very important discovery of the division of mountains into primary and secondary. Since he wrote, succeeding mineralogists have confirmed the truth of his observations, and have thus raised geology, from a vague and confused state, to a high pitch of certainty and utility. A few writers have tried to overturn this distinction, *by asserting that it is fanciful*; yet these speculations, like all others not founded on truth and accurate investigation, have sunk into deserved oblivion.

The primitive strata are the following: granite, gneiss, micaceous schistus, ardesia, sienite, porphyry, primitive limestone, primitive greenstone, greenstone schistus, serpentine, quartz, pitchstone, and topaz rock. Granite is considered by Werner as the fundamental rock, or that upon which all others are laid, and it is but very rarely that it alternates with other rocks. It is disposed in layers or strata, which are often enormously thick, and frequently horizontal, and extend thus for many miles through a whole chain of mountains. All the other primary strata alternate with each other, but never with the transition or stratified rocks. The greenstone, wacken, and pitchstone are the only exceptions; the two first being common to the three first-mentioned formations, but the pitchstone only to the primary, and stratified, or *flotzgebirge*. The

## TRANSITION, OR UBERGANGSGEBURGE

comprehend all those rocks, the lowermost strata of which contain few or no petrifications; in the higher they are more abundant; but only petrifications, the originals of which no longer exist. These mountains also abound in metallic veins and in grottos. Those of Antiparos, Crete, &c. are in this kind of rock; as are the Hartz metalliferous mountains, and those of Derbyshire. They seem to have been formed after the primitive, and earlier than the stratified (*flotzegebürge*) rock. The strata of this formation are the following: *grawacken*, *grawacken slate*, sandstone, some species of *ardesia*, greenstone, *mandelstone*, limestone, and Dr Reufs conjectures that some species of  *sienite* and *porphyry*\* may belong to this class of rocks. The

## STRATIFIED (*Flotzegebürge*)

appear to have been formed after the transition rocks. They consist of sandstone, limestone, argillite, with numerous petrifications;

\* *Mineralogische Geographie von Böhmen*, 2 Band, § 177.



factions ; also, basalt, shistose porphyry, pitchstone, greenstone, wacken, and the various coal strata.

From the view of these three formations, we observe that the greenstone and wacken occur in every one of them, but the basalt is peculiar to the stratified rocks. The

### VOLCANIC

comprehends the various stony substances altered by action of fire: these are, lava, pumice, volcanic ashes, and volcanic tuff. The

### ALLUVIAL

consist of gravel, sand, clay, &c. and are the debris of the other strata.

Having thus mentioned the division of the different rocks, according to their relative antiquity, I shall now make a few general geognostic observations on the rocks of the Scottish isles, &c. I shall first mention the

## PRIMARY ROCKS.

*GRANITE.* This rock forms but a small portion of the Scottish isles, it being found only in the isle of Arran, and in the low part of Mull called Rofs, and in the Shetland islands. Upon the Mainland, however, I observed it forming mountains in Sutherlandshire, a considerable part of the county of Aberdeenshire seems to be formed of it, and also the lofty mountain of Cruachan upon the west coast. Granite veins are pretty frequent in several of the islands, as in Arran where they traverse the common granite, and in Coll, Tiree, Rona, the Orkney and Shetland islands, &c. where they traverse micaceous shistus, gneifs, or hornblende slate. Upon the mainland, in the route from Bernera to Perth, the granite veins are extremely common.

*GNEISS.* This rock I observed in Coll, Tiree, Rafay, Rona, in the Shetland islands, and in several places upon the Mainland of Scotland; in particular it forms the summit of the high mountain called Ben Lomond. It sometimes alternates with micaceous shistus and hornblende rock, and it is traversed by granite veins, as is the case in Coll, Rona, &c.

*MICACEOUS SHISTUS.* This rock forms a portion of the isles  
of

of Arran, Bute, and Mull; it is just to be observed in Coll, but a very considerable extent of the Shetland islands are composed of it. In the Mainland it appears to extend through the whole district of Cowal, and to the extremity of the isthmus of Cantyre, and in all the country from Bernera to Dunkeld; and from Dunkeld to Loch Lomond by Inveraray, the micaceous schistus is the prevalent rock. Upon the east coast it is frequent among the other primary strata. It alternates with schistose quartz in the island of Mull, and with hornblende and gneiss in the island of Coll; and it is to be observed in several places passing to ardesia, and it is traversed by granite veins, and has pieces of granite enclosed in it.

*ARDESIA.* Primitive argillaceous schistus. This rock occurs in Arran, Bute, Isla, Jura, Easdale, and Seil. In Isla there is a species of it which contains pieces of granite, which, however, seem to have been formed at the same time with the ardesia. In Easdale, Seil, Bute, and Arran, it is quarried for economical purposes; but the slate of Easdale is by far the best.

*SIENITE.* A rock nearly allied to sienite seems to form the craig of Ailfa; it also forms part of the island of Arran, and the lofty Cullin mountains in the island of Skye.

*PORE.*

*PORPHYRY.* I observed fragments of porphyry among the granite mountains in the island of Arran, which is probably of primitive formation, and the porphyry, which forms so considerable a part of the hill of Glamofcard in Skye, seems to be of primitive formation.

*PRIMITIVE LIMESTONE, or MARBLE.* This rocks occurs in vertical strata at I-columb-kill, also in the island of Tirie, and in several parts of the Mainland. I observed it alternating with primary rocks, particularly at Portfooy, where it is in vertical strata and alternates with talcaceous schistus and serpentine.

*PRIMITIVE GREENSTONE.* I have not met with this rock in any part of Scotland excepting in the island of Islay, yet I think it very probable that a careful examination may discover it in many places.

*SERPENTINE.* There are no strata of this rock in the Hebrides, nor the Orkney islands; but in Shetland it forms extensive hills, and there it seems evidently to be of primitive formation. At the interesting spot, Portfooy, there are great vertical strata of serpentine alternating with marble, talcaceous, and hornblende schistus.

*QUARTZ.*

*QUARTZ.* In the islands of Isla and Jura there are mountains of granular quartz, and it is there to be observed alternating with, and passing into micaceous schistus. In the isle of Coll there are also considerable rocks of granular quartz. In the island of Tirie I observed the rare appearance of a vein of granular quartz traversing strata of micaceous schistus and hornblende slate. In Caithness the mountain of Scaraban is composed of quartz; and at Portsoy there is a hill which affords schistose quartz. In many places veins of quartz are to be observed traversing the primary strata, and in the island of Bute there is a quartz vein which presents appearances irreconcilable with the Plutonic theory.

*PITCHSTONE.* The only species of this stone which I have ever seen, that may be considered as primary, is that upon the hill of Glamofcard in the island of Skye. It there seems to alternate with porphyry, but of this I am not as yet certain. In the island of Arran there are appearances of pitchstone in the form of veins traversing the granite, but as all veins are of an after formation to the rocks which they traverse, this cannot be reckoned equally old with the granite, or other primitive rocks.

### TRANSITION ROCKS, (*Ubergangsgebürge.*)

*GRAWACKEN.* This is a rare rock in the districts through which I passed. The only appearance I ever noticed was a small portion lying on a reef in the island of Seil.

*GREENSTONE.* The greenstone of the island of Mull appears to belong to this formation, as it is found near to limestone that contains belemnites.

*LIMESTONE.* This species is found in the island of Mull, and contains in it cornu ammonis and belemnites; hence I reckon it to belong to the transition rocks.

### STRATIFIED ROCKS, (*Flözgebürge.*)

*SANDSTONE.* Of this I observed two kinds, the siliceous and argillaceous.

The siliceous does not frequently occur. The sandstone of the island of Rume approaches nearly to this kind, and in the Orkney islands there are strata of siliceous sandstone that alternate

ternate with argillaceous sandstone. Argillaceous sandstone forms the Cumbray islands, the fouth extremities of Bute and Arran; and it also appears in the islands of Seil, Mull, Eigg, Skye, Rafay and Scalpa. Almost the whole of the Orkney islands are composed of argillaceous sandstone, but it forms a very small portion of the Shetland islands. It also skirts the east coast of Scotland from the Pentland Firth to the small fishing town called Buckie; and again this sandstone makes its appearance near to Aberdeen, and continues along the shore all the way to the Frith of Forth.

*LIMESTONE.* In the island of Arran there are considerable strata of limestone which is covered by argillaceous sandstone; and in some places the limestone and sandstone alternate. In the Orkneys limestone is to be observed covered by sandstone, and even traversed by veins of sandstone.

*ARGILLITE* with numerous shells is found in the island of Arran; and in the island of Eigg.

*BASALT.* This rock, which, as we have before observed, is peculiar to the Flotzgeburge, is found in almost every part of Scotland, either in strata, or in veins. I observed it disposed in strata in the island of Seil, at Oban, in the islands of Mull,  
d 2
Eigg,

Eigg, Canna, and Skye; and these strata either alternate with argillaceous sandstone, wacken, or greenstone. Frequently also veins of basalt traverse these strata.

*BASALT VEINS.* These veins are extremely common in most of the Hebrides, but are rarely to be observed in the Shetland or Orkney islands. I observed them traversing granite, gneiss, micaceous schistus, sienite, porphyry, hornblende slate, sandstone, and limestone. In the island of Arran there are several very remarkable veins which are partly formed of basalt. Thus in Glencloy there is a vein, (traversing clay porphyry), which is composed of basalt in the middle, but, upon one side is sandstone breccia, and, on the other is hard siliceous sandstone. At Tormore, upon the west side of the island of Arran, there are several other very remarkable veins partly formed of basalt.

*BASALT TUFF.* I observed this rock at Dumbarton castle, and in the islands of Mull and Canna, where it always accompanies rocks of trap formation. In the island of Canna it is remarkable for having pieces of wood inclosed.

*PITCHSTONE.* This curious fossil is found very frequently in  
the



the island of Arran, but generally in the form of veins. These veins traverse the common argillaceous sandstone, and are often of great magnitude. It is also disposed in stratified veins along with other substances at Tormore in Arran. In the island of Mull it seems to lie between sandstone and basalt; but in Eigg it forms considerable veins traversing basalt. This fossil, which was before considered as very rare, is thus shewn not to be so uncommon; and I have lately learned that it has been observed in veins traversing sandstone in Morven, and in veins traversing basalt at Ardnamurchan.

*GREENSTONE.* The country between the primary strata at Dunkeld, and the banks of the Frith of Forth presents many appearances of flötz greenstone; and, in the same tract there is also wacken of a similar formation.

*COAL.* In the island of Arran there is a stratum of blind coal inclosed in sandstone. In Mull, Eigg, Canna, Skye, it is observed always stratified with basalt or wacken.

## VOLCANIC ROCKS \*

have never been discovered in Scotland.

## ALLUVIAL.

Of these there are examples in the Highland vallies, where the debris from the mountains are deposited in beds and covered by heath. The great banks of sand, and the immense beds of peat which we find sometimes alternating with beds of clay or sand, are of this kind.

## MINE-

\* Of the pseudo-volcanic rocks, which are different species of rocks that have been exposed to accidental fire, we have instances in Fifeshire. Upon the shore between Dyfart and Easter Wemyfs I picked up several fine specimens of porcellanite, which seems to be the clay that accompanies the coal altered by fire, as masses of scorix and charcoal still adhered to it.

TO

JOHN WALKER, DD. MD.

FELLOW AND SECRETARY TO THE PHYSICAL CLASS

OF THE ROYAL SOCIETY,

REGIUS PROFESSOR OF NATURAL HISTORY,

AND

KEEPER OF THE MUSEUM OF THE UNIVERSITY

OF EDINBURGH;

THIS VOLUME,

OF THE

OUTLINE OF THE MINERALOGY OF THE SCOTTISH ISLES,

IS DEDICATED,

AS A TESTIMONY OF THE GREAT REGARD AND ESTEEM

OF HIS MUCH OBLIGED PUPIL,

AND OBEDIENT

HUMBLE SERVANT,

*THE AUTHOR.*

SHERIFF-BRAE, LEITH, }  
26. JULY, 1800. }

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# MINERALOGY

OF THE

## SCOTTISH ISLES.

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### CHAPTER I.

*From Edinburgh, by Glasgow, to the Craig of Ailsa.*

IN travelling from Edinburgh to Glasgow, by the Livingstone road, the country continues, for a considerable way, pleasant and well cultivated; but as we approach the Kirk of Shotts the scene is much altered. In place of inclosed fields, exhibiting the operations of thriving agriculture, extensive moss grounds appear, forming a striking contrast to the cultivated country through which we had just passed. Happily,

A

however,

however, these moorlands are now viewed in a more favourable light than heretofore: the brown burnt-like aspect of a peat moor does not now strike the mind with ideas of bareness and sterility; as we know, from experience, that labour and a little expence may soon convert them into luxuriant fields.—A few miles after passing this desert, we come in sight of Glasgow; but its low situation, and the want of hills, render it, when compared with Edinburgh, far less interesting as a picturesque object. The nearer we approach the town the country improves, and is considerably diversified with wood and cultivated fields.

The rocks which occur in this tract are all of secondary formation; which is commonly the case where the country is low and flat. As our journey was rapid, I can only say, in general, that the strata are, sandstone, limestone, basalt, wacke, mandelstein, coal, with its accompanying shistose clay, &c. and iron-stone.

The sandstone is generally used for the purposes of building; but, from different quarries it is more or less durable. This fact leads us to remark, that chemical trials, combined with correct mineralogical observations, might, in many instances, enable us to determine, with some certainty, as to the  
probable

probable durability of stones employed in building. Indeed, those who have been long in the habit of analysing and examining such stones, can, even by their appearance, judge of their probable durability\*: a circumstance sufficient to encourage us to pursue a mode of investigation which has hitherto engaged little attention.—The limestone which occurs in this district varies considerably in its appearance: but we had not an opportunity of observing it particularly. It is quarried in several places to a considerable extent, and then burnt, and used for manure, and for building. It is burnt for these purposes in the common draw-kiln, which is ill constructed, as there is not only a great waste of heat, but, by exposure to all the variations of the weather, the burning is rendered precarious and uncertain. My father remedied these defects in a kiln which he built eight years ago, and which he still conti-

A 2

nues

\* We have a curious instance of this related of the late Mr Bayen; a gentleman who had paid much attention to the genera of marble and serpentine. Walking one day in the Place de la Revolution, at Paris, with his friend and colleague Deyeux, he pointed out to him several of the marble pillars, which, he said, notwithstanding their present solid appearance, would decay in a short time, and in the particular places he mentioned. Accordingly, a year had scarcely elapsed when his prediction was fulfilled: many of the pillars began to decay, and even considerable hollows were quickly formed in some of them.—*Annales de Chymie.*

nues to use as economical, both with regard to time and fuel. It differs from the common kiln by having the body or cylindrical part very deep, and covered with a dome, which is connected with a vent that has a damping plate, so as to allow a very advantageous management of the heat. Besides, it has another very considerable advantage over the common kiln, that is, it can be erected in a town without detriment to the neighbourhood, as all the noxious matter is carried away by means of the chimney †.

The country in the neighbourhood of Glasgow, as far as I had an opportunity of examining, is composed, 1st, of basalt, which

† A vulgar prejudice has long prevailed, that the noxious matter of limestone is more dangerous than that of common coal; and the many horrid stories on record, of sudden deaths in the neighbourhood of lime-kilns, still continue the delusion with the ignorant.—The modern chemical discoveries have shown, that common coal, bulk for bulk, furnishes more of the noxious matter (carbonic acid and carbonated hydrogen) than limestone: therefore, the noxious effects of the common kiln does not depend on any peculiar malignity of the vapour which issues from the stone, but upon the construction of the furnace.

The patriotic Count Rumford has lately proposed a new plan of a lime-kiln, which certainly deserves to be tried: To us it appears objectionable, not only from the close attendance that the fires require, but also that a considerable portion of heat is lost by its being open at top.—See *Rumford's Essays*.



which has sometimes in-lying crystals of felspar, basaltic hornblende, augit, leucit, mica, and a few interspersed particles of quartz; 2. basalt porphyry; 3. grunstein; 4. limestone. The short time I could afford to spend in Glasgow, and my anxiety to get forward to the Islands, prevented me from examining the relation of the different strata to each other; which, however, I the less regret, as that circumstance is but slightly connected with my present object.

Professor Faujas de St. Fond has given us a short account of the mineralogy of the environs of Glasgow; but his descriptions are unluckily obscured by a rigid adherence to a theory which has no foundation in nature. He considers all the rocks we have now mentioned, as lavas; and those he denominates basaltic, porphyritic, and granitic lavas. I do not hesitate a moment in saying, that, in my opinion, there is not in all Scotland the vestige of a volcano. I do not rest this assertion upon my own authority, (for that would be presumptuous;) but upon that of Dr. Walker, who has examined more of the mineralogy of Scotland than any man now living, and whose collection of Scotch fossils is the largest that has ever been made. Besides, it wars with every principle of systematic classification, to arrange and denominate fossils from any *theory* we may adopt as to their formation.

We

We now pursued our journey from Glasgow to Greenock, down the river Clyde: a voyage which presents the traveller with many scenes of uncommon beauty. At Glasgow the river is narrow, with low formal banks; but as we approach Dumbarton, the river becomes wider, the country more beautiful, and the scene is soon rendered interesting by the appearance of the singular rock of Dumbarton. From this the mountains of Cowal extend, along the north side of the river, to Rosneath; forming a fine contrast of Alpine wildness, with the comparatively low green hills which reach to Greenock upon the south side of the river. The strata between Glasgow and Greenock, upon the south bank of the river, are, sandstone, limestone, basalt, and wacken. Those of the north bank, to the town of Dumbarton, continue to be nearly of similar rock; forming, in this route, some considerable heights, particularly about Frisky Hall, where the rocks have a fine terraced appearance. Immediately below the house of Frisky, at the porter's lodge, we observed a small quarry of wacken, which is now celebrated as affording fine specimens of prehnite. The town of Dumbarton is situated in a plain of considerable extent; and the rock upon which the castle is built, rises from it in a similar manner with Arthur's Seat, near Edinburgh, but is much more striking, from the great flatness of the country. It is composed of black basalt; but, upon the side facing the town,

we

we observed a basalt tuff covered by sandstone. Professor St. Fond remarks that this rock is formed of a black basaltic lava; but upon the lower part, facing the town, there is to be observed a current of muddy lava, having, intermixed, fragments of basalt, more or less altered.—At different periods the rock of Dumbarton has been of considerable consequence, on account of the strong fortress which is built upon it. When Mary, the unfortunate and lovely Queen of Scotland, was imprisoned in England, and her kingdom wrested from her, the solitary rock of Dumbarton held out against every attempt to take it; and was the only place in the kingdom that dared to acknowledge her authority.

If we glance over the country as it extends towards Lochlomond, we observe it rising gradually until the prospect is bounded by vast mountains, marking, by their height and shape, a change in the nature of the strata, and forming the grand entrance into the Highlands upon this side of Scotland. If we examine the country more particularly, we find our conjecture right; for at Luss, upon the banks of this beautiful loch, strata of micaceous schistus, and other primitive rocks, make their appearance. These strata extend towards the Clyde, and form a considerable part of its north bank, from Dumbarton to Rosneath, a small village opposite to Greenock.

Greenock,

Greenock, a populous and flourishing town, is situated upon the side of the river, at the bottom of hills of considerable height; and remarkable for the quantity of rain which falls during the year, which is said to be more than in any other part of Scotland. The strata in the immediate vicinity of the town are, basalt, wacken, sandstone, limestone: and in some places the sandstone is to be observed traversed with basaltic veins; and the wacken, besides zeolite, contains a curious fossil nearly allied to leucit.

From Greenock our farther progress down the Clyde was more interesting, from the grandeur and variety of the objects which now occupied our attention. After passing the Gourock lighthouse, we observed the beautiful island of Bute, with the neighbouring and Cumbray isles stretching across the view; and, farther distant, the wild mountains of Arran appeared over the low part of Bute towering among the clouds. The hills upon the opposite bank of the river are strikingly contrasted. Upon the Cowal shore the country rises into considerable hills of micaceous schistus, which are partly heath-clad, and join with the bare and sterile mountains that extend from this shore through Argyleshire. Upon the opposite bank of the river the country is much lower; there are no steep hills upon the shore; and the strata, which are horizontal, are, red and  
white

white-coloured argillaceous sandstone, sandstone breccia, basalt, and frequently basaltic veins traverse both these strata. The breccia, as is often the case with this kind of rock when it occurs upon the sea-shore, forms beautifully wooded cliffs, which extend to the sweetly-retired village of the Largs. These secondary strata extend from the Largs to Saltcoats, and from thence far through Ayrshire; while the primary rocks, on the opposite bank of the river, appear to extend to the Mull of Cantyre.—In a few hours after passing the Cumbray isles, and the majestic island of Arran, we landed upon the great rock which is called

#### *THE CRAIG OF AILSA.*

This stupendous rock is said to be 400 feet high, and is about two miles in circumference. It is somewhat of a conical shape, and very precipitous on all sides: the only landing-place being on the N. E. where there is a small beach, formed by the fragments which have fallen from the neighbouring rocks. It is much lower now than it was formerly; as is evinced, not only by the numerous fragments lying on the beach, but also more fully by the nature of the bottom near it, which, according to the most accurate soundings, is gravelly to a considerable distance.

B

After

After having walked around part of it, and ascended near to the summit, I was forced to return, as the captain of the vessel was anxious to proceed to Arran. On this account, I was prevented from examining it so accurately as could have been wished. This glance, however, was sufficient to satisfy me as to the general nature of the rock of which it was composed.

The greater part seems to be formed of different species of very compact sienite; which, particularly on the east side, presents immense groupes of columns, similar in appearance to the basaltic columns that occur so often in different parts of Scotland. In ascending towards the summit, and a little below the solitary ruin of a castle, I observed two considerable basaltic veins traversing the sienite.

C H A P.

## C H A P. II.

*Description of the FOSSILS mentioned in the preceding Chapter.*

PREHNITE—*Frisky-Hall.*

SILEX PREHNITES, Wern. HALB ZEOLITH, Esthner. BOS-  
TRICHITES, Dr. Walker.

It is either in flat masses, cellular, or botroidal, or partly assuming a mammillary figure; is generally radiated and composed of small prismatic crystals—sometimes so small, and so near to each other, as to assume, in some degree, a compact texture, almost resembling chalcedony.

*Colour.* Varies, from apple green, to yellowish green, pale yellow, and white; but, when affected by the weather, it acquires an ochry, or opaque white colour.

*Lustre.* The external lustre little glancing\*; internal is pearly.

*Transparency.* It is semi-transparent; but, when acted upon by the weather, it becomes considerably opaque, and much resembles certain species of sulphat of barytes.

*Hardness.* Gives sparks with steel; takes a pretty good polish.

B 2

*Fracture.*

\* *Wenig glänzend.* Germ.

*Fracture.* The fracture in the direction of the foliæ appears foliated, but across the radii approaches to the conchoidal.

*Fusibility.* Dr. Hope melted it, and, by slow cooling, had again a pretty regular crystalline texture.

It is contained in a species of wacken, which, by its degree of induration, appears passing to the state of basalt. It is frequently accompanied by calcareous spar. Another substance is often found with it, which is probably of the nature of zeolite.

It is formed of long prismatic radii, which have the following character.

*Colour.* White.

*Lustre.* Pearly.

*Transparency.* Nearly transparent.

*Hardness.* Difficultly scratched with a knife.

#### OBSERVATIONS.

The Prehnite has received many denominations, by different mineralogists: thus it has been called green felspar, apple-green quartz, filiceous zeolith, cape-chrysolith, emerald, prase, and crysoprasi:—a striking proof of the imperfection of mineralogical nomenclature. The justly-celebrated Mr. Werner, to whom



whom we owe so much of our most accurate information, names it Prehnite, after Colonel Prehn, a Dutch officer, who found it at the Cape of Good Hope, and first brought it to Europe. Since its discovery at the Cape of Good Hope, it has also been found in Dauphiné; and Dr. Groscke of Mittau first discovered it at Frisky-Hall. This is not the only place in Scotland where this beautiful fossil is found; for I have observed it in the castle rock and Arthur's Seat at Edinburgh, and we shall afterwards notice it in the island of Mull.

#### LEUCIT—*Greenock*:

*SARCITE*, Dr. Townson's Tracts in natural history. *BORAX*  
*MARGODES*, Lin.?

This fossil is of a reddish-brown colour, and generally crystallised in the form of a 24 edron: it is also, in some instances, amorphous, with an earthy fracture\*.

It has always occurred opaque, and of such a hardness as to yield with difficulty to the knife.

With the blow-pipe it loses its colour, and melts like felspar.

It

\* Dr. Hope has in his possession a very fine specimen of this fossil, which he found at the Calton Hill. Dr. Townson has figured it in his Tracts.

It is found in the cavities of wacken, and sometimes imbedded in calcareous spar.

Abbé Huay remarks that this fossil is considered as a zeolite †; and La Metherie, who had examined specimens of a similar fossil from the Calton-Hill at Edinburgh, remarks, “ On trouve, au mont Calton-Hill, proche d’Edimbourg, un cristal à vingt-quatre facettes trapezoidales, comme celui-ci. Il est rougeatre, poreux, terne, comme de la brique.—On croit qu’il doit entrer dans la zéolite leucitique ‡.” Dr. Townson, in his lately-published Tracts in natural history, considers it as a new genus, and names it Sarcite: this, however, cannot be admitted, until the fossil shall be regularly analysed. Mr. Camara of Lisbon, a most intelligent mineralogist, informed me, that he had frequently met with this fossil in other countries, but always considered it as nearly allied to leucit. It appears, then, that it should still be reckoned of the nature of leucit, until it shall be more particularly examined in the way of chemical analysis.

SIENITE—

† Annales de Chymie.

‡ Theorie de la Terre, tom. 2de, p. 308.

SIENITE—*Craig of Ailfa.*

*CALOMACHUS*, Dr. Walker's *Classes Fossilium*.

So far as I can determine at present, this rock appears to be a very compact species of sienite, in which the felspar is the most prevalent ingredient. Sometimes the felspar seems passing to the state of earthy felspar; and then it forms a basis in which we observe red or white-coloured crystals of common felspar and hornblende, and particles of quartz: thus forming a species of sienitic porphyry.

ARRAN.

# A R R A N.

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## C H A P. III.

*Size and Situation of the Island. Cliffs, Mountains, Surface, &c. Brodick Bay, and its Environs; comprehending Cory-Gills, Glen-Cloy, Glen-Shirreg, Goatfield, and Glen-Rosa.*

**T**HIS island is about thirty-two miles long and twelve broad; situated in the mouth of the Frith of Clyde, about eight miles from Bute, and sixteen from Saltcoats in Ayrshire. Its shape is irregular, but not so much so as many of the Western Islands which are exposed to the Atlantic Ocean. Here, the vicinity of the Scottish and Irish shores prevents any great destruction of land; as is evident from the lowness of the cliffs round the island, which have not the precipitous, rugged and bold aspect of many of the Western Islands.

*CLIFFS.* The cliffs are seldom above two hundred feet high; are generally precipitous: having frequently, however, an intervening





intervening bank between the cliff and the sea, formed by the destruction of the rocks, which are either of sandstone or micaceous shistus. Considerable sandy beaches frequently occur, formed of the debris of granite, sandstone, and micaceous shistus; and sometimes we remark a considerable extent of coast covered with enormous masses, which have been torn away by torrents, or separated from the neighbouring rocks by the vast expansive power of frost.

*MOUNTAINS.* No regular ridge of mountains is to be observed: these being either in the form of groups, as Goatfield and the adjacent mountains, which present astonishingly grand peaked summits; or irregular, forming round-backed hills, as those towards the south part of the island.

*SURFACE.* The land is in general very high, particularly towards the north end, where the wonderful group composed of Goatfield, Caime-na-callich, &c. present mountains near 3000 feet high. Here Nature exhibits to the astonished eye the most terrific and sublime scenery; to convey even a faint idea of which would require an able pen. The southern parts are lower; and in place of the bare rocky appearance of the north, we have heath-covered hills, and a considerable portion of cultivated land.

The island is divided into two parishes, Kilbride and Kilmory, belonging to three proprietors; the Duke of Hamilton, Marquis of Bute, and John Fullerton, Esq. of Kilmichael; and yields about 5000 l. of yearly rent. This indeed might be much increased, were proper methods of cultivation followed; and were long leases and larger farms properly granted, more happiness, industry and wealth would be the natural consequence.

In describing the island particularly, I shall begin with

*BRODICK BAY*, situated on the east side. This beautiful bay is bounded, on the S. by the hills of Cory-gills; on the W. by the vales of Glencloy and Glenfhirreg, and, on the N. the tremendous Goatfield forms a lofty boundary. It is of an irregular shape; about five miles long, and four broad; having about five fathoms water, with good anchorage ground: but it is only in moderate weather that vessels can ride in safety. From this bay passage-boats go to Saltcoats, about sixteen or eighteen miles distant, which renders this the principal thorough-fare in the island; so that the population is considerable. Many visitors come from the mainland, during the summer months, to enjoy the free air, and admire the wonderful scenery of this interesting island: but the want of a good inn is much to be regretted.



regretted. On the north side of the bay stands Brodick Castle, an old ruinous building, inhabited occasionally during part of the summer by the Duke of Hamilton. It is situated upon the side of Goatfield, commanding a most extensive and delightful prospect; and might easily be made a beautiful seat. About two miles distant, in Glencloy, is situated the pleasant seat of the worthy and most hospitable family of Fullerton, of Kilmichael, who have now resided in the island upwards of 700 years.

*Mineralogy.* The mineral history of this part of the island is, in many respects, interesting; not only on account of the variety of fossils which it affords, but also in presenting to us, in a short space, a representation of the structure and materials of nearly the whole island. On this account I shall be minute in my description; as I may have occasion to refer to this particular part, when describing the other quarters of the island.

The south side of the bay is low immediately upon the shore: it however rises gradually; forming the hills in the neighbourhood of Cory-gills, and, towards the sea, cliffs of considerable height, almost entirely composed of sandstone\*. This sand-

C 2

stone

\* M. de C. Laffone has observed, that the surface of a sandstone, which had  
the

stone is pretty compact, of a reddish colour, much resembling that found in Shetland; and is here and there alternated with strata of breccia, composed of rounded fragments of quartz, with fragments of sandstone, of various sizes and shapes; and both these strata run at an angle of from  $10^{\circ}$  to  $15^{\circ}$ . In many places there are very considerable veins of basalt, or what have been called Whin-dykes †, crossing the sandstone in various

the year before been left uncovered, was invested with a siliceous crust, nearly as hard as agate: the particles of which it was formed must therefore have been conveyed and deposited by water. *Mem. Par. 1774. Kirwan's Geological Essays, p. 112.*—This is a proof of the solubility of siliceous earth in water: a fact denied by the Plutonists. It is more demonstrably confirmed by the following fact, from Mr. Kirwan's Geological Essays, p. 140. “About the year 1760, the Emperor of Germany being desirous to know the length of time necessary to complete a petrification, obtained leave from the Sultan to take up and examine one of the timbers of Trajan's bridge over the Danube at Belgrade. It was found to have been converted into agate to the depth only of half an inch; the inner parts were slightly petrified, and the central still wood.”

† The term Whinstone, like many other popular denominations, does not convey a distinct idea of any particular genus of fossils; but is used by the inhabitants of Scotland, and of the north of England, to express those fossils which are of *trap formation*. Mineralogists, in many instances, appear to have used it in a very vague manner: thus some describe trap, others basalt; and not unfrequently wacken, greenstone and indurated clay have been arranged under this name.

rious directions. Some may be observed rising from the sea, and penetrating the sandstone. In other places, where the superincumbent sandstone has been completely carried away, veins can be remarked running, with little variation in diameter or direction, for nearly a mile. These veins are not only to be observed upon the sea shore, but can be traced running, in various directions, and of different diameters, through the sandstone and other rocks in the interior of the island, as we shall afterwards clearly demonstrate. In ascending the hill towards Cory-gills, a very considerable vein of dark leek-green pitchstone makes its appearance, running from the cliffs upon the shore, thro' the sandstone, to the Lamfash road, where we soon lose it among the sandstone in the neighbouring hills. This vein is of various breadths; in some places, as at the Lamfash road, being about eight feet. It does not appear to have altered the sandstone, where it is in contact with it; but, in some parts of the vein, the pitchstone, as it approaches the sandstone, loses much of its lustre, and, in fracture and hardness, approaches to the nature of basalt.

The

name. It is much to be wished that it could be entirely laid aside; particularly when we perceive that the great Werner has framed satisfactory characters for these different rocks.

The appearance of pitchstone in the form of veins, and in secondary strata, has not as yet been observed by other mineralogists. Mr. Werner, from his own extensive knowledge, and the accumulated information of his numerous pupils, is of opinion, that pitchstone is always disposed in strata, and entirely confined to primitive mountains. The late Abbé Spallanzani describes several veins of pitchstone lava that he observed in the Euganean mountains; but it is difficult to determine with certainty whether this be the true pitchstone\*.

Higher up, above the houses of Cory-gills, I observed a number of columns which are composed of clay-porphry. These pillars are in various directions: some are perpendicular to the horizon; others more or less inclined; and I observed, farther up, that they are quite horizontal. They are in the form of four or six-sided columns, from six to ten feet long, and two or three feet in diameter, having a whitish crust from decomposition. They are not jointed; nor is there any appearance of balls, or what the volcanists call *volcanic bombs*. I endeavoured to discover the position of the porphyry with regard to the sandstone, but could not detect them in contact with each other; yet, from the nature of the rocks

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\* Spallanzani's Travels in the Two Sicilies, vol. 3d, p. 251, &c.

all around, I am inclined to believe that it rests on the sandstone. In descending from this porphyry hill towards Lam-lash, the sandstone again makes its appearance, but is soon lost; being covered with a rock which is principally composed of dark-green coloured hornblende, with a little felspar and quartz, and answers nearly to the greenstone of the Germans. This greenstone forms the summits of several hills in the neighbourhood, and may be remarked running towards the sea, forming high cliffs. In one place I observed a great body of green-coloured pitchstone, which runs quite in an opposite direction to the vein I observed crossing the Lam-lash road: in short, it appears to be stratified, and to run immediately below the greenstone. About twenty yards lower, another mass occurs, about ten or twelve feet thick; and which, so far as I could determine, appears to form a stratum, running between the sandstone and greenstone. I was informed that this mass of pitchstone had been traced to the face of a high cliff upon the sea-shore, where it is said to lie upon sandstone, which also covers it; and that it was there also split into columns, like basalt.

Having now mentioned the position of the veins and strata upon the south side; I shall return to the sea-shore, where we  
observe

observe the bay rising towards the west, forming the one side of Glencloy.

*GLEN-CLOY.* This glen is nearly three miles long, and half a mile broad; open towards the east, but bounded on the other sides by high hills. At the top, or west part, of the glen, the hills are highest, forming a very romantic groupe of rocks. The north and south sides, which are of considerable height, become gradually lower as they approach the sea, where they form part of Brodick Bay. The bottom of the glen rises gently from the sea, forming a small angle with the hills that bound it. Immediately under the peat moss, or heather, we discover boulder stones, which form a thick bed, from three to thirty feet thick; and in other places they are collected together in heaps, being thrown into this form by the force of water. These boulder stones are not of very considerable size, and vary but little in that respect at the top or bottom of the glen; which shews that the greater part of them have not received their rounded form by attrition in the water of the glen, but are derived from decomposed breccia. They consist of granite, porphyry, sienite, breccia and sandstone, which are all to be observed in the neighbouring hills. Through the glen runs Glencloy burn, formed by the springs and rains from the  
the

the hills : it is narrow, but, during violent storms, it overflows a considerable part of the glen, and has thus laid bare the rocks, and shows us, in a satisfactory manner, the nature of the subjacent strata. The bottom of the glen is composed of the common red-coloured argillaceous sandstone, and here and there are strata of breccia ; and both are traversed with veins of basalt, which run in very various directions, and are from three to twelve feet in breadth. These veins, in their passage thro' the strata, (to use the Huttonian language,) do not appear to have occasioned in them any alteration with regard to hardness : on the contrary, we often find a species of semindurated clay interposed between the sandstone and basalt, thus forming a stratified vein.

Reufs, the celebrated German geologist, in his mineralogical history of Bohemia, describes two stratified veins which he observed in the Bunzlauer circle. As it is of importance to turn the attention of the young mineralogist to those curious, and, I believe, rare, appearances, I will shortly mention the nature of those veins observed by Reufs. One of the veins traverses argillaceous sandstone, and is about a fathom wide ; its sides are of common argillaceous ironstone, about five or six inches wide : to this succeeds a layer of wacken-clay, about half a foot wide ; then a thin layer of wacken, or rather a rock

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inter-

intermediate between wacken-clay and wacken; lastly, the middle of the vein is basalt. The other vein has argillaceous ironstone for the *saalband* or sides, but the middle is wacken clay. The sandstone, as it comes in contact with the vein, is remarkably great-grained and iron-short\*.

The hills on the north and south sides of the glen are of the same height; and the pente of the hills appears to correspond pretty nearly with the elevation of the strata. The hills on the south side are formed of sandstone and breccia, which, towards the upper end, form very lofty precipices. Many veins of basalt traverse the sandstone, and loose nodules of brownish-black and black pitchstone lie scattered about here and there. On the north side of the glen, near to Brodick wood, a considerable body of dark leek-green coloured pitchstone makes its appearance; but it is so much covered with grass, that it is difficult to say whether it forms a vein or a stratum. It is well worthy the attention of those who may visit Arran, to endeavour to determine this point. In ascending the hills upon this side, after gaining a considerable height, the sandstone disappears, when  
a clay

\* Mineralogische Geographie von Böhmen, von Franz Ambros Reufs, vol. 2.



a clay-porphry is to be observed; and upon the brow of the hill, where the rains, &c. have broken down the porphry, several curious phenomena appear. In the first place, I observed the porphry in columns similar to those at Corygills: next, the basaltic veins running in different directions through it. One great vein is to be observed rising from the neighbouring sandstone, penetrating the clay-porphry; and, as it rises upwards, getting a considerable curve, when it branches: one branch rises to the top of the hill; the other runs but for a short way into the porphry, in the form of a wedge. Near to the same place a curious *stratified* vein makes its appearance, running in an almost opposite direction to that we have just mentioned, and terminating in a wedge-like form. On the upper side it is formed of sandstone breccia; the lower is hard siliceous sandstone; but the middle is basalt.—The west or upper end of the glen is formed of sandstone pretty much traversed with veins of basalt, which are more or less inclined, and of various diameters. Besides this sandstone, we observe lofty precipices of sienite, which form strata elevated at an angle of about  $30^{\circ}$ . This rock is not only very much varied in the nature of its constituent parts, but also in the degree of intimacy of combination, which renders it very difficult to distinguish its different species. It is also traversed with

veins of basalt, but not so much so as the sandstone \*. It forms the higher part of several of the hills betwixt the top of this glen and the Shislin, and is all along traversed with basaltic veins.

It appears, from the description that has been now given, that the sandstone forms by far the greatest part of the glen; the next in proportion is the porphyry, and lastly the sienite.

The

\* Dr. Hutton, in his speculations upon the theory of the earth, remarks, “ If it be by means of heat and fusion that strata have been consolidated, then, “ in proportion to the degree of consolidation they have undergone from their “ original state, they should, *ceteris paribus*, abound with more separations in the “ mass. But the conclusion is found consistent with appearances. A stratum of “ sandstone does not abound so much with cutters and veins as a similar stratum “ of marble, or even a similar stratum of sandstone that is more consolidated: “ they are in general intersected with veins and cutters; and in proportion as “ strata are deep in their perpendicular section, the veins are wide, and placed at “ greater distances.” This does not appear to be consistent with the fact; for it is to be observed, in Arran, that the sandstone contains more veins than the sienite, which last is harder than any sandstone in the island; and we observe that the sienite contains a greater number of veins than the granite, although it be softer and less compact.

The determination of the relative position of strata and veins is the great object of the geologist, and without it his labours will be of comparatively little value. It is, no doubt, of importance to know that a country is composed of particular kinds of rock: yet this will be very unsatisfactory, if we know not whether these rocks be primary or secondary, how they lie with regard to each other, and, consequently, if they be favourable for the appearance of metallic veins, coal, &c. Many travellers, as my friend M. Camara de Bethencourt has observed †, satisfy themselves, in their geological observations, by following a very superficial and absurd mode of investigation. Thus, some are contented to sit in their carriage and view the rocks as they pass along; others, with more apparent curiosity, examine the debris at the bottom of the hills, and, by means of their telescopes, determine the nature of the highest mountain. It is plain that these practices must be very detrimental to the advancement of true geological knowledge: they are the more so, when we consider, that the greatest labour and assiduity is often employed in vain to delineate the true geological character of some parts of a country. In the course of my limited travels I have experienced the truth of this observation; for, after having spent many days in endeavouring to deter-

mine

† Neues Bergmannisches Journal. B. i. § 272.

mine the relative position of certain strata to each other, I have been obliged to rest satisfied with a general conclusion drawn from the nature of the surrounding rocks. Thus, in Glencloy, I could not discover the porphyry and sandstone at their junction; yet, if we consider that the porphyry, both here and at Corygills, is found upon the summit of sandstone hills, and that, in this place, we observe the same basaltic vein apparently traversing the sandstone and porphyry, we may presume that they are of the same formation, and that the porphyry covers the sandstone. We have more certainty with regard to the sienite, which appears to be of an origin anterior to the sandstone; as is pretty well shewn from the appearance of a breccia that lies upon its surface, which had been interposed between it and the sandstone, before the causes which formed the glen had removed the sandstone.

*GLENSHIRREG.* This glen is of considerable extent, bounded upon one hand by Glencloy, and on the other by Glenrofa. The hills towards the W. are not so rugged as those at the top of Glencloy, and both the bottom and sides are formed of the common sandstone, much traversed with veins of basalt; but towards the S. W. we observe a clay-porphry, which forms part of the rocks higher up than the sandstone, and is, in fact, part of the mass we observed before in Glencloy.

*GOATFIELD.*

*GOATFIELD.* This mountain, according to Professor Playfair, is about 2945 feet above the level of the sea, and is reckoned the highest in the island. It rises pretty rapidly from the south side of Brodick Bay, until we arrive at the region where the micaceous schistus disappears. At this height there is a kind of irregular plain, from which the mountain rises in the form of an obtuse pyramid; and is very precipitous, being entirely formed of granite. On the W. where it forms part of Glen-rofa, it is extremely steep, which is owing in a great measure to the want of micaceous schistus and sandstone; for, in general, wherever these occur the declivity is less sudden. On the east side the pente is more gradual; marking, according to the steepness, the presence of granite, micaceous schistus, or sandstone. It declines a little towards the N. but it rises again, forming one of the boundaries of the rude Glen-Sanicks: it also forms the top of the bare, rugged and sterile Cory-Glen, and the top of the other two great hollows between the Cory-Glen and Glen-Sanicks.

The lower part of Goatfield is composed of the usual red-coloured sandstone, and is traversed by veins of basalt; this continues for several hundred feet up the mountain, when it at last disappears: the micaceous schistus rises from under it, separated only by a stratum of breccia, thus shewing the relative position

position of the sandstone and micaceous shistus. The micaceous shistus continues until we arrive at the plain formerly mentioned; but the side of the mountain, in some places, is so covered with the debris of granite, micaceous shistus, &c. that it is only by the appearance of the granite, in the neighbourhood of this plain, that we are aware of its existence, as the ascent is hardly more steep over the micaceous shistus than the sandstone, which is not generally the case; for we find, when the strata are not covered with debris, that the sandstone is far less steep than the micaceous shistus, and this last than granite. Even in this way, we have a kind of general rule for judging of the nature of mountainous ridges. If they be peaked, and very precipitous, we may presume that they are of granite; if they be less lofty, and not peaked, but still somewhat approaching to the conical shape, we may suppose them to be composed of micaceous shistus; and, lastly, if we observe these skirted by lower mountains, with a trifling pente, we may conclude that they are composed of sandstone and limestone. Although these observations may hold true in general, yet they will sometimes be found liable to considerable variations: thus we know that the shape, and other appearances, of mountains composed of similar rocks, are apt to be varied by several circumstances, particularly by the horizontality or verticality of the strata, their degree of compactness, and their  
aptness

aptness to be weathered. It would be an addition of some consequence, if we had a few general rules on this subject. Saussure well remarks, “ Les signes qui peuvent donner quelque indice de la nature des montagnes, à de grandes distances, et au travers des plantes qui les couvrent, sont en petit nombre, et méritent d’être étudiés et consacrés par des termes propres.”

The pyramidal part of the mountain has a very sterile and wild aspect; being completely covered with loose blocks of granite, and destitute of all vegetation, excepting a few lichens, which only add to its bleak appearance. These blocks differ very much in size, some being twenty feet long\*, and generally of a quadrangular shape; and are so heaped upon each other, as to render the ascent very difficult. Having, however, gained the summit, we are well repaid for our labour by a most extensive view of a wonderful diversity of country. To the

E northward

\* Dr. Walker has observed immense solid masses of granite in different parts of the Highlands: but these are vastly inferior to others that have been found in other countries. About thirty miles from the Cape of Good Hope there is a large mass of granite, called the Pearl Diamond, which is about half a mile in circumference, and 400 feet high. *Phil. Trans.* 1778, p. 102.

northward we look down upon the peaked summits and deep glens in the neighbourhood of Goatfield, whose arid and reddish appearance suggests to our minds the effects of a dreadful conflagration. Beyond these, the isthmus of Cantyre, the island of Ila, the lofty and dreary paps of Jura, the long mountainous ridges of Argyleshire, and the far-distant mountains of Mull, which are faintly descried, present a view rather to be felt than described. On the E. the well cultivated island of Bute, the frith of Clyde, the Cumbray Islands, backed with the beautiful coasts of Renfrewshire, form a most picturesque scene. Towards the S. we have, below us, the lower part of the island spread out like a map, forming a singular appearance of heath-covered mountains and cultivated glens: farther distant, the charming coasts of Ayrshire, the shores and mountains of Galloway, as far as the Mull, the stupendous craig of Ailsa, rising from the bosom of the ocean, all delight the eye and ravish the imagination. Lastly, on the W. the coast of Ireland, from Fairhead to Belfast Loch, concludes the amazing view from this interesting height.

*GLENROSA.* This very striking glen, situated upon the west and south-west sides of Goatfield, is about five miles long, and half a mile broad, bounded by very high mountains. The  
bottom



bottom forms a considerable angle with the sides, rising gradually towards the upper, or north end, where it is formed partly by the mountain called Keid-voe, and partly by Goatfield. The mountains on the opposite sides of the glen are of different heights, (being far higher on the east than west;) but the inclination of the opposite slopes is the same, being about  $70^{\circ}$ . At its entrance upon the shore at Brodick Bay, it has Goatfield on the north, and Glenshirreg on the south. On the south side, the strata are common argillaceous sandstone, traversed by basaltic veins; but this continues only for a short way, as the micaceous schistus soon makes its appearance. Upon the north side, a very little sandstone is to be observed at the bottom of the hill, the upper part being formed of micaceous schistus. Amongst the debris of the micaceous schistus I observed great blocks of a rock, which is principally composed of hornblende, and now and then intermixed with quartz, and a substance that appears to be the same with the paliopetre of Sauffure. The micaceous rocks upon both sides of the glen lie upon granite, which soon presents itself as we proceed up the glen, and forms the mountains upon both sides to its further extremity. This granite, which is similar to that of Goatfield, appears to be dispersed in great strata, that run N. and S. which is nearly in the direction of the glen. If we view them from

the bottom of the glen, they appear like great perpendicular walls, which are split in many places into rhomboidal masses; but if we clamber upwards for some hundred feet, we at length discover the edges of the strata, extending for a great way, and emerging here and there from above the loose blocks of granite, which have fallen from the mountains, or have been formed by the splitting of the banks themselves.

It was long believed, by geologists, that granite never occurred in strata, but merely formed great massive mountains. This has been shown to be erroneous by many later observers; yet La Metherie, in the last edition of his *Théorie de la Terre*, speaking of granite mountains, remarks, “ Les masses ne sont  
 “ ni par bancs, ni par couches, comme l’ont prétendu de fa-  
 “ vans naturalistes. J’ai parcouru une grande quantité de ter-  
 “ reins primitifs, et je n’y ai jamais vu de couches. Quelque-  
 “ fois on apperçoit des masses assez considérables de granites,  
 “ ayant une figure presque rhomboïdale, superposés les uns  
 “ sur les autres. Mais on ne fauroit regarder ces superposi-  
 “ tions pour des couches, puisqu’elles n’ont rien de régulier,  
 “ et que ces masses, presque rhomboïdales, ne se rencontrent  
 “ que très rarement. Le plus souvent ces granites sont fen-  
 “ dues, en différens sens. Ces fissures se correspondent  
 “ quelque-

“ quelquefois ; ce qu'on prendroit, au premier coup-d'œil,  
 “ pour des espèces de couchés ; mais un examen plus appro-  
 “ fondi en fait bientôt reconnoître la différence †.” To these  
 observations we will oppose that of several geologists who have  
 observed strata of granite, similar, I imagine, to those which  
 occur in Arran, in different parts of Europe. The late cele-  
 brated M. Saussure, whose accuracy of observation is not to  
 be questioned, discovered granite dispersed in strata in many  
 parts of Europe ; as may be seen by consulting his most inte-  
 resting and elegant volumes. Reuss, in his mineralogical geo-  
 graphy of Bohemia, has detailed minutely many similar ap-  
 pearances ; and my learned friend Dr. Mitchell informs me,  
 that the Reifenbergs, a chain of mountains which separate Si-  
 lesia from Bohemia, are composed of granite, for above fifty  
 miles, and in this long course it is invariably disposed in strata  
 nearly horizontal ‡.

Upon the east side of the glen several curious appearances are  
 to be observed. Of these, the most interesting are the basaltic  
 veins,

† Tom. iv. p. 352.

‡ Mr. Kirwan, in his Geological Essays, refers to several other authors who  
 describe granite disposed in strata.

veins, which traverse the granitical strata, as they do the porphyry and sandstone \*. The first vein which I discovered, being between three and four feet in diameter, is to be observed rising through the granite, several hundred feet above the bottom of the glen. Its lower part is hid by the heather, and loose blocks of granite, which cover the sides of the mountains. As it rises upwards it becomes gradually narrower, and at last divides into two branches, which run through the granite, contracting and enlarging their diameter from a few inches to more than two feet. The extremity of one of these branches appears either to have been broken, or to sink inwards as to cause one part of the branch to appear separated from the other, as is represented in the plate; where A is the granite, B the basalt vein, C the branch having the appearance of being separated from D by intervening granite †. In the body of the great  
vein

\* However commonly we observe basaltic veins traversing the granite in this island, yet it appears to be a rare occurrence in other countries. Reuss never observed it in Bohemia; and Sauffure, in a late communication to the *Bibliothèque Britannique*, assures us that he never observed any basaltic rock among granite. *Bibl. Brit.* vol. vii.

† Rocks which are disposed in strata present similar appearances with the vein above described, and of this we have a curious example in Salisbury Craigs near Edinburgh. This hill, which is entirely composed of rocks of trap formation,  
tion,

vein there is immersed a considerable wedge-shaped piece of granite, marked in the plate at E; which has the usual hardness, colour, &c. of that species of which Goatfield is formed. The granite and basalt are not intermixed at their junction; no matter is interposed; and they are not altered in the least by being in contact with each other. In the neighbourhood of this vein were found specimens of rock crystal in cavities of the granite; and some of the crystals were of considerable size, but generally of a smoke colour. I also picked up a species of granite similar to the *pierré graphique* which is found at Portsoy\*; also a stone much  
resem-

tion, affords some fine views of its stratification, in a lofty cliff that extends around a considerable part of it. Towards the north extremity of this cliff, the red-coloured sandstone, which lies below the basaltic rock, is much waved in its course, and, at one place, a part of the sandstone stratum appears detached and immersed in the basaltic rock. The inclosed piece of sandstone is of great size, still preserves its stratified-like aspect, only it is very hard. Dr. Hutton reckons it a strong proof of the truth of his theory: but Mr. Deriabin, an intelligent mineralogist, who examined it along with me some time ago, thinks, that the stratum is not broken, only that it sinks behind the basalt, as I have conjectured may be the case with the vein above described. Dr. Hope informs me that several similar appearances are to be observed in the neighbourhood of Edinburgh.

\* I found a similar rock among some fossils sent me from Hudson's Bay; and, by a late memoir of Patrin in the *Bibliothèque Britannique*, (vol. 8. p. 78.) it proved also to be a production of Corsica;

resembling the veined granite of M. Sauffure; and likewise a curious species of granite, where the quartz, felspar and mica were distributed in a radiated form, as is the case with many zeolites.

Near to the summit of Goatfield I picked up several pieces of rock, which is evidently the same with the paliopetre of Sauffure, which he found loose near to the summit of Mont Blanc in Switzerland †. Lower down, but upon the same side of the glen, many fragments of basalt are to be observed, lying upon the sides of the mountains, showing the presence of basalt veins; and at the Keid-voe a great vein is to be seen, rising perpendicularly through the granite. Nearly at the same place, I was much surprised to find several columns of dark leek-green coloured pitchstone lying amongst the debris of the granite; but, after considerable labour, I was not able to discover its situation.

Not far distant from this, in ascending towards the summit of Goatfield, amongst the loose blocks of granite which cover its sides, I observed a curious appearance. Upon  
breaking

† Voyages dans les Alpes, tom. 7me, p. 275.

breaking these rocks, with an expectation of discovering rock crystal, I found in several of them masses of compact granite, of different sizes, either rounded or angular. Somewhat similar appearances have been observed by other mineralogists: thus Mr. Werner has in his possession a mass of granite which contains pieces (geschiebe) of gneifs\*; Mr. Roster found between Ellbogen and Schlackenwalde, in Bohemia, a great-grained granite †; and Mr. Sauffure observed a mass of granite which contained an oval piece of gneifs ‡. Mr. Werner reckons his specimen a proof that the gneifs is of earlier formation than the granite; in other words, that the pieces of gneifs have been broken off a stratum which was deposited before the granite. Mr. Sauffure, however, is of an opposite opinion: he is inclined to believe that these pieces of granite or gneifs have been formed simultaneously; and that they have, by some peculiar circumstance, affected a rounded form, which is not manifested in the other parts of the rock. This conjecture is rendered more probable from the following fact: “ I have often seen, says he, in veined granite, rounded pieces of a far  
 F “ finer

\* Werner, Kurze Klassifikation der verschiedenen Gebirgsarten.

† Emmerling Lehrbuch der Mineralogie. B. 3.

‡ Voyages dans les Alpes.

“ finer grain, which nevertheless had been formed simultane-  
 “ ously, since we observed the continuity of the layers of the  
 “ fine-grained, with that of the granite in great grain and  
 “ thick layers.”

The west side of the glen is formed in part by a granitical mountain, named Ben-echleven, which presents to us the great flat sides of the granitical strata. Its top is covered with enormous blocks of granite, which rest upon it in a most fantastical manner. This mountain declines rapidly towards the N. E. forming a tremendous hollow, named Cory-dain, whose bottom is far elevated above that of Glenrosa, but is lower than the bottom of the next hollow, named the Feun-hody, which is raised far above either, presenting to the bewilder'd eye an amazing scene of ridged and peaked rocks of granite. In the Cory-dain, the granite, at first sight, appears to be stratified horizontally; but an examination shews us that is owing to the splitting of the granite. Here also we observe the granite disintegrating in the form of sand, and, what is more rare, decomposing in the manner of some species of basalt, that is, in crusts \*. Sauffure, speaking of this kind of decomposition, remarks :

\* Granite decomposes in concentric layers.—Charpentier Mineralogische Geographie der Churfürstlichen Lande. § 31.



marks : “ Un autre fait, dont je trouvai la solution en exami-  
“ nant ces granites de prés et avec attention, c’est celui de ces  
“ exfoliations que j’avois observées dans la vallée supérieure.  
“ C’est un fait connu de tous les minéralogistes, que la plupart  
“ des pierres sont plus tendres dans le sein des montagnes qu’à  
“ leur extérieur, et qu’elles acquièrent à l’air un degré de  
“ dureté sensible. Il suit de-là, que la partie extérieure, ou le  
“ bord de la tranche verticale d’une grande assise de granite,  
“ doit se durcir par le contact de l’air, tandis que l’intérieur  
“ de la même assise conserve un certain degré de mollesse. Et  
“ tant que les assises inférieures demeurent un peu molles, le  
“ poids énorme de toutes celles qui reposent sur elles doit à la  
“ longue les comprimer. Mais les parties extérieures, durcies  
“ par le contact de l’air, ne sont pas susceptibles de la même  
“ compression. Elles doivent donc s’en séparer, et former ainsi  
“ les exfoliations que l’on observe\*.”

F 2

A R R A N.

\* Voyages dans les Alpes, tom. 6me, p. 318.

# A R R A N.

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## C H A P. IV.

*Description of the FOSSILS mentioned in the preceding Chapter.*

### PITCHSTONE.

*ARGILLA PICEA*, Werner. *RETINITE*, La Metherie. *OPALUS PICEUS*, Gmelin.

#### PITCHSTONE *from Lamlast Road.*

*Colour.* Dark leek-green.

*Lustre.* Internally it is glancing\*, with a waxy lustre †; is often beautifully iridescent, and this is particularly the case at the thin edges of the splinters.

*Hardness.* Gives a few feeble sparks with steel, but is very brittle.

*Fracture.*

\* Glänzend.

† Wachsglanz.

*Fracture.* More or less perfectly multiplied conchoidal, or splintery; often shistose; and rarely presents distinct concretions.

*Fragments.* Almost always in the form of four-sided irregular columns.

*Transparency.* Transmits a very little light at the edges.

*Fusibility.* At  $23^{\circ}$  of Wedgewood's scale, it becomes black, is much rent, and internally a little porous; at  $55^{\circ}$  it had formed a porous enamel; and at  $70^{\circ}$  it became perfectly white, and the enamel was little porous.

It frequently contains a few crystals of white felspar, which appear of the nature of adularia; and I observe interspersed grains, apparently of quartz. This species is often intermixed with one similar to that observed at Brodick wood.

#### PITCHSTONE—*Brodick Wood.*

*Colour.* Dark leek-green; but the number of distinct concretions often give it a lighter hue.

*Lustre.* Little glancing\*, with a greasy lustre †.

*Transparency.* Transmits a very little light at the edges.

*Hardness.*

\* Wenig glänzend.

† Fett glanze.

*Hardness.* Gives a few sparks with steel.

*Fracture.* Uneven, conchoidal, and sometimes splintery, with numerous distinct concretions; in the gross is often flaty.

It sometimes contains crystals of white felspar and quartz, crystallised in six-sided pyramids.

It decomposes, by the action of the weather, in the form of a white tegmen, which is often separable into layers; and, by the decomposition of the felspar, it gets a cellular appearance, when it requires an experienced eye to distinguish it from some of the productions of Lipari. It is also frequently traversed with another species, which has a greater degree of lustre, and is more difficultly decomposable by the action of the weather; so that specimens of this kind, when decomposing, present a striped surface of dark-green and white, the dark-green being the undecomposed species. Gerhard, in his Mineral System, mentions a species of gneiss, or granite, that contains obsidian, a stone much allied to pitchstone. Dr. Townson, in his Travels through Hungary, remarks, that this gneiss is a species of obsidian, with black and white layers, containing also, probably, a few crystals of adularia and scales of mica. The stone I have now described appears to be of the same kind, and this is rendered more probable from its sometimes containing felspar.

BROWNISH-

BROWNISH-BLACK PITCHSTONE—*South Side of Glencloy.*

*Colour.* Brownish-black.

*Lustre.* Little glancing, with waxy lustre.

*Transparency.* None.

*Hardness.* Gives a few sparks with steel.

*Fracture.* Uneven, with a tendency to the conchoidal.

*Fusibility.* At  $21^{\circ}$  it intumesced a little; its colour was slightly altered; the surface glazed, and, internally, porous. At  $31^{\circ}$ , intumesced considerably, and softened. It had then, externally, a brownish glazed covering; internally, colour is grey, and very porous. At  $65^{\circ}$  it had intumesced very much; forming an externally cavernous, yellowish-brown coloured mass. At  $100^{\circ}$  it became more compact.

There are generally a few crystals of white felspar dispersed through it; and it acquires, by the action of the weather, a slight brown tegmen.

## BLACK PITCHSTONE.

*Colour.* Black.

*Lustre.* Little glancing, with a waxy lustre.

*Transparency.*

*Transparency.* None.

*Hardness.* Gives a few sparks with steel.

*Fracture.* Straight, flaty; and the flates appear to be formed by the superposition of small foliæ. The plates are also sometimes covered by a metallic yellow-coloured illinition.

*Smell.* When powdered, it emits a bituminous smell; which renders it probable it may contain inflammable matter\*.

It has generally a few crystals of white felspar dispersed, and these by decomposition acquire a brown colour: sometimes we also observe a yellow-coloured, nearly transparent substance accompanying the felspar.

These different kinds of black pitchstone appear to pass into basalt. A curious specimen of this kind occurred to me in the neighbourhood of Kilmichael-House, in Glencloy. One part is common black pitchstone, but it gradually loses its lustre; its fracture passes from the conchoidal to the plain splintery; then it gives a grey streak, is not at all fragile, in short, is a fair basalt.

O B S E R-

\* Mr. Kirwan has found several pitchstones to contain inflammable matter.

## OBSERVATIONS.

When pitchstone was first discovered, it was believed by mineralogists to be the lapis obsidianus of Pliny \*: its resinous or pitchy colour, however, sufficiently distinguished it from the true obsidian, which was afterwards found in Hungary, Iceland, the South-Sea Islands †, &c. It was first discovered in Saxony; but it has not till now been described as a British fossil.

From its great resemblance to certain volcanic productions, it has occasioned a considerable warfare between the Neptunian and volcanic philosophers. The volcanists rest their opinion on the following facts. 1. Pitchstone has been observed to pass into obsidian; a stone which is found in the neighbourhood of Mount Hecla in Iceland, and hence reckoned volcanic. 2. Pearlstone, which seems only a species of pitchstone, is

G found

\* Baron Veltheim has endeavoured to shew that the obsidian of Pliny corresponds to several other stones.

† Neues Bergmannisches Journal. B. i. § 94.—The whole of the Isle of Ascension, according to Foster, is composed of obsidian.

found not only to inclose balls of obsidian, but even to pass, on the one hand, to obsidian, and, on the other, to real pumice\*. Mr. Camara, who had examined the pitchstone of Hungary, was convinced, from its alternation with rocks decidedly Neptunian, that it could not claim a volcanic origin; and he rendered his proof more complete, when he demonstrated, that the obsidian was converted into a porous spongy mass by the blow-pipe, intimating that it had never been exposed to the action of volcanic fire †. More lately, Lampadius, professor of chemistry at Freyberg, has found, that the pitchstone is affected by fire in the same way as the obsidian ‡; and has completely overthrown the volcanists, by the discovery, that the true obsidian contains 2 lb. 5 oz. of water per cent. ||

As the pitchstone which occurs in Arran is convertible into a porous or fibrous mass by the action of the fire, and forms  
veins

\* Esmark N. Bergmannisches Journal. Vol. 2.

† Bergmannisches Journal, 1794. B. 2. § 245.

‡ Neues Bergmannisches Journal. B. 1. § 84.

|| A whole pound weight of obsidian was distilled in a porcelain retort, and afforded 145 grains of pure water.



veins in sandstone, a volcanic formation cannot be attributed to it.

*Fusibility of Pitchstone.* Pitchstone has been found by mineralogists to possess so very different degrees of fusibility, that it leads me to enquire if they have all employed the true pitchstone in their experiments. Mr. Morveau Guyton found the pitchstone of Menil mountain, near Paris, to remain unaffected at a very high degree of Wedgwood's scale\*. Mr. Kirwan; who has made many experiments on their fusibility, found that the most fusible formed an enamel at  $130^{\circ}$  of Wedgwood; but in general were far more refractory, some remaining unchanged at  $160^{\circ}$  †. It is plain that these fossils are quite distinct from the pitchstone of Arran: indeed, were they proved to be the pitchstone of Werner, I would not hesitate to arrange the Arran stones as a new and distinct genus. It is now known, however, that several stones, which formerly passed for pitchstone, belong to the semiopal. Dr. Mitchell informs me that the infusible pitchstones of Hungary are semiopals; and Dolomieu remarks, that the pitchstones of the island of Elbe,

G 2

Elbe,

\* Journal Polytechnic.

† Elements of Mineralogy. Vol. I. p. 293, 294.

Elbe, Piedmont, and the wood which is converted into yellow and white pitchstone from Hungary, are all very difficultly fusible, and he therefore reckons them resiniform chalcedonies †, (or, more properly, semi and wood opal.) It is not then improbable that the pitchstones, which Mr. Kirwan and Morveau Guyton examined, were semiopals, or stones nearly allied to it.

The real pitchstone, according to Emmerling, is easily fusible ‡; Dolomieu found the pitchstones of the Isles Ponces and of the Paduan mountains easily fusible; and, lastly, Messrs. Camara, Deriabin and Lampadius observed a similar fusibility. These facts agree with my trials on the Arran pitchstone, and entitle me to reckon it the pitchstone of Werner.

### B A S A L T.

*BASALTES*, Marmor. Agricol. *BORAX BASALTES*, Lin. *BASALTES COLUMNARIS*, Waller. *ARGILLA BASALTE*, Werner.  
*COMMON TRAP*, Kirwan.

BASALT—

† Journal de Physique. Vol. 40. p. 215.

‡ Lehrbuch der Mineralogie. B. I. § 264.

BASALT—*South Side of Glencloy.*

*Colour.* Black.

*Lustre.* A number of shining particles dispersed through it, which is probably hornblende\*.

*Transparency.* None.

*Hardness.* Scarcely gives fire with steel.

*Fracture.* Even earthy, but is very compact.

By decomposition acquires a brownish-coloured tegmen.

BASALT, *which forms a vein running in the porphyry—  
Head of Glencloy.*

*Colour.* Lavender blue, intermixed with yellowish green; by decomposition, red.

*Lustre.* None.

*Transparency.* None.

*Hardness.* Yields pretty easily to the knife.

*Fracture.*

\* Hornblende having been found to contain charcoal, or probably carbone, as a constituent part, has been ingeniously mentioned by Dr. Walker, as one fact, to shew the transition from plumbago to hornblende, which he imagines he has observed in several other instances,

*Fracture.* Rather uneven fine splintery.

*Fusibility.* Melted at  $103^{\circ}$ .

BASALT, which forms veins traversing the granite—  
East Side of Glenrosa.

*Colour.* Greyish, or black.

*Lustre.* A number of crystals of hornblende, dispersed through it, give it a slight degree of lustre.

*Transparency.* None.

*Hardness.* Gives a few sparks with steel.

*Fracture.* Uneven earthy.

Gives a grey trace.

*Fusibility.* Melted at  $58^{\circ}$ . This fusibility distinguishes it from the species of basalt examined by Mr. Kirwan. He found them fusible from  $120^{\circ}$  to  $130^{\circ}$ ; and the figurate trap, or columnar trap, melted at  $100^{\circ}$ .

It contains yellow-coloured olivin, and in greater quantity than I have observed in other species.

In the former edition of this work, I conjectured that both the pitchstone and basalt might contain potash. Since that period, Dr. Kennedy has analysed basalt, wacken-porphry and greenstone, and these he finds to contain a small portion of

soda

foda and muriatic acid †. Dr. Mitchell, to whom I communicated Dr. Kennedy's experiments, has lately repeated them upon the famous basalt of Stolpen, but obtained a very different result. Having detected a small portion of muriatic acid, he then powdered a quantity of the stone, and mixed it with sulphuric acid; then distilled to dryness, and lixiviated the solution: the solution was decomposed by the acetite of lead; the supernatant liquor was then evaporated to dryness, and the acetous acid burned off. The residue, which was pure alkali, afforded, with nitrous acid, prismatic nitre: a decisive proof of potash.

### S I E N I T E.

*SIENITES*, Marmor. *PYROPOECILUS*, Plin. et Al. *STENITES*, Dr. Walker's Class. Fossil. *GRANITES SIENITES*, Gmelin. Syft. Nat.

This rock we have remarked forming strata at the head of Glencloy, and it occurs in many other parts of the island: I shall now mention its external characters. To prevent repetition, I will shortly detail the different species, placing the ingredients in their order of proportion.

1. Felspar;

\* Transactions of the Royal Society of Edinburgh, vol. 5th.

1. Felfpar; reddifh.

Hornblende; green, and fometimes black.

Quartz; white, and fometimes brown.

This fpecies is more or lefs compact, and is fometimes fhiftofe.

2. Hornblende; green.

Quartz.

Felfpar.

This aggregate, which is almoft entirely compofed of hornblende, has the following characters:—

*Colour.* Dark leek-gren.

*Lufre.* A number of fhining points difperfed through the mafs, owing to the hornblende.

*Transparency.* None.

*Hardnefs.* Gives fire with fteel, but not very plentifully.

—Leaves a grey trace. It is difficultly diftinguifhable from many fpecies of bafalt, and is often intermixed with patches of the firft fpecies.

3. Quartz.

Felfpar.

Hornblende.

This fpecies, owing to the great proportion of quartz, has much the appearance of a fandftone.

4. Horn-

## 4. Hornblende.

Quartz.

Felspar; greenish-coloured.

The hornblende, in this compound, has sometimes a metallic lustre, approaching to the nature of schiller spar; and the felspar is tinged green, owing to the diffused matter of the hornblende.

## O B S E R V A T I O N S.

The different species of sienite were long confounded with basaltic and granitic rocks: a circumstance which was owing, not only to the want of an appropriate name, but to the difficulty of distinguishing the gradations. Werner first named it greenstone; but he now calls it Sienite, from a conviction that it was a similar stone which Pliny described as being found at Sienna in Upper Egypt. In antient times it was quarried in great quantities at Sienna; and from thence was brought to Rome for the building of great public edifices, and for the use of the statuaries, who worked it into pyramids, obelisks, &c. The famous Sarcophagus of Cheops, and Pompey's Pillar at Alexandria, are now known to be of sienite.

As the discovery of metallic veins is one of the great objects of mineralogy, we think it not out of place to introduce, among the general observations we may have occasion to make during the course of the work, a short account of the different veins of ore which have been observed traversing similar rocks in other countries. In pursuance of this plan, we may remark, that sienite, in some places, is rich in metals: thus, at Schaufenberg there are veins of silver and lead, and part of the productive Altenberg mine-works are in sienite: we believe that the veins of Strontian in Argyleshire run in a similar rock.

#### CLAY PORPHYRY—*Cory-Gills.*

*THON PORPHYRY*, German.

*Colour.* Brownish basis; by decomposition, acquires a white tegmen.

*Lustre.* None.

*Transparency.* None.

*Hardness.* Is difficultly scraped with a knife.

*Fracture.* Splintery.

*Smell.* Strong earthy smell, when breathed on.

*FELSPAR*



*FELSPAR*—Is of a brownish colour; sometimes white and crystallized.

*QUARTZ*—Is of various colours, white, yellow, or smoky; of different shapes, angular, rounded, or regularly crystallized, presenting often six-sided pyramids, which is a rare appearance in porphyry: it is also sometimes dispersed through the basis in the form of strings.

**PORPHYRY**—*Glencloy.*

The basis of this porphyry differs, in general, but little from that of Corygills: in particular instances, however, we observe it nearly in the state of hornstone, and having the following characters:

*Colour.* Grey.

*Lustre.* None.

*Transparency.* A very slight degree at the edges.

*Hardness.* Gives a few sparks with steel.

*Fracture.* Even.

*Smell.* A strong smell, when breathed on.

The crystals of felspar are much larger than in the clay-porphry; and, besides, I observed it to contain a softish substance, probably steatitical.

#### GENERAL OBSERVATIONS.

The true porphyry was long confined by mineralogists to a particular stone which was supposed to have a jaspideous basis; but Werner has extended its signification much farther, and now reckons eight different kinds. It would be useful here to follow the Linnæan mode, by dividing them into distinct genera; and then the species might be described in short characters, as has been done in botany. This will probably be reckoned useless labour by those who think that fossils are not capable of such arrangement: we are well convinced, however, that, in the present instance, as well as in many other parts of mineralogy, much good may be done by such attempts.

In modern times, porphyry has been principally used for ornamental purposes; and, where compact, it has been found to answer well for millstones. The Greeks and Romans used it for the construction of their finest edifices; and the statuary often cut it into busts, vases, &c. of the most exquisite workmanship.

The

The porphyry in this island, so far as my experience goes, does not afford any veins of ore; yet in other countries it is sometimes productive. Thus, in different parts of Germany, a species, similar to what we observe in this island, has been found to contain veins of tinstone, iron ore, manganese, galena, and molybdæna.

### SILICEOUS SHISTUS.

*GEMEINER KIESELSCHIEFER, Wern. HORNFLINT.*

Among the debris which covers the bottom of Glencloy, I discovered specimens of a rock which seems to be siliceous shistus; but I could not discover it *in situ*. It presents the following characters:

*Colour.* Grey, or greyish black.

*Lustre.* None.

*Transparency.* Transmits extremely little light at the edges.

*Hardness.* Gives fire plentifully with steel.

*Fraçture.* In the gross, flaty; of the single plates, more or less fine splintery, inclining to the even.

It has dispersed through it grains of quartz, and very minute

nute particles of a softer substance, whose nature I could not determine.

### GRANITE.

*GRANITES GENUINUS*, Lin. *GRANITES DURUS*, Cronsted. *SAXUM quartzo, spato scintillante et mica in diversa proportione mixtis, compositum*; Waller, Syft. Miner. vol. i. p. 407.

The granite of this island is, in general, pretty compact; of a whitish-brown colour, owing to the flight-brown tinge of the felspar. To describe all the varieties that occur might be useful; but that is more adapted for a systematic treatise of mineralogy than an outline of this kind. I shall only, therefore, give a particular account of two species; the Great-grained, or Common Species, and the Small-grained.

#### I. GREAT-GRAINED GRANITE.

This species is not only remarkable by its forming a very considerable part of the solid materials of the island, but also on account of the peculiarity of its composition; as it frequently contains three species of felspar, and the quartz is often crystallized.

*1st Species, FELSPAR*—Is of a white colour, with a slight tendency to the brown; having the usual lustre, transparency, and hardness.

*2d Species, ADULARIA?*

*Colour.* White.

*Form.* Either in amorphous masses, or crystallized in hexahedral prisms, bevelled at both ends.

*Lustre.* External, like that of crystals not much polished; internal, same.

*Transparency.* Sometimes objects can be seen pretty distinctly through the crystals; but when they are a little decomposed, opacity is produced.

*Fracture.* Plain foliated, and sometimes striated.

*Hardness.* Gives fire plentifully with steel.

*Fusibility.* At  $100^{\circ}$  the surface was formed into a yellow-coloured enamel.

*3d Species*—Is of a white colour, having nearly the usual hardness, fracture, &c. of the common felspar; differing principally in the lustre, which is like that of polished metals, reflecting, in certain directions, a silver light.

QUARTZ—

*QUARTZ*—Is frequently colourless; also greyish, pale yellow, pale, or dark brown, and sometimes nearly black, when it is called Morion.

Is very often crystallized; and either in the form of hexangular prisms, terminated by hexangular pyramids at one or both ends, and the prisms are feamed across. The crystals are sometimes found several inches long, and from two to three inches diameter; of a pale brown, or rather smoke colour. These last are much valued by the lapidaries.

*MICA*—Is often black; sometimes golden yellow, tombac brown, or green. It is generally in the form of irregular plates; and pretty frequently hexagonal plates occur, which, being superimposed upon each other, form a hexagonal figure of some magnitude. It is the mica lamelleuse hexagone of Rome d'Isle, (vol. ii. p. 509.) and the hexagonal mica of the Abbé Huay, (Miner. vol. v. p. 296.)

The constituent parts of the granite are very various in their proportion; but, in general, the felspar forms the most considerable part, then the quartz, and lastly the mica.

## II. SMALL-GRAINED GRANITE

Is very compact, with an uneven fracture; composed of felspar and quartz, in nearly equal proportions, with very few scales of black mica. It is subject to much variety; not only on account of the size of the particles, but also from their relative proportion, their degree of compactness, &c. Some varieties are so compact, and have such a general appearance, as easily to pass for sandstone: but a careful examination of the figure of the particles, the want of substramen or basis, and, lastly, its situation in the earth, afford sufficiently distinct marks of difference. It is generally found in fissures, which traverse the great-grained granite in all directions; but it also occurs in patches dispersed through it\*.

## B R E C C I A.

I have already remarked that the common breccia, which runs among the sandstone, is formed of fragments of sand-  
I stone

\* It has been observed in the mountains of the Hartz, that granite affects the magnetic needle; but it is said only in mass, and in a perpendicular vein. Mr. Deriabin, however, informs me, that this is not quite correct; for he has observed it to act in detached pieces.

stone and quartz, immersed in an arenaceous basis. Another species occurs upon the summit of the sienite hills, back from Glencloy. It has an arenaceous basis, approaching, in appearance, to basalt; and containing rounded or angular masses of granite similar to that which forms Goatfield, micaceous shistus, quartz, porphyry like that of Glencloy, basalt, and palio-petre. I was not able to discover its real situation; but its composition shewed that it was probably interposed between the primary and secondary strata. The circumstance of its containing granite, explained a phenomenon which long puzzled me—the appearance of rounded masses of granite upon the summit of several high hills; these evidently owing their origin to the decomposing breccia.

ARRAN.



# A R R A N.

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## C H A P. V.

*Cory; Cock of Arran; and Loch-Ranza.*

**H**AVING now given a pretty extended description of the strata and fossils in the neighbourhood of Brodick Bay; I shall, in the next place, proceed to trace the strata round to Loch-Ranza, which is situated upon the north-west side of the island.

From Brodick Bay, the cliffs all around are low, and, for a great way, composed of the usual red sandstone, which is much traversed by veins of basalt, of various widths, and running in different directions. Coves occur in several places, but none are of considerable size: frequently calcareous stalactites hang from their roofs. The action of the sea upon the sandstone has given a singular aspect to the whole shore; owing

to soft sandstone being washed away, while the more compact and hard, which appears to have been formed in fissures, is left standing in long ridges, or crista. The sandstone, as it rises upwards, forms part of the lower region of Goatfield, in the vicinity of the micaceous shistus, which it, in all probability, covers. About a mile from the Cory, nearly one hundred feet above the level of the sea, there is a stratum of limestone, about twelve feet thick, running at an angle of  $20^{\circ}$ , and covered with red-coloured argillaceous sandstone; but, below, interposed between the limestone and sandstone, there is a layer of a red shistose clay. In this clay I observed regular series of shells, deposited in layers, (all appearing of the same species,) with their convex sides regularly downwards. The stratum is sometimes straight, but often waved and twisted. It also frequently contains radiated calcareous crystals, which are of a reddish colour, owing to the admixture of iron. In a fissure of the sandstone, above the limestone, I observed stalactites of peat, of considerable size and consistence, which appear to have been formed by the infiltration of the soluble peat-matter through the sandstone. To the N. of this stratum there is a considerable ravine, which luckily afforded me an opportunity of observing the junction of the different strata. Here I traced the common red-coloured argillaceous sandstone from the shore to a considerable height, and, in some places, observed

served it intermixed with fragments of quartz; thus forming a kind of breccia. As we approach the primitive rocks, the sandstone strata become more elevated; and, at length, I observed it lying on a compact shistose rock, which appeared to be of the nature of micaceous shistus; but it was so much decomposed by the action of the weather, that I could not well determine exactly as to its particular designation. This micaceous shistus? continues but for a short way, when it is to be seen lying on the granite, which rises upwards, forming a very steep ascent, which leads to the rugged and sterile-looking Coryglen. This glen is very precipitous on all sides; is broader than any in the Goatfield groupe, but is comparatively shorter: its bottom is higher than that of Glenrosa, but not so much elevated as that of the Cory-dain or Feun-hody. It is entirely composed of granite; which is here split, as usual, into immense blocks, that are piled in vast tumuli upon the tops of the surrounding mountains, or cover the sides and bottom of the glen, as with ruin and desolation.

Having returned again to the sea-shore, I continued my journey; and, as I approached the Cory, observed a vein of soft, red, shistose sandstone, containing rounded pieces of argil running through the sandstone N. E. and S. W. At the Cory, where there are a few houses, I observed quarries of  
sandstone,

sandstone, of a beautiful white colour, and of good consistence for building. These quarries are now worked, by a company, for the construction of the Crinan Canal. Here there is also a stratum of limestone, about thirty feet thick, considerably inclined to the horizon, running N. N. W. and divided into strata, as the stratum formerly mentioned, with intervening clay and shells, but the clay is more or less indurated. From this towards West Sanicks, the shore is composed of the common red-coloured sandstone, intersected here and there with veins of basalt; but it is often so covered with boulder stones of different kinds, as to render travelling very difficult. The rounded masses of granite, scattered up and down here, are of a most astonishing size; some of them hundreds of tons weight. Near to the Sanicks, there is an immense stratum of breccia, which is composed of rounded fragments of quartz, and micaceous schistus, cemented by an arenaceous ground. The breccia is in many places much broken. Immense masses of it, many hundred tons weight, lying separated from the stratum only a few feet, render it probable, that these masses were disunited by frost. In one place, I observed, a considerable section of the breccia, which I examined very carefully, in order to discover if the masses of quartz, were compressed and smaller at the lower than the upper part, but no difference could be observed. Very remarkable instances of this kind have been observed

served

served in other countries; thus in Bergm. Erde-Besch. 182, we are told that in the mountains of Quedilix and Portfjallet in Norway, which consist of an argillaceous puddingstone, the siliceous pebbles it contains, are observed to be compressed to the thickness of the fourth of an inch, in the lower parts of the mountains, but to increase in size and roundness in proportion as their situation is higher. Also in the Vivarois, the lowest strata of primitive limestone, have been found of the thickness of one-tenth of an inch; but in proportion to their elevation in the mountain their thickness increases, until at its summit; it arrives at thirty or forty feet. 1. Soulavie, 178. Ferber made the same observation in England.

At a little distance from the shore, is the entrance into the deep South Glen-Sanicks, which is about four miles long; running nearly E. and W., and bounded on both sides by lofty mountains. As I observed a considerable stream of water running through this glen, I determined to examine it, as it was probable that the strata would be well exposed. Having walked for upwards of a mile in the direction of the glen, I descended into the ravine formed by the water, but found still the usual red-coloured argillaceous sandstone. As we continued clambring upwards, I observed several veins of sulphat of barytes, some nearly four feet wide, traversing the sandstone;

stone; and, by a little care, I obtained specimens pretty well crystallized. About a quarter of a mile further on, a very compact arenaceous breccia (principally composed of rounded pieces of quartz, and a species of basalt, which has, interposed, grains of felspar, and a yellow substance,) makes its appearance; and this extends to a considerable distance; but it is at length apparently interrupted by a stratum of hornblende rock. This stratum of hornblende rock is only a few feet wide; and it appears to lie immediately on the granite. I have to regret that I could not obtain more satisfactory views of the junction of these strata, owing to the great covering of debris. I am somewhat confident, however, that the disposition of the strata is pretty nearly as now stated, viz. that in the lower parts, and for a considerable way upwards, is argillaceous sandstone; next, arenaceous breccia; then a bed of hornblende rock; and, lastly, granite.—The glen is now bounded by lofty granite mountains: on the N. is the Caimes, with part of Caimenacaillich; and, towards the S., Keich-na-hien and Goatfield form boundaries awfully grand. Its sides are much furrowed by the action of the rain: which circumstance, with the red colour of the decomposing granite, the immense granitic blocks which cover the sides and tops of the mountains, form altogether a sterile and tremendous scene.

————— In lonely regions, here, retired  
 From little scenes of Art, great Nature dwells  
 In awful solitude.

Here I observed several veins of basalt traversing the granite; and, in some places, I could trace the perpendicular veins from the top to the bottom of the mountains. At the top of this glen is the hollow called Cory-na-huave, which is bounded by Caime-na-callich and Keid-voe. Its bottom is higher than that of Glen-Sanicks; and is entirely composed of granite, traversed with veins of basalt, some of which have a considerable degree of curvature.

Having examined this glen as far as my time would permit, I was again proceeding toward the sea-shore, when I thought it might be interesting to examine the junction of the granite and schistus in some of the neighbouring glens. I therefore changed my course, as soon as we came to the rock of breccia which I have just described; and from this I crossed over a hill of similar rock to North Glen-Sanicks. Here we observed a stream running through the glen, and in it I found the schistus in immediate contact with the granite. The schistus appeared to be a very compact micaceous rock; but the granite was not intermixed with it at the junction, nor were there any veins

to be observed shooting from the granite into the micaceous rock. We now crossed over the hills into another glen, where I observed another junction of the granite and shistus, but it presented nothing remarkable.

I now returned again to the shore, below the entrance of South Glen-Sanicks; so that I might proceed regularly on my tour through the island. After passing the Sanicks burn, I found the sandstone, breccia and basaltic veins still continuing; but the appearance of the mountains was much changed. The peaked summits, and almost perpendicular, furrowed sides, now disappeared: the mountains were clothed with heather to their summits, which were more or less round-backed: intimating an alteration in the materials of which they are composed; which is really the case, as the granite had now disappeared, the summits of the largest hills being of micaceous shistus, which, in some places, alternated with talcaceous shistus. I now wandered along a mile or two of shore composed of sandstone; when my attention was arrested by the remains of workings for coal, at a little distance from the sea-mark the Cock of Arran. This coal stratum, which is but of small extent, runs in the sandstone, accompanied by the usual coal metals, as, argillaceous ironstone, shistose clay containing numerous vegetable impressions, &c., and at the bottom of a  
mountain



mountain of micaceous shistus. It is similar to that which is found at Kilkenny in Ireland, and is called blind-coal\*. I observed two pits, about fifteen feet deep, which had been dug in cutting the coal stratum; but, as the coal soon disappeared, the pits were left, and the salt-pans which had been erected were rendered useless. The situation of this stratum is such, as to preclude all hopes of finding any considerable quantity of coal, although fresh sections were made: for we invariably find it to be the case, that wherever coal strata come into the vicinity of high mountains, they then most certainly decrease in breadth, and become bad, owing to the great admixture of earthy matter. Thus, many of the seams of coal which have been found in France are trifling, and continue but for a short way; owing to their situation, being found in vallies that are bounded by granite, or other primary rocks †.

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\* Dr. Hutton conceives that this species of coal presents an irrefragable proof of the truth of his theory. Here, says he, is a coal having all the properties of that which has been submitted to the action of heat; the bitumen is separated, and charcoal remains. To the Neptunists, this affords one of the strongest arguments against the theory. The separation of bituminous matter shows a want of immense compression, which is the grand fundamental basis of the hypothesis. It is indeed this circumstance, principally, which distinguishes it from the volcanic theory, and has led Mr. Kirwan to name it the Plutonic.

† Journal des Mines.

The great frequency of basaltic veins is another cause which may render the coal, if it should again be deemed worthy of attention, of an indifferent quality, and difficult to work.

From this stratum to the Cock, which is the most northern point of the island, the shore is covered with immense masses of sandstone and breccia, which have tumbled from the neighbouring hills by the action of the weather. Ironstone is found scattered upon the shore, and is probably connected with the coal workings. The Cock is not, as I expected, a headland, but merely an enormous mass of sandstone, lying loose upon the shore, having a fancied resemblance to the head of the cock. Here the cliffs are of considerable height, composed of sandstone and breccia, traversed with veins of basalt of various sizes. One of these veins is composed of a reddish brown-coloured basalt, with, interspersed, white-coloured, apparently crystallized specstein of Werner; and the basalt, where it is in contact with the sandstone, is hard, and much resembles hornstone. After leaving this, a striking appearance presents itself to our view, of the whole face of an immense stratum of breccia, which was shattered to pieces, and rolled towards the sea, by an intense frost some years ago: the crash of its fall was heard far off. The sandstone upon this part of the coast is alternated with layers of shistose clay; and where the clay is washed  
away

away, the sandstone lies exposed, having the appearance of a regular pavement. If we examine it more nearly, we find the sandstone strata split into two, four, or six-sided irregular figures, and connected together by the clay, which gives it an artificial aspect; by the decomposition of the clay, the pieces of sandstone are separated, and lie scattered on the shore, and are apt to be taken for the work of art. From this to within a mile of Loch Ranza, the sandstone, as usual, forms the cliffs upon the shore, and is backed by mountains of micaceous schistus, upon which it rests. Here, however, the sandstone disappears, and the micaceous schistus now forms the cliffs, which become higher as we approach Ranza. At the place where the sandstone disappears, there is a great basalt vein, about thirty feet wide, running in a rock intermediate between ardesia and micaceous schistus. As we approach nearer to Loch Ranza, the sea has exposed several other similar appearances, but far more distinct than the first. These veins are of various sizes; some are curved in their direction; one, in particular, is forked, or divided into two branches, which run in very different directions through the micaceous schistus. A few hundred yards from the entrance of the Loch, the sea has formed an interesting section of the strata, which demonstrates, in a satisfactory manner, the relative position of the sandstone, limestone, and micaceous

caceous shistus. The micaceous shistus which forms the shore, is inclined at an angle of  $45^{\circ}$  and dips to the S. E.; the secondary strata, are inclined at an angle of  $45^{\circ}$ , but dip to the N. W. so that the two kinds of strata meet together, similar, as Hutton remarks, to the two sides of a lambda, or the roof of a house. The secondary strata are of red coloured argillaceous sandstone, (which sometimes appears passing into breccia :) which alternates with limestone. This limestone sometimes contains masses of hornstone, a fact, somewhat similar to the occurrence of flint in the chalk beds of England. Sauffure remarks that hornstone is confined to the secondary limestone, quartz being the sporadic matter which he has observed in primitive limestone. Many other veins may be observed traversing the micaceous shistus, before we arrive at the entrance of Loch Ranza, but any detailed account of these would be but a repetition of what has been already mentioned.

*GLEN-RANZA.* This glen is about two miles long, and half a mile broad, running nearly north and south, bounded on both sides by lofty round-backed mountains, that rise at a very considerable angle, and are nearly of the same height on both sides of the glen. The inclination of the opposite mountains is the same, and the strata run at the same angle.

The



*JUNCTION OF THE PRIMARY & SECONDARY STRATA NEAR LOCH RANSA*

A A Sand-Stone      B B Lime Stone Strata      C Micaceous Shistus  
 D Basaltic Vein



*R. Wall sculp*

*EAST SIDE OF GLEN ROSA*



The bottom of the glen is but little elevated, and nearly level; about one half is covered with a salt water loch, which adds greatly to the beauty of this romantic spot. The hills are composed of micaceous schistus, containing a greater or lesser proportion of quartz and mica; indurated chlorite is also dispersed through it, and towards the mouth of the loch there is a considerable stratum of ardesia, or primitive argillaceous schistus, bounded by the strata of micaceous schistus.

*GLEN-ES-NA-BIRACH.* From the top of Glen-Ranza, we enter, by a narrow passage, into a long deep glen, running nearly in the same direction, called Glen-es-na-birach, bounded on both sides, with mountains of compact micaceous schistus, which lie upon the granite. The granite and schistus are often intermixed at their junction, and sometimes small granite veins are to be observed issuing from the massive granite, and traversing the schistus. This latter appearance was considered by Dr Hutton, as a demonstration of the truth of his theory, with regard to the formation of granite. I will not now make any observations on this particular opinion, as I intend to consider it somewhat fully in a subsequent part of the work. As we advance further up the glen, the micaceous schistus disappears, when both sides are formed of granite, of the same kind with that of Goatfield. The bottom is also formed of granite, as is well demonstrated.

demonstrated by the stream, or burn, which has laid bare the rocks through the whole extent of the glen; it is indeed by rivulets of this kind that we are often enabled to have a distinct view of the mineral structure of highland countries. From the further extremity of this glen, is the ascent to Caime-na-caillich, which is in several places rugged and difficult, from the number of loose blocks of granite spreading all around. Upon ascending, we first stop at the edge of what is called the Garife-hodie: Here a wonderful and most tremendous scene presents itself to our view. An immense hollow, many hundred feet deep, dreadfully rugged and broken, almost entirely surrounded with mountains, whose serrated summits are covered with immense tumuli of granite, exhibits to us, in very legible characters, the vast operations of nature, in the formation and decomposition of our globe. What man, possessed of reason, contemplating this awful scene, could doubt of the existence of that BEING, whose power and wisdom are far beyond the reach of human comprehension? If such a man exist, vanity, not soundness of judgment, is the distinguishing feature of his character. Few, indeed, of those who deny, or even doubt the existence of Deity, have ever beheld, far less studied, the stupendous and awful works of nature. It is not, then, much to be wondered at, that the pride and arrogance, which so often characterise the closet philosopher, should find  
their



their way to mix with their daring and impious speculations ; which have for their end the propagation of the worst principles, the dissolving of all the bonds, and destroying the sweetest endearments of human society.

Upon the edge of the hollow, I observed several fragments of porphyry, but I could not discover any fixed rocks of it, owing to the blocks of granite scattered all over the sides of the mountains. In ascending from this, to Caime-na-callich, several other appearances of porphyry, and also fragments of basalt and pitchstone, presented themselves. After considerable fatigue I was so fortunate as to discover two veins of basalt, upon the side of Caime-na-caillich looking into the Garifehodie ; and, between these, there appeared a perpendicular vein of pitchstone, all running in the common granite. This pitchstone, is of a green colour, much resembling that from Brodick wood. It forms a vein, about two feet wide, and, what is remarkable, it is formed into two regular columns, from two to twelve inches diameter, and having from three to six irregular sides \*. I could not, however, discover the situation of

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the

\* It would be worthy the attention of future travellers to determine whether the basalt be not included in the same vein with the pitchstone, thus forming a stratified vein.

the porphyry, although it was scattered in some places of the mountains in considerable quantities. Having gained the summit of this great mountain, which is nearly of an equal height with Goatfield, I had a very grand view; yet not so extensive as that from Goatfield.

Its summit has a most singular appearance, owing to its being covered with enormous piles of quadrangular masses of granite, which rest upon each other in a most fantastic manner, and have much the appearance of artificial tumuli. Such appearances are by no means peculiar to Caime-nallich, for I have already remarked them upon the top of several of the granite mountains in the island. Here we can trace the granite in its various stages of decomposition, from the solid rock to the loose sand; in its beginning disintegration it splits into masses, having a greater or lesser tendency to the quadrangular form; but these masses have still a degree of connection amongst themselves, as is the case upon the mountain top. The next step is the enlargement of the fissures, by which the masses are loosened from their connection, and tumble down from their elevated situations, upon the summits of the neighbouring mountains, or are hurried with impetuous velocity down the mountain side, covering the bottom of the glens with these stupendous ruins.

Lastly

Lastly, these detached masses, by the action of the weather, are completely disintegrated, forming a loose sand, which is left upon the tops or sides of the mountains, or is carried in great quantities to the sea shore by the torrents \*. Sauffure, at sec-

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tion

\* Dr Hutton remarks, that the stony matter of this globe has been formed by the decay of a former world, whose debris has been collected by various means, at the bottom of a former ocean. This part of the Huttonian theory differs but little from that of Count Buffon, yet it is so material for the general support of the whole, that if it shall be disproved, the solidity of the theory in general will be much impaired. If we examine a few of the numerous facts on this subject, we shall find no proof of the debris being carried to the fathomless depths of the ocean; on the contrary, we will observe it disposed of in a very different way. Thus in some cases, the loose materials washed from the mountains, are observed filling up great hollows; and in other instances, rivers deposit their earthy matters, and form extensive plains, and not unoften the debris having reached the sea shore, is thrown back upon the same or other shores. The following facts are in proof of these remarks. The plains of Crau and Camarque, in lower Languedoc, were formed by depositions from the Rhone, and the plains of Lombardy from that of the river Po; the lands of Holland and the Delta of Egypt, seem also to be depositions of the debris, brought to the sea shore by great rivers. In Egypt, the gathering of debris is very great, as is well authenticated by historic evidence: thus, we are told, that the town of Damietta, in lower Egypt, about the year 1243, was upon the sea shore, but is now about twelve miles from it: and the town of Foc-ah which, three hundred years ago, was situated at the mouth of the Nile, is now seven miles distant. The country about the Baltic is also gradu-

ally

tion 604 of his *Voyages dans les Alpes*, remarks, that granite is disposed in strata, but that they are not always to be distinguished, particularly in the granite of low countries and plains. This he conceives to be owing to the granite of low hills containing a great quantity of *pierre de corne*.

This

ally incroaching upon the sea. Linnæus remarks that the sea ports of east and west Bothnia are every year decreasing, and becoming incapable of admitting vessels; the inhabitants of the ports are obliged to change their seats, and sometimes remove a quarter of a mile nearer the sea. On the eastern side of Gothland, near Hoburg, the increase of the continent for these last ninety years, is about two or three toises annually. The inhabitants of west Gothland remark that the sea decreases every ten years four or five lines perpendicularly, which, amounts, to forty or fifty lines in a century. According to this calculation, 600 years ago the sea was 25 inches deeper than it is at present. In Arran we have also a striking proof of the formation of land by the accumulation of debris. Innumerable other instances might be mentioned. But we will not cite more, but conclude this note with the following ingenious observations from Mr Kirwan's *Geological Essays*. "Mariners were accustomed, says he, for some centuries back, to discover their situation by the kind of earth or sand brought up by their sounding plummets; a method which would prove fallacious, if the surface of the bottom did not continue invariably the same. Fortis in his *Travels through Dalmatia*, p. 285, relates that urns thrown into the Adriatic upwards of 1400 years, so far from being covered by mud, were found in the same situation, as they could have been supposed to have been the first day of their fall; therefore, notwithstanding many particles of earth are, by rivers, conducted to the sea, yet none are conveyed to

any

This pierre de corne, he continues, contains a great proportion of argillaceous earth; and as most stones, which have this earth as a constituent part, and in considerable proportion, split into rhomboidal masses, so he concludes that it is the earth of the pierre de corne which is the cause of the splitting of granite, thus forming the numerous masses which prevent us from observing the strata. This explanation, however ingenious, does not hold true with regard to the granite of this island: no argillaceous stone of that kind enters into its composition, yet still it splits into very numerous rhomboidal masses.

*GLEN-HALIMIDEL.* Upon the east side of Glen-Ranza there is an opening leading to a glen, named Halimidel, which is about

any distance, but are either deposited at their mouths, or rejected by currents or by tides; and the reason is, because the tide of flood, is always more impetuous and forcible than the tide of ebb, the advancing waves being pressed forwards by the countless number behind them; whereas the retreating are pressed backward by a far smaller number, as must be evident to an attentive spectator; and hence it is, that all floating things cast into the sea, are at last thrown on shore, and not conveyed into the mid regions of the sea, as they should be, if the reciprocal undulations of the tides were equally powerful." Kirwan's Geological Essays, P. 440, 441.

about two miles long, running W. N. W. and E. S. E. but which soon changes its direction, running nearly in a line with Es-na-birach. It is narrow at the bottom, but widens upwards, owing to the inclination of the sides, which form an angle of about  $60^{\circ}$ ; and the bottom also rises, forming a considerable angle with the sides. It is composed of various species of micaceous schistus and quartz. In several places basalt veins may be observed traversing the micaceous schistus, many hundred feet above the level of the sea: even in the bottom of the glen, where the burn has exposed the micaceous schistus, we observe basalt veins crossing it. Upon the east side of the glen, several hundred feet above the level of the sea, there are two quarries, which were formerly worked for ardesia, but are now discontinued. The ardesia is of various colours; generally bluish or green, and is intermixed with white quartz; the fissures often contain crystals of actynolite, and a species of quartz penetrated with actynolite, forming a stone somewhat resembling prase.

A R R A N.

# A R R A N.

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## C H A P. VI.

*Description of the FOSSILS mentioned in the preceding Chapter.*

### LIMESTONE—*Cory.*

*Colour.* Grey.

*Lustre.* A very faint degree of lustre.

*Transparency.* None.

*Hardness.* Scrapes with a knife.

*Smell.* Emits a strong earthy smell.

*Fracture.* Even, fine, splintery, and very compact.

*Fusibility.* At 140° Wedgewood, no appearance of fusion.

Another species is also found at the Cory; of a dark-brown colour, minutely foliated, difficultly scraped with a knife, and wanting transparency.

LIME-

LIMESTONE—*near the Cock.*

*Colour.* Brick red.

*Lustre.* A slight degree of lustre from some dispersed foliæ.

*Transparency.* None.

*Hardness.* Pretty difficultly scraped with a knife.

*Fracture.* Generally foliated, passing to the compact earthy.

INDURATED LITHOMARGA?—*found loose on the shore between  
Brodict Bay and the Cory.*

*Colour.* Light blood-red.

*Lustre.* None.

*Transparency.* None.

*Hardness.* Yields to the knife with considerable difficulty;  
gives a pink streak.

*Fracture.* Even, bordering upon fine splintery.—Does not stain the finger; feels dry; does not acquire a polish by friction; after immersion in water for two days, no appearance of disintegration.

BASALT



BASALT—*from a vein near the Sanicks.*

*Colour.* Greyish green.

*Lustre.* None.

*Transparency.* None.

*Fragments.* Uneven earthy.

*Hardness.* Pretty easily scraped with the knife.

*Fusibility.* Melted at 58°.

BLIND - COAL.

*KOHLENBLENDE*, German. *NATIVE MINERAL CARBON*, Kirwan.

*Colour.* Black; when fresh broken, reflects a golden yellow, or violet colour.

*Lustre.* That of metals not much polished.

*Hardness.* Yields rather with difficulty to the knife.

*Fracture.* Plain foliated.

Is not coated with illinitions, as that from Kilkenny in Ireland. It does not stain the fingers.

Hardly burns until wholly ignited, when it consumes flow-

M

ly,

ly, with a light, lambent, blue flame, which continues for a short time. According to Mr. Kirwan's method, it contains, in the 100 parts, 93 of carbon and 7 of ashes.

Mr. Kirwan, in the second volume of his Mineralogy, remarks, that coals are not soluble in acids. I have observed, however, that the coal of Arran is rendered soluble in water, by means of the nitrous acid, the carbonaceous basis appearing to be converted into an oxyd.

This substance has been placed in various parts of the mineral system, as with black-lead, molybdæna, manganese, &c.; but the late correct analyses that have been made, show it is carbon nearly in a pure state. Mr. Kirwan, upon consideration of its great purity, places it at the head of the coals, with the name of Native Mineral Carbon.

#### A R D E S I A.

*ARGILLITE*, Kirwan. *PRIMITIVE ARGILLACEOUS SHISTUS*.

*DACHSCHIEFER*, Emmerling. *ARDESIA TEGULARIS*, Linn.

*Colour.* Greyish blue, or greyish green; sometimes both colours are intermixed in the same specimen.

*Lustre.*

*Lustre.* Silky.

*Transparency.* None.

*Fracture.* Streight, flaty.

*Fragments.* Tabular.

*Hardness.* Yields pretty easily to the knife.

*Streak.* Grey.

Does not adhere to the tongue; feels rather greasy, particularly the green-coloured; does not stain the fingers. There are often contained in the fissures, crystals of glassy actynolite.

#### MICACEOUS SHISTUS.

*LEPIDOTES*, Dr. Walker. *SHISTOSE MICA*, Kirwan. *GLIMMER*

*SCHIEFER*, Werner. *GNEISSUM MICACEUM*, Gmelin.

The few observations I have to make on this genus of rock should, in strict order, have been introduced in chapter second; but I wished previously to examine a greater number of specimens, so as to be better able to give a general idea of the whole.

It would be inconsistent with the brevity of this outline to

describe all the species of this rock: I shall therefore only mention it in general.

*MICA.* The mica, in general, is of a grey, or black colour; the scales very small, and indeed often hardly distinguishable.

*QUARTZ* Is of a white colour; is sometimes disposed in layers; and, in some specimens, has a granulated appearance.

*TALKERDE*, Werner; *TALCITE*, Mr. Kirwan; *LEPIS*, Dr. Walker. This substance occurs very frequently, indeed more so than the mica; yet, as I am not well acquainted with the names given to its admixture with other fossils, I still retain the term Mica for the whole, in speaking in general.

These three substances are often conjoined, forming a species of slate; in other examples we observe only quartz and mica conjoined, or quartz and talcite; and, lastly, felspar, indurated chlorite and hornblende add to its variety. In general, the rock which these substances make is very compact; and often they are so intimately combined, that it is difficult to determine whether it be mica, talcite or chlorite that is intermixed with the quartz. Frequently we see  
the

the quartz a-wanting, when the mica passes to the state of ardefia.

*USE, &c.* Several kinds of this rock, particularly the quartz, have been used for the building of ovens and furnaces, on account of their great infusibility. No rock is more favourable for metallic veins; indeed, many of the richest mining countries are formed of it: we may instance the vast mines of Sweden, which are almost entirely situated in micaceous schistus.

A R R A N.

# A R R A N.

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## C H A P. VII.

*Glen-Catacol, Glen-Ersay, Glen-Clachan, Shiskin, Tory-Lin, Benin-Head, Whiting Bay, Lamlasth Bay, Lamlasth Island.*

HAVING glanced over the glens and strata in the neighbourhood of Loch-Ranza, I will now proceed around the island by Glen-Catacol, which is about a mile and a half from Ranza. The shores in this direction are bounded by cliffs, which are neither very high nor rugged, but beautifully adorned with low shrubs, giving a richness of appearance seldom observed upon the shores of this island. The cliffs and mountains in the vicinity are formed of micaceous schistus, of various degrees of hardness, owing to its being more or less intermixed with quartz. They are separated from the sea by low beaches, of considerable extent, which, in some places, are cultivated. The entrance to the glen is bounded by lofty, precipitous mountains

tains of micaceous shistus; but this soon disappears, as the glen changes its direction, running N. N. E. and S. S. W.: then the mountains are formed of granite similar to that of Goatfield. In several places of the glen fragments of basalt occur; demonstrating the presence of veins traversing the granite, as we have already observed upon Caime-na-callich and Glenrosa. Upon one side of the glen we observed a narrow valley, into which we entered, but found that the granite was still the prevailing rock. At one place, indeed, I discovered great masses of porphyry; but I could not detect them *in situ*. It is probable, however, that it forms veins running in the granite, as the quantity of debris is too small for supposing the existence of strata. After a very fatiguing walk, I reached the top of the glen, when I observed a considerable plain, in which is situated a lake, about a mile long and half a mile broad, which is named Loch-Tan. It is bounded upon two sides by lofty granite mountains; but is open towards the others; one leading to Glen-Erfay, the other to Catacol. The margin of this partakes much of the sterility of the surrounding scenery: vegetation hardly shews its head: a few lichens and tufts of heather are the only ornaments of which it can boast:

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A joyless coast.

Around a stormy lake.

Yet

Yet here the grandeur and sublimity of the surrounding granite mountains, enveloped in clouds and mist, excited in my mind a vast variety of ideas; for,

Surely there is a hidden power that reigns  
'Mid the lone majesty of untam'd nature,  
Controlling sober reason.

Upon ascending the granite mountains on the east side of the loch, I observed considerable quantities of the debris of basalt upon the top of the mountains, showing that the veins had reached to the very summit\*.

I walked onward to Glen-Erfay, and, in my way, observed large blocks of a beautiful dark leek-green coloured pitchstone-porphry, remarkable not only for the number, but also for the size and beauty, of the crystals of felspar. I was not so fortunate as to find it forming a fixed rock in the neighbouring granite mountains; yet it is probable that future observers may discover it in veins, similar to that observed on the side of  
Caime-

\* Sauffure observed fragments of greenstone upon the summit of Mont Blanc; very probably originating from a vein of greenstone which reached to the summit of this great mountain. *Voyages dans les Alpes*, tom. 7me, p. 280—288.



Caime-na-callich. Some mineralogists will rather be inclined to suspect that it alternates with granite: as this is said to be the disposition which it affects when among the granite mountains of other countries. According to Charpentier †, who made this observation, porphyry containing pitchstone alternates with granite near Meissen in Saxony. Dr. Mitchell, who was lately on the particular spot described by Charpentier, informs me, that he could not observe any such alternation, and therefore presumes that the observation of Charpentier is erroneous. Having reached the side of Glen-Erfay, I observed it taking its rise from the lower part of Caime-na-callich and the neighbouring mountains, and running, in an irregular course, towards the sea. It is said to be nine miles long, and is reckoned the most extensive glen in the island. Its sides and bottom are formed of granite, which continues until we come within a mile of the lower extremity of Loch-Erfay, when strata of micaceous and talcaceous schistus make their appearance. These strata continue to the entrance of the glen on the sea-shore; and here they are covered and succeeded by red argillaceous sandstone and sandstone breccia.

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† Charpentier Mineralogische von Churfachsen, § 63.

As I had an opportunity, upon my former visit to this island, of walking along the shore from Catacol to the entrance of Glen-Erfay, I will now shortly mention the nature of the rocks that occur in this tract, and then continue the description onwards to the other parts of the island.

From Catacol to Whitefarland, a farm belonging to Fullerton of Kilmichael, the cliffs are low, composed of micaceous schistus, but defended from the action of the sea by intervening sea-banks similar to those noticed between Catacol and Loch-Ranza. Near to the farm of North Tundergay, I observed a remarkable vein of basalt penetrating the micaceous schistus. The micaceous schistus is much waved; but, as it approaches the side of the vein, it loses its shining glimmery appearance, breaks into thick plates, and, where in immediate contact with the basalt, it forms a compact kind of ardesia. The vein, as it rises from the sea, is fairly crossed by a species of micaceous schistus approaching to breccia; and here also the basalt and micaceous schistus are much jumbled together, and some pieces of the vein are apparently insulated in the micaceous schistus. Here, then, we have two facts; the former, the apparent transition from micaceous schistus to ardesia; the other, masses of basalt immersed in the micaceous schistus, in a similar manner to the basalt I observed embedded in the granite upon the east side of Glen-Rofa. At Whitefarland there is a considerable extent of  
natural

natural wood, which adds greatly to the beauty of its appearance, which is much heightened by the lofty granite mountains that bound it on one hand, with the sea and long-extended isthmus of Cantyre on the other. From this to Imachar the same micaceous strata continue, forming beautiful cliffs and considerable sea-beaches. At Imachar the micaceous schistus is undulated, and traversed with quartz, so as to give the whole a kind of maculated aspect; and it continues to form cliffs until we come to the stream which issues from the entrance of Glen-Irfa. Upon one side of this stream I observed primitive schistus, but upon the opposite side sandstone cliffs make their appearance. These cliffs have a considerable beach interposed between them and the sea; and the strata of sandstone and sandstone breccia are elevated at a greater angle than any I have observed in the other parts of the island. The retreat of the sea from these cliffs is not only marked by the considerable beach we have just mentioned, but also by the caves which are dispersed in them. These cliffs soon disappear, when porphyry is to be observed; but we can only trace it a little way, the covering of grass preventing any further examination. The country is now low and flat, so that we have an easy walk to the house of the Shifkin; and the only rock I noticed was the red argillaceous sandstone, which I observed in the bottom of several burns: thus intimating that the whole strata over which I had

passed, after leaving the porphyry, was sandstone. At the Shiskin the land is low and flat. The mountains in the neighbourhood have a different appearance from those about Loch-Ranza; are lower; their sides less precipitous; in short, have much of the general aspect of those about Glencloy, all announcing a change in their composition. We have a good opportunity of determining the truth of this conjecture, in the Clachen glen, which is but a short distance from the Shiskin. The sandstone strata, which we have just mentioned as forming the low country around the Shiskin, stretches up the glen for a considerable way. At one place, on the south side, I observed a considerable stratum of limestone, which is covered, and even, in some places, intermixed, with sandstone breccia; and, nearer the upper extremity of the glen, shistose clay, richly impregnated with iron, makes its appearance. As we proceed upwards the glen becomes very deep; and, upon the north side, considerable rocks of clay-porphry occur, apparently covering the sandstone, as I conjectured may be the case at Glencloy and Corygills. As we approach still nearer to the upper extremity of the glen the sandstone disappears, when a sienite, similar to that at the head of Glencloy, is to be observed, and, so far as I could determine, rises to the summit of the neighbouring hills.

About

About two miles N. W. from the Shiſkin, after paſſing through a mooriſh flat, we come to Tormore, which is the promontory of this plain. Here are cliffs of conſiderable extent, which contain a range of extenſive caves, celebrated by tradition as the reſting place of Fingal, the father of our great Oſſian, who, it is ſaid, uſed to retire here after the fatigues of the chace. In the farther extremity of the greateſt, or what is called the King's Cove, are a few ſcratches, made by idle fiſhermen or ſmugglers, which, by ſome, have been referred to the Fingalian age.

As the appearances at this promontory are very intereſting, I ſhall make the deſcription as diſtinſt as poſſible; and, to be regular, I ſhall begin at the north-eaſt end, or Machry Bay, and ſo on to Drumoodon point. The bay is of conſiderable extent; and the ſhore, all around to Irſa, is formed of ſandſtone. The bottom of the bay is a low ſandy beach; but, towards Tormore, it riſes, forming cliffs, which are continued all around to Rue-varey, or the columnar promontory, for the ſpace of about a mile and a half: and theſe cliffs are from forty to one hundred feet high. Between the cliffs and the ſea there is a conſiderable ſandſtone beach, which is remarkable for the great variety and the number of veins that traverſe it, in different directions: theſe, at firſt ſight, appear confuſed; but

a little

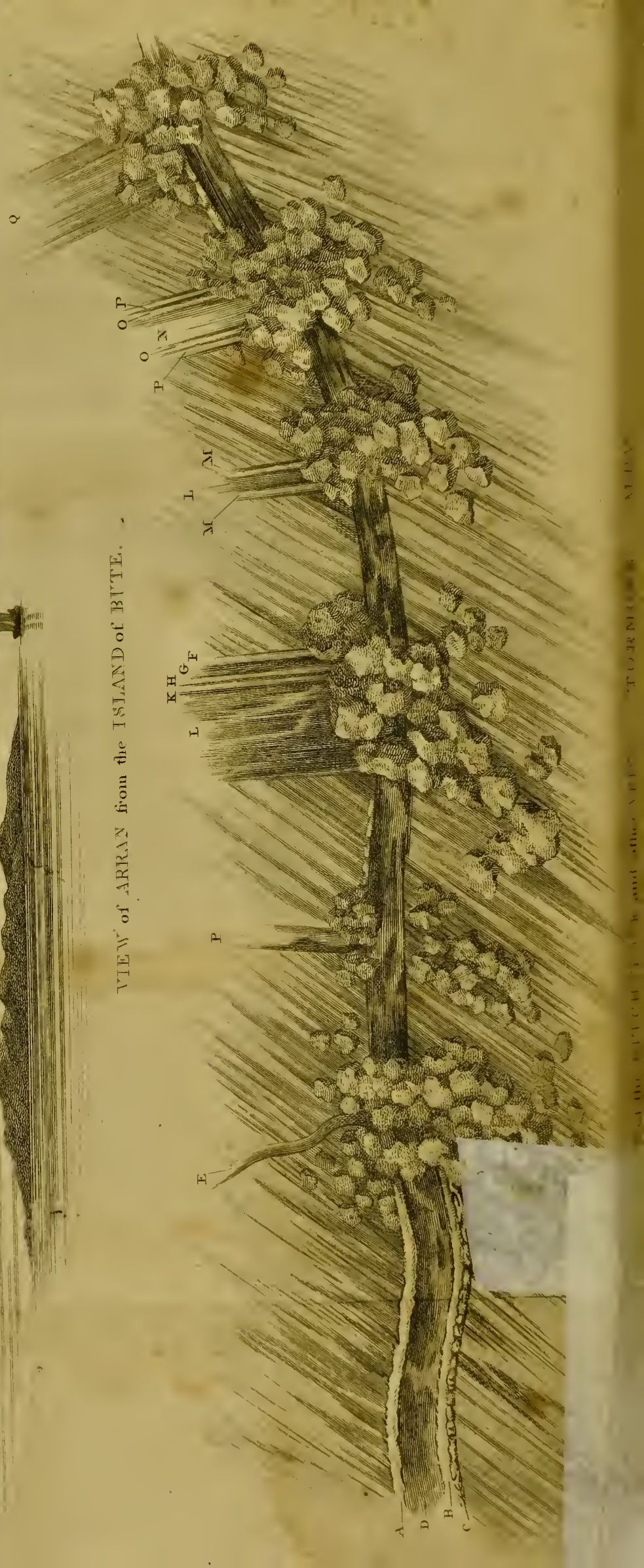
a little attention soon discovers a beautiful and distinct display of a most curious disposition of rock. As the pitchstone veins are the principal objects of curiosity, I will describe these first; and, to make the detail accord with the engraved plan, I will begin from the extremity of the great pitchstone vein as it rises from the sea, and so trace it back to near Machry Bay.

The great vein of green-coloured pitchstone, D, as it rises from the sea, is several feet wide, has a considerable inclination to the horizon, is slightly bent in its course, and traverses the common red-coloured argillaceous sandstone. It has, for some yards, the character of a *stratified vein*; that is, it contains layers or stratulæ of different substances deposited in the same fissure along with the pitchstone. Upon the side of the vein next the sea, there is a layer, A, of a substance which appears inclined at an angle of  $60^{\circ}$ , dips in the same direction with the pitchstone D, and has a similar curve. It is not unlike a compact sandstone; but it is probably of the same nature with B on the opposite side of the vein, only more altered by the action of the weather and the sea. Upon the opposite side of the pitchstone, we observe a layer, B, which appears to be of the nature of hornstone, or, rather, verging to quartz: it has a similar curve and dip with the pitchstone. Immediately beside it  
there





VIEW of ARRAN from the ISLAND of BUTTE.



TO BE PRINTED BY AND SOLD AT THE SIGN OF THE TOWER, IN ST. MARTIN'S LANE, AT THE SIGN OF THE TOWER, IN ST. MARTIN'S LANE, AT THE SIGN OF THE TOWER, IN ST. MARTIN'S LANE.



there is a thin layer of basalt, C, which is decomposing in balls; and this, again, is bounded by the common argillaceous sandstone strata. The vein continues thus stratified for about twenty yards, when the layers, A, B, C, appear to come nearly horizontal, and soon they entirely disappear under the debris. Further on, where the pitchstone is almost free from the covering of debris, it appears to be bounded on both sides by the common argillaceous sandstone; yet this is doubtful, as there may be small portions of the other stratulæ, which the debris prevents us from observing.

At a little distance from where the sandstone appears to form the side of the great vein D, we observe E, which is a vein of rock similar to that of B, is from six to eight inches wide, and is waved in its course. At some distance from this, there is a vein of basalt, P, about five feet wide, running nearly E. and W. which is much the same direction with the last mentioned vein. The next vein which we meet with is about thirty feet wide; runs N. W. and N. and N. E. and E. which is nearly in an opposite direction to the great vein. Upon one side, there is a layer, F, of a wax-coloured substance, intermediate between hornstone and pitchstone; next, is a layer, G, of high olive-green coloured pitchstone, about two feet wide; again, we have a layer, H, about half a foot wide, of the same pitchstone-hornstone,

hornstone as F; then, a layer of indurated clay, K; and, after this, the whole vein is formed of basalt, L. The sandstone which bounds this vein, in place of being red, the usual colour, is partly a yellowish-white colour. I endeavoured to discover its junction with the great vein D, but without success, owing to the great covering of debris: I observed it, however, upon the opposite side of D, but at a distance, entering into the neighbouring sandstone cliffs. At a little distance from this, we meet with another remarkable vein: the sides, M, M, are of basalt\*; but the middle, L, is of breccia †. Still nearer to Machry Bay, another curious vein is to be seen: it is about eight feet wide; the sides, P, P, are of fine white-coloured argillaceous sandstone ‡; next, are two layers, O, O, of basalt ||, which

\* This basalt does not differ from that from the south side of Glencloy, described at page 53.

† This breccia is formed of variously-shaped masses of common and arenaceous quartz, and indurated clay, connected by a basis which is only an agglutination of smaller particles of the same kind.

‡ This sandstone only differs from the stratified kind by its having a white colour.

|| This basalt has a black colour; and has, dispersed through it, crystals of hornblende, calcareous spar, and iron pyrites: this last, by decomposition, often gives the whole a brown colour.

which decomposes in balls; and the middle, N, is formed of a rock which has crystals of felspar and rounded pieces of quartz, immersed in a basis that seems one of the gradations from pitchstone to hornstone. The last vein, Q, which I observed running, in a cross direction, to the great vein of pitchstone D, is about ten feet wide, and entirely composed of green-coloured pitchstone.

The great vein continues visible for a little way after passing the vein Q, and is nearly of the same diameter; but, as we approach very near to Machry Bay, it is not to be further traced, on account of the covering of debris. Near to its termination, however, I observed the hornstone pitchstone substance forming a layer upon one side, and even, in some places, intermixed with it.

I have to regret that this interesting piece of mineralogy is so imperfectly detailed; yet I trust it will serve to excite others, better qualified, to give it a more particular examination. I would particularly recommend an attention to the appearances presented by the junction and crossing of the veins; which I had not an opportunity of exploring, on account of the great covering of debris: a hindrance which some future action of the sea may remove.

The next object which claims our notice, is, the determination of the relative position of the sandstone and porphyry. The cliffs, besides the sandstone, of which they are principally composed, are, in some places, varied by a clay-porphry, very similar to that of Glencloy; with this difference, that the crystals, felspar and quartz are larger. The porphyry, so far as I could determine, does not seem to lie on the sandstone, but merely to skirt it. Several basalt veins are to be observed traversing it, in different directions. One vein, about seven feet wide, runs through it in a perpendicular direction, and gradually narrowing towards the top of the cliffs, when it is lost among the sandstone that lies behind. Another runs more in a horizontal direction, and between the sandstone and clay-porphry. Another vein, which is nearer to Machry Bay than the other two, is to be observed running with porphyry on the one side, and sandstone on the other: it soon divides; one branch penetrating the porphyry, the other running between the sandstone and porphyry.

To the W. of the King's Cove, I observed great masses of green-coloured pitchstone scattered upon the shore; but I could not discover whether they belonged to the great vein D on the other side of the cove, or had been separated from other veins or strata. Upon the top of the cliffs, at the same place, I observed

ferred a variegated pitchstone, which was decomposed, in some specimens, almost to a brownish-white earthy powder, cropping through the grafs; but I could not discover whether it formed a vein or stratum.

From this to within a short distance of the columnar promontory of Drumoodon, the cliffs are of sandstone; but, in some places, they appear covered with a porphyry: of this, however, I cannot say any thing satisfactory. I observed many basaltic veins traversing this sandstone; and, upon examining the connection of the veins and strata, I found the basalt and sandstone, at their junction, in several places, intermixed; and also the basaltic veins, besides the angle they form with the horizon, had a considerable inclination of themselves.

At a little distance from the columnar promontory, I observed low, shelving rocks of clay-porphry, which extend beyond the point Rue-Varey on the one hand, and seem to be connected with the porphyry on the other. The promontory is a striking object; is pretty high; and composed of red-coloured argillaceous sandstone, which is covered by irregular columns of a porphyry which, in some places, has much resemblance to basalt-porphry, in others is evidently clay-porphry. This fact is a presumptive proof that the conjecture I have

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made,

made, with regard to the situation of the porphyry of Glen-cloy and Corygills, may be true.

Having passed Rue-Varey, which is the most western point of Arran, we came to the farm of Drumoodon, which is situated upon the sea-shore, with a considerable sandy beach before it, and, behind, the sandstone cliffs are still continued. Here we find, resting upon the sandstone, a curious species of rock, having a tendency to split into columns; but of which I cannot give a determinate opinion, as I do not find any description, in the mineralogical works I have consulted, that corresponds with it. I have marked it, in the short description that is detailed in the following chapter, as intermediate between basalt and sandstone. These cliffs become gradually lower, and at length disappear, being succeeded by an extensive beach covered with fragments of the neighbouring rocks. After passing this beach, which forms one side of the plain of the Shislin, considerable cliffs now rise before us, which are formed of clay-porphry of considerable height, but much split by the action of the weather, which gives an indistinct idea of stratification, similar to the granite observed in the Cory-Dain, at the head of Glen-Rosa. These cliffs contain several caves, but none of them are of any considerable size; and the shore is covered with great masses,

masses, which have been separated from the cliffs by the action of the sea and weather. These masses have a peculiarity of form, which characterises the rock from which they have been separated. This remark may appear fanciful; but several circumstances lead me to imagine, that one accustomed to observe with attention the debris upon the sea-coasts, &c. may often guess as to the peculiar nature of the rocks themselves, by observing the shape of the fragments. The whole shore, to Tory-Lin, appears to be composed of clay-porphry, and in some places sandstone is to be observed, and both are traversed with veins of basalt. I picked up fragments of dark leek-green-coloured pitchstone, in different places, among the debris of the neighbouring rocks; but had not leisure to determine its situation. From the Shiikin to Tory-Lin, there is a tolerable road; which is a rarity in this island, and extremely agreeable to the traveller, after having scrambled around the shore from Brodick Bay. The land now becomes lower, and has more of the rural appearance of the Lowlands of Scotland: agriculture is followed with some spirit, and even many of the sea-beaches are cultivated.

Tory-lin consists of a few houses, pleasantly situated in a hollow, at a little distance from the sea shore, and surrounded  
with

with sandstone hills. In the burn which runs by the houses, I observed veins of basalt traversing the sandstone in different directions, and amongst the boulder stones which cover its bottom, fragments of a light blackish green-coloured pitchstone presented themselves, showing the existence of veins or strata of that fossil in the neighbourhood. Upon the shore a curious species of porphyry, (different from wacken-porphry,) makes its appearance, and seems to be traversed with veins of common basalt, which are here of very great size.

On my second visit to Arran, I walked a-cross from Tory-Lin to Lamash harbour, which gave me an opportunity of observing a part of the islands, with which I was before unacquainted. I will therefore shortly mention what occurred in that route; before proceeding to mention the very few observations I made on the southern part of the island. After leaving Tory-Lin, we ascend for some time over the usual red-coloured argillaceous sandstone, it at length disappears, and the higher grounds are formed of porphyry. This porphyry continues until we come to the farm of Achariach, when red-coloured argillaceous sandstone is to be observed in the bottom of a burn, and is apparently traversed by a vein of white-coloured sandstone. As we proceed onwards, we ascend some high grounds, where the porphyry again appears, and it now  
continues



continues all the way to the hills upon the side of Lamlaſh bay. Theſe hills are compoſed of white-coloured ſandſtone at the top, but lower down of common red-coloured ſandſtone.

The ſhore from Tory-Lin to the Benin-Head, the moſt ſouth-ern part of the iſland, is principally compoſed of ſandſtone, tra-versed with veins of baſalt, which are ſometimes of great ſize, and run in a great variety of directions. The hills back from the ſhore appear to be entirely compoſed of porphyry\*, but are not of any great height. The whole country to the Benin-head is conſiderably cultivated, and is here and there diverſified with ſmall villages, which give to the whole a pic-tureſque feature, which we have ſeldom an opportunity of ob-ſerving in this iſland. At the Benin-head, the cliffs are of conſiderable height, and are compoſed of ſandſtone, porphyry, and baſalt. The porphyry and baſalt have a tendency to the columnar form, and both are tra-versed by baſalt veins, which are often of a great ſize.

From this to Whiting Bay, the cliffs are low, formed of ſandſtone, and tra-versed with baſalt veins, which run in a  
great

\* I find in my notes, that ſienite is marked as one of the rocks of this part of the country. I am now ſomewhat doubtful of that fact, and will therefore leave it as an object for future enquiry.

great variety of directions. The hills, however, up from the shore, now change their appearance, presenting broad, bare, perpendicular faces, similar to those which occur in all basaltic countries; and upon examination, we find them to be composed of various species of basalt,\* lying upon a red-coloured sandstone, which is intermixed with grunerde, and a grey shistose clay. This basalt is often columnar, and the perpendicular crags, being scattered in various directions, and often rising in groupes above each other, have a pleasing effect. Near to Whiting bay, there are considerable rocks of greenstone of nearly the same species with that found near Corygills; it is not in any considerable quantity, and appears to be the rarest rock in the island.

At Whiting bay, the cliffs disappear, and are not to be observed until we come to the entrance of Lamash bay; in their place we have an extensive beach, bounded by gradually rising sandstone hills, much traversed with basaltic veins. When the tide ebbs, the bottom of the bay exhibits a most astonishing collection of basaltic veins, which have been laid bare

\* Stucke, a German chemist, on breaking a certain cellular basalt, found the cells to contain water. He analysed 20 ounces of this water, and found it to contain fourteen and a half grains of filix. *Stucke Untersuch.* 119. *Kirwan, Geological Essays*, p. 118.

bare by the action of the sea; here they are to be seen running in every direction, meeting and crossing each other in a most curious manner; in short, this is one of the best parts of the island for observing the various crossings, &c. of these singular appearances\*. At the entrance of the bay of Lamlash, the sandstone forms considerable cliffs, which continue a short way of considerable height, but are gradually lower as we approach the village of Lamlash, where there is an extensive flat beach. These cliffs are also traversed with veins of basalt, and in some places a few hundred yards from the shore, I observed many detached masses of green pitchstone, indicating its existence in the neighbourhood.

Lamlash bay, which is the best harbour in the island, and one of the best in the Firth of Clyde, is of a semi-circular shape, and is formed in part by Holy island or the island of Lamlash, which lies across it, leaving two entrances, one from the north, the other from the south, which last is always preferred

P

ferred

\* It will be somewhat difficult to explain the appearance of so many veins in so small a space of ground as Whiting bay, according to the Wernerian Theory. For surely had all these been at one time open fissures, the sandstone would not at the same time have supported itself. Saussure, imagines, that this objection may be removed, by supposing, that these fissures were formed successively.

ferred by mariners. It is bounded upon the Arran side by hills of red and white sandstone, traversed by basaltic veins. Upon the east side of the bay, attempts have been made to discover coal, but without success.

Lamlash or Holy island, is about three miles long, and half a mile broad, precipitous on the east, also considerably abrupt on the west side, but the north and south ends are low. It is composed of red-coloured sandstone, which is in some places formed into small caves; one is celebrated for being the residence of the holy disciple of St. Columba, St. Mool-jos, or the servant of Jesus. This sandstone is covered in many places with a species of basalt, very similar to that near Whiting bay, and with difficulty distinguishable from sandstone. I have been very much at a loss with regard to the particular denomination to be given to this rock; and I must still remain in doubt †. It forms in many places regular columns, generally six-sided, which rise range above range, giving a faint idea of the stupendous scenery of Staffa or Boshella.

† Saussure mentions a basalt much resembling sandstone, having a prismatic rhomboidal form, and containing hornblende crystals. *Observations sur les Collines du Brisgau—Journal de Physique, An Deuxieme, p. 329.*—Nay, even sandstone has been found columnar: thus the columnar boulders, found in Iceland, is a sandstone.—Eggert Oiafsen *Reise durch Iceland.*

la. Upon the west side, the columns are of greater size than upon the east, and the same matter appears to form the summit of the island, which is reckoned about seven hundred feet high. Upon the south-east part of the island, I observed a rock principally formed of crystals of hornblende, which is in some places traversed by basalt veins\*, and also stratified with the common sandstone; and towards the south-west extremity, basalt veins are seen traversing the sandstone.

P 2

A R R A N.

\* This basalt has a very great specific gravity, owing to its being abundant in iron.

A R R A N.

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C H A P. VIII.

*Description of the Fossils, occurring in the preceding Chapter.*

PITCHSTONE—*From Tormore.*

THE following series of fossils affords us a curious example of the gradations, which we often observe between the different kinds of rock. These gradations were either overlooked, or but vaguely understood, until the time of Werner, who by the beautiful discovery he made in thus tracing the steps of nature, attracted the attention of mineralogists. An eminent mineralogist of our own country, has made great progress in this interesting enquiry, and it is to be hoped, he will soon gratify us with the result of his labours.

## No. I.

PITCHSTONE—*from the great vein D.*

*Colour.* Brownish.

*Lustre.* Little glancing, and greasy.

*Transparency.* None.

*Fracture.* Uneven, approaching the splintery.

*Hardness.* Gives a few sparks with steel.

Quartz, and a reddish substance like garnet is dispersed through it.

## No II.

PITCHSTONE *passing to Hornstone.*

*Colour.* Light wax yellow, yellowish green, weak reddish brown.

*Lustre.* None.

*Transparency.* None.

*Fracture.* Even, splintery, sometimes uneven.

*Hardness.* Hardly touched by the knife.

*Smell.* Gives a strong earthy smell when breathed on.

*Fusibility.* At 55° was covered with a slight enamel; at 69°  
became

became white, slightly softened, and was then somewhat porous. A fragment from a six-sided column softened at  $81^{\circ}$ , and at  $118^{\circ}$  a compact brown vitreous mass was formed, which had interspersed white grains.

By decomposition it acquires a white, and in some varieties a brick-red colour. It has dispersed through it crystallised and amorphous quartz, chalcedony, a very few crystals of white felspar, calcareous spar, and also minute dark leek-green-coloured crystals, probably pitchstone.

### N<sup>o</sup> III.

*Fossil which appears pretty nearly of the nature of Hornstone, or rather verging a little to Quartz—from the stratulum B.*

*Colour.* Pale blackish brown; or, dark grey, approaching to black.

*Lustre.* Very little glancing.

*Transparency.* A very slight degree at the edges.

*Fracture.* More or less fine splintery, and very compact.

*Hardness.* Gives fire plentifully with steel.

Pieces of quartz are dispersed through it, as in the former; and a few crystals of felspar now and then occur.



N<sup>o</sup> IV.

*Fossil still more nearly approaching to Quartz, which is intermixed with the green pitchstone of the great vein D.*

This species of rock differs little in colour from the preceding; but has more lustre and transparency, and is a little harder. It acquires a white crust by the action of the weather. It has also, interspersed, crystals of quartz.

## O B S E R V A T I O N S.

These different gradations are all to be observed in the same vein, and appear to graduate or pass into each other. Thus, the first, or brownish-coloured pitchstone, by its little lustre, seems verging to the second; and, in reality, we often observe, in the same specimens, the one passing into the other. The pitchstone-hornstone substance, N<sup>o</sup> II. as its name implies, has partly the character of the pitchstone, and partly that of hornstone. The degree of fusibility intimates that it is sensibly different from the pitchstone, yet not sufficiently refractory for hornstone. Klaproth found a substance of this kind fusible; and Mr. Kirwan mentions a greenish-white hornstone, from Lorraine, which, from its being fusible, seems analagous to this.

We

We are sometimes so lucky as to find specimens where the second passes into the third; and often we observe the third passing to the fourth.

These four kinds of rock, then, present to us a complete gradation from pitchstone to hornstone; and we have a few steps towards quartz. In other countries, we have accounts of nearly similar appearances; and these I may shortly mention, as they will add fresh interest to the detail we have now given. Reufs informs us, that he observed pitchstone passing, by various stages, to hornstone, at Garfeback, near Meiffen\*. Esthner remarks, that the Saxon pitchstone passes sometimes to hornstone †. and Mr. Kirwan, in his Elements of Mineralogy, observes that it passes to hornstone.

CLAY PORPHYRY, *when passing to hornstone—Tormore.*

*Colour.* Greyish.

*Lustre.* None.

*Tran-*

\* Sammlung Naturhistorischer Aufsätze, &c. von Franz. Ambros Reufs, § 362.

† Esthner, Mineralogie, B. ii. § 445.

*Transparency.* A little at the edges.

*Fracture.* Even, passing to the fine splintery.

*Hardness.* Gives a few sparks with steel.

It contains, immersed in the basis, crystals of common red felspar, and white felspar approaching adularia. The crystals are of considerable size; and this is one of the principal distinctions between this species and some of those found in Glencloy. It decomposes, in the form of a brick-red crust, similar to some of the stones which are intermediate between pitchstone and hornstone.

In other specimens, the porphyry, as it comes in contact with the veins of basalt, has a base considerably resembling it; and at the columnar promontory of Drumodooon, the specimens often cannot be distinguished from what is called trap-porphry.

*A substance intermediate between sandstone and wacken, having a tendency to the columnar form—Farm of Drumoodon.*

*Colour.* Yellowish.

*Lustre.* None.

Q

Tran-

*Transparency.* None.—It feels much like a sandstone.

*Fracture.* Even earthy, with the appearance of rounded concretions.

*Hardness.* Gives a few sparks with steel: but it contains confused fragments of quartz, which may have been the cause of this.—Emits a strong earthy smell, when breathed upon\*.

*Fusibility.* Melted at 79°.

#### OBSER-

\* Lampadius has discovered that hornblende contains charcoal diffused thro' it; and Mr. Kirwan has shown that some species of pitchstone contain it. It is conjectured that it may exist in other fossils, and cause the peculiar earthy smell which we perceive by breathing upon them.

# OBSERVATIONS TO BE MADE,

FOR THE FARTHER ELUCIDATION OF THE

## MINERALOGICAL HISTORY OF ARRAN.

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### VEINS.

I. **T**O examine the basalt, wacken, and pitchstone veins, (which occur in so many parts of the island,) with a view to discover if they be *stratified*. We should describe accurately the disposition of the stratulæ of such veins, as it will enable us to determine their relative antiquity: thus, according to Werner, the parts nearest the sides of a vein are the most antient, those in the middle the most modern, and the intermediate of a middle age.

II. In the examination of veins, it will be of consequence to observe how they cross each other; which, Mr.

Werner remarks, will enable us to determine their relative antiquity: thus, if two veins cross each other, the most modern is that which crosses the other; and, of two veins, the one which interrupts or stops the other is the most antient.

III. To examine carefully the country in the vicinity of veins, so as to determine if there be any beds of a matter similar to that which fills the veins. It follows, from Mr. Werner's theory, that we should generally observe such appearances.

IV. To examine if the sides of the veins be more or less hard; where in contact with the granite, micaceous schistus, porphyry, sienite, or sandstone.

V. To examine the basalt, and other veins, with a view to observe whether they contain petrifications, or even wood unaltered; also, if they contain boulder stones.

STRATA.

## S T R A T A.

VI. To determine the direction and inclination of all the strata throughout the island; so as to know whether they have much the same general arrangement, and if they are frequently situated in a similar manner with the strata at the mouth of Loch-Ranza.

VII. To examine particularly the strata of sienite; so as to discover its connection with the granite, porphyry and micaceous schistus.

VIII. In examining the great glens, as Glen-Rofa, Sannicks, &c. it will be of consequence to examine very particularly as to the disposition of the granite in strata; thus either to confirm or refute the observations on the stratification of the granite.

IX. To discover whether the porphyry, which is observed among the granite mountains, be disposed in veins or strata.

X. To

X. To endeavour to discover the situation of the hornblende and paliopetre which is observed in blocks at the entrance of Glen-Rofa.

XI. In traversing the hills of micaceous schistus, to be careful in observing if any rocks of trap formation occur in *strata*.

XII. To determine the position of the breccia, with regard to the other rocks, at the head of Glencloy; and also, to examine, more particularly, the extent and position of the breccia of South Glen-Sanicks.

XIII. To examine very particularly the appearance of the granite, at its junction with the micaceous schistus and ardesia, in different parts of the island. In this investigation it will be necessary to observe, 1. If the schistus, where in immediate contact with the granite, be not harder than it is at a distance. 2. If veins of granite are to be observed stretching from the granite, and traversing the schistus. 3. If the granite veins have the same grain with that of the granite of the neighbouring mountains. 4. If the granite and schistus be irregularly intermixed at their junction. 5. If the granite and schistus ever  
alternate



alternate with each other. This Werner considers as a rare appearance. I have not observed it in Arran. 6. If the micaceous schistus, where it covers the granite, can be observed gradually changing its character, and at last, where in junction with the granite, not distinguishable from it: a fact which has been observed in other countries, and demonstrative of the granite and schistus being formed nearly at the same time.

**BUTE.**

*B U T E.*

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C H A P. IX.

*Outline of the MINERALOGY of the Island of BUTE; with Observations upon the Formation of the Bed of the CLYDE, and an Account of the Route from BUTE to the Island of JURA.*

**T**HIS island is about eighteen miles long; and the broadest part, extending from east to west, is five miles. It is seven miles distant from the island of Arran; but is separated from the district of Cowal by a channel which is only about half a mile broad, and, in some places, sixteen fathoms deep. Towards the north end it rises into hills of considerable height; but these are neither sufficiently high nor extensive to afford scenes so sublime as those which characterise the mountains of Arran. The southern part of the island is, in general, (excepting at its most southern extremity,) low, well cultivated, and, in several places, beautifully ornamented with wood, particularly

ticularly near to Mount-Stewart, the charming seat of the Marquis of Bute. Although this island be destitute of fine mountainous scenery; yet, the extensive cultivation, and the general appearance of bustle and life, form a striking contrast to the lone wastes of the island of Arran.

Rothesay, the only town in the island, is pleasantly situated upon the shore of a considerable bay of the same name. It is principally supported by the herring fishery, and a very considerable cotton manufactory.

The island seems to be traversed by three irregular vallies, which run from east to west. One crosses the island at the town of Rothesay; the second at Kaimes Castle, in the north; and the other at Cil-Chattan, in the southern part of the island.

The mineralogy of this island, so far as I examined it, does not appear to be particularly interesting: but a closer investigation may discover many things which escaped my notice; as I examined it in very unfavourable weather, and, besides, had the misfortune to lose the specimens I had collected.

The whole of the island to the north of Rothesay is composed of primitive rock, which rises into considerable hills about Kaimes Castle, the seat of Lord Bannatyne. This half of the island is pretty nearly surrounded by the neighbouring land of Cowal, so that the sea can have little power over its shores, which are indeed very low; but the narrow channel, as I have already remarked, is very deep. The strata, in general, are micaceous shistus, ardesia, and shistose talc; and they alternate, and pass into each other. Sometimes we also observe chlorite; which is either massive, or forms a species of slate; and not unoften I remarked quartz, more or less penetrated with the chlorite, forming a dark-green-coloured stone, similar to that I found in Arran. In several places considerable veins of quartz are seen, traversing the strata in different directions; and sometimes they exhibit curious phenomena. I observed upon the sea-shore, about a mile and a half south of Kilmi-chael ferry, a vein of quartz which deserves to be particularly noticed. As it rises from the sea, it is very narrow; but it soon becomes wider, and then divides into several considerable branches, which traverse the strata in different directions. One of these branches presents an appearance similar to that observed in Glenrosa, in the island of Arran, and described at pages 38, 39. This branch, having traversed the strata for several feet, is interrupted by a mass of micaceous shistus; but it a-

gain

gain appears at a little distance, and still in its former direction. Masses of micaceous schistus are also to be observed in the midst of the quartz vein. The appearance of a mass of micaceous schistus, which is a fusible stone when compared with quartz, in the midst of a quartz vein, must be considered as decisive against the theory of Dr. Hutton: for it is impossible to suppose that it should remain unaltered in a heat capable of melting quartz, or keeping it in a soft state.

The basaltic veins, which occur so often in Arran, are also pretty common in this island, and are found from two to ten feet wide, traversing the primitive strata in various directions; and I even noticed them upon the top of the highest hills.

Near to Lord Bannatyne's castle there are several slate quarries, which have been worked for some time, and are still continued. These slates, however, are not so much used as those from Easdale, which are, even here, preferred for economical purposes. In some parts of Germany, as at Ruhla\*, they employ a compact micaceous schistus for the roofing of houses;

R 2

and

\* Voight Mineral Reisen durch das Herzogth. Weimar. Th. 2. Sc. 24.

and it is preferred to some kinds of ardesia, from its great durability. Probably some species of micaceous schistus, equally useful with that used in Germany, may be found among the hills in the northern parts of the island. Mr. May, the chamberlain of Bute, informed me, that trials had been made for lead in the northern parts of the island, but without success. This I reckon no satisfactory proof that lead is not to be found in the island; as, in all probability, the persons, employed to make the trials, were but little versed in the business.

The north side of Rothesay bay is entirely composed of primitive rock, so is also the north side of Scalpa bay, which is situated upon the west side of the island, and nearly opposite to Rothesay; but the south sides of these bays are composed of red argillaceous sandstone, and sandstone breccia. The junction of these primary and secondary strata, is therefore to be looked for in these bays.

The country between Rothesay and Cil-Chatan bay; which is the lowest, most beautiful, and best cultivated part of the island; is composed of strata of red argillaceous sandstone, and sandstone breccia, alternating with each other, and both are traversed with basaltic veins. Upon the shores, on both sides of this part of the island, there are inland cliffs, similar to those

near

near the north end of Arran, and in several places we remarked banks of coral and sea shells \*, considerably above the high water mark. These appearances, as well as those that occur in Arran, are proofs of the land gaining on the sea.

From Cil-chattan bay, to the southern extremity of the island called Gurroch-head, the face of the country is much altered; it now becomes nearly as high as in the north end, rising into irregular hills with abrupt perpendicular crags, that are almost characteristic of a basaltic country. From the little opportunity I had of observing this part of the island, I can only say in general that it is composed of argillaceous sandstone, stratified with basalt, and traversed by basaltic veins. The basalt is sometimes columnar, and frequently contains much hornblende. I was told that lime had been found in this part of the island.

## GENERAL

\* These banks are usually made of the *Millepora polymorpha*, of which there are many curious varieties.

## GENERAL OBSERVATIONS ON THE CLYDE.

Having now finished the outline of the mineralogy of the islands in the Clyde, I shall make a few observations upon the mode which nature appears to have followed in the formation of the bed of the river, the rocks and islands.

The appearance of islands in any quarter of the globe, naturally suggests to the mind, the idea of some powerful agent which has convulsed and broken the solid land, and formed it into detached masses. This opinion is not fanciful, for appearances, in many countries, show us, that the greater number of islands have been formerly joined together, and must have constituted part of the adjacent continent. Thus, if we examine the rocks upon the opposite sides of the Clyde, we shall find a great similarity in their nature. 1. At Campbeltown, which is only a few miles from the extremity of the isthmus of Cantyre, we observe a small portion of secondary strata, which corresponds to that upon the opposite coast of Ayrshire. 2. The rocks upon the north and south ends of the island of Arran correspond exactly with the strata upon the north and south sides of the Clyde. 3. The north end of Bute is composed of a similar rock with that of Cowal, and  
the



the fouthern extremity is compofed of the fame rock with the Cumbray iflands, and thefe are of the fame rock with that of the Largs, which is on the fouth bank of the river. Thefe facts would feem to indicate, that the oppofite banks of the Clyde were at one time joined together, forming a very confiderable extent of folid land. If this be admitted, (and there feems little doubt of its truth,) we muft now endeavour to difcover what means were employed to break down the land.

Philofophers in their fpeculations on this fubject, have generally mentioned two agents, which they imagine have produced thefe ftriking and awful phenomena; thefe are the waves of the ocean, and earthquakes. The firft opinion has been ftrenuoufly contended for by the late Dr. Hutton, who affirms, that all bays, peninfulas, iflands, &c. have been formed by the long continued action of the waves of the ocean. This fpeculation at firft fight feems very plausible, but a more attentive confideration difcovers to us a very exaggerated account of a comparatively partial operation; and this is indeed pretty evident from the following facts. The channel between Italy and Sicily, is nearly the fame to day, as in the time of the Romans. The ifthmus of Corinth has not been vifibly altered for upwards of 2000 years. Scylla, of which Homer has given a correct defcription, is now nearly in the  
fame.

same state as when he wrote \*. The ruins of Beritta, the favourite seat of Augustus, are still to be observed in their original situation, upon the bank of the sea, and so situated, as to be out of the reach of the waves ‡. Ancona built by the Syracusians, is still by the sea shore †. Here, then, we have instances of the land resisting the powerful waves of the Mediterranean for upwards of three thousand years.

Dr. Hutton who was aware of some of these facts, remarks, that “ Our land is wasted by the sea ; and there is also a natural progress to be observed, which naturally takes place on this occasion ; for the coast is found variously indented, that is to say, more or less, according as the land is exposed to this wasting and wearing operation of the sea, and according as the wasted land is composed of parts resisting, with different degrees of power, the destroying cause. The land, thus being worn and wasted away, forms here and there peninsulas, which are the more durable portions of that which had been destroyed around ; and these remaining portions are still connected with the mainland, of which they at present form a part.

“ But

\* Spallanzani's travels through Sicily, vol. 4. p. 172.

‡ Maundrell's travels from Aleppo to Jerusalem in 1669, &c.

† Maundrell, *ibid.*

“ But those promontories and peninsulas are gradually de-  
 “ tached from the mainland, in thus forming islands, which  
 “ are but little removed from the land. An example of this  
 “ we have in Anglesey, which is but one degree removed from  
 “ the state of being a promontory. These islands again, in  
 “ being subdivided, are converted into barren rocks; which  
 “ point out to us the course in which the lost or wasted land  
 “ upon the coast had formerly existed.

“ To be satisfied of this, let us but look upon the western  
 “ coast of Scotland, from the islands of St Kilda to Galloway,  
 “ on the one side, and to Shetland on the other; in this tract,  
 “ we have every testimony for the truth of the doctrine that  
 “ is consistent with the nature of the subject. The progress  
 “ of things is too slow to admit of any evidence drawn imme-  
 “ diately from observation; but every other proof is at hand;  
 “ every appearance corresponds with the theory; and of every  
 “ step in the progress, from a continent of high land, to the  
 “ point of a rock sunk below the surface of the sea, abundant  
 “ examples may be found. We do not see the beginning and  
 “ ending of any one island, or piece of country; because the  
 “ operation is only accomplished in the course of time, and the  
 “ experience of man is only in the present moment. But man  
 “ has science and reason, in order to understand what has al-

“ ready been from what appears ; and we have but to open  
 “ our eyes and see all the stages of the operation, although not  
 “ in one individual object. Now, where the nature of things  
 “ will not admit of having all and every step of the progress  
 “ to be perceived in one object, an indefinite progression in  
 “ the various states of different objects, showing the series or  
 “ gradation from a continent to a rock, must form a proof in  
 “ which no deficiency will be found \*.”

This is very probably a correct delineation of the mode  
 which nature follows in altering the land, in some few in-  
 stances ; but it cannot be general, as it would give an age to the  
 world quite inconsistent with the Hebrew chronology ; we  
 must therefore consider it as untenable. It may be reckoned  
 unphilosophical thus to shelter ourselves under the cover of  
 what has been, by some, considered a traditional tale ; when  
 facts and reasoning should decide the truth of the argument.  
 I am by no means of this opinion, and however unfashionable  
 it may appear, I am firmly persuaded, that any chain of reason-  
 ing, that does not coincide with that chronology, is false. As  
 I have now proved the insufficiency of this theory, I might  
 proceed to consider the other ; yet to prevent the sceptical,  
 from the use of any undue argument, I will endeavour to show,  
 that allowing Dr. Hutton's observations to be correct, they will  
be.

\* Theory of the Earth, vol. 2d. p. 265.

be found quite insufficient to explain the breaking of the land of the Clyde, &c. From the account I have already given of the nature of the strata upon both sides of the Clyde, it is evident, that the ocean, in its supposed action, has broken down the hard primary strata, in preference to the softer secondary strata; a fact which strongly indicates the agency of some other power than the sea. Thus we find a considerable portion of the primary strata carried away from the north end of Arran, and Bute, while the secondary and softer strata at the opposite ends of these islands, with the sandstone isles the Cumbrays, stand in the middle of the Firth, defying the rage of the waves. Further, if we look at the map, we will find that all the arms of the sea which are connected with the Clyde, in place of being situated in the secondary strata, upon the south bank of the river, are only in the north side traversing a mountainous country which is entirely composed of hard primitive rock. The great depth of these lochs or arms of the sea is very decisive against Dr. Hutton's explanation. Loch Fyne, at its upper extremity, nearly opposite to Inveraray, is about 60 fathoms deep: Loch Strevin, a small arm of the Clyde, almost inclosed at its entrance by the island of Bute, is yet 38 fathoms deep: Loch Goyle, situated further up the Clyde, is, at its upper extremity, where it is not a mile broad, about 37 fathoms deep: and Loch Long, near its head, is 28

fathoms deep. These lochs are far removed from any violent action of the sea, or of currents; so that it is impossible that they could have been formed as Dr. Hutton conjectures, allowing millions of ages for the purpose.

The other opinion which we have mentioned, viz. "that the land has been often submerged and broken by earthquakes," seems to afford us a less improbable explanation of the present state of the Clyde, than that advanced by Dr. Hutton. The frequent occurrence of earthquakes, in the different quarters of the globe, affords us numerous instances of the submergence and breaking of the land: yet we are acquainted with none so extensive as that of the Clyde. This, however, is of little importance; as it is not improbable, that these catastrophes were more frequent at a former period, than now. It would extend these observations to a great length, were I to enter into a detail of all the effects of earthquakes; I shall therefore only select a few facts as illustrative of the present opinion. In 1692, when the town of Port-Royal, in Jamaica, was destroyed by a dreadful earthquake, vast masses of land were sunk far beneath the level of the sea, and mountains of considerable extent sunk down, leaving in their place extensive lakes. In 1693, the island of Forca disappeared, being swallowed up by the ocean during a tremendous earthquake. In 1678, there  
was

was a great inundation in Gascony, caused by the sinking of a part of the Pyrenees: the mountains having displaced the waters, which exist in the cavities that are contained in the bowels of the earth. In the late most awful earthquakes that have ravaged Peru, large mountains have been divided into two parts and separated; others sunk down, when large and often bituminous lakes have risen in their place; and lastly in the earthquakes that devastated Calabria, there are instances of mountains sinking into the bowels of the earth\*.

These facts entitle us to conclude, that at some former period, this country was convulsed by great earthquakes, when the beds of the Clyde, and its numerous lochs were formed, by the submergence of the solid land: at the same time Arran, Bute, &c. received their insular form, being part of the land that had escaped the power of the earthquakes. These islands, as well as the lands on both sides of the river, have, no doubt, since that period, experienced some alteration from the long continued action of the weather and the waves of the ocean.

*Route*

\* The earthquake that was felt in Canada, in 1663, overwhelmed a chain of mountains more than three hundred miles long. Clavigero's history of Mexico, p. 321.—Kirwan's Geological Essays, p. 502.

*Route from the Island of BUTE to the Island of JURA.*

In travelling from the island of Bute to the Western Isles, we have the choice of different tracks, as may be seen from the map. That which we pursued, although not the most convenient, was yet interesting, as it allowed us to glance at a considerable extent of highland country.

Having examined Bute as much as circumstances would permit, we crossed the Kyles to a small house called the Kerry, situated in the district of Cowal. In crossing, we perceived, at a distance, several boats, filled with men dressed in black, slowly rowing up the sound. So unexpected an appearance did not fail to attract our attention; and we were told that it was a funeral procession to a burying-place in the adjacent mountains of Cowal. Surely we could have hardly witnessed a more striking scene. Mortality is at all times awful; but it was here presented to us in a most impressive manner. The wild and lofty mountains rising from the sides of the channel; the almost perfect stillness of the water, which could be faintly heard dying away along the shore; the universal silence, not even disturbed by the scream of sea-fowl—seemed as if nature was  
unwilling



unwilling to disturb the performance of the last and melancholy services to the dead.

At the Kerry, the shore is adorned with sweetly-rising natural wood; so that we left it with regret, to traverse a country where grey, rugged mountains, and brown heaths, are the only objects to which our attention could be directed. Having walked for about five miles through a dreary mountainous country, principally composed of micaceous schistus, interspersed with chlorite, and traversed with quartz veins; we came to the next ferry-place, which is situated upon the banks of Loch-Fyne. We crossed from this to East Tarbet, a distance of about nine miles; and observed the mountains on both sides of the loch, all the way to Loch-Gilp Head; having the same general appearance, and being probably composed of similar rocks with Cowal.

East Tarbet is situated upon the narrowest part of the peninsula of Cantyre; for it is here only about two miles to the sea on the west side, which is called West Tarbet. There is a tolerable road from the east to the west side; which is of some use, as this is not only the principal thorough-fare to the islands of Ila and Jura, but boats coming from the Western Islands have their cargoes unloaded here, and then are drawn across the  
isthmus,,

isthmus, in preference to the circuitous and dangerous voyage by the Mull of Cantyre. It was once proposed to cut across this narrow neck of land; but the bad ground at West Tarbet inclined the canal company rather to cut a canal from Crinan to Loch-Gilp Head, through a more considerable track of ground, but reckoned more favourable for shipping. The canal is now far advanced; but it is very probable that its utility will by no means coincide with the sanguine expectations that have been raised, by the company, and the country in general.

The country, about East Tarbet, is bleak and rugged. The hills rise to a considerable height; and are composed of micaceous schistus in the lower part, but gneiss is to be observed towards the summit, and now and then indurated chlorite is found among the debris. West Tarbet presents a more pleasing scene, from the natural wood that grows there with considerable exuberance.

From East Tarbet I now continued my journey towards the island of Jura, along the banks of Loch-Fyne, which is adorned with natural wood, giving a rich and picturesque effect to the high cliffs that rise above the road. The strata are, in general, micaceous schistus, in some places alternating with considerable strata of hornblende rock, and traversed by basaltic veins: and

I was

I was told that considerable limestone quarries were opened among the neighbouring hills, and consequently must be primitive limestone. In many places we observed persons cutting down the wood, for the purpose of making charcoal for the use of the iron forge near Oban. This is to be regretted; for, in a short time, the whole wood will be destroyed, and the country deprived of one of its greatest ornaments; and merely for the supply of the working of an iron furnace, that probably might be carried on equally well by a carefully-carbonized peat.

Having walked for several miles along the bank of the loch, we now changed our course, and crossed through a long, dreary moor, and over hills, when we descended to the plain at the head of Loch-Kilifled. The rocks are, all the way, of micaceous schistus, which is, in many places, quite disintegrated, the loose mica forming banks several feet thick. This mica, if free from iron, might be of considerable value; as we find Mr. Wedgewood using the fine white mica of Cornwall for the manufacture of porcelain and his very useful pyrometers †. It is therefore worthy the attention of the proprietors to examine the neighbouring country, where probably considerable quarries of colourless

T mica

† Journal des Mines, No. 3. p. 119.

mica might be found. At the head of Loch-Kilised I observed a considerable stratum of blue-coloured, granularly-foliated limestone, stratified with micaceous shistus. The micaceous shistus is here frequently mixed with felspar, forming a species of gneiss difficultly distinguishable from sandstone.

After leaving this plain, we had a difficult ascent for a considerable way, but the tediousness of the track was a little relieved by the natural wood through which we passed; this, also, soon disappeared, when brown mosses, and grey, bleak hills, were again characteristic of the country. Having walked for several miles through this dreary and desert spot, we were suddenly stopped upon the brow of a hill, from which we had a view of the grey, sterile mountains of the mainland, rising into various rugged forms, and intermixed with lochs, thus presenting a wild and desolate scene. Soon afterwards, we came in sight of the rugged island of Jura, the island of Isla, and, farther distant, the mountains of Mull. These we viewed with much pleasure, as they were soon to be objects of our particular attention. We now descended from the mountains to the sea-shore; where we observed an old, gloomy, ruinous building, called Castle Swein, situated in a wretched-looking country. Even the few inhabitants we saw, had something so melancholy and depressed in their appearance; their miserable huts were in such unison with

with the scenery—as to occasion in us an unusual lowness of spirits. We hastened, therefore, from this spot, and crossed a small ferry, and then walked about three miles to the shore opposite the island of Jura. The strata, all the way from Kilmisdale to this place, seem to be principally micaceous schistus, frequently passing to talcaceous schistus.

We here were fortunate in getting a boat, in which we passed to the island of Jura.

We now examined a part of this island, and then crossed to Ila, where we remained a few days; and again returned to Jura, previous to our voyage to the Slate Islands. As it would be irregular, and little satisfactory, to detail the observations in the exact order in which they were made, I prefer first giving an account of Ila, and then of Jura.

## ISLA AND JURA.

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### CHAP. X.

*Abstract of the Mineralogy of the Islands ISLA and JURA.*

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#### ISLA.

**T**HIS island is thirty-two miles long, and, in some places, nearly as broad. It is the most southern of the Æbudæ, or Hebrides; and its name is traditionally derived from Isla, the daughter of one of the kings of Lochlin, or Norway, who was buried in the parish of Kildalton. Dr. Campbell, in his Political Survey of Great Britain, remarks that it is the Epidium Insula of Ptolemy; and he imagines (erroneously, however) that it is denominated Isla, or The Isle, as being the seat of government when the Western Isles were ruled by the princes of the Isles.

It approaches somewhat to a square shape, and is much intersected by the sea, in particular by two considerable lochs, one on the west side, called Loch Graynard, the other upon the southern extremity, called Loch-in-daal. It is bounded upon the N. E. by the rugged and sterile island of Jura; on the E. by the isthmus of Cantyre; towards the S. it is separated only about 20 miles from Ireland; but on the W. it is exposed to all the violence of the Atlantic Ocean.

The cliffs around the coasts of the island are, in some places, of considerable height, particularly at Macarthur's Head, where they rise with great grandeur and magnificence. The shores are often covered with immense masses which have fallen from the neighbouring cliffs; but, in other quarters, the cliffs disappear, when we have shores bounded by considerable sandy beaches. Beds of cailloux roulés, or boulder stones, are to be observed upon the shore, but placed a considerable distance above high-water mark; and in the space of ground between the two lochs just mentioned, there is an extensive links, or down, where we find, under the thin covering of grass, sand, boulder stones, and shells. These appearances, which are proofs of the retiring of the sea from the land, are to be seen in many parts of the Western Islands.

This

This island, when compared with many of the Hebrides, is low; none of the hills being above 1700 feet above the level of the sea. The low grounds are pretty flat, often well sheltered; and, through the exertions of the present proprietor, Walter Campbell, Esq, of Shawfield, improvements are carried on with spirit: the moor lands are daily rendered arable: thus beautifying the island, and rendering it the most productive of the Hebrides, its yearly rent being now about 10,000 l.\*

*MINERALOGY.* To render the few observations I have to make on the mineralogy of this island distinct and satisfactory, I will first describe that species of rock which forms the interior, with its accompanying veins, and then trace the other strata around the coasts of the island.

*Mining Field.* The interior, or middle part of the island, from its containing a great number of metallic veins, and being the seat of all the workings, may be called the Mining Field.

It

\* On the forfeiture of the Macdonalds, Isla, Jura and the lands of Muckrain were given to Campbell of Calder, upon condition that he would pay 500 l. of yearly feu-duty out of Isla. Campbell, about fifty years ago, sold these lands to the Shawfield family for 12,000 l. which is now their yearly rent: a most striking example of what may be done by spirited improvements.



It is entirely composed of blue-coloured limestone, which is supposed to occupy about thirty-six square miles; extending in distance (so far as I could observe) to the sea-shore; neither does it rise to any considerable height, for other rocks generally take its place when it rises to a few feet above the level of the sea. The limestone strata dip towards the S. W. Numerous symptoms of galena occur in this limestone, and several veins have been worked with considerable advantage. The principal seat of these workings seems to have been in the neighbourhood of Garthsnefs, which is situated about the middle of the limestone district. At this place there are the remains of a lead vein, which runs S. E. and N. W. and dips towards the S. Besides the galena, there also occurred; in the working, rich copper pyrites; and it is said that, at one time, specimens of sulphurated manganese had been discovered. At Glasgow-beg there is another vein of galena, running E. S. E. and W. N. W.; but it is traversed by a basaltic vein, which runs nearly S. S. W. and N. N. E. At a little distance southward from this, we observe an open cast vein, which runs E. and W. and dips to the S.: it is also crossed by a basaltic vein, as that at Glasgow-beg: the basaltic vein is about nine feet wide, and has thrown the lead vein about three feet from its original direction. There are many other mineral appearances besides these now mentioned; but it would extend these notes too far to specify more of them.

Many

Many other basaltic veins are also to be seen: some traverse the metallic veins; others cross each other: in short, a plan of this mining field would represent a limestone district divided into a number of angular and square fragments.

The basaltic veins are of various sizes, from one to twelve feet in width. Many of them run parallel to each other; some run in a cross direction, marking, according to the manner in which they intersect, their relative antiquity †; and not unoften these veins stand up like artificial walls, owing to the limestone being more easily acted upon by the weather, and being consequently first carried away.

Besides the galena, considerable quantities of copper pyrites have been found, but the quantity too small to be of any consequence. Also, upon the south side of the limestone district, near to Loffit hill, iron ore has been quarried; but its situation is not yet well ascertained; and I am afraid, from the accounts I have heard, that it will be trifling. The workings in these veins have never afforded fluor spar; they produce only barytes and calcareous spar. Fluor spar is a rare production in Scotland:

† Werner Neue Theorie von der Entstehung der Gänge.

Scotland: I have only observed it twice; once in Shetland, as will be mentioned afterwards; and in a vein among the granite mountains of Aberdeenshire.

Before concluding this short description of the mining field, I shall mention two remarkable facts, which seem well authenticated.

1. *Silver*. It is confidently affirmed that a lump of capillary silver, weighing sixteen ounces, was found with the galena, in the vein at Garthsnefs. This is an interesting fact; and, should the veins be again opened, will prove a fresh incentive to carry on the working with spirit, as it is not improbable that veins of silver may be found. We know that scarcely three years have elapsed since native silver was discovered in Great Britain, and it is of consequence to observe, that it occurred in a situation somewhat analogous to that in Isla, the silver forming a string, branching from the side of a vein of galena †.

2. *Quicksilver*. A quantity of this valuable metal was discovered in a peat moss some years ago; and Dr Rotheram informs me that it is now in the possession of Mr Campbell. Some slight search has

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been

† It was at Hurland, in Cornwall, where this silver was discovered.

been made to discover its situation, but without success. This must not, however, be considered as a proof that no veins exist; for, to determine this, it will require a more regular mode of investigation than has yet been pursued. Farther, the following facts show that limestone rocks are not unfavourable to the production of quicksilver: 1. It is found in globules, in white limestone, at Marfala, in Sicily; (*Mineralogie Sicilienne*, par Borch, Turin 1780.) 2. Behind Guancavelica, in South America, the ardesia passes into limestone, which is rich in silver and mercury; (*Helm Tagebuch reisen durch Peru*, p. 431.) In the mineralogical collection at Paris there are specimens of limestone, brought from the neighbourhood of Grenoble, which contain quicksilver\*.

*Observations.* The mineral treasures of this island, from their being situated so near the surface, must have early attracted the notice of the inhabitants; particularly as the Norwegians, the former masters of the island, were early celebrated as miners. We do not, however, find any mention of these mines, until the time of Boethius †, who wrote 300 years ago; but

\* *Journal des Mines de la Republique Francoise*, No. 1. p. 77.

† Boethius Scotor. Reg. Descript.

but even at that period they seem to have been of much consideration, for he remarks, “ cum frumenti ferax, tum metallorum dives.” Since that period they have passed through many hands; but do not appear, in any of them, to have been conducted with all the judgement necessary for so difficult and important a business. It is a matter of much regret that these mineral appearances, as well as many others, equally interesting, in different parts of Scotland, have not been prosecuted with more advantage. Many circumstances have contributed to this want of success; but, we apprehend, the principal one is to be found in the ignorance of the generality of miners, who are too often men of little education, and obstinately wedded to their own foolish practices. Even in Cornwall, where the mining business should be best understood, we observe them often working in an expensive manner. In Scotland particularly, wanderers from other countries, not regularly bred in the principles and practice of mining, have often imposed upon landed proprietors, by holding out to them flattering prospects of great gain, and have thus thrown a temporary obstacle in the way of improvement. It is to be hoped that the increasing taste for chemical and mineralogical studies will enable proprietors to treat such pernicious pretenders with that contempt they so justly deserve.

Having described the mining field, I shall now proceed to examine the rocks around the shores of the Island; and to do this with regularity, will begin at Portaskeg, a small harbour situated upon the south of Isla. Here the cliffs are low, and composed of compact micaceous schistus; which passes either to Ardesia, or Gneiss; and in all these gradations, are to be observed, rounded or irregular shaped pieces of granite. This granite, which is composed of red-coloured felspar, and white quartz, and sometimes iron pyrites, cannot be said to be connected by a paste in the manner of a breccia, as the granitic masses and schistus pass into each other, showing that they have been formed at the same time. Ferber \*, who has observed similar appearances in the mountains of Russia, agrees with Pallas †, in supposing that gneiss, micaceous schistus, and ardesia, are formed from the detritus of granite mountains; and upon this theory, he explains the appearances we are now considering. He conjectures, that the grosser particles of granite, having undergone a little alteration, are agglutinated in the form of granite, and inclosed by an aggregation of the smaller parts, which become argillified, forming the ardesia. This explanation is untenable, and unnecessary, when we con-

sider

\* New Transactions of the Imperial Academy of Petersburg, vol. 11.

† Observations sur les Montagnes, 4to. Petersburg.

sider that after the greater part of the granite was precipitated, still a small quantity might remain, which would be deposited along with the ardesia, and form thin strata inclosed in it †, or irregular shaped dispersed pieces, as in the case at Portaskeg.

From Portaskeg the coast becomes gradually higher as we approach Macarthur's-head, and is formed for a considerable way of rocks similar to those I have just mentioned, which the sea has in some places hollowed out into considerable caves. As we approach nearer to this great head-land, the cliffs become much higher, and the micaceous schistus, &c. disappears; a granulated quartz taking its place\*. Immediately upon the shore, I observed a large basaltic vein traversing the granulated quartz, rising up through it like an immense wall, and

† Karsten 3 Helvet. Mag. and Monnet 25 J. Physique, 85.

\* Mr Mills, in his account of some strata in Ireland and Scotland, detailed in the Philosophical transactions of the Royal Society of London, for 1790, has given a description of Isla. As it differs considerably from the observations I am now to detail, it will be necessary as I proceed, to contrast our observations; so that future travellers, may be enabled to judge, who is in the right. Speaking of this part of the island, he says, "that it is composed of chert, which extends to Macarthur's-head.

and extending along the shore to a considerable distance ; in some places forming a powerful barrier between the sea and a few cottages, which are built at the bottom of the cliffs. Having reached the head-land, I observed the cliffs rising to a great height, and composed of strata of arenaceous quartz, elevated at an angle of  $45^{\circ}$  ; and the rocks being tinged of a red colour, give a very wild character to the scene. This arenaceous quartz extends to a considerable distance ; but is at length interrupted by a rock, which has much the appearance of a breccia, being composed of variously shaped pieces, (and some of great size) of the granulated quartz, connected by smaller particles of the same quartz ; which has intermixed mica, and talc \*. Frequently the whole has a red colour, which is owing either to the decomposition of the mica, or sulphuret of iron, which is sometimes dispersed through it. As we wandered along the shore, I observed this breccia interrupted by a vertical stratum of micaceous shistus : upon one side of the stratum, is the breccia ; on the other, is the distinct granulated quartz. I would recommend this appearance to the particular attention

\* Dr Townson in his travels among the Carpathian Alps, observed great strata of granulated quartz, (what he calls primitive sandstone) lying upon granite, and he observed it in all the strata from fine granulated quartz to that of breccia, as in the case with the rock of Isla.—Travels through Hungary, 4to.



tion of future travellers, for I must confess, I was so fatigued when I reached this spot, that I could not give it that attention it undoubtedly deserves. The granulated quartz now forms cliffs along the shore, until we come to a small bay, where strata of micaceous schistus appear; and here the hills rise to a considerable height, being composed of micaceous schistus upon the lower part, and towards the summit, probably of granulated quartz. We now crossed over some higher grounds until we reached Ben-vinkie, which is said to be the highest hill in the island, although it is not more than 1700 feet above the level of the sea. The lower region of this hill is composed of micaceous schistus; but as we go upwards, granulated quartz makes its appearance; and upon the south-west side, which is very steep, a great vein of basalt reaches very nearly to the summit. The country becomes lower after passing this hill, and is pleasantly diversified with small irregular hills, that are intermixed with natural wood. The cliffs upon the shore are not very high, but are much broken by the action of the sea, which has formed many detached rocks; and these, having a grey colour, present a striking picture of sterility. Along with the micaceous schistus, we have now strata of ardesia, chlorite-slate, hornblende rock\*; and these

\* These Mr Mill includes under the name of Hornstones.

these continue to Loch-Kunestle, a small harbour on the coast. At this harbour, we observed a low hill called Knock Kunestle, which is composed of ardesia, chlorite-slate, &c. in its lower part; but upon the summit, decomposing greenstone makes its appearance. I could not determine whether it forms a stratum or a vein; but observed, that when in a state of decomposition, it affected the compass at the distance of four feet. From this to Lugwillan, the coast and country continue rugged, and composed of the same rocks as those which extend from Macarthur's-head to Loch-Kunestle. This little village, unluckily for the traveller, is extremely wretched; presenting a sad picture, if not of poverty, yet of dirtiness and sloth. It would certainly be much for the advantage of the proprietors, as well as conducive to the comfort of the peasantry, if commodious houses were built, and strict regulations with regard to cleanliness enjoined. I mention with pleasure, that Mr Campbell, has already in part begun this meritorious plan, and it is not to be doubted that he will soon feel the advantages of it.

After leaving Lugwillan, we met with a small harbour named Leodamis, or Lowdinas bay, which affords shelter to small vessels; but like other harbours upon this coast, it is dangerous from the number of sunk rocks, which extend to a considerable distance. The rocks in this neighbourhood are com-  
posed

posed of micaceous shistus, which by its decomposition forms a fine white sand, that covers the shore; and at the upper extremity of the harbour, I observed several pieces of melanteria, or black chalk, which seemed to have been detached from strata that probably alternate with the micaceous shistus. We now walked for ten miles, through a level country, to Lochlaggan, a sinuosity upon the side of Loch-in-daal. The rocks in this tract, are composed of micaceous shistus, and the general appearance of the country, to the extremity of the island, where it is terminated by the lofty Mull of KInhouth, announce a similarity of composition. From Loch-in-daal to the village of Bowmore, we passed thro' a level country, formed principally of micaceous shistus\*, which appears, in some places, to alternate with greenstone. This last mentioned fossil, as also wacken, have been observed, in other countries, in a similar situation; but basalt, as Dr Mitchell informs me, is peculiar to the flotzgeburge, or stratified mountains. We are, therefore, to consider the observations of the celebrated Charpentier † and

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Faujas

\* Mr Mills remarks, that the whole extent to Kenhouth-head, and so on to Bowmore, is hornstone.

† 4 Helvet. Mag. 445. 546. Ibid. 3. 236. Charpentier, 81, 187.

Faujas St. Fond †, who assert that basalt strata occur in primitive mountains, as indicating only greenstone or wacken.—The village of Bowmore, which is the principal one in the island, is pleasantly situated upon the banks of the loch, and is the centre of all the business in the country. From this to Kiliru the roads lead through a flat country, part of which seems to have been gained from the sea. Near Kiliru is the seat of Mr. Campbell, which is pleasantly situated at the head of the loch, but is much exposed, from the want of planting. From Kiliru to the point of Runs, the island is in general low, excepting about the Runs, where it rises into hills, of which Bentarvil is the highest. Being disappointed in examining that part of the island, we crossed from Kiliru to Kilchoman. The country, in this direction, is low, interspersed with small lochs, and in some places well cultivated; and micaceous schistus, traversed with quartz veins, is the only rock that occurs. Near to Kilchoman, I observed an old, ruinous, gloomy building, which was once the seat of the turbulent Macdonald, prince of the Isles, but is now peacefully inhabited by the minister of the parish. From Kilchoman to the sea-coast, the country is low; and the rocks, which extend along the shore, continue to form low, broken cliffs of micaceous schistus, alternating

† Faujas sur le Trap, p. 86.

ternating with sand banks, until we come to Saneg-more. Here the cliffs rise to a considerable height: and, being much exposed to the ocean, are broken into many fantastic forms, presenting a grand and romantic piece of scenery. Knowing, from Mr. Pennant\*, that there was a fine cave in these cliffs, we wished to examine it. Accordingly, having procured guides, through the goodness of Mr. Campbell of Sanicks, we descended a steep precipice to its entrance, when we found ourselves surrounded by lofty, rugged precipices, which towered far above us. The grandeur of the scene was much heightened by the turbulence of the sea, which came rolling in slowly, but with awful majesty, dashing among the rocks, with a noise that resounded on all sides like the discharge of artillery. Having entered the cave, we found it pretty extensive, but damp and black, owing to the water falling from above. At a little distance, the guides directed us into a narrow opening on one side, into which we scrambled with some difficulty, but found only a dark, dreary cavity, of little extent. As we walked onwards, the cave became larger; but we were soon stopped by a pool of water, which appeared to be pretty deep. The guides crossed through it, and walked to the further extremity of the cave; and the effect produced by the retiring of the lights,

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was

\* Voyage to the Hebrides.

was not the least interesting part of this scene. Formerly, when the cave was dry, the gentlemen of the country used to illuminate this wild grotto, and collect all the beauty of the isle to dance to the bagpipe.

We now left the cave; and, in our ascent, observed several basaltic veins traversing the micaceous shistus. From this to the mouth of Loch-Grynard, is an alternation of sandy beaches and low cliffs of micaceous shistus and ardesia, in some places traversed with basaltic veins, of various sizes, from a few feet to nearly forty feet wide. These appearances are so numerous, that I could not possibly afford time to examine them all minutely; so that it will not be surprising that after travellers should find, in some places, strata instead of veins. Loch-Grynard is of considerable extent; is usually bounded by sandy banks, but sometimes low rocks of micaceous shistus appear; and at its head are the links or downs we have already mentioned, which extend nearly to Loch-in-daal. From this loch to the great caves which are situated upon the north-west part of the island, the shore is, as usual, an alternation of low, rugged cliffs of micaceous shistus and sandy beaches; but, as we come nearer to the caves, the cliffs are much higher, and, in place of micaceous shistus, we have rugged precipices of granular quartz. We descended a path made in these  
cliffs,





*J. Grant sculp.*

*VIEW of the GREAT CAVE of ISLA looking outwards.*



cliffs, which brought us among rocks terribly broken by the sea; and after walking a few hundred feet, the caves presented themselves with much dignity. The height of the rocks in which they are situated; the wild and rugged grandeur of the neighbouring hills; the solitude of the place; all add fresh interest to this striking scene. The great cave, or what is called, in the Erse language, Ea-maur, is about thirty-three yards wide at its entrance, and from six to eight yards high: as we go inwards, the roof becomes higher, but it soon again contracts in all its dimensions; and about 150 yards from its entrance, it is so narrow and low, as to prevent any one from getting farther. It is situated in granular quartz, as is the case with the other smaller caves. The celebrated Sauffure has lately published a series of experiments upon the temperature of caves, in which he obtained some curious results. I repeated them carefully in the great cave, but did not find a difference of more than 8° of Fahrenheit between the temperature of the cave and that of the shade.

At a little distance from the caves, I observed the granular quartz covering a species of shistose talc, and, also, a species of marl, in the neighbourhood of the granular quartz and micaceous shistus: but I had not an opportunity of examining their relative position.

\* Mr Mills remarks that the caves are in rocks of chert.

position. From this we crossed a very fatiguing moor to Portaskeg: the rocks, all the way, are of granular quartz, (extending even to the summit of the highest hills,) excepting a few places upon the sea shore, where micaceous schistus appears.



### J U R A.

THIS island is about 32 miles long, and 6 broad; but at Tarbet it is nearly divided, being only a mile and a half broad. It is bounded on the E. by Knapdale and Cantire; on the S. by the island of Isla; upon the W. by Colonsay, Oransay, Mull, &c.; and towards the N. the Slate islands. It is in general very mountainous, particularly upon the S. W. extremity, where are situated the high hills called the Paps of Jura. None of the Hebrides present such a mass of rugged barrenness. The hills are often grey and bare; and the scanty portions of the lower ground which are cultivated, seem ill managed. The shore upon the east side is in general low; but upon the west it rises frequently to a great height, and is broken into many striking forms; particularly we observe extensive caves, which afford  
shelter





Engraved by R. Scott Edin.

CAVES on the WEST COAST of the ISLAND of JURA.

shelter to the deer and goats that browse among the neighbouring rocks.

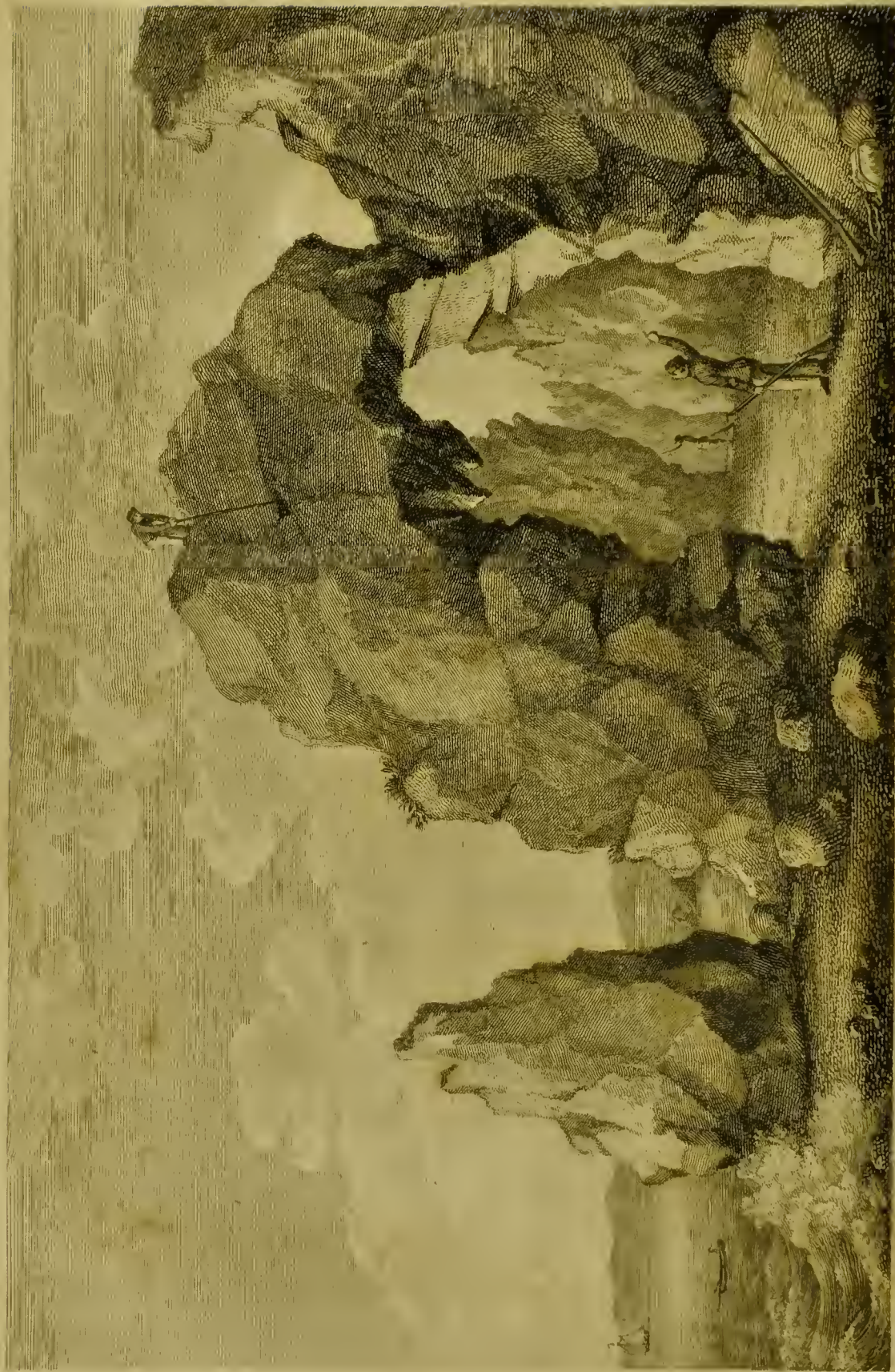
*MINERALOGY.* The mineralogy of this island, as far as I examined it, is but little interesting, as it does not differ materially from that of the shores of Isla. I shall not omit, however, to give a short account of it, as its mineralogy has not engaged the attention of any writer.

Immediately below Ardfin, the seat of the hospitable Archibald Campbell, Esq. I observed strata of granular quartz, inclined at an angle of  $45^{\circ}$ ; yet they are not regularly so, for I observed them inclined at different angles in other parts of the island. This rock forms the coast of the island all along the sound of Isla, and, as far as I could observe, it appears to extend along the whole west coast. The cliffs are, in some places, of considerable height; and the great masses which are separated from them have, in general, a tendency to the pyramidal shape. This is another fact, similar to what I observed in Arran, showing that particular rocks break in such a manner as to be characteristic of their peculiar nature. These quartzey masses, by further decomposition, fall into small crystalline grains, which cover the shore, in some places, to a considerable extent:

extent; and form a sand, which is assuredly among the purest that nature affords. It has been used with much success in the making of fine glass; and I have little hesitation in saying, that it is worthy of being more generally known as an article for glass-making: indeed it might also be advantageously used for the making of flint, and different kinds of porcelain, in the place of powdered quartz, or flint.

Many basaltic veins are to be seen traversing these quartz strata, which extend along the sound of Isla and the west coast of the island: and it is curious to observe the manner in which these two rocks decompose; for upon this circumstance depends the varied appearance of the rocky scenery on the west coast of Jura. Sometimes the basalt decays first, leaving only the empty space which the vein had formerly filled; and this afterwards is much enlarged by the decaying of the quartz: thus forming caves such as are represented in the plate. In other instances, the granular quartz decays first; and either falls away from the side of the basaltic vein, or is washed away by the sea: thus leaving the basaltic rocks extending across the beach like immense walls. These great masses of basalt are often broken into various shapes; but  
the





Engraved by R. Smith.

. View of a PERFORATED BASALTIC VEIN. 1.70. east of the  
ISLAND OF UIRA.



the most striking appearances are formed by the central part of the vein decaying first, which leave magnificent arches: but the engravings of this coast will convey a more lively idea of the character of these rocks, and the general appearance of the scenery, than any description.

There are many caves upon this coast, and some of them of vast size; but my time did not allow me to visit the most remarkable.—In wandering among the rocks, I observed several banks of coral sand; which I was happy at observing, as it will be of great use to this island, heretofore destitute of all kinds of calcareous matter, and abounding with much improvable peat moss.

*PAPS of JURA.* These mountains, which are the most elevated in the island, are distinguished by different names. The three most remarkable are, Beinn-a-chaolis, or, the Mountain of the Sound; Beinn-sheunta, or, the Hallowed Mountain; and Beinn-an-oir, or, the Mountain of Gold. The last mountain is the highest; being about 2600 feet above the level of the sea; and is, like the others, somewhat of a conical shape.

We clambered to the summit of one of these hills, but found the ascent very steep, and fatiguing, from the number of small loose stones that cover its sides: but our fatigues were

soon forgot in the immensity and variety of the prospect now before us. Immediately below was the rugged scene of the grey, storm-beaten rocks of Jura, interspersed with numerous lakes; conveying, as Mr Gilpin remarks, the idea of complete sterility. To the S. the island of Isla seemed spread under our feet; and, farther distant, appeared the coast of Ireland. To the W. we observed the small isles of Gigha and Cara, the isthmus of Cantyre, and the lofty red-coloured granite mountains of Arran, forming a striking contrast to the sombre hue of the mountains of Cantyre; and, still at a great distance, our view was bounded by the distant county of Ayrshire. On the N. E. we observed the wild alpine ridges of Argyleshire, extending all the way to Ben-Lomond. To the W. the Hebrides appear, scattered through the ocean: the isles of Colonsay and Oransey are in our immediate neighbourhood; farther distant, is the mountainous island of Mull, the celebrated I-colmkill, with the adjacent isles; and the long-extended isles of Coll and Tirie appear like a haze in the horizon.

These mountains are principally composed of strata of a granular quartz, elevated at an angle of  $45^{\circ}$ , and dipping to the south-west. From the summit of the hill, the strata appear to run in different directions; some curved, and others nearly horizontal: these appearances, however, are probably more owing

owing to the situation from which I viewed them, and the ends of the strata being worn down by the rain, &c. than to any alteration in their dip or direction. The fragments of rock which cover the sides and tops of these mountains, are broken into small angular fragments; which, observed at a distance, and even with a telescope, would show us, that they are formed of a rock very different from granite; as the latter almost always decomposes in large rhomboidal masses.

I frequently observed masses of this granular rock; which, from its containing felspar and mica, is to be considered as a true granite. This fact, will be reckoned, by certain geologists, as decisive against the opinion of Mr Werner; who affirms, that granite is the oldest rock, and consequently, that upon which the others rest. It cannot be denied, that there are several facts, detailed by the most intelligent geologists, which show, that granite is sometimes of a cotemporaneous formation with ardèzia\*, micaceous schistus†, and gneifs‡; yet they are so rare, that I can only conclude from them, as I have before mentioned, that after the greater part of the gra-

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nite

\* Reufs Mineralogische Geographie von Böhmen, B. 2. 180.

† Journal de Physique. New series, vol. 13,

‡ Emmerling's Mineralogie, B. 3.

nite had been precipitated, still a small portion remained in solution; and was afterwards deposited along with the gneifs, or other primary rocks. The opinion of Mr Werner, on the other hand, is supported by so vast a mass of evidence, as bears down all opposition. Thus, according to Sauffure, the granite of the Alps, excepting in one or two instances, is always covered with other strata; itself forming the interior, and often the highest parts of the mountains. The same observation has been made by Baron Born, and Esmark in the mountains of Hungary and Wallachia; by Palaffo, La Peyrouse, and Carbonieres in the Pyrenees; by Reufs in the mountains of Bohemia; Lazius in those of the Hartz; by Patrin, Herman, Pallas in the vast extended empire of Russia; by the French mineralogists in all the granite mountains of France; also in the granite mountains of the West Indies, and in the few which have been examined in England † and Scotland.

Having mentioned the different kinds of rock which form the coast and hills, from Ardfin, along the south and west parts of the island. We will now proceed along the eastern shore.

† In the great mine in Cornwall, called the Cooks Kitchen, I have been told, that the granite has been found above the ardesia (or killas). I have not as yet had it accurately confirmed.

shore, from the same place. Upon the shore, at a little distance from Ardfin, strata of micaceous schistus, alternating with rocks intermediate between talcaceous schistus and ardesia, appear, and continue forming low cliffs along the shore to the harbour of the small isles \*. These rocks are sometimes very compact, and have a tendency to break into irregular columns; so that in some points of view, they are not unlike columnar basalt: we also observed basaltic veins traversing them in many places. From this the country gradually rises as we approach the high hills, the paps of Jura; and in some places, as upon the road leading from Ardfin to Small Isles, chlorite-slate is to be observed alternating with the other rocks. This chlorite-slate, sometimes passes to hornblende-rock, by a mixture of green hornblende; and it sometimes contains calcareous spar, and crystals of yellowish-green actynolite dispersed; but this latter is a rare appearance. Not unoften I observed the chlorite penetrating the quartz, forming a dark green coloured stone; and here I was so fortunate as to discover that rare fossil, the crystallized chlorite, of which a particular description is given in the following chapter. If we still continue our course towards the high hills, we  
at

\* About a mile distant from Ardfin, we landed upon a small low island, which is composed in general of a coarse talcaceous schistus; and between the strata we observed layers of beautiful hornstone.

at length find the granular quartz rising from under the micaceous schistus, at an angle of  $45^{\circ}$ , and from this, the whole country to the summit of the mountains is formed of the same rock.

We would naturally conclude, from finding the quartz strata lowermost, that it had been deposited before the micaceous schistus; this is only true in part, as we sometimes observe the micaceous schistus passing to granular quartz, at a great distance from the junction †.

As far as my experience goes, mountains of granular quartz are to be considered as rare occurrences in Scotland: in Caithness, I observed quartz mountains, as will afterwards be mentioned: and Mr Williams tells us of quartz mountains in Rosshire\*: but these are the only instances I am acquainted with. It is even an unfrequent rock in other countries; in the Carpathian Alps, Dr. Townson informs us, he observed what he calls primitive sandstone lying upon granite; and Mr Deriabin, to whom I showed the Jura rock, assures me that it is similar

† In Braindorf, in Saxony, granular quartz has been observed passing into micaceous schistus. 2. Crell. Leytr. 64.

\* Williams's Mineral Kingdom, vol. 2. p. 52:

similar to that which forms so great a portion of these mountains.

As the discovery of limestone would be of much service in the agricultural operations of this island, we were anxious to ascertain if any such strata existed between the Small Isles and the Sound of Isla. To determine this, we examined not only the shores, but the ravines upon the sides of the hills, yet without success. This failure in our researches does by no means imply that limestone does not exist in this district, particularly when we recollect that these rocks are not unfavourable to it. We have many instances of limestone being found in micaceous shistus, in different parts of Scotland, as at Dalmally, near Blair in Athol, &c. † It may even occur in granular quartz; as Escher has observed limestone among granular quartz in the valley of Reufs.—Townson upon the granulated quartz (primitive sandstone) of the Carpathian Alps, &c.

The harbour of the Small Isles is rendered pretty safe by  
three

† Werner has observed limestone alternating with micaceous shistus and ardenia, in Saxony: so has Charpentier, and that in great strata. Werner, Kurze Classific. 14. Charpent. 55, 56, 57, 174, 201, 400.

three or four small islands, that defend it from the violence of the sea. It will admit vessels of several hundred tons; yet, as the island and the neighbouring country are but thinly inhabited, few vessels are to be seen enlivening this solitary scene. The country in the neighbourhood rises gradually as it approaches the Paps of Jura, which here present a magnificent and striking mountainous scene. The strata, from the shore to the vicinity of the Paps of Jura, are composed of micaceous shistus; excepting at one place, about half a mile north from Mr Macnicol's house, where we observed a stratum of ardesia tegularis (roof slate) cropping through the heath. This stratum, which appears to be of considerable breadth, is bounded by the micaceous shistus; and, near the junction, the micaceous shistus contains cubical crystals of iron pyrites\*.

From the Small Isles to Luggan, the strata of micaceous shistus still continue, often very compact, and frequently traversed by basaltic veins. At Tarbet, which is the narrowest part of the island, the land immediately upon the shore is low; and the eye is refreshed by the appearance of a beautiful

\* May not the presence of cubical pyrites, in micaceous shistus, be indicative of the vicinity of ardesia tegularis?



tiful green flat, at the bottom of the grey hills which bound the shore. From this to Kenawochrach, the northern extremity of the island, micaceous shistus appears to be the general rock, but it is sometimes alternated with ardefia tegularis. At one place the ardefia has been quarried; and, from what we could learn, there can be little doubt that, with well-directed experience, the working may become of consequence.

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ISLA

## ISLA AND JURA.

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### C H A P. XI.

*Description of the FOSSILS mentioned in the preceding Chapter.*

#### GRANULAR QUARTZ.

*CYAMEA*, Dr Walker's *Classes Fossilium*. *PRIMITIVE SANDSTONE*, Mr Kirwan's *Geological Essays*, p. 208. *QUARTZ*, *Ibid.* p. 179.

This rock, which we have so often observed in the islands of Isla and Jura, is described by Dr Walker under the name of *Cyamea Juræ*; and, more lately, Mr Kirwan, in his *Geological Essays*, describes similar rocks under the names of *Arenaceous Quartz* and *Primitive Sandstone*. There are many species of this rock in these islands; but I will only mention three of the most remarkable.

## 1. COMPACT.

*Colour.* White, or grey.

*Lustre.* Little glancing.

*Transparency.* Transmits light at the edges; but when the specimen is thin, the light passes through the whole.

*Hardness.* Strikes fire with steel.

*Fracture.* Even, coarse splintery, and frequently shiftose in the grofs.

Intermixed with quartz, (which is so compact as to render the granular character difficultly observable,) I always observed a number of white specks, which are either felspar or mica, or both, usually in a state of decomposition. Sometimes veins of compact quartz are to be observed traversing this species.

2. MICACEOUS. This species is composed of quartz, and a small portion of mica. The mica is always in small scales, and is either yellow, brown, or white. Often the mica is so abundant, that we have a true micaceous shistus.

3. GRANITIC. In this species, the granular appearance is more evident: and, intermixed with the quartz, are numerous crystals of red and white felspar, of various sizes, from a pin-

head to half an inch ; and a few scales of mica also, now and then, occur. Not unoften cubical crystals of iron pyrites are intermixed with the other ingredients, and, by their decomposition, cause the stone to acquire a brown colour, or to disintegrate altogether. This species, therefore, is to be reckoned an approximation to the granite, from which it differs but in the proportion of felspar and quartz.

#### MICACEOUS SHISTUS.

This rock occurs in Isla and Jura, and is considerably varied in its appearance. The quartz is of various colours, as black, blue, or white ; and is generally granular. The mica is also of different colours, as black, brown, greenish, or white : the scales are, in general, small ; the largest are those in the rocks in the strata that extend to the north end of Jura. The micaceous shistus at Lag in Jura, at a distance, is not unlike basalt ; but a nearer examination discovers a compound of black and dark-blue coloured quartz, with small scales of black mica very closely compacted together. It often also contains iron pyrites, which, by its decomposition, forms a number of rust-coloured spots. Sometimes crystals of felspar occur when it passes to gneiss ; or the quantity of quartz particles increase when it passes to the state of arenaceous quartz.

ARDESIA.

## ARDESIA.

*Colour.* Bluish or blackish grey.

*Lustre.* Silky. This silky gloss, Mr Kirwan remarks, intimates magnesia.

*Transparency.* None.

*Fracture.* Streight, flaty; the laminæ are undulated upon the surface.

*Hardness.* Easily scraped with a knife: but this degree of softness is probably owing to the influence of the weather, as the specimen now described was taken from the surface of the stratum.

*Streak.* Grey.

*Smell.* Emits a strong earthy smell when breathed on.

Cubical crystals of iron pyrites are dispersed through it; and these, by the escape of the sulphur, are converted into brown iron ore. It is worthy of remark, that the pyrites which occurs in the primary strata is much less liable to decomposition than that which we find in the secondary; and farther, that altho' we find pyrites very abundant in the primary strata, yet the combinations of the sulphuric acid with earths are rarely to be observed.

observed \*. Mr Kirwan, in the second volume of his Mineralogy, explains to us the difference between those pyrites that effloresce and decompose quickly, and the others which decompose more slowly. He remarks, that those pyrites which effloresce spontaneously, contain iron in a metallic state; but the others which decompose more slowly, and by the separation of their sulphur, have the iron in the state of an oxyd.

#### CHLORITE SHISTUS.

*SLATY CHLORITE*, Kirwan's Mineralogy. *ARGILLA CHLORITES SHISTOSUS*, Werner.

*Colour.* Dark-green.

*Internal Lustre.* Little glancing.

*Transparency.* None.

*Fracture.* Slaty; lamellæ pretty easily separable.

*Hardness.* Yields easily to the knife.

*Streak.*

\* Gypsum has been discovered mixed with mica in Mount St. Gothard; 44 J. de Physique. Pallas has observed gypsum associated with felspar in Siberia; 5 Nord. Beytrage. Sulphat of Barytes has been observed in gneiss in the mountains of Savoy, as mentioned by Werner. These are the few instances that are known.

*Streak.* Green.

*Smell.* Has a strong earthy smell, when breathed on.

Frequently grains and layers of quartz are to be observed mixed with the chlorite; and sometimes the quartz is penetrated with it, forming a fossil not unlike prase. Iron pyrites are sometimes intermixed with the chlorite, and, by their decomposition, colour the rock brown. Crystals of green hornblende are also to be observed intermixed with the chlorite; and according to the quantity of hornblende, the rock passes more or less to the state of hornblende rock.

#### FOLIATED CHLORITE.

*BLATTRIGER CHLORITE*, Werner, Eshner's Mineralogie, Emmerling's Mineralogie.

The *colour* is that of the common chlorite.

It is found not only massive, but also dispersed, and crystallized.

The crystals are in the form of a double conical pyramid, with truncated apices; and are to be observed also in the form of a cylinder, with a cone or conical pyramid upon each extremity.

The

The crystals are small, with little lustre on the outside, but strong glancing † internally.

*Lustre.* Intermediate between the greasy and mother of pearl.

*Fracture.* Foliated; but most commonly curved foliated.

*Transparency.* Semi-diaphanous; or such as to permit light to pass thro', but so little that objects cannot be distinguished.

*Hardness.* Not easily scratched with the nail, yet yielding easily to the knife.

*Fragments.* Tabular; feels a little fatty; and is not remarkably heavy.

It is found investing white-coloured quartz, but more commonly well crystallized in cavities of the quartz. I have only observed it in the island of Jura, among the strata of chlorite schistus, upon the road from Ardfin to the harbour of the Small Isles. According to Emmerling, it is a very rare fossil; as it has been observed in one other place only, that is, upon the mountain of St. Gothard, in Switzerland, where it is accompanied by crystals of adularia, reddish-brown schorl, and rock crystal.

HORN-

† Stark glänzend.



## HORNSTONE.

*ACHATES PETROSILEX*, Lin. *SILEX CORNEUS*, Wern. *NICOMIA*, Dr Walker. *CHERT*, Angl.

*Colour.* Pale brown; in some parts green, when intermixed with the magnesian rock in which it lies.

*Lustre.* None.

*Transparency.* Transmits a little light at the edges.

*Fracture.* Fine splintery.

*Hardness.* Strikes fire plentifully with steel.

Where it is in contact with the magnesian rock, it is much intermixed with it, has a green colour, and at length fairly passes into the talcaceous shistus of which the island is formed. Sometimes we find veins of crystallized calcareous spar traversing it.

## TALCACEOUS SHISTUS.

*LAPIS OLLARIS*, Waller. *TALCUM OLLARIS*, Lin. *TALC SCHEI-  
FER*, *VERHARTETER TALC*, Germanor. *TALCUM PROPRIUM  
OLLARI*, Werner.

*Colour.* Dark-greenish black, or yellow.

*Lustre.* Nearly as shining as silk.

*Transparency.* Sometimes transmits a little light at the edges;  
in other specimens, when it passes to ardesia, it is opaque.

*Fracture.* Shistose.

*Hardness.* Yields to the knife easily; but, as it passes to the  
state of argillite, becomes harder.

*Streak.* Grey.

This rock is to be observed passing, upon the one hand, to the chlorite slate, and, on the other, to ardesia. It is found in different parts of the islands of Isla and Jura, as has been mentioned in the preceding chapter.

LIME-

## LIMESTONE.

*Colour.* Dark blue.

*Lustre.* Very weak, principally from a few shining particles dispersed through it.

*Transparency.* None.

*Fracture.* Even, fine splintery.

*Hardness.* Yields with some difficulty to the knife.

*Streak.* Grey.

It forms the central part of the island of Iſla, and contains no petrifications; which renders it probable that it is of primitive formation. It may be objected to this, that all primitive limestones have a scaly or granular grain. We cannot doubt that, in general, this observation is perfectly correct; but it seems liable to exceptions: as Mr Kirwan, in his Geological Essays, mentions, upon the authority of the Helvetic Magazine, that the mountains of Wetterhorn, Wellhorn and Burghorn are formed of primitive limestone having a splintery fracture; and I shall afterwards mention primitive limestone, or marble, with a splintery fracture, as occurring in the Hebrides. Mr Kirwan further mentions, that, as some traces

of muriatic acid are to be found in secondary limestone, and none in the primary, this may serve as a good test for distinguishing them. I have not, however, made any experiment, with this view, upon the Isla limestone.

### COMPACT MARL—STONE MARL.

*VERHARTETER MERGEL*, Germanor. *CALCAREUS MARGA INDURATA*, Werner.

*Colour.* Yellow, or yellowish white.

*Lustre.* None.

*Transparency.* None; but, when much penetrated with filiceous matter, transmits a little light at the edges.

*Fracture.* Fine splintery.

*Hardness.* Yields with difficulty to the knife; and, when penetrated with filiceous particles, scarcely yields to the knife.

Is slowly acted upon by acids, and feels heavy.

It is used for the purposes of agriculture, but it requires several years before it falls.

MELAN-

## MELANTERIA, Pliny—BLACK CHALK.

*SHISTUS scriptura atra, ater inquinans*, Linn. *ARGILLA NIGRICA*, Werner. *SHISTUS NIGRICA*, Waller. *MELANTERIA*, Dr Walker.

*Colour.* Bluish black.

*Lustre.* Longitudinal fracture extremely little glancing, and the cross fracture none.

*Fracture.* Longitudinal fracture, curved flaty; but the cross, fine earthy.

*Streak.* Little glancing. Colours black, but without the lustre of plumbago.

*Hardness.* Pretty easily scratched with a knife.

This fossil occurs often in the neighbourhood of aluminous shistus; and is always found, disposed in beds, in the primitive mountains, particularly in ardesia. As it writes upon paper, and has a bluish-black colour, it has often deceived the uninformed, who have imagined they have discovered black lead: the difference of lustre, and other characters, however, sufficiently distinguish them. It has also been taken for coal, or reckoned a proof of the vicinity of coal strata. Thus, Dr Reufs,

Reufs †, in travelling through Bohemia, tells us, that he observed a shaft sunk several fathoms through ardesia, and, upon enquiry, he found it was in search of coal. This coal, however, upon examination, he found to be a species of aluminous slate, very nearly resembling black chalk. This should serve as a strong caution against making trials, without having first examined carefully the rocks which we think indicate the presence of coal; and farther, whenever any coal-like substance (which was the case here) is observed only among primitive rocks, it should excite a still stronger doubt, when we recollect that coal has never yet been detected, nor probably ever will, in any quantity, in primitive mountains.

SEIL,

† Mineralogische Geographie von Boehmen, Zweiter band, § 202.

## SEIL, EASDALE AND OBAN.

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### CHAP. XII.

*Voyage from JURA to the Slate Islands of SEIL and EASDALE;  
thence to OBAN and the Island of MULL.*

HAVING found it very inconvenient to examine the west and northern parts of Jura, Mr Macnicol, the minister of the island, (to whose kindness we were much indebted,) procured a boat, and we sailed from the harbour of the Small Isles to the island of Seil, a distance of about 30 miles. As the weather was charming, we kept close along the shore of Jura, which gave us an opportunity of landing upon different parts of the island. Having reached the northern extremity, the wind increased a little; soon after, we heard the great whirlpool, the Coryvrekan, raging, in the sound between Jura and the island of Scarba.

We

We now passed the rugged island of Scarba, which is apparently composed of micaceous schistus traversed by basaltic veins; next, the island of Luing, said to afford much ardesia; soon after, the small isle of Balinahuia, where there is an extensive quarry of ardesia; and, at some distance, we observed the island of Garveloch, where there is a considerable quarry of schistose marble\*, first discovered, many years ago, by Dr Walker. After much opposition from an extremely violent tide, we at length landed upon the island of

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S E I L.

THIS island, about 3 miles long, and 2 miles broad, is separated from the island of Easdale by a strait a few hundred feet broad, and from the mainland by a narrow pass over which a bridge has been thrown. The island is in general flat, yet not without hills, from the highest of which we have a pleasant view, of the many  
ny

\* This marble rises in flags of a considerable size, some 3 feet by 2, and even 4 feet by 3; takes a good polish; and is of a white or grey colour, and is sometimes clouded; and has a fine grain.



ny small isles scattered over the ocean, with the distant mountains of Mull and Jura.

The greater part of the island is composed of rocks of primitive formation, and these are micaceous schistus and ardesia. Basaltic veins are also very frequent, traversing both kinds of strata; and, where the stratified matter is washed away, or has fallen down by decomposition, the perpendicular veins appear often like basaltic crags, and, at first sight, may be taken for strata. Considerable veins of quartz are also to be observed traversing the primary strata upon the south and east shores of the island; and, near to the southern extremity, I observed a vein of quartz which contained a quantity of iron pyrites, but apparently too small to be of any importance.

Besides these primary strata, I observed, upon several parts of the island, small portions of the transition (uebergangsgebürge) and flötz rocks (flötzgebürge). Near to Mr Campbell's house, I observed the ardesia covered by grauwacken, and both apparently traversed with the same basalt vein; which leads us to suppose that they were formed at the same time; and, in support of this, I may mention, that German mineralogists have observed these rocks to alternate\*. Upon the side of the

B b island

\* Emmerling, Band. 3. § 105.

they are divided into quarriers and day labourers. The quarriers are paid annually at a certain rate for every thousand flates : from 10d. to 15d. I believe, as their work has been attended with more or less difficulty. The day labourers are employed at the company's expence in opening new quarries, and have from 10d. to 1s. a day.

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O B A N.

AS the weather continued very pleasant, we preferred going to Oban by sea, in place of the circuitous rout by land. Having procured a boat, we left Seil, with a fine breeze ; our voyage was agreeable, with scenery often striking ; on one hand, was the lofty coast of Mull, extending from Loch Bay to Crogan, all apparently basaltic ; on the other, the mainland rising into small hills, also with a basaltic aspect. Having passed the isle of Kerrera, which lies across the bay of Oban ; in a short time afterwards, we landed at the village. The bay of Oban is of a semicircular form ; is from 12 to 14 fathom deep, with good anchoring ground, and will contain 500 sail

of

of merchant ships. The village is pleasantly situated at the upper part of the bay, a station excellently adapted for the fishing. The decline of this branch of trade, has indeed been unfavourable to the rise of Oban; but it is, notwithstanding, the most considerable village on this part of the coast, containing about 586 inhabitants. It is to the exertions of the two brothers, the Messrs. Stevensons, who settled here in 1778, that Oban is chiefly indebted for its present flourishing condition.

As we were anxious to proceed on our journey through the islands, well knowing the variable state of the weather in these highland countries; we took but a glance of the rocks in the neighbourhood of Oban. The strata immediately upon the shore, on both sides of the town, are formed of dark blue coloured argillaceous shistus; immediately above this, I observed in some places basalt, or basalt porphyry. As we approach Dunolly castle, which forms the extreme point of land upon one side of the bay, vast rocks of breccia appear; and these continue all the way to Dunstaffnage castle\*. Both these castles

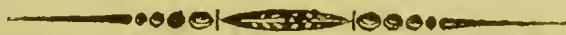
\* At Boregonium, which is a few miles from Dunstaffnage, there are, according to Dr. Garnet, undoubted volcanic appearances. Dr Walker informs me, that the pumice, which Dr. Garnet mentions, is the scoriae from the iron furnaces, which were worked at that place by our ancestors.

tles are built upon rocks of breccia, which is composed of variously shaped pieces of granite, micaceous shistus, and sandstone, connected by an arenaceous breccia. Upon different parts of the coast, and in the interior of the country, this breccia seems to lye upon a red coloured argillaceous sandstone. From Oban, the country becomes gradually higher as we approach the great mountain of Cruachan; and the strata also change. If we walk by the Inveraray road, we observe wacken, and sometimes basalt covering the sandstone; and in many places great rounded masses of granite, which formerly constituted part of the breccia, are to be seen scattered about. These sandstone and basalt strata, probably continue until ardesia and micaceous shistus, which form the lower region of Cruachan, make their appearance; and this is succeeded by the granite, which rises through it, and continues to the top of the mountain\*.

Mr. St. Fond has given us a chapter upon the lithology of Oban, in his travels through Scotland; but he has here, as usual, intermixed his theoretical speculations with the descriptions of the strata. He denominates the blue argillaceous  
shistus

\* I owe this information, with regard to Cruachan, to my friend Mr. Cad-dell.

shistus of Oban, a limestone; this, he says, is an aquatic production; but the basalt, he imagines to have been superinduced in a melted state under water, which prevented the limestone from being altered; and further, he describes the breccia as a volcanic matter, which has been thrown up in a similar manner with those volcanic eruptions “in which water heated to the highest degree of ebullition, enters into concurrence with fire, and the different elastic emanations generated by subterraneous combustion.” I must confess my inability to comprehend this explanation; at any rate, it is now useless to attempt supporting this part of the volcanic theory, as it has been demonstrably refuted by Mr Kirwan, in his paper on basalt.



*VOYAGE TO MULL.*

HAVING arranged every thing for the continuance of our journey, we set sail for the island of Mull, which is about 15 miles from Oban. In our way, passed near to the isle of Kerrera, of which Faujas gives the following account. “A part of this island is volcanic; on the coast fronting Mull, there  
“ are

“ are collections of compact lavas in masses, and in large currents. This basaltic lava appears sometimes in the form of prisms, which are not very regular; at least in the places I had an opportunity of examining. I also found some rocks of micaceous schistus of a whitish colour, and others which were greenish, with a porous texture. These schistus, or gneiss, are composed of quartz, steatites, and small scales of mica.

“ Near the rock of micaceous schistus, there is found common slate of a deep grey colour, approaching to black; the beds of which are almost even with the ground; quarries might easily be opened here with great advantage to the country. They would even become an object of commerce. Among the slate, there are found some brilliant pyrites, the crystallizations of which are cubical †.”

We next passed the island of Lismore, which is about nine miles long, but very narrow: it is according to Williams, composed entirely of limestone, traversed with basaltic veins. Dr. Mitchell supposes that the limestone belongs to the transition rocks.

† Travels through Scotland, &c.

rocks (uebergangsgebürge). From the greater part of the island and being formed of limestone, at the same time well sheltered, it is rendered one of the most productive spots in the Highlands. After a short voyage, we came close in with the coast of Mull, but on account of the tide, we were obliged to pull along the shore for some miles, which gave me an opportunity of examining the shore, until we landed on the coast below Achinacraig.

C c

MULL.

# M U L L.

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## C H A P. XIII.

### *Outline of the MINERALOGY of the Island of MULL.*

**T**HIS island is about 22 miles long, and 16 miles broad. It is reckoned by some writers to be the Maleos of Ptolemy \*; and Cambden is of opinion, that it is the Mille of Pliny †. On the north, it is bounded by Ardnamurchan; on the east, by the rugged sterile looking mountains of Morven, and the isle of Lismore; to the south, are the isles Jura, Scarba, and Slate isles; and on the west, I-kolmkill, Staffa, Coll, and Tiree.

The coast of this island is much diversified in its appearance; in many places we observe a great extent of steep and bold  
rocky

\* Campbell's Political Survey, vol. I. p. 599.

† Britannia, p. 848.



rocky shores, forming tremendous precipices; particularly upon the south shore near Loch Buy. Often the shores are low, but still rocky and dangerous; seldom is there any sandy beach, the coast being generally covered by the immense masses that have fallen from the neighbouring cliffs. It is low, however, towards the S. W. extremity which is called the parish of Rofs.

The island is very mountainous, and some of the mountains rise to a considerable height; particularly Ben-More, which is reckoned the highest in the island. It is much intersected upon the west side, where there are two considerable lochs or arms of the sea, called Loch Skridan, and the other Loch-na-gaul.

*MINERALOGY.* Achnacraig, where we landed from Oban, is situated at a little distance from the sea shore, with some considerable flats near it; and these being cultivated, and in some places wooded, enliven the scene considerably. The rocks are in general basalt and wacken, which are in many places traversed with basaltic veins. The occurrence of veins of basalt crossing a similar rock, seems to be very rare; as I am well informed, that foreign mineralogists, have never observed such appearances. Mr Faujas St. Fond, in describing

this part of the island, seems to have been much struck with one of these veins, which he compares to a circus; and has given a long detail of the way in which it may have been formed. This was all very unnecessary, as this vein does not differ from many others to be observed in the island; and the idea which Mr St. Fond raises of its magnificence, is far stretched—it is trifling when compared with the grand appearances upon the coasts of Isla and Jura. As we advance towards Loch Speleve, the cliffs upon the shore do not increase much in height; but there are land cliffs behind them considerably higher. The rocks are almost entirely of basalt and wacken, all the way to the loch, as also the hills in the neighbourhood. About half a mile from Achnacraig, I observed a stratum of blue coloured limestone, covered with calcareous sandstone; but these strata are visible only for about 80 feet, when they are lost under the basalt. This limestone contains in it belemnites, and is therefore to be reckoned with the transition rocks; and is what Mr Kirwan considers as the most ancient of the secondary strata\*.

As there is a good road, along the shore of the island, from Achnacraig to Tobermory, we preferred it to coasting by sea.

Having

\* Geological Essays, p. 226.

Having left Achnacraig, we passed, for about a mile, through little wooded glens, which are extremely pleasant, particularly in a country where wood is truly a rarity. The strata still continued basaltic, excepting at one place where I observed a stratum of blue-coloured limestone cropping thro' the soil. As we journeyed along the shore at the bottom of the high hills which bound it, I judged it necessary to examine some of them to their summits; that I might obtain more distinct information of their nature, and have an opportunity of surveying the neighbouring country. The day being fine, we began to ascend a high hill, about two miles from Achnacraig. The ascent was very steep, until we reached an extensive plain several hundred feet above the level of the sea. The strata, to this height, were basalt and greenstone, and both frequently traversed with basaltic veins. The greenstone, even at a considerable distance, has a singular scorified-like aspect, from the felspar having decayed, and the remaining hornblende, resembling a dark green, or blackish cellular mass, not unlike the scoria of an iron furnace. The plain was covered, to its whole extent, with loose stones of an iron-brown colour. Hardly a trace of vegetation could be seen; and the deep silence of this desert was disturbed only by the rushing of the cold piercing wind across the mountain. The loose masses of rock just mentioned, I found to be of breccia, which is composed of variously

riously shaped masses of quartz, earthy felspar, hornstone, and granite, connected by a basalt or wacken? basis †. It is probably of the nature of basalt tuff; which, according to German mineralogists, is a rock with a basalt or wacken basis, having, immersed, fragments of other rocks, as granite, quartz, &c. We now walked towards the summit of the mountain, which we reached, after having passed over a succession of smaller plains, or platforms, separated from each other by steep basaltic craigs. The summit is composed entirely of basalt, which contains much hornblende; and this rock has the property of reverberating the compass at a considerable distance, and even in detached pieces. From this elevated situation we had a fine view of the island. Towards Tobermory the mountains appear to become gradually lower; but, upon the west side, a tremendous groupe of variously-shaped mountains appears before us, and among them Ben-more rises with much dignity. The glens, which we observed run from the mountain, are of great depth, very steep, and apparently composed of strata of basalt and greenstone. These strata, however, run in a direction contrary to that of the vallies, which intimate that the land has

† I am obliged to mark this doubtful, as I unluckily lost the specimens, which would have enabled me to determine the nature of the basis.

has sunk down, as we have already explained in our speculations upon the formation of the bed of the Clyde. We now descended from the mountain, but by a different route from that which we followed in ascending; and although it was fatiguing and difficult, it afforded us an opportunity of observing the basalt and greenstone alternating with each other, and elevated nearly to an angle of  $45^{\circ}$ .

We now continued our journey along the Tobermory road, with hills upon one hand, but in a short time the land on the other became low, stretching out towards the fount of Mull, to a point on which is situated Duart Castle. The hills, as also the hills near the shore, are still basaltic; but we were informed that there is, at the castle, a great stratum of limestone, which affords cornua ammonis and shells. As we approached Achnacrossh, we observed, upon the shore, strata of argillaceous sandstone, with interspersed bituminous and coaly matter, as is usually the case with sandstone in coal countries; and, at a little distance, a rock, which seems to be analogous to greenstone, of which a particular description is given in the following chapter.

From this to Arros the shores are low, but the hills rise to a considerable height; and both are formed of basalt, greenstone,  
and

and wacken, which I sometimes observed traversed with basaltic veins. The basalt, but more particularly the wacken, contains zeolite, which is either compact, fibrous, or crystallized. I regretted extremely that I had not an opportunity of examining this part of the country more particularly, as there can be no doubt but that it would afford much curious information with regard to the rocks of trap formation. I have however to offer as an apology, (if such a thing is becoming,) that, in travelling over all that track of country, we were envelopped in thick clouds and pouring rain; so that the few observations as to the nature of the hills, were made by examining the debris in the ravines, or were now and then assisted by the partial dispersion of the clouds. I may now also remark, that, in travelling these countries with a view to the particular examination of their mineralogy, it will be absolutely necessary for the traveller to carry along with him a tent, and other conveniences, so that he may encamp among the mountains, and examine them leisurely, and with that scrupulous accuracy which the importance of the subject requires.

At Arros there is a small colonade of basalt, upon which there are still the remains of an old castle, once inhabited by Macdonald prince of the Isles. In the bed of the river of Arros, (a small stream of water which comes from the neighbouring  
basaltic

bafaltic hills,) I observed numerous blocks of granite, fimilar to thofe upon the hill near Achnacraig. Thefe blocks feem to be derived from a bafalt tuff fimilar to that obferved near Achnacraig; and it is probable that fuch a rock may be difcovered in the neighbouring hills. It will be an object worthy the attention of future travellers, to afcertain, whether this bafalt tuff? merely covers the bafalt, as has been obferved by Reufs in the mountains of Bohemia, or alternates, as is the cafe with the bafalt tuff in the ifle of Canna, and in other parts of Scotland. It matters not in which of thefe fituations it be found: it is ftill to be confidered as a fecondary rock, and, like thefe, to have been deposited from an aqueous fluid. Probably fome may think that thefe maffes have been feparated from the decomposing bafalt itfelf, as it fometimes contains pieces of granite. This, however, is an appearance fo rarely to be obferved in this ifland, that I can hardly imagine the granite blocks to be derived from that fource.

Profeflor St. Fond has speculated upon this fubject, as he obferved fimilar appearances in different parts of the ifland. For the information of my readers, I will extract the following paffage from his Travels. “ Thefe lumps of granite (fays he) may have been  
 “ ejected from granite quarries, which perhaps exifted at great

“ depths under these ancient volcanoes, by the explosions which  
“ took place at that epoch, when extensive combustions wasted  
“ these countries, and formed groups of islands, which seem  
“ to have the same origin.

“ It is, besides, within the verge of possibility, that those  
“ parts of the mountains where they are now found were not,  
“ at that period, elevated summits, but rather formed part of  
“ the bottom of the sea, and that these granite blocks were  
“ rolled from a distance by the currents. It is possible that  
“ circumstances of subterraneous explosion, equally terrible  
“ with those which formed the isle of Santorini in the Archi-  
“ pelago, or Montenove in Italy, may have raised up the bot-  
“ tom of the sea into volcanic peaks; or, if it should appear  
“ more plausible to some, we may refer to a period when  
“ mountains still higher were covered by the sea: a fact, which  
“ cannot be doubted, since marine bodies are found in great  
“ abundance in beds of limestone, or clay, situated on the Alps  
“ or Appenines, at a height three or four times greater.”

At Arros, we changed our route; and in place of going on  
to Tobermory, we took our course across the island to Luggan  
Ulva. The road, which is but indifferent, leads us among  
hills of no considerable height, to the plain of Knock, situ-  
ated



ated at the head of Loch-na-gaul. The hills are composed of strata, of basalt, and wacken; which are sometimes traversed with basaltic veins. The loch, which is of considerable extent, is bounded upon one side by the mountain of Ben-more, with other neighbouring hills, that extend towards the sea shore, forming lofty crags, not unlike those of Salisbury Hill near Edinburgh; on the opposite side, are the hills that bound the road which leads towards Luggan Ulva. Ben-more, which is the highest mountain in the island, is of considerable magnitude; and Mr St. Fond remarks that it has much the appearance of the famous volcanic mountain Vesuvius. We did not ascend this mountain, so that I cannot give any account of the rocks of which it is composed; but I have had the opportunity of examining specimens brought from it by Mr. Caddel. It would seem from these, that it does not differ from the other parts of the island which I have already described, being composed of basalt and greenstone; even to its very summit. This agrees pretty nearly with the observations of Mr. St. Fond, who tells us, that it is composed of lava; that is basalt. We pursued our journey along the opposite side of the loch, which led us to Luggan Ulva; I found little variety of rock; the basalt and wacken strata traversed with basaltic veins, still continu-

ing. The wacken, however, affords many beautiful specimens of zeolite, and also a rarer fossil, the prehnite.

Nearly opposite to Luggan Ulva, lies the small island of Ulva, which is evidently composed of the same rocks; and farther distant, is the isle of Geometra, which is also basaltic.

As soon as the weather, which had been for some time tempestuous, became moderate, we crossed at the mouth of Loch-na-gaul, and landed immediately under the high cliffs, which we had seen from the head of the loch. We now walked along a considerable extent of shore, which is bounded by lofty crags, composed of basalt and wacken strata, and both traversed by basaltic veins, which run in very different directions. Immediately upon the shore, I observed strata of argillaceous sandstone, and sandstone breccia; and we were told, that both coal and lead had been discovered in several places in the neighbourhood. About 200 feet above the level of the sea, on the tract which takes us across the mountains to Loch Skriddan, our attention was arrested by the appearance of a curious species of breccia. It is composed of fragments of quartz, micaceous schistus, compact limestone containing flint, and the whole cemented by an arenaceous basis; sometimes it has a calcareous basis, when it has a yellow colour, owing  
to

to a decomposition of the limestone. Below the breccia we observed a compact micaceous shistus. In going higher up, we had a more distinct view of the stratification; which is as follows: 1. Micaceous shistus. 2. Breccia covering the micaceous shistus. 3. Sandstone, more or less of the nature of breccia, covering the breccia. 4. And higher up the mountain appeared the basalt; but we could not determine correctly its situation with regard to the strata just mentioned. The appearance of micaceous shistus in a basaltic country, is a singular phenomenon, well deserving the attention of future travellers.

From this, we continued our journey in the direction of the great Bourg head, (a lofty promontory at the entrance of Loch-skriddan,) over which we crossed, and descended to the shore of Lochleven or Skriddan. The strata in this tract are still basalt and wacken; and both are traversed with basalt or wacken veins; and contain much zeolite. I accidentally discovered a piece of black pitchstone porphyry, similar to that which is found in Glencloy, in the island of Arran. This Loch, which is pretty extensive, is bounded on both sides by basaltic hills; and at its upper extremity, there is a grand groupe of basaltic hills that congregate nearly to the opposite side of the island, about Loch Spelve. We crossed the loch  
near

near its mouth, and walked along the shore, which is low and basaltic, until we approach Artown, when it juts out into a promontory, which presents several very beautiful ranges of basaltic columns. Upon the N. E. side of the promontory, we observed, immediately upon the shore, a stratum of coal, which has for its roof a mass of imperfectly shaped basaltic pillars; and its floor is also basalt. The stratum is about 12 inches thick; and sometimes interposed between it and the basalt there is a thin layer of blues (shistose clay), which is mixed with the coal, and deteriorates its quality. We could only observe the stratum running for a short way, as the sea has thrown up debris along the bottom of the rocks, where the coal is situated: yet we were told, that it is to be seen cropping out upon other parts of the coast. As the country is low in the neighbourhood of the coal; it is certainly worthy the attention of the proprietors, to endeavour by trials skilfully conducted, to know how far this stratum extends; and whether other strata exist near to it. It has been objected to this, that if any trials should be made, it would merely satisfy curiosity, without the probability of success; as it is imagined that basaltic rocks are very unfavourable to coal. We cannot deny the fact, that coal is seldom so regular under basalt, as under sandstone; yet, in a country where the best part of the year is wasted in the operations of cutting and drying peat, there

there can be no doubt, that the discovery of a bed of coal, (although it should not be so extensive as those in the sandstone countries), would be of the highest importance.

We are further encouraged to make regular trials, when we know that in other parts, considerable beds of coal have been found among similar rocks. Thus at Borrowstounness, according to Mr. Williams, we find thick strata of basalt interposed between beds of coal, which are worked to a great extent: and in the Bathgate hills, coal and basalt alternate with each other\*. In Bohemia, according to Reufs, coals inlaid in basalt are worked †; in the Faroe islands, coal is found in strata among basalt ‡: at Meissen, in Hesse, a bed of coal from 6 to 90 feet, is found covered with basalt, to the height of 600 feet ||.

Mr Mills, in the paper which I have already mentioned, when describing Isla and Jura, gives an account of a remarkable appearance near Artown, which unluckily I had not an opportunity of viewing. As it will be interesting for future  
travellers

\* Williams's Mineral Kingdom, vol. 1. p. 70.

† Mineralogische Geographie von Boehmen.

‡ Haidinger Gebergsarten.

|| Bergm. Journ. 1792, 319, and Kirwan Geological Essays, p. 311.

travellers, I shall here insert his description, and make a few observations on it.—“ About a quarter of a mile from the spot where the bearings were taken, is a deep glen, running N.N.E. to the sea. It is about 30 yards in length, and 20 in breadth. The strata are disposed in the following manner: The uppermost is 10 yards of lava, with horizontal divisions, and vertical joints, taking the form of rude pillars. Under this, is a horizontal bed of perfectly vitrified substance, which appears to have been a shale, and is from 1 to 2 inches in thickness. Beneath this, is about three yards of siliceous gravelly concrete; below which, are horizontal beds of indurated marl of various thickness, from 6 to 12 inches. The whole of these beds taken together, are about four yards; and there is a large fissure in them, on the west side of the glen. Lastly, are 10 yards of rude lava, containing specks of quartz, and mica unaltered; pieces, apparently of granite; and in some, nodules of calcined chert. The whole is incumbent on regular basalt pillars of various dimensions, from 18 to 6 inches in diameter, varying in their number of sides; some having 5, some 6, others 7, &c.” This gentleman, by denominating his fossils upon theoretical principles, has thrown a considerable degree of obscurity over his description. To me, the following appears to be the true account:—

*Lava*

*Lava.*—This is probably basalt: for he appears to use this term in different parts of his memoir, as expressive of all kinds of basalt.

*Vitrified substance.*—This is certainly the same with the black pitchstone which we have already observed upon the opposite side of Loch Skriddan; and which we were told had been found near Bunefan and at Bennenoch.

*Siliceous gravelly concrete.*—Probably a coarse sandstone? If this supposition be correct, it is another example of pitchstone being contained between sandstone and a rock of trapp formation, similar to that I suspected in the island of Arran.

*Indurated marle.*—This is probably the same with the limestone, which contains flint upon the coast between Loch-na-gaul, and Loch-Skriddan.

*Calcined chert.*—This is likely hornstone; which, however, is a rare occurrence in basalt. Emmerling. B. 3. § 187.

We now left Artown, and walked on to Bunefan; the country still continued to be formed of basalt, containing many

beautiful specimens of zeolite passing to chalcedony, and also prehnite. Near to this place, there is a little river which marks the termination of the secondary, and the beginning of the primary strata. Upon the east bank, I observed the basalt; but upon the west, the strata are of micaceous schistus. I endeavoured, as far as my short time would allow me, to discover the junction of the strata, but was not so fortunate as to observe them in actual contact: yet, I think it not improbable, that the basalt lies upon the micaceous schistus. This supposition, may to some appear to invalidate the observation I have made in a former part of the work, viz. that basalt is never found among primary strata. This is by no means the case; for here, the basalt forms a great extent of country; and in some places, as at Artown, it contains coal; so that, although it lies on micaceous schistus, without any intervening breccia, it cannot be considered as primitive. It appears to me a good mode of ascertaining whether a rock be primary or secondary, to examine whether it alternates with strata decidedly primitive; and whether, at its junction with the primary strata, it seems to be in part intermixed, and partly assuming the nature of these strata; thus intimating that they have been deposited at the same time.



The micaceous schistus extends quite across this part of the island; and continues for about a mile after we leave Bunefan, in going to the southern extremity of the island. In this extent it is somewhat varied in its appearance, being more or less compact, sometimes containing garnets, and traversed with basaltic veins. In other places, as upon the side of Loch-Artineg, I observed it alternating with strata of quartz, from one to three feet thick, and which broke into thin layers.

To the micaceous schistus succeeds beautiful red granite, which continues to the extremity of the island, forming low, round-shaped hills. This part of the island, which is called Rofs, is low, intersected with small lakes, and diversified with natural wood. The shores are low, but rugged and broken; and in some places we observed large empty fissures, which appear to have been formerly filled, either with an earthy matter, as basalt, or with a metallic ore. The granite appears to be disposed in beds, as we have already mentioned to be the case in Arran. Dr Walker, many years ago, observed this disposition of the granite, not only in Mull, but in many other parts of Scotland; which is a further and decisive proof of the fallacy of La Metherie's observations. The granite sometimes splits into rhombs, and what is more uncommon, into columns, not unlike basalt. This appearance of columnar granite is,

I believe, rather a rare occurrence; at least I do not find it mentioned but by Reufs, who discovered beds of granite split into columns, not unlike basalt\*. In many places I observed basaltic veins traversing the granite; and these are of various sizes, and run in very different directions. Upon the side of Loch-Artineg I observed a vein running through the granite, visible for nearly a mile, and often branching out in different directions. Sometimes I observed pieces of granite included in the basalt veins; and in one instance I observed the granite, which bounds the side of the vein, mixed with the basalt.

The fourth side of Ross continues to be formed of granite and micaceous schistus, until we come upon a line with Bunefan, when the basaltic rock commences. From this to Loch-Buy the country and coast are principally formed of basalt and wacken, excepting at Gribun, where sandstone and limestone are to be observed, and at Carseg, where there are considerable appearances of limestone. The rocks upon this coast, in some places, rise to a most tremendous height, particularly at Innimore, where we observe many ranges of basaltic columns towering

\* Mineralogische Geographie von Boehmen, Erster band, § 120. I think that Saussure, somewhere in his Travels, mentions a similar appearance.

towering above each other with vast magnificence. This stupendous scene is rendered doubly interesting when its rocks are obscured by a tempest: the dashing of the furious ocean below; and the fall of vast cascades from the rugged summits, seen dimly thro' the clouds, present a scene of uncommon sublimity.

There are several appearances of coal upon this coast, but the most remarkable is that upon the hill called Beinan-ini. This hill is composed of horizontal strata of basalt and wacken, which alternate, and rise to the top of the hill like great natural terraces. The coal appears in the bed of a rivulet upon the side of the mountain; is about three feet thick, and is immediately covered by basalt. It is one of the greatest strata of coal that has yet been discovered in the Western Islands, and consequently is worthy of particular attention. Several trials have been made with a view to the working of it; but of a nature so trifling, that they can deserve notice only as showing how little the importance of the subject has been understood. Sir David Murray of Stanhope, so far as we can learn, was the first gentleman who seems to have been aware of its consequence; for, about the beginning of the last century, he purchased this hill solely on account of the coal which it contains. He proposed to open the stratum in a very extensive manner,  
and

and to work it until he should be satisfied whether it was practicable to continue it to advantage. This scheme was unfortunately frustrated by a failure in his affairs, which made him stop working a short time after he had begun. Since that period, the property has come into the possession of Sir James Riddell of Ardnamurchan, who seemed inclined to continue the work of his predecessor; but the business appears to have been committed to persons who were satisfied with making very superficial and unsatisfactory trials. This is much to be regretted, when we consider, that the establishment of coal-works, in so central a spot of the Hebrides, would not only be a great comfort to the inhabitants of the islands, where peat is scanty, and not to be procured without difficulty, but would make all the operations of the farmer to go on with new life, and would, in every way, contribute much to the improvement of the Western Islands. It is therefore worthy of the public spirit of the highland proprietors, to form a general subscription, so as to enable them to determine the question, whether the coal of Mull can be worked so as to be advantageous to the inhabitants of the west coast of Scotland and the Hebrides.

Having spent a few days in Ross, which gave us an opportunity of examining I-colum-kill, we walked again to Loch-Skriddan,

Skriddan, where we took a boat, and rowed along the lofty coast to Luggan-Ulva. In our way we passed the small island of Inch-Kenneth, remarkable not for its variety of fossils, as it is composed of red-coloured sandstone and limestone? but for the interesting account which Dr Johnson has given of the happy family of Sir Allan Maclean.

We now walked from Luggan-Ulva to Torloisk, the seat of the late worthy Mr Maclean. The shore is rugged; but the country is in several places considerably cultivated, particularly near Torloisk. The rocks, all the way, are of basalt and wacken; and both contain beautiful specimens of zeolite, which are generally fibrous, and sometimes appear passing to chalcidony. I observed, in some places, a red-coloured wacken alternating with the basalt. I also remarked blocks of granite similar to that we observed at Arros.

From Torloisk to the northern extremity of the island, the same basaltic rock continues; and, so far as I could judge, the whole of the coast towards Tobermory is of the same nature.

GENERAL

*GENERAL OBSERVATION.* From this rapid and imperfect outline, it appears, that a great portion of this island is composed of rocks of trap formation, and that they even form many of the high hills. The primary strata, upon the other hand, form a very small part; being confined (as far as my experience goes) to the parish of Ross, and the small patch upon the shore between Luggan-Ulva and Loch-Skriddan.

MULL.

M U L L.

---

C H A P. XIV.

*Description of the FOSSILS mentioned in the preceding Chapter.*

IT may appear unnecessary again to introduce an account of the ardesia tegularis, as I have described it in Arran and Jura. The description which now follows, however, is that of one of the most celebrated slates in Britain, and therefore it should not be omitted.

ARDESIA TEGULARIS—*from Easdale.*

*Colour.* Dark blue.

*Lustre.* Little shining.

*Transparency.* None.

*Fraçture.* Perfectly slaty.

F f

*Fragments.*

*Fragments.* Tabular.

*Hardness.* Yields pretty easily to the knife.

*Streak.* Of a lighter colour than the slate itself; and the powder does not feel greasy.

*Adhesion.* Does not adhere to the tongue.

*Smell.* Pretty strong earthy smell when breathed on.

This species differs from that of Bute, in containing less magnesia, and being more durable. It frequently also contains cubical crystals of pyrites, and these long resist decomposition.

GRAUWACKE, German—*Island of Seil.*

RUBBLE STONE, Kirwan's Mineralogy.

This species is composed of fragments of ardesia and quartz, with scales of mica, or talc, connected by a reddish argillaceous matter. This genus of rock was for some time imagined to be peculiar to the Hartz (the great mining country belonging to the Elector of Hanover); but later investigators have observed it in other parts of the continent of Europe. We have much information concerning it in Lazius's observations upon the Hartz.

LIME-



LIMESTONE—*Achnacraig.*

*Colour.* Dark blue.

*Lustre.* A degree of lustre owing to dispersed foliæ.

*Transparency.* None.

*Hardness.* Difficultly scraped with the knife.

*Fracture.* Earthy; sometimes approaching splintery.

Has pyrites dispersed thro' it; and sometimes I discovered it to contain Belemnites. By decomposition it acquires a yellowish colour, and this is much aided by the presence of the iron pyrites.

GREENSTONE?—*Achnacrofb.*

*Colour.* Whitish, from the great proportion of felspar?

*Lustre.* None.

*Transparency.* None.

*Hardness.* Gives fire pretty freely with steel.

*Fracture.* Earthy.

This rock appears to consist principally of a whitish-coloured matter, which is probably of the nature of compact felspar; and, intermixed with it, I discovered small portions of a green-coloured substance resembling hornblende, with a few interspersed crystals of common felspar and iron pyrites. It acquires a brownish-white tægmen by decomposition.

GREENSTONE—*Hill near Achnacraig.*

GRUNSTEIN, German. SAXUM FERREUM, Waller. SAXUM  
GRANDÆVUM, Linn.

The greenstone found upon this hill is composed usually of equal portions of white-coloured felspar and dark-green hornblende. I also observed specimens where the hornblende forms the greater part of the stone, and the felspar imbedded in it as a basis. In others, the felspar and hornblende are so intimately combined together, that it is only by the decomposition of the stone that we discover its compound nature.

HORN-

HORNSTONE—*Hill near Achnacraig.*

*Colour.* Brown.

*Lustre.* None.

*Transparency.* Transmits a little light at the edges.

*Fracture.* Fine splintery.

*Hardness.* Gives sparks freely with steel.

By decomposition it takes a cream colour, and an earthy fracture; and, in this state, the diffused particles of quartz are rendered more distinct, from their longer resisting the influence of the weather.

## EARTHY FELSPAR.

*CONTINUOUS FELSPAR*, Angl. *FELSPAR EN MASSE*, Dolomieu.

*PETROSILEX*, Journ. de Phys. New Series, vol i. La Mether.

Theorie de la Terre.

*Colour.* Brick red.

*Lustre.* None.

*Fracture.* Earthy.

*Trans-*

*Transparency.* None.

*Hardness.* Give sparks freely with steel.

Dolomieu, in a paper published in the *Journal de Physique* \*, endeavours to prove that this fossil is distinct from felspar, and, after a long chain of observation, he concludes by naming it Petrofilex. La Metherie, who seems of the same opinion, denominates the true hornstone of the Germans Keratite, and agrees with Dolomieu in applying the term Petrofilex to this fossil †. I am, however, still inclined to think, that it will be more correct to use the terms hornstone and petrofilex in the signification as adopted by Werner; and that the petrofilex of Dolomieu is to be considered as a species of felspar; or, if it be truly distinct from every other fossil, that it should be distinguished by a name that has no reference to one already in use. Dolomieu always refers it to the rocks of primary formation; yet this is not quite correct; for Reufs † mentions a species of porphyry, with a basis of earthy felspar, resting on sandstone.

LIME-

\* Vol. i. New Series.

† *Theorie de la Terre*, tom. ii. p. 173.

‡ Reufs, *Aufsatze*, § 388. *Mineralogische von Boehmen*, B. ii. § 124.

LIMESTONE—*between Loch-na-gaul and Loch-Skriddan.*

*Colour.* Yellowish.

*Lustre.* None.

*Transparency.* None.

*Fracture.* Fine splintery.

*Hardness.* Scarcely yields to the knife, and sometimes strikes fire with flint.

Contains, sometimes, crystallized rhomboidal calcareous spar; also dispersed particles of quartz; which are frequently so plentifully intermixed, as to increase the hardness very much. But the most remarkable intermixed substance is flint and hornstone.

The flint has the following characters:

*Colour.* Greyish black.

*Lustre.* Like that of common flint.

*Transparency.* Transmits light pretty freely, but objects cannot be discerned.

*Fracture.*

*Fracture.* Conchoidal; sometimes multiplied conchoidal.

*Hardness.* Gives sparks plentifully with steel.

It has immersed in it particles of quartz similar to those we observe in the limestone; and also intermixed is the hornstone, which has the following characters:

*Colour.* Light blue.

*Lustre.* None.

*Transparency.* Allows light to pass at the edges.

*Fracture.* Nearly even.

*Hardness.* Gives a few sparks with steel.

It has also, interspersed, calcareous spar and quartz. By action of the weather, it becomes opaque and white; and the quartz and calcareous spar falling out, causes the hornstone to have a cellular appearance. Not unoften we observe the hornstone passing to flint, and *vice versa*.

Dr Walker, in his mineralogical lectures, informs us, that, although he has travelled over a considerable extent of Scotland, he has seldom observed any appearance of flint. This warrants us to conclude that it is a rare production in Scotland.

land. Similar limestone rocks, containing flint, occur in the north of Ireland, in Switzerland †, and my friend Mr Deriabın informs me that he observed a rock resembling that of Mull in Transylvania.

GRANITE—*from Ross, in Mull.*

This granite, which forms the coast of Ross, in Mull, is composed of beautiful flesh-coloured felspar, white quartz, and black mica. Sometimes the granite is very small-grained, with a great proportion of black mica, which gives it a blackish colour; or we observe it where the felspar is in the greatest proportion, when it has a fine uniform red colour. Rarely we observe whitish-coloured crystals of felspar, and steatites; which last, according to the observations of Werner, is formed by the decomposition of the mica.

G g:

BASALT:

† Helv. Mag. 116.

BASALT—*Torloisk, Luggan-Ulva, &c.*

*Colour.* Black.

*Lustre.* Slight degree, from a number of very minute, shining particles.

*Fracture.* Even, passing to conchoidal.

*Hardness.* Gives a few sparks with steel.

*Streak.* Grey.

The weather seems to have very little effect upon it, excepting when it contains iron pyrites. It frequently contains zeolite, which is generally radiated; and is sometimes to be observed passing, by imperceptible gradations, to fine milk-coloured chalcedony. As the late Mr Pelletier of Paris has shown that zeolite contains potash, and as it here passes to chalcedony, it is not improbable that some species of chalcedony may afford alkali.

WACKEN,



WACKEN, highly impregnated with Iron—*Torloisk.*

*Colour.* Tile or copper red.

*Lustre and Transparency.* None.

*Fracture.* Even.

*Hardness.* Yields with considerable difficulty to the knife.

Is very heavy, and emits an earthy smell when breathed upon. I observed it passing into common-wacken.

G g 2. O N 7

# ON COAL.

---

## CHAP. XV.

### *Method of discovering COAL.*

**A**FTER the description which I have given of the different appearances of coal in the island of Mull, I intended to have added a short account of the method to be followed in discovering coal strata or veins; but I found that this would be more distinct if detailed in a separate chapter. I shall now, therefore, state the observations.

If a certain extent of country is supposed to contain coal, we should begin our examination by determining the extent of the primary strata; which will considerably abridge our labour, as these strata never contain coal.

We

We should next examine the nature, direction, dip, and relative extent of the different secondary strata; which will give us an opportunity of discovering any appearances that indicate the presence of coal. These particular places are to be examined with the most scrupulous accuracy; and the coal strata to be sought for by digging, or boring, according to the nature of circumstances.

Such is the general mode of proceeding in these researches. I shall now mention, particularly, the rocks which are indicative of coal; then the method of determining whether coal strata do exist in a certain situation—first, as determined by the appearance of fragments of coal, and, secondly, by boring, where no actual appearance of coal is discovered.

The principal rocks, which are mentioned by mineralogists as indicative of coal, are the following:

1. White argillaceous sandstone. If this sandstone has, interspersed, bituminous or carbonaceous matter, it is reckoned a good symptom of the vicinity of coal.

2. If

2. If bituminous shale, shistose clay and argillaceous ironstone are observed, it is a further, and a very favourable symptom of coal.

3. If sandstone and limestone alternate, and be accompanied with bituminous shale, it is reckoned favourable for coal.

4. Sometimes where sandstone and basalt alternate, coal has been found.

5. Mr Kirwan remarks that there is great probability of finding coal in the neighbourhood of mountains of argillaceous porphyry †.

6. Although coal has never been observed alternating with primary strata, yet it has sometimes been found in their immediate vicinity; and coal has even been observed lying on granite. I believe, however, that such coal strata are generally trifling.

Having

† Geological Essays, p. 347.

Having, from an accurate investigation, discovered such strata as render the presence of coal probable; we must next endeavour to discover its actual existence. To do this, we must examine the beds and banks of rivulets, where, if small pieces of coal appear, we may be pretty certain that coal strata exist near at hand. Ditches are to be examined; for, in forming them, it is often necessary to cut thro' the thin covering of gravel and sand which conceals the crop from our view. We sometimes observe a sooty-like matter spread on the ground: this is formed from the decomposition of coal, and is therefore a good symptom of its vicinity. Not unfrequently we observe masses of coal, or bituminous wood, immersed in the breccia which is observed in coal countries: but this is often a fallacious appearance; for, upon cutting thro' the breccia, we find that the subjacent rocks contain no coal; so that the pieces of coal or wood, which the breccia contains, are to be considered as merely accidental.

After having observed any of the above-mentioned appearances; our next endeavour is to observe the crop, or the outburst, of the strata. This is a matter of much difficulty; and requires particular attention to the disposition of the fragments of coal, &c. If they be found upon the banks or bed of a rivulet,

vulet, we must search from one extremity of the ravine to the other, to discover the crop of the stratum. If the foot-like matter is observed, it will be necessary to remark whether it lies upon a declivity or a plain; as inattention to these circumstances has often been the cause of great disappointment and expence to the coal-miner in overshooting the stratum, that is, cutting beyond its real situation. Upon a declivity, we know that the decomposing and loose matter of a crop will naturally spread downwards, in proportion to the steepness of the ground. On this account, wherever appearances of coal occur upon a declivity, we must trace the debris upwards; when we shall find it increase in depth towards the crop, and the coal is less and less decomposed as we approach nearer to it. On the other hand, where the footy matter occurs upon a plain, we always find it thicker, and far less spread, than upon a declivity; and, what is of consequence, it often spreads in a direction contrary to the rise of the strata. If we are so lucky as to observe the crop, we now endeavour to detect the stratum; which we do, either by digging towards its dip, or by following the fragments of coal until we have the stratum fairly under our eye.

It often happens, however, that a country may be, in general, very favourable for coal, yet no pieces of coal or sooty matter are to be observed, owing to the coal strata lying deep: in such cases a good deal of discernment is necessary to determine the particular places where the trials are to be made. As it would be very expensive, in such cases, to dig down until we should meet with the coal, the common practice is to bore the ground; by which, at a small expence, we can know the magnitude and nature of the strata, to a great depth.

In searching for coal, by boring, our first object is, to determine the point to which the strata rise; as it is this which enables us to determine at what place we shall begin to bore. The plan, at the end of this chapter, will sufficiently explain the mode of proceeding in this operation. Suppose A B C D to represent a tract of country which is suspected to contain coal, and where the rise of the strata is towards A. We there make the first perforation, which will pass thro' the strata 4, 3, 2, 1, to the depth of ten or twelve fathoms. If no coal occurs among these strata, it is better to make a new perforation, than to sink deeper. We therefore proceed onwards to B, where we suspect that the stratum 5 is ten or twelve fathoms deep. We here bore through the strata, 8, 7, 6, to 5;

H h

and,

and, as no coal occurs, we do not bore deeper, but proceed to the point C, where we make a perforation through the strata 11, 10, 9, to 8. By being still unsuccessful, we proceed onwards to D, where the stratum 11 will be about ten or twelve fathoms deep, and here we find coal at 12.—By this practice, it is plain that that no stratum of coal can escape notice, as the last perforation always reaches down to the stratum which was nearest to the surface in the former bore.

Having discovered the breadth of the stratum, either by digging, when it is near the surface, or by boring, when it is covered by a great load of other strata; our next concern is, to determine whether it be of sufficient importance to be worked. If it is not more than 15 inches in breadth, even altho' pretty near the surface, it is not worth working; but if it be two feet, or two feet and a half wide, and of good quality, it can be worked in most situations with advantage.

The quality of the coal is ascertained from the following circumstances:

1. Its general appearance: whether it be more or less mixed with stoney matter; or if there be laminæ of bituminous shale

or



or sandstone, dividing it into stratulæ; or if it contains much pyrites or sulphuret of iron.

2. To these may be added the test of chemical analysis, by which we ascertain the proportion of carbon, bitumena and ashes.



*Plan illustrating the method of boring for Coal*







# MINERALOGICAL TRAVELS

THROUGH THE

HEBRIDES, ORKNEY AND SHETLAND ISLANDS,

AND

MAINLAND OF SCOTLAND,

WITH

DISSERTATIONS UPON PEAT AND KELP.

IN TWO VOLUMES,

*ILLUSTRATED WITH MAPS AND PLATES.*

---

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IRISH ACADEMY, OF THE HONOURABLE DUBLIN SOCIETY, OF THE  
GEOLOGICAL SOCIETY OF LONDON, OF THE PHYSICAL  
AND MINERALOGICAL SOCIETIES OF JENA, &c.

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M I N E R A L O G Y

OF THE

*SCOTTISH ISLES.*

VOLUME II.

---

*I-COLUMB-KILL AND STAFFA.*

---

C H A P. XVI.

*Outline of the MINERALOGY of I-COLUMB-KILL and STAFFA.*

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I-COLUMB-KILL.

THIS island is mentioned by writers under the different names of Hii, Iona, and I-columb-kill; but it is now generally denominated by the inhabitants I, or I-columb-kill: the

latter name being derived from St. Columba, the tutelary faint of the Hebrides. It is about three miles long, and from half a mile to a mile and a half in breadth. It is low, (yet not without hills, of which Dun-ii is the highest,) bare and rugged, excepting in the neighbourhood of the religious houses, where the ground is flat and cultivated, yielding about 140 l. per annum, which is nearly the rent of the whole island. The shores are in general low and rocky, yet in a few places there are pretty high cliffs.

*HISTORR.* The early history of this island is involved in the general obscurity which veils the ancient history of Scotland; so that the many traditional tales concerning it, which have reached our times, are not worthy of serious attention. The most ancient written records that concern it, are not earlier than the æra of the landing of St. Columba. This remarkable man left Ireland, his native country, not, as Mr Pennant remarks, from discontent, but with the noble and generous intention of dissipating the ignorance which then covered the Hebrides. He landed finally upon I, where he built religious houses; and the island was soon afterwards presented to him by Connal king of Scotland. Having contributed much to the diffusion of Christianity through the wilds of the Hebrides, and other parts of Scotland, he died, at the age of seventy-seven.

ven. He was certainly a man of much piety and goodness of heart; and his manners, altho' extremely austere, were well calculated for the people of the age in which he lived. For two hundred years after his death, the religious of this isle lived quietly, and in the high estimation of all the country. About the year 716, the ferocious Danes, who had harassed every part of Scotland with their barbarous invasions, at length disturbed this seat of religion and learning; massacred the greater part of the monks, and drove the remainder from the island. Some time afterwards the whole of the Western Islands were subjugated to the regular Danish government, when many of the monks again returned to I. From this period, however, the college of I gradually declined, until the twelfth century, when the Romish priests having got possession of all the monasteries, the Culdees, or sect of St. Columba, were dispersed, and gradually sunk from notice, leaving behind them a high reputation for learning and virtue.

*MINERALOGY.* At the usual landing place, from Rofs in Mull, the shore is rugged, and formed of a rock which appears to be composed of quartz pretty intimately combined with chlorite, and hornblende. It is, however, subject to much variety; for it is observed passing on the one hand to hornblende

rock, and ardesia; and on the other, into a siliceous talcaceous schistus\*. It is traversed with veins of the granites garbenbergensis of Linnæus, a rock which is composed of quartz and mica. As we proceeded on towards the N. end of the island, we examined the venerable ruins of the Cathedral, and other houses, which were formerly the residence of the religious of the North; "whence savage clans, and roving barbarians, derived the benefits of knowledge and the blessings of religion." The description of these buildings, would be interesting to the antiquary; but it is an object unconnected with my present pursuit; and besides, they have been illustrated by the descriptions and drawings of Mr Pennant, and Dr Garnet. I regret much, however, that I am prevented from communicating to the public, the elegant and truly characteristic drawings made by my friend Mr Bell: they are the only ones I have ever seen that convey a complete idea of these remarkable ruins.

The strata which we observed at the landing place, continue to the N. E. extremity of the island, when they give place to hornblende slate, sienite, and hornblende rock having much the

\* Mr. Mills says, that the rock at the landing place is laminated hornstone. Philosophical Transactions of the Royal Society of London, 1790, p. 77.

the appearance of serpentine. These rocks alternate with each other, and are to be observed traversed by basalt and granite veins. From this to Dun-ii, the highest hill in the island, the hornblende and sienite strata, continue forming, upon some parts of the coast, cliffs of considerable height. We ascended to the summit of this hill, which I found to be composed of primitive rock; and principally of hornblende slate. As we walked onwards, by the west side, to the southern extremity of the island, we saw upon the coast several sandy beaches and steep cliffs; and the strata continued to Porta-curach, to be hornblende slate, and sienite, traversed with basalt and granite veins. We observed at a distance, two shelving rocks of a green colour; which are probably of the nature of serpentine, or hornblende. At Porta-curach, or St. Columba's landing place, there are cliffs of considerable height, which are composed of strata of hornblende rock, having much the appearance of serpentine, and sienite. These strata are traversed with veins of granite, and veins of quartz, (which have a light fiskein-green colour, owing to its admixture with hornblende,) are also to be observed. The beach is covered with numberless rounded fragments of marble, quartz, of an amethystine hue, fiskein-green-coloured quartz, and lapis nephriticus. We now walked across this island, over the usual hornblende and other rocks, to the marble quarry. This marble,

or what is now called dolomite, forms a great stratum about 40 feet wide, running N. N. W. and S. S. E. and bounded by nearly vertical strata of a rock which is in some parts of the nature of shistose talc or passing to chlorite slate\*. The marble as it approaches the other strata, is more or less mixed with talc, which causes it to become scaly or fibrous, with a yellowish green colour; thus approaching to the nature of talcaceous shistus. I often also observed masses of nephrite, and of fine green talcaceous shistus, immersed in the marble; the nephrite appears to have been formed at the same time with the marble, as I observed it disseminated and combined with it in a similar manner as the hornblende in the fiskin-green quartz; the talcaceous shistus, however, is dispersed in large irregular masses that seem to have been broken off from the neighbouring strata. From the marble quarry to the landing place, the shore is bare and rugged; and the strata do not differ from those we have already described. At a little distance from it, we observed several islands and rocks, entirely composed of red granite: thus rendering it probable, that this island was formerly joined with the granite coast of Rofs, in Mull.

Dr.

\* Upon one side of the stratum, I observed a layer of felspar; which is intermixed with quartz, passing to hornstone.

Dr. Garnet, in his lately published tour through the Highlands, remarks, that the greater part of this island is formed of limestone; and that the strata are all of secondary formation. The first observation, as far as my experience goes, is incorrect; for after having walked around a considerable part of the island, I only found marble in one place; and was informed, that it had been observed in another spot. The other observation is contradicted by the account I have just given of the strata of the island.

---

S T A F F A.

AS I had not an opportunity of landing upon this remarkable island, I am prevented from giving any description of the rocks of which it is composed, from my own observations; I will, therefore, give a short account of it drawn from the accounts of others; which I have confirmed and corrected by specimens brought from the island.

The

This isle is about one mile long, and half a mile broad, and nearly two miles in circumference. It is not very high; the highest part, which is that immediately above Fingal's cave, being about 114 feet above the level of the sea. Its coast is steep, and bounded by magnificent basaltic colonades; which are in several places broken into caves; and of these, the most remarkable is that called Fingal's cave. It is not above 25 years since the wonders of this little spot were made known to philosophical enquirers, by Sir Joseph Banks, who communicated his elegant drawings and description, to the late Mr. Pennant. This will not appear surprising, if we consider that those, who are accustomed to travel frequently among the Hebrides, become so much accustomed to the appearance of basaltic colonades, that it requires something very extraordinary to excite their curiosity. Staffa, even at no great distance, has a more diminutive appearance, than other basaltic rocks, which are by no means so magnificent; and probably, from this circumstance, it long escaped the attention even of the gentlemen of this neighbourhood. The emotions excited by the view of this magnificent scene, are thus expressed by the learned President of the Royal Society: "At nine o'clock, (says he,) after  
" a tedious passage, having had not a breath of wind, we ar-  
" rived, under the direction of Mr. Maclean's son, and Mr.  
" Leach. It was too dark to see any thing, so we carried our  
tent



“ tent and baggage near the only house upon the island, and  
“ began to cook our supper, in order to be prepared for the  
“ earliest dawn, to enjoy that which, from the conversation of  
“ the gentlemen, we had now raised the highest expectations of.  
“ The impatience which every body felt to see the wonders we  
“ had heard so largely described, prevented our morning rest ;  
“ every one was up and in motion before the break of day ;  
“ and with the first light arrived at the south-west part of the  
“ island, the seat of the most remarkable pillars, where we  
“ no sooner arrived, than we were struck with a scene of mag-  
“ nificence which exceeded our expectations ; though formed,  
“ as we thought, upon the most sanguine foundations ; the  
“ whole of that end of the island, supported by ranges of na-  
“ tural pillars, mostly above fifty feet high, standing in natural  
“ colonnades, according as the bays or points of land formed  
“ themselves ; upon a firm basis of solid unformed rock, above  
“ these, the stratum which reaches to the surface or soil of the  
“ island, varied in thickness, as the island itself formed into  
“ hills or vallies ; each hill, which hung over the columns be-  
“ low, forming an ample pediment ; some of these above 60  
“ feet in thickness, from the basis to the point, formed by the  
“ sloping of the hill on each side, almost into the shape of those  
“ used in architecture. Compared to this, what are the cathe-  
“ drals or the palaces built by men : mere models or play  
VOL. II. B “ things ;

“ things ; imitations as diminutive as his works will always be  
 “ when compared to those of nature. Where is now the boast  
 “ of the architect ! regularity, the only part in which he fan-  
 “ cied himself to exceed his mistress, nature, is here found  
 “ in her possession ; and here, it has been for ages undescrib-  
 “ ed. Is not this the school where the art has been originally  
 “ studied ; and what has been added to this by the whole Gre-  
 “ cian school ? a capital to ornament the column of nature,  
 “ of which they could execute only a model ; and for that very  
 “ capital, they were obliged to a bush of acanthus : how am-  
 “ ply does nature repay those who study her wonderful works !  
 “ With our minds full of such reflections, we proceeded along  
 “ the shore, trading upon another Giants causeway ; every stone  
 “ being regularly formed into a certain number of sides and  
 “ angles ; till in a short time, we arrived at the mouth of a  
 “ cave, the most magnificent, I suppose, that has ever been  
 “ described by travellers.

“ The mind can hardly form an idea more magnificent than  
 “ such a space, supported on each side by ranges of columns,  
 “ and roofed by the bottoms of those which have been broke  
 “ off in order to form it : between the angles of which, a yel-  
 “ lowish stalagmitical matter has issued, and serves to define  
 “ the angles precisely ; and at the same time, vary the colour  
 “ with

“ with a great deal of elegance ; and to render it still more  
“ agreeable, the whole is lighted from without ; so that, the  
“ farthest extremity, is very plainly seen from without ; and  
“ the air within, being agitated by the flux and reflux of  
“ the tides, is perfectly dry and wholesome ; free entirely  
“ from the damp vapours, with which, in general, natural ca-  
“ verns abound.” The learned Bishop of Linköping, re-  
marks, “ how splendid do the porticos of the ancients appear  
“ in our eyes, from the ostentatious magnificence of the def-  
“ cription we have received of them ; and with what admira-  
“ tion are we seized, on seeing even the colonades of our mo-  
“ dern edifices ! But when we behold the cave of Fingal, for-  
“ med by nature in the island of Staffa, it is no longer possible  
“ to make a comparison ; and we are forced to acknowledge,  
“ that this piece of architecture, executed by nature, far sur-  
“ passes that of the Louvre ; that of St. Peter’s at Rome ; and  
“ even what remains of Palmyra and Paestum ; and all that the  
“ genius, the taste, and the luxury of the Greeks, were ever ca-  
“ pable of inventing.”

Such were the very strong impressions which the columnar  
rocks of Staffa made on the learned gentlemen who first explor-  
ed them ; and we are not to be surprized, that the contempla-  
tion of scenery so new and striking, should have raised in their

minds a picture, which to other travellers may seem over-coloured. Although I had not an opportunity of landing on the island, yet from what I saw, and have frequently been told, I do not in the least doubt that the ruins of Palmyra, or the vast remains of Egyptian architecture, would more powerfully interest the feelings, than all the wonders of Staffa. But this is mere matter of opinion ; I will therefore pass to the account of its mineralogy.

From all the accounts which have been published, and the specimens which I have examined, the island seems to be principally formed of basalt and wacken. The basalt is generally in the form of columns, which are, 1. Triangular : of this form, there are specimens in the museum of the University. 2. Quadrangular. 3. Pentagonal. 4. Hexagonal. 5. Heptagonal. 6. Octagonal. 7. Articulated like the Giants causeway or those of the beautiful columns at Dunbar harbour. 8. Jointed without the convex or concave extremities. These pillars generally rest upon a basalt tuff or breccia \*, and the strata of basalt columns (as is the case in other parts of Scotland,) follow the more or less inclined direction of the tuff or breccia. The colonades are usually  
covered

\* Faujas' Travels, vol. 2. p. 58. 59. He there names the basalt tuff, gravelly lava.

covered by a thick stratum of basalt, which has sometimes an irregular columnar shape. Mr. St. Fond also mentions, that he observed cubical zeolite, octogonal semitransparent zeolite: white semitransparent zeolite, in crystals of thirty facettes: this is probably leucit: and also zeolite passing to chalcedony.

Both Mr St Fond, and Mr Mills, inform us, that they found granite among the rolled stones upon the shore of the island. These are either derived from the basalt tuff, or they have been conveyed by currents from the neighbouring granite coast of Ross: but the first supposition seems the most probable.

I-CO-

## I-COLUMB-KILL.

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### C H A P. XVII.

*Description of the FOSSILS mentioned in the preceding Chapter.*

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Sisikin-green coloured QUARTZ of *I-columb-kill*.

The quartz which forms a part of the sienite, and hornblende rock of *I-columb-kill*, has often a white or bluish colour, with the usual lustre, transparency, fracture, and hardness; but it is also liable to considerable variety; owing to its being more or less intermixed with hornblende. With a very small admixture of hornblende, it acquires a greasy lustre; and has a hardly perceptible sisikin-green colour: with a greater proportion of hornblende, it has a pale sisikin-green colour, with

with a weak degree of lustre and transparency, and a plain splintery, or imperfectly conchoidal fracture: and lastly, with a still greater quantity of hornblende, it has a dark fishkin-green colour, with little transparency, and a coarse splintery fracture.

Dark, approaching to leek-green coloured FELSPAR—

*I-columb-kill.*

The felspar of the sienite is generally of a brick or flesh-red colour; but is also of various shades, from pale to dark leek-green: this is owing to its being more or less penetrated with chlorite or hornblende.

HORNBLENDE ROCK, having the appearance of ferpentine—*I-columb-kill.*

This rock is of a dark green colour, and is composed of minute crystals of hornblende, with a small portion of quartz; which has a dark fishkin-green colour. Similar rocks have been observed in other countries: thus Humboldt and Charpentier, in their dispute with regard to the magnetic property of a ferpentine rock, remark, that it has often a great resemblance

blance

blance to hornblende rock\* ; and Mr Kirwan in his geological Effays, hints, that hornblende rocks may be mistaken for ferpentine. The greater specific gravity, and the crystalline texture of the hornblende rock, distinguish it from ferpentine.

### MARBLE, or DOLOMITE, of I-columb-kill.

*Colour.* Snow-white, but frequently verging to yellow, or finkin-green, from the admixture of talc.

*Lustre.* Hardly perceptible, and only from a few dispersed foliae.

*Fracture.* Splintery, passing to the even ; rarely granular foliated, and sometimes imperfectly shistose.

*Transparency.* Transmits light at the edges.

*Hardness.* Yields with difficulty to the knife.

*Chemical character.* Dissolves very slowly in acids, which is a good test for distinguishing it from other kinds.

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\* Neuis Bergmannischis Journal.



According to Mr Tennant, 25 grains afford, of carbonic acid and water about 12, magnesia 4.4, lime 7.8, and 1.0 insoluble substance.

*USE as a Manure.* As this marble contains a considerable portion of magnesian earth, it is probable that it will produce similar effects, when laid on the ground, with the magnesian limestone examined by Mr Tennant \*. I shall therefore mention the fact which he discovered; as it will be of consequence, not only to the inhabitants of this isle, but to farmers in general. This gentleman informs us that, in the neighbourhood of Doncaster, two kinds of limestone are employed in agriculture: the one, which contains two thirds of magnesian earth, must be used sparingly, and spread evenly over the ground; for, if used abundantly, it diminishes the fertility of the soil, and prevents vegetation for several years: the other, which is pure limestone, altho' laid upon the ground in great quantities, is never injurious—on the contrary, produces much fertility. Farmers should therefore be careful to examine whether the limestone they are to employ dissolves slowly in acids; as this

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is

\* Philosophical Transactions of the Royal Society of London, 1799. Part 2d.

is the character which marks the presence of the magnesian earth.

*Flexibility and Elasticity of Dolomite.*

In the Borghefe palace at Rome, there is a slab of dolomite, which possesses a very considerable degree of elasticity and flexibility, and Mr Fleuriau de Belvue has discovered a nearly similar stone at Mount St Gothard in Switzerland \*. He observed that all the specimens which possessed this property, were to be obtained only from the outside of the strata, and in the parts which had been most exposed to the weather. This circumstance led him, along with Mr Dolomieu, to suppose, that its peculiar properties were owing to the separation of a part of its water, which thus weakened the adhesion, and probably altered in a small degree the arrangement of the integral molecules. He confirmed this idea, by exposing Carrara marble, gypsum, and other inflexible stones to a low degree of heat, by which they acquired a considerable degree of elasticity and flexibility. He found, however, that it was only those marbles that had a crystalline grain, and contained little iron or argill, that could be made flexible and elastic.

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As the dolomite of I-columb-kill agrees in many of its properties with that from St. Gothard, it deserves to be tried whether it will become flexible and elastic, by treating it as directed by Mr Fleuriau de Belvue. His process is very simple: he puts a thin slab of the marble into a sand bath, and keeps it at the temperature of 30° of Reaumur for an hour and a half, or, if it be a pretty large slab, for a considerably longer time. He then removes it, and allows it to cool, and even to absorb a little moisture; and then presses it in all directions, so as to destroy that adherence among the particles which the fire has not affected.

### NEPHRITE.

*TALCUM NEPHRITICUM*, Lin. & Wern. *JADE*, *BEILSTEIN*, &  
*BITTERSTEIN*, German.

*Colour.* Yellowish or fishkin-green; olive-green; and sometimes approaching leek-green.

*Fracture.* Coarse or fine splintery.

*Transparency.* In pretty thin pieces, it allows objects to be seen through it indistinctly, but is generally more opaque.

*Hardness.* Sometimes gives fire with steel. In other specimens, is difficultly scraped with a knife.

*Feels greasy.*

It is dispersed thro' the marble, and is seen passing gradually into it; has sometimes scales of mica mixed; and not unfrequently we observe narrow veins of asbestos traversing it. It is a curious fact, that the pieces we find upon the shore are often harder than those which we break out of the marble.

The only use that is made of it, is for ornamental purposes; but the pieces which have been found in I-columb-kill are generally too small for any fine work. In Turkey it is wrought into very elegant handles for daggers and scimitars; and La Metherie remarks that the many fine pieces in oriental nephrite may have been made before it acquired its present hardness, which, he supposes, was produced by exposure to a gentle heat †. Some of the pieces which have been found in Iona are extremely beautiful; and there can be no doubt that, were it quarried on purpose, many magnificent specimens might be obtained.

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† *Theorie de la Terre*, tom. 2.

## BASALT COLUMNS of Staffa.

Several years ago, Mr St. Fond analysed this basalt, and found it to contain, in the hundred parts—filex 40, argil 20, lime 12, magnesia 5, iron 21. More lately, Dr Kennedy of Edinburgh has repeated this analysis, and found nearly similar ingredients; with the difference, that he always obtained a small portion of soda and muriatic acid. According to his trials, 100 parts contain—filex 48, argil 16, oxyd of iron 16, lime 9, moisture and other volatile matter 5, soda about 4, and muriatic acid about 1.

COLL

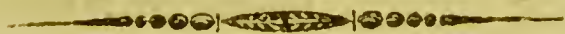
## COLL AND TIRIE.

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### C H A P. XVIII.

#### *Outline of the MINERALOGY of COLL and TIRIE.*

HAVING examined as much of the islands of Mull and I-columb-kill as our time would permit, we took leave of the worthy family of Torloisk, and walked to the harbour of Quines, which is situated upon the north-west part of Mull. Here we luckily found a boat about to sail for Coll, an opportunity which we gladly embraced; and, after a tedious passage of ten hours, we landed at the seat of Colonel Maclean, where we were most politely received.



## C O L L.

THIS island is about fourteen miles long, and two miles broad. It is low, rugged and bleak; but in some places there are beautiful flats, which, during the summer, being cultivated, or adorned with wild flowers, form a striking contrast with the weather-beaten rocks which skirt them. The shore, upon the east side, is generally low and rocky; on the west, it rises into considerable cliffs, and, in many places of this side, great sandbanks extend for a considerable way. These banks are often of considerable height, and form groupes of sandhills; which are sometimes covered with the *Arundo arenaria*, *Galium verum*, &c.; but more frequently they present only a dreary waste: for, during storms of wind, the sand rises in clouds, to overwhelm and destroy the neighbouring country. The inhabitants have themselves partly to blame for the continuance of this evil, by their obstinacy in rooting up certain plants which prevent the blowing of the sand: thus, it is a common practice to use the *Arundo arenaria* as a substitute for ropes, and the *Galium verum* as a yellow dye; two plants which are very remarkable

markable for their power in binding the sand. Colonel Maclean has prohibited this very pernicious practice, by severe penalties; which, it is hoped, will have the desired effect.

*MINERALOGY.* At the Loch, where is situated the seat of Col. Maclean, the island is low; but upon the E. and W. great sand-banks appear. The loch is small, rocky and shallow; so that, in stormy weather, it can afford very little shelter for vessels. If we proceed along the south part of the island, towards Loch Alin, considerable sandy beaches present themselves; but they are now and then interrupted by tracks of gneiss. This gneiss is traversed, in several places, by great veins of granite. The granite, which fills these fissures, is easily distinguishable from that which is deposited in strata, by the great size of its constituent parts. Dolomieu, during his travels, often observed granite in veins, which, he remarks, is easily distinguished from that which forms strata; and Mr Besson also informs us, that the granite veins of Limousin are distinguished from those in strata by the great size of the felspar and quartz. This is not, however, always the case; for Mr Charpentier has mentioned veins of small-grained granite which he saw in Saxony †, and I have observed similar appearances in the Highlands of Scotland.

† Charpentier, Mineralogische Geographie der Chursächsischen lande, § 261,



Scotland. At Loch-Alin, Col. Maclean showed us a small vein of Galena, about three inches wide, traversing the gneifs and sienite strata ; but it was so near the shore, that we had not an opportunity of tracing it but for a short way. Such an appearance, however, deserves farther investigation, when we consider, first, that veins of ore, altho' very trifling at the surface of the earth, increase much as they descend, which is the case with the rich mines of Freyberg and Franconia ; secondly, that the rock, in which this vein runs, is, in other countries, extremely productive of rich ores ; thus we know that the greater part of the Saxon, Bohemian and Saltzburg mines are situated in mountains of gneifs. Near to this mineral appearance, I observed several veins of basalt traversing the gneifs ; and one of them seemed to run nearly in the same direction with the strata : thus intimating that a rent had been formed in the same direction with the strata, or that this basaltic matter really forms a stratum which has been deposited along with the gneifs ; of course, it ought to be considered as of primitive formation.

As we continued our journey around the island, I observed the gneifs strata interrupted by a small extent of quartz rock, which contained beautiful crystals of actynolite. This was again succeeded by strata of gneifs, which, in some places, form hills, that are often covered with immense loose masses, broken

from the strata by the power of the weather. Upon examining these masses, I observed them sometimes resting upon smaller pieces, as if they had been raised by the hand of art; but a more close examination showed us, that the smaller masses were the more solid parts of the gneiss, that still resisted the influence of the weather. This fact will explain many of the curious appearances called Rocking Stones, which antiquaries have been often pleased to consider as proofs of the early knowledge of our ancestors in powerful machinery. This gneiss continues to the farm of Knock; but it is now and then to be observed alternating with micaceous schistus and hornblende slate, and frequently all these strata are traversed with basalt veins. The hornblende, in some places of this track, but particularly at Griffopool, is most beautifully crystallized; so that, with very little trouble, magnificent specimens may be procured. At Knock, the gneiss is much traversed with basalt veins, which are of various sizes; some not exceeding a quarter of an inch in width, while others are more than three feet. The gneiss here contains a very great proportion of a red-coloured felspar; and the quartz has sometimes a skin-green colour, similar to that which we observed in the island of I-columb-kill. From Knock to the northern extremity of the island, gneiss, hornblende rock and micaceous schistus are the principal rocks which

which occur; and from the north point, all along the east side, to Colonel Maclean's house, the same strata continue.

In some places of the interior of the island, I observed considerable cliffs of quartz, which is either massive or granular, resembling that from the island of Jura\*; but I had not an opportunity to determine its situation with regard to the gneiss, or the other primitive rocks of which the island is composed.

## D 2

## TIRIE.

\* Mr Fleurian de Belvue, as I have before mentioned, having found that different species of marble, by being heated, acquired a considerable degree of flexibility and elasticity; also made a series of experiments on different kinds of sandstone and granular quartz. He found that several of them, by being made repeatedly red-hot, and then plunged into water, acquired a remarkable degree of flexibility; and that some kinds of granular quartz became even as flexible as the famous elastic stone which was brought from the Brazils. The granular quartz of Coll is quite the same with that which Mr Belvue used for his experiments; and there is no doubt that, if it be tried, it will acquire the same curious property.

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T I R I E.

THIS island, which is separated from Coll by a narrow sound, is about eleven miles long, and two miles and a half broad. It has many sand-banks, like those in Coll, which are also very destructive. There are a few hills, which are from two to three hundred feet high; but the greater part of the island is low, with interspersed rocks, and numerous small lakes. This island, when viewed from an eminence, appears altogether sterile and waste; yet the quantity of arable land among the rocks is said to equal half the extent of the island: a proportion vastly greater than that of Coll. In the middle of the island there is a large and very beautiful plain, which contains 1200 Scotch acres, and is elevated about six feet only above high-water mark. During stormy weather, the sea not unoften meets across this plain, and is productive of bad consequences. The inhabitants have endeavoured to avert this evil by building a defence of stone and earth on the one side, while the sea, on the other, has raised a considerable barrier of boulder stones: yet neither have been sufficient to resist the waves of the Atlantic.

This.

This island appears to have been formerly joined to the island of Coll; the isle of Guna, which lies in the sound, being apparently part of the intermediate land, which has escaped destruction. On this account, there is but little difference in their composition; the greater part of Tirie being formed of strata of hornblende rock, gneiss and sienite, which are in general very much elevated. These strata are, in different parts of the island, traversed with veins of basalt; and, at the south-west part of the island, I observed a great quartz vein, interspersed with iron pyrites, traversing these strata; and also a great vein of compact arenaceous quartz, which is intermixed with leaves of talc, crystals of felspar, and a few pieces of galena. Probably this vein, upon trial, might afford lead ore in such quantity as to be worthy of working. It would be of little consequence to enter into a detail of the slight alterations of the strata in particular parts of the island; I shall therefore terminate my few observations, by giving a short account of the marble quarry, which has rendered this island so remarkable.

The marble quarry is situated immediately upon the sea-shore, at a farm called Belepétrich: here the shore is low and rocky; but at a little distance there is an eminence, called the Hill of Belepétrich. The strata are nearly vertical; and are composed of hornblende rock, and a compound of deep-red coloured.

coloured felspar and quartz, which has sometimes crystals of hornblende interspersed. The marble forms a stratum of very considerable extent; it appears also to be nearly vertical, and is bounded by the rocks we have just mentioned. It is crossed in some places by small veins of quartz and reddish-coloured hornstone; and I observed a vein of granite, composed of felspar and quartz, traversing it. This stratum of marble has been considered by several travellers as a vein; but I apprehend this is a mistake. In other countries we find marble in a similar situation: thus Voight \* informs us that it has been observed between hornblende slate and sienite, and even that it has been found between granite in Sweden †.

Upon the opposite side of the hill of Belephetrich, there is a stratum of white marble, which is situated among the usual rocks which compose the island. This stratum seems also to have been quarried, but, like the other, is long since given up as unprofitable.

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\* Voight, Prack. 48.

† Ibid. Briefe ueber der gebergslehre, § 12.

AS I have to describe particularly only two fossils belonging to these islands, it would be unnecessary to throw them into a distinct chapter: I shall therefore insert the descriptions in this place.

Red-coloured MARBLE—*Belephetrich.*

*Colour.* Pale blood-red, light flesh-red, and reddish-white.

*Lustre.* None, except from a number of dispersed shining foliæ.

*Fracture.* Fine splintery.

*Transparency.* Transmits light freely at the edges.

*Hardness.* Yields pretty easily to the knife.

There are dispersed through it,

1. *Hornblende.* The crystals are of various sizes, from the tenth of an inch to three inches long; and they vary somewhat in the intensity of the green colour. It is mixed in different  
pro-

proportions with the marble: so as to produce pale blackish-green, dark asparagus-green, and a colour approaching to leek-green. Transparent sea-green calcareous particles are frequently to be observed intermixed with the hornblende, and also beautiful, but very minute garnets.

2. *Mica*—Is sometimes in pretty large plates; is of a yellow, tombac brown, or green colour; and appears passing to schiller spar.

#### White MARBLE—*Belephetrich*.

*Colour.* White, or very light blue.

*Lustre.* Pretty considerable, from the foliæ.

*Fracture.* Granularly foliated.

*Transparency.* Transmits light at the edges.

*Hardness.* Yields with difficulty to the knife.

There are dispersed through it scales of mica and crystals of hornblende. When the hornblende is minutely diffused, it gives the marble a green, or yellowish-green colour: then it has a splintery fracture, with little lustre, and increased hardness. Sometimes the hornblende seems to be very intimately  
combined



combined with the marble; when it forms those beautiful yellowish green spots, which have made this variety of the Tirie marble to be so much admired. These yellow spots have been reckoned by some mineralogists as the same with the spargelstein of Werner.

*CORUNDUM, or ADAMANTINE SPAR, of Tirie.*

The Honourable Mr Greville, in his memoir on the adamantine spar, observes—"I had observed, in the specimens which Mr Raspe called Jade, or a new substance from Tirie, on the west coast of Scotland, a great resemblance to corundum: but having then had only a cursory view of the substance, I am indebted to Mr Hatchett for the examination of a specimen of it, which he had from Mr Raspe's collection. The Tirie stone resembles crystallized corundum of the coast †, in texture and colour: it is also as refractory, when examined by the blow-pipe, with different fluxes. Its specific gravity is 3.049; consequently nearer the specific gravity of pure corundum than the above mentioned lump 2.785, and the matrix of corundum 2.768. The Tirie stone will scratch glass readily, but not rock crystal: its hardness, therefore, corresponds with that

† Coast of Coromandel.

of the corundum \*." I believe there are specimens of this corundum in the Museum of the University; and of these I shall probably communicate an account at the close of this volume.

E I G G,

\*Philosophical Transactions of the Royal Society of London, 1798, p. 40.

## EIGG, RUME AND CANNA.

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### C H A P. XIX.

*Outline of the MINERALOGY of EIGG, RUME and CANNA.*

HAVING thus taken a general view of the islands of Coll and Tirie, we left with regret the hospitable family of Coll, whose numerous and polite attentions had rendered our stay in this island so agreeable.

We sailed from the bay immediately below Col. Maclean's house, and, after a voyage of five hours, we landed upon the island of Eigg, and walked to Mr Macasgill's, who, we found, was at that time on the mainland; yet, during our stay in this island, we experienced every attention from his family.

## E I G G.

THIS island is the property of John Macdonald, Esq. of Clanranald, is between four and five miles long, and from two to three miles broad. It is hilly; the principally flat and cultivated piece of country being confined to the shore opposite the mountainous isle of Rume.

*MINERALOGY.* The harbour upon the south-east extremity of the island, where we land in coming from Coll, is formed by a small isle, called Eilean-Chastell, which is composed of basaltic rocks. The shore, immediately opposite to this isle, is high; and the cliffs are split into pretty regular basaltic pillars, which are of considerable size. As we proceed towards the east side, the shore becomes lower; but this is only for a short way, as it soon rises again upon the east coast, forming cliffs of vast height. These stupendous precipices extend all along the east and north part of the island; forming many wild and romantic scenes, and affording several distinct views of the disposition of the strata. The strata are nearly horizontal; and are, in some places, so well exposed, that we can observe their  
alternation

alternation from the level of the sea to the summit of the cliffs. I shall therefore, in describing them, begin with the lowermost stratum, which is,

1. *Sbistose Clay*. This stratum is a few inches thick; and is composed of a dark-coloured sbistose clay, which contains numerous well-preserved shells apparently of the genus tellina.

2. *Compact Limestone*. This forms a thin stratum, lying immediately upon the sbistose clay.

3. *Sbistose Clay*. This stratum is about ten inches thick, and rests upon the limestone.

4. *Compact blue Limestone, containing shells*. This stratum is about ten inches thick, and rests upon the sbistose clay. It acquires a yellow colour by decomposition; so that it is well distinguished from the other strata, even at a distance.

5. *Sbistose Clay*. This rests on the limestone.

6. *Basalt*. The covering of grass prevented me from discovering the basalt in immediate contact with the clay; yet, from its vicinity, it is very probable that it covers it.

7. *Fi-*

7. *Fibrous Limestone.* The stratum of basalt is covered by a thin layer of this species of limestone, which has a blackish colour from mixed bituminous matter.

8. *Basalt.* This covers the limestone.

9. *Argillaceous Sandstone.* An immense stratum of this sandstone lies upon the basalt. It is in general soft, but we were told that sometimes it is very hard. This harder kind is probably got by blasting, as the interior of sandstone rocks, as Charpentier\* observes, is the hardest; or it may be other harder sandstone strata alternating with the softer, as I have observed in the Orkney Islands and other parts of Scotland.—This sandstone frequently contains impressions of shells; and it alternates with strata of basalt, which are from four inches to several feet thick. This alternation renders it very probable that the basalt may also contain similar animal remains; and this conjecture is rendered the more probable from several facts which have been lately discovered. Thus Mr Kirwan informs us that Dr Richardson had discovered shells in the basalt of Ballycastle †; Bruckenman has observed muscle shells, ammonites

\* Charpentier, Mineralogische Geographie der Chursächsischen lande, 44.

† Kirwan's Geological Essays, p. 252.

nites and corallites in the basalt of the pretended extinct volcanoes of France †; and impressions of leaves have been observed in basalt, as related by Lenz ‡.

10. *Basalt in columns.* This forms a great stratum, which covers the argillaceous sandstone. The columns are varied, not only in their size, and in the number of their sides, but also in their direction being perpendicular, horizontal, or bent, like those of Staffa. The bent columns are generally smaller in their dimensions than those that are perpendicular or horizontal.

11. *Wacken.* This forms an immense stratum, which we observe resting upon the basalt columns. It frequently contains beautiful crystallizations of zeolite.

12. *Red-coloured Wacken.* This stratum is only a few inches thick, and it rests upon the wacken. It is perfectly similar to that which we observed in Mull.

13. *Basalt.* This forms a great bed, which lies on the red-coloured wacken, or, when it is a-wanting, on the common wacken.

These

† 1 Chym. Ann. 1794. § 103, &c.

‡ Lenz. 374.

These strata are traversed in several places by veins of basalt; which do not appear, in any instance, so far as I have examined, to have occasioned any alteration in their direction or hardness.

Nearly at the northern extremity of the island, the cliffs, we have now been describing, turn inwards, and run in a semicircular form, until they again appear upon the coast on the west side of the island. The semicircular track, included by these cliffs, is pretty flat, of considerable extent; and the cliffs, which bound it, are composed of strata similar to those on the east and north sides of the island. The bottom, in such places as I examined, is composed of strata of limestone containing shells, alternating with shistose clay, and sometimes resting on basalt or sandstone. Upon the south side of this track the sandstone and limestone disappear, and now basalt and wacken form lofty precipices. Immediately at the bottom of these basaltic rocks, upon the sea-shore, I picked up several pieces of black pitchstone, much resembling that found in the islands of Arran and Mull; but I could not discover whether it forms veins or strata. From this to within a mile of Eillean-Chastil, the island is bounded in many places by lofty precipices: and the interior is formed of irregularly-shaped,



shaped, grey-coloured, columnar hills, and, among these, Scure-Eigg, which is the highest, has a very singular appearance.

In the sea cliffs there are several considerable caves. They are generally situated in a wacken which is traversed by basalt veins. This wacken contains most elegant specimens of capillary zeolite, also calcareous spar, quartz crystals, and chalcidony; and in several places I observed a red-coloured wacken similar to that which is described at p. 235, vol. i. Several of these caves are of considerable extent, and are open to day; others are narrow at their entrance, but enlarge considerably as we go inwards.

The minister of this parish, who was so good as to accompany us to several parts of the island, led us, by a very rugged path, to a wild sequestered spot, where there is a cave, remarkable, in the annals of this isle, for the murder of the Macdonalds, inhabitants of Eigg, by the Macleods of Skye. As this story is truly characteristic of the state of society in those parts at that period, I think it will not be uninteresting to relate it shortly.

A party of the Macleods having landed upon the small island of Eillan-Chastel, behaved so outrageously to the women who

were there tending cattle, that their friends instantly pursued, and put several of them to death. This so enraged the clan of Macleod, that they determined to take revenge, by ravaging the isle, and putting to death the murderers of their brothers. The islanders, sensible of their weakness, prepared to shelter themselves, upon the first appearance of an enemy. Soon afterwards a number of boats were seen approaching the isle; when the trembling inhabitants retired, in despair, to this cave, their only refuge. The Macleods soon landed, and traversed the whole island; but, as they could discover no human being, they concluded that the Macdonalds had made their escape to the mainland, or to some of the adjacent islands. Disappointed and enraged, they were about to leave Eigg, to return to Skye, when unfortunately one of the horde observed the mark of footsteps on the snow, and thus they were enabled to discover the cave where the wretched inhabitants had taken refuge. Shrieks of despair were interrupted for a little, by a proposal of the Macleods, that if the murderers were given up to punishment, the other lives should be spared. This was only a cruel aggravation of their sufferings, as the Macleods were the aggressors. Connected, as the Macdonalds were, by the dearest ties, they determined to perish together, rather than to give up one of their number. The Macleods, with the most savage barbarity, instantly

instantly kindled great fires at the mouth of the cave, which soon suffocated the whole of the miserable inhabitants.

One often listens even to such a tale, as to the description of a battle, without much interest: but the view of the scene never fails to awaken a keener sympathy—the circumstances are brought nearer to the mind, and seem to be passing before us. We stood on the very ground where this tragedy was acted, and felt our sensibility increased by the sequestered and dreary place in which the deed was done. But even this interest was faint, when compared to that we felt, when, after creeping for a considerable way through a low and narrow entrance, half covered with brushwood, we found ourselves at last within a large and gloomy cave, the extent and height of which we could not distinguish; and perceived the gleams of the lights we carried reflected from the bones and skulls of the unhappy Macdonalds. The force with which the truth and all the circumstances of this dreadful tale struck at this moment upon our minds, and the strange variety of sensations excited by an event so extraordinary, it is not easy to find words to express.

The entrance of the cave is low and narrow, for about 12 feet. The cave itself extends to a height of 22 feet, the breadth 24 feet, and in length it extends inwards nearly 213 feet. The air was damp and raw. Our lights struck faintly on the black

sides of the caves, without dispelling that deep and solemn gloom, which harmonised so well with its melancholy story. The projecting masses of the rock were dimly illuminated, while the skulls and scattered bones caught a strong light. Our figures, too, touched with the pale flame, showed the features, or an outstretched arm, while the parts of the body removed from the light were lost in the gloom. Even the deep and sonorous voice of the parson had its effect. The whole scene was admirably adapted for the canvas: but it would require a very rare talent in the painter who should attempt it.

A short way from this cave, after walking over rocks of basalt and wacken, I observed on the shore two veins of black pitchstone. These veins are about ten feet distant from each other, are from half a foot to three feet wide, and are a little bent in their course. They run in a species of basalt, which contains a considerable portion of zeolite, and in some places small layers of chalcedony. The pitchstone and basalt are sometimes intermixed at their junction, and even pieces of the pitchstone appear immersed in the basalt. But the most remarkable circumstance attending this pitchstone, is the intermixture of one of the veins with a vein of hornstone. This appearance





PITCHSTONE and HORNSTONE veins  
traversing BASALT, ISLAND EGG.

pearance is represented in the plate \*, where A is the basaltic rock in which the veins run ; B is the vein of pitchstone, and C is the hornstone vein. The vein of hornstone, at D, is about two and a half feet wide ; but it varies much in this respect, as it shoots through the pitchstone. At E, the hornstone has inclosed a wedge-shaped piece of pitchstone. At G H there are two stripes of hornstone, one of them, G, containing a thin piece of pitchstone.

These appearances may be explained, by supposing, that, after the vein of pitchstone had been formed, new rents extended both through it and the basalt, and that these were afterwards filled with hornstone. The pieces of pitchstone inclosed in the hornstone, appear to have been broken off the pitchstone vein, and at the time when it was rent, and were afterwards surrounded by hornstone.

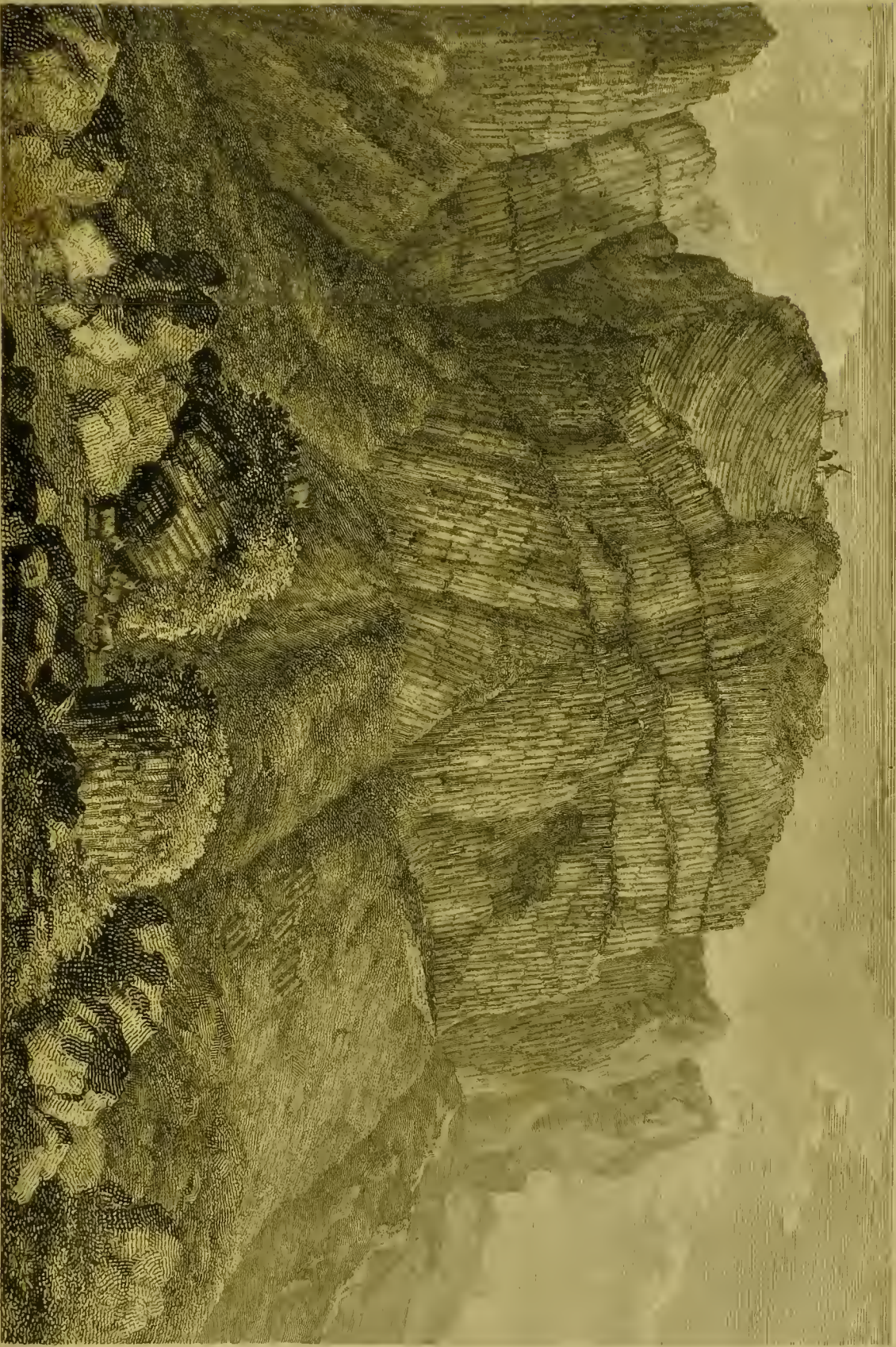
Altho' pitchstone has been discovered in various parts of Europe, it has not been before described as belonging to the rocks of trap formation. Haquet, indeed, mentions, that he observed basalt columns converted into glass, among the basalt of the  
Ve-

\* It must be understood that the plate represents a horizontal section of the pitchstone and hornstone veins.

Veronese. This is very probably pitchstone; yet we cannot say so with certainty, as the appearance is not described with sufficient exactness. Obsidian, however, which, as we have before observed, is nearly allied to pitchstone, has been lately observed by Humboldt, stratified with basalt, at the top of the peak of Teneriff.

We now ascended from this to the Scure Eigg, which we have before observed to be the highest part of the island. This hill, from its peculiar shape, has, at a distance, a singular appearance; but as we approach nearer, it rises much in grandeur, and at length, a stupendous columnar promontory bursts on our view. The whole of this promontory is perfectly mural, and extends for upwards of a mile and a half, and rises to the height of several hundred feet. It is entirely columnar, and the columns rise in successive ranges until they reach the summit, where, from their great height, they appear diminutive. Staffa, which is the most magnificent assemblage of natural columns that has yet been discovered, is the only one that can bear a comparison with Scure Eigg. Staffa is an object of the greatest beauty and regularity; the pillars are as distinct as if they had been raised by the hand of art; yet it has not the extent or sublimity of Scure Eigg: the one may be compar-  
ed





Engr'd by R. Brown & Co.

*Solomon's PROMONTORY of New-England*



ed with the greatest exertion of human power; the other is characteristic of the wildest, and most inimitable works of nature.

The columns are disposed in different directions, being either perpendicular, curved, or horizontal. Sometimes we observe the horizontal pillars crossing each other; the sides of the horizontal columns appearing above and below the ends of those horizontal columns which lie in a contrary direction. They vary considerably in the number of their sides, having three, four, five, six, and seven sides; but I did not observe any of them jointed. I conjectured, at first, from the nature of the strata of which the island is composed, that these columns were basalt; but a nearer examination showed that they were formed of a species of porphyry, with a basis intermediate between basalt and pitchstone. The same kind of porphyry seems to form many of the other hills in the interior of the island.

RUME.



## R U M E.

AS the voyage from Eigg to Rume is rather dangerous, on account of the terrible squalls of wind which often blow from the high lands, we did not prolong our stay, after we had made the few observations which have been just mentioned. We therefore sailed from the west side of the isle of Eigg, and, after a pleasant sail, we landed at Kinloch, at the head of Loch Skrefert in Rume. Here we had our exertions assisted by Col. Maclean's officer, and the other people of the island, who manifested every wish to serve us.

*DESCRIPTION.* This island, which is the property of Col. Maclean of Coll, is about eight miles long, and nearly as broad. It lies between the isles of Eigg and Canna, and is about seven miles NNW, from Eigg, and four from Canna. It is altogether mountainous; in short, it may be reckoned a groupe of mountains, of which, Aisgobhall is the highest. Its shores are in general very bold and rocky, and often present tremendous perpendicular precipices.

Loch-

Loch-skrefort, which is the only harbour in the island, is about two miles long, and is bounded upon both sides by hills of considerable height, which rise pretty rapidly from the sides of the loch. The strata upon both sides are of red-coloured sandstone. At Kinloch, the small village at the head of the loch, the land is low and continues pretty much so, to the shore opposite to the island of Canna, forming a kind of valley which is bounded by lofty hills, which are more rugged upon the south than the north side. The bottom of this valley is elevated in the middle; and here we observe another valley which runs quite in a contrary direction. The hills upon the north side of this valley are composed of red-coloured sandstone, which is elevated at an angle of  $12^{\circ}$ ; and it is also stratified with basalt, and traversed by basalt veins. These veins are even to be observed bursting out upon the top of the hills; and often the basalt, in these veins has a remarkable power over the compass: detached pieces act very powerfully. The sandstone by decomposition assumes various tints, as red, purple, white; &c. and often it also decomposes in flates; and these are frequently curved. Upon the shores, masses of onyx and sardonix are to be observed; probably coming from the sandstone or basalt.

As the mountains upon the south side of the loch are much higher than those upon the north, and their shape and general appearance considerably different, we agreed to ascend one of them, so that we might become acquainted with the rocks of which it is formed. Accordingly, we began to ascend the mountain called Halival, which rises immediately from Kinloch, but found it fatiguing not only on account of the wetness of the ground, but also from the many hollows into which we frequently tumbled, owing to their being concealed by long heather. Having reached the first shoulder of the hill, we found an extensive platform, which is formed of basalt and greenstone; and the sandstone which had continued from the bottom of the hill, does not go higher than this. Above this platform, the appearance of the hill is much altered, the heather disappearing, the side of the hill being covered with grey stones, and appearing to rise by a succession of platforms or terraces. We now clambered upwards over a wilderness of stones of greenstone and basalt, until we were about 60 feet from the summit. Our further progress seemed now to be stopped, as the mountain appeared to be surrounded by large blocks of greenstone standing in an almost perpendicular direction. Our guide, however, conducted us to the summit by a steep path, which was not without danger. Unluckily, a few minutes before we reached the summit, it was enveloped in clouds, so that

that it was only as they cleared away, that the mountain of Aifgobhall was to be observed towering above us; and by its terraced aspect, announcing a similarity of composition with that on which we were standing. At some distance several other hills appeared with terrible, bare, rugged, intervening glens; and all apparently composed of trap-formation rocks. As we were resting upon the summit, I picked up specimens of a dark green-coloured crystallised pitchstone; but I did not discover it *in situ*: near to the same places, I observed several pieces of a rock resembling the Lydian stone which seemed to traverse the greenstone in the form of veins. As the clouds were now spreading all around, we found it necessary to descend; but we took a different rout, so that we might see as much variety of rock as possible. We did not, however, meet with any fossil differing from what we had seen in the ascent; and the disposition of the strata appeared to be the same, viz. greenstone and basalt forming the higher parts, and red sandstone the lower. From the slight examination of this mountain, and the general appearance of the others in the neighbourhood, it is probable that all the south side of the valley is formed of sandstone in the lower parts, and the upper of rocks of trap formation.

I cannot omit mentioning a curious appearance which I observed, in examining a ravine upon the south side of the valley,

where it was said coal had been found. Immersed in the basalt, which forms part of these hills, I discovered pieces of limestone, (with interspersed bituminous matter,) from 4 to 12 inches long, and 2 inches in diameter. In the Philosophical Transactions of the Royal Society of London for 1796, we have the account of a nearly similar appearance observed in the works of the Huddersfield canal. In perforating a hill by a subterraneous tunnel, the workmen met with a fault or break in the strata through which they were cutting, when they found a rib of limestone, and a number of pyritical limestone balls, from one ounce to upwards of 100 lb. weight. No limestone had been discovered in that country nearer than 20 miles. In Rume, so far as I could learn, there is not any strata of limestone: a circumstance which may possibly render the explanation of these phenomena a little difficult.

As circumstances did not allow us to spend more time in this island, we left Kinloch, and, after a rugged walk during a violent storm, we reached the shore of the island opposite Canna. Here we found a most magnificent, bold, broken coast, formed of strata of red-coloured sandstone, which are elevated at a considerable angle, and alternate with basalt, and are also traversed with numerous veins of basalt.

Besides



Besides these appearances, I observed, as we were walking along the shore, waiting until the storm should allow us to cross to Canna, vast strata, apparently of basalt, or wacken, lying on the sandstone, at the summit of the tremendous cliffs which here bound the island. I now regret extremely that the inclemency of the weather prevented me from examining these strata; for unquestionably they would have proved highly interesting, if we may judge from the specimens that had tumbled from them upon the beach. The following are a few of the fossils which I picked up on the shore.

1. Green, or yellowish-green coloured heliotrope\*, which adhered to masses of basalt †, or forming little balls immersed in it.

2. Basalt, containing rounded balls of green earth, along with similarly-shaped masses of calcareous spar.

3. Basalt,

\* This heliotrope is sometimes so soft, that it has a good deal the appearance of pitchstone.—Is this owing to its being altered a little by the action of the weather?

† From the specimens being a good deal decomposed, I cannot say with certainty whether this is to be considered as a basalt or a wacken: I at present rather think it is a basalt.

3. Bafalt, containing chalcedony : and this chalcedony is frequently penetrated with the green-coloured heliotrope, forming a stone that seems to be the plafma of the Italians.

4. Bafalt, with whitish, or light-brown coloured hornstone, which has fometimes an apple-green colour, from its being penetrated with heliotrope.

5. Maffes of hornstone, which contain beautiful quartz cryftals.

6. Chalcedony in ftalactites ; and, what is remarkable, pieces of the ftalactites are obferved lying in, and furrounded by calcareous fpar.

7. Beautiful maffes of onyx, which are, in fome fpecimens, covered with a white cruft.

The weather having now become a little more moderate, we croffed the found to Canna, thro' a very tremendous fea.

CANNA.

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C A N N A.

THIS island, the property of John Macdonald, Esq. of Clanranald, is about five miles long, and two miles broad. It is low; but its shores are bounded by steep and lofty cliffs. It is remarkable for its harbour, which is reckoned one of the best among the Hebrides: yet it is difficult of approach in stormy weather, owing to the narrowness of the entrance, and the sunk rocks that lie near it. This harbour is formed, upon the N. by Sand island, which is separated from Canna by a strait, which is left nearly dry at every ebbing of the tide. The island is low, and consists of rocks of trap formation. The end, which forms the entrance of the harbour, is of basalt tuff, having basalt pillars resting upon it. The opposite side of the harbour is formed by the island of Canna, which is here of considerable height, and rising by beautiful and regular terraces. These terraced appearances, which are in general pretty sure marks of a basalt country, do not here deceive us, as the rocks are decidedly basaltic, and in several places are split into columns.

In examining this island, we walked along the shore towards the W. which we found low and rocky, but bounded by considerable land-cliffs of columnar basalt. This basalt, in some places, rests upon basalt tuff; but, farther on, I observed the tuff exposed without any covering—the basalt, if it had ever been super-imposed, being washed away; and, near to the place, the basalt pillars are seen wore down by the action of the sea, the ends standing up under the water like a regular pavement. At a place called Tarbet, the cliffs on the shore assume a bold form: they there rise to a great height, and are immediately washed by the sea, or, in other places where there is an accumulation of debris, the further action of the waves is prevented. The superior stratum of these cliffs is columnar basalt. The pillars vary very much, not only in size, but also in the number of sides; and frequently they are to be seen bent, when their length and breadth is less than the upright ones. Immediately below the stratum of basalt, there is a stratum of wacken, which contains calcareous spar, elegant capillary zeolite, quartz crystals, blackish-coloured crystals, whose nature I am ignorant of, and, more rarely, crystals of leucit, or Vesuvian garnet. To this succeeds another stratum of basalt; and below it, a stratum of wacken; and so on, alternately, to the bottom of the cliffs.

Having

Having walked for a considerable way along a narrow path in the face of these cliffs, the violent wind and rain forced us to scramble to the summit, as it was impossible to walk longer in this track, without the risk of being precipitated into the sea, or among the rocks. We now crossed the island to a place called Dun-eudain, where coal had been formerly wrought: unluckily the cliff had fallen down, so that I had not an opportunity of seeing it. We were told, by the people who had worked it, that it was a stratum from 6 to 8 eight inches thick, and was inclosed in whin rock (basalt or wacken). Its situation, upon the face of a high cliff, was given as the reason why the working was stopped: this is a circumstance, however, of little detriment; for, if the coal stratum had been of considerable extent, many economical expedients might have been used to raise the coal. From this, in going around the other parts of the island, the cliffs become lower; but they soon rise again, and continue of great height nearly to the harbour of Canna. In many places of these cliffs the strata are well exposed: thus, upon the east side, near to Compass-Hill, the uppermost stratum is basalt, with a slight tendency to the columnar form; below this, is a stratum of basalt tuff; this is again succeeded by basalt; and so on, alternately, to the bottom of the cliffs. The shore is covered with a vast collection of debris from the cliffs; and, in some places,

it even seems to form a kind of alluvial breccia, in which vast masses of columnar basalt are immersed.

*Compass-Hill*, which we have already mentioned, is situated at the top of the cliffs we have been just describing; and appears, at its summit, to be formed of a species of basalt, which, by decomposition, acquires the power of affecting the compass: hence this eminence has received its name. Other rocks in the island, however, are much more powerful in this respect: thus the basalt at the outer point of the harbour affects the compass at the distance of between 25 and 30 feet.

Near to this hill, but immediately upon the shore, there is an isolated rock, called Humbla, which is interesting to the antiquarian, as there is upon its summit the ruin of a small castle, where, it is said, an old jealous highland chieftain, even long ago, vainly endeavoured to confine a handsome wife. At a little distance, there is another rock, where basalt tuff lies on basalt; and, in the tuff, I observed several pieces of wood slightly bituminated. In one place I saw a piece of wood about two feet long, but only a few inches thick: thus intimating that it had acquired its shape either by the pressure of the superincumbent rocks, or by the contraction of the argillaceous

aceous earth of the basalt\*. In proof of this latter opinion, which seems the most probable, I may observe, that the carbonated wood found in limestone, or among coal, is never observed to be flattened.

As the appearance of wood, thus slightly altered, in a rock of trap formation, is interesting for geology, I will now shortly mention a few similar appearances which have been observed in other parts of the world. At Stackhouse, in Westerwald, there are strata of carbonized wood, which alternate with wacken and clay †. Mr Esmark observed a vein, at the depth of 200 fathoms, entirely filled with carbonized wood ‡. Werner mentions veins of wacken, at Bautzen, that contain pieces of bituminated wood ||. Near Rennes, a whole chestnut tree was observed lying horizontally among schistus; of which the bark was converted into pyrites, the sap into jet, but the center was wood slightly altered, being nearly in the state of char-

H 2

coal.

\* Kirwan's Geological Essays, p. 46.

† 1 Berl. Beob. 52, 56. Kirwan's Geological Essays, 311.

‡ Neues Bergmannisches Journal.

|| Werner Neue Theorie von der Entstehung der Gänge.

coal\*. Mr Pennant informs us that wood is found inclosed in the solid rock in different parts of Iceland, and, like that of Canna, is very much flattened: what is remarkable, pieces of the wood are often found so little altered, and of such a size, as to be easily planed, and made into middle-sized tables †.

*EIGG,*

\* Journal de Physique, Mai, 1786.

† Introduction to Arctic-Zoology, p lx.



## EIGG, RUME AND CANNA.

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### CHAP. XX.

*Description of the FOSSILS mentioned in the preceding Chapter.*

#### Columnar PORPHYRY of *Scure-Eigg*.

This rock has, dispersed thro' it, numerous crystals of yellowish or white-coloured crystals of felspar; and the basis presents the following characters:

*Colour.* Black.

*Lustre.* Little glancing, or rather glimmering.

*Fracture.* Even, approaching more or less to the conchoidal.

*Transparency.* None.

*Hardness.* Gives a few sparks with steel; but sometimes yields also with great difficulty to the knife.

It decomposes into a greyish-white powder.

*Fusibility.*

*Fusibility.* At  $29^{\circ}$  it had acquired a grey or white colour, and was converted into a kind of enamel.

This change by action of the heat, conjoined with the external characters, confirm me in the belief that it is intermediate between pitchstone and basalt.

### PITCHSTONE—*Eigg.*

*Colour.* Deep black, or bluish-black.

*Lustre.* Pitchy, strong glancing.

*Fracture.* Uneven; or, even, with a greater or less tendency to the conchoidal; and sometimes fibrose.

*Transparency.* None.

*Hardness.* Scarcely gives fire with steel.

*Fusibility.* Formed a black cellular mass at  $47^{\circ}$ , and at  $52^{\circ}$  was more compact.

There are, interspersed, a few crystals of felspar, and thin layers of a yellow-coloured substance.

HORN-

HORNSTONE, which traverses the Pitchstone—*Eigg.*

*Colour.* Pale greenish-grey.

*Lustre.* None.

*Fracture.* Even, or fine splintery.

*Transparency.* Hardly perceptible at the edges.

*Hardness.* Gives fire pretty plentifully with steel.

There is, dispersed thro' it, calcareous spar and chalcedony. The chalcedony is of a bluish-white, or light-yellow colour; and is similar to that which I have mentioned in the preceding chapter, as being contained in the basalt. It is sometimes cellular; and these cells are lined with quartz crystals, and filled with a nearly liquid bitumen.

BASALT, in which the Pitchstone Veins are situated—

*Eigg.*

*Lustre.* Little glancing, from a number of minute crystals of hornblende which are dispersed through it.

*Fracture.* Uneven.

*Hardness.*

*Hardness.* Yields with some difficulty to the knife; and leaves a grey trace.

By decomposition it acquires an iron-grey colour.

#### GREENSTONE—*Rume.*

It is composed of crystals of hornblende and felspar; and, intermixed, there are beautiful transparent grass-green coloured crystals, which resist decomposition, while the felspar and hornblende are reduced to an iron-brown or greyish powder. It has a very great specific gravity.

#### Crystallized PITCHSTONE—*Top of Halival, Rume.*

It is of an olive, or dark leek-green colour; and has the usual lustre, transparency and hardness. The crystals are immersed in a rock formed of felspar, with a few scales of tombac-brown coloured mica. They are from the tenth to the half of an inch long; which is much greater than the crystallized pitchstone of Bohemia. I could not discover the form of the crystals, on account of their being much broken; yet I have no doubt that it

is a crystallized pitchstone. As this is a very rare fossil, having been discovered only in another part of Europe, it is well deserving the attention of those who visit Rume.

### CHALCEDONY—*Rume.*

This chalcedony is of a bluish-grey, or brownish colour, or even of a milk-white colour, thus approaching to the nature of semiopal; and has the usual lustre, transparency and hardness. It is frequently accompanied by calcareous spar, hornstone, and crystallized quartz. It is also stalactitical; and, what is curious, we sometimes observe fragments of the stalactites inclosed in the calcareous spar\*. It is frequently penetrated with

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I

helio-

\* The explanation of the formation of siliceous or chalcedonic stalactites has been considered a difficult problem in geology, and no doubt there is some truth in the opinion. Upon reading with a view of collecting facts on this subject, I met with one which deserves to be generally known, as it will help to explain several of the remarkable forms that the stalactitical chalcedony assumes. Baron Trebra, whilst in the deepest mines at Kromnitz in Hungary, paid particular attention to the appearance of the siliceous stalactites, and observed that those newly formed,

heliotrope, or bloodstone; when it has characters exactly resembling the plasma of the Italians.

PLASMA ?—*Rume.*

*Colour.* Dark apple-green.

*Lustre.* Glimmering.

*Transparency.* Sometimes allows the light to pass thro' pretty freely.

*Fracture.* Even, with a tendency to the flat conchoidal.

*Hardness.* Does not give fire with steel so readily as chalcidony.

This stone was formerly considered as a species of chalcidony; but Werner has lately described it as a distinct genus.

Abbé

formed, or forming, in place of breaking, as is the case with the calcareous, were flexible, and this in a very great degree †.

† Mineralien cabinet gesammelt und beschrieben von dem Verfasser der Erfahrungen von innern der gebirge.

Abbé Eftner confiders it as an intimate combination of calcedony and talcerde. This may be the cafe with the fpecimens he examined ; for I have little doubt that chalcedony may, in one inftance, be penetrated with heliotrope, and, in the other, with talcerde, yet the refulting fossils may be difficultly diftinguifhable by their external characters.

Dark apple-green coloured HORNSTONE—*Rume.*

*Lustre.* None.

*Fracture.* Coarfe splintery.

*Transparency.* Allows a little light to pafs at the edges.

*Hardnefs.* Gives fparks very plentifully with fteel.

It has brownifh-coloured fpots difperfed thro' it. This appears to be hornftone penetrated with heliotrope ; and the fuppofition is rendered more probable, from the difperfed brown-coloured fpots, which are characteriftic of the prefence of heliotrope.

HELIOTROPE, or, ORIENTAL JASPAR—*Rume*.

*CHALCEDONIUS HELIOTROPIUS*, Lin. *XANTHUS*, Walker.

*Colour.* Dark grass-green, or yellowish green; and marked with spherical spots of an iron-brown, or light olive-green colour.

*Lustre.* Glimmering, with a weak waxy lustre.

*Transparency.* Very little at the edges.

*Hardness.* Gives sparks plentifully with steel, but not so much as flint.

The red, olive-green, or iron-brown coloured spots and veins are merely accidental, as the same stone is to be found without them. It is considered by Emmerling as an intimate of green earth and chalcedony; and this is countenanced by its situation in Rume, as both green earth and chalcedony are found accompanying it. A fossil of this name is described by Pliny, at the 10th chapter of the 37th book of his natural history; but its properties are so different from the stone with which we are acquainted, that we must, for the present, consider it as different. It is to be hoped that the intelligent and well-informed Mr. Hawkins, who has travelled over so much of the East, where

it



it is said the heliotrope of Pliny is found, will clear up this difficulty.

#### BASALT TUFF—*Canna.*

This rock is composed of rounded masses of basalt, wacken mandelstein, and argillaceous sandstone, connected by a basaltic basis. Very considerable loose masses of sandstone are to be observed in different parts of the island; and seem to be derived from this breccia or basalt tuff: as I did not observe any fixed rock of sandstone in the whole island.

*SKYE.*

# S K Y E.

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## C H A P. XXI.

### *Outline of the MINERALOGY of SKYE.*

**H**AVING spent two days in examining what was curious in Canna, we failed for the island of Skye, and, after a tedious passage, we landed at Rue-dunan, which is about 12 miles from the harbour of Canna.

The island of Skye is about 70 miles long; but it varies much in breadth, owing to the number of lochs or arms of the sea with which it is intersected. Cambden imagines that it is the eastern Æbudæ of Ptolemy\*, while others reckon it the Dumna.

Its

\* Ptolem. Geograph. lib. viii.

Its present name is of Norwegian origin, being derived from *Ski*, a mist; and from the clouds that almost perpetually envelope the lofty mountains, it has been styled *Ealand-skianach*, or the cloudy island †. It lies between the mainland of Scotland, and the Long-island; it is, upon the west side, many miles from the Long-island; but on the east, it is separated from the mainland in some places by a sound not half a mile broad. The shores are rocky, and the cliffs in many places are of great height. It is very mountainous upon the SW. where the Cullin mountains rise to a great height, and afford many scenes of the greatest sublimity. To the north of these mountains, the island is formed of comparatively low hills, which continue to within a few miles of the extremity, when they are succeeded by a plain, which forms part of the parish of Kilmuir. South from these mountains, is the low, narrow, parish of Sleat, which forms a peninsula, that is reckoned the most productive part of the island.

*CAVES.* There are considerable caves that occur in different parts of the island; one at Comesketel, on the south side, is fam'd for having afforded shelter to the unfortunate Prince Charles when he was escaping from Scotland after the battle  
of

† Dr M'Pherson, in Pennant's Tour.

of Culloden. There are also, in several places, grand cascades ; one in particular, upon the east side of the island, is reckoned little inferior to the fine fall at Fyers, which is between Fort Augustus and Inverness.

*LOCHS.* This island appears, at some former period, to have been very much exposed to violent convulsions, which have broke up the land, and formed the many lochs which traverse it. The most considerable of these lochs are Snizort, Follart, and Bracadale.

*MINERALOGY.* Rue-dunan, where we landed, after leaving Canna, is situated at the bottom of the Cullin mountains, and at the head of loch Brittle. The mountains rise here, with the utmost grandeur ; but the continual covering of clouds, prevented me from investigating them with so much accuracy as I wished. I found, that the sides of the loch, and the lower part of these mountains, were composed of basalt ; but the superior parts, appeared to be wholly of sienite and hornblende rock, traversed by basalt veins. The faces of the mountains were bare, steep, and rugged, and were much traversed by open fissures. In some places, I observed the brows of the hills covered with hornblende rock, which, by its brown colour,  
had

had much the appearance of the serpentine rocks in the island of Unst in Shetland.

Having taken a slight view of these mountains, we intended to proceed to Talysker, as being a central spot for the investigation which we proposed of the coast of Skye, from Ruedunan to Dunvegan-head; but, in this, we were disappointed, as the worthy Col. M'Leod of Talysker, to whose attention we were recommended, died on the very day on which we landed upon the island. We were now glad to take shelter in the first house we came to, and luckily, we met with an obliging man, the shepherd to a gentleman in the army; he lodged us comfortably in his master's almost waste mansion-house; but we soon wearied of this retirement, and set out for Grule, at the head of loch Eynort, where, we were informed, the minister of the parish resided. The path led us through a hilly country, which, as far as I examined, appeared to be composed of basalt and wacken; and both contained fibrous, and variously crystallised zeolite. At Grule, we waited upon Mr Macleod, the minister, to whom we were entire strangers, yet he gave us a most kind reception, and the next day accompanied us near to the valley of Talysker; but we found no variety of rocks, the whole being composed of basalt or wacken; at little Breeze hill, which is near to the vale of Talysker, there is a pretty

colonnade of basalt pillars, which, Mr Pennant, in his voyage to the Hebrides, erroneously mentions as the most northern groupe of columns in Scotland. As the weather was very stormy, we remained with our good host for three days, but on the fourth, our anxiety to proceed on our journey, overcame every obstacle; and we left, with regret, Mr Macleod's hospitable cottage. Upon gaining the upper part of the glen, the rain and mist increased, and prevented us from having a view of many parts of the country. We continued our journey among basaltic hills, until we found ourselves on the side of Loch Harpart, an arm of the sea, which is of considerable extent, and bounded upon both sides by low basaltic hills. From this we walked on to Loch Bracadale, another arm of the sea, in which we observed several small islands, which were all apparently basaltic; as is also the case with the neighbouring country. As the storm had somewhat abated, the remainder of our walk to Dunvegan, the bleak seat of General M'Leod, was not so disagreeable: we, however, observed no variety of strata, as the same basaltic rock still predominated; but at a distance we remarked several truncated hills of considerable height; and two of them, called Macleod's Tables, are said to have a considerable resemblance to Table Mountain at the Cape of Good Hope.—At Dunvegan there is a loch of considerable extent, which is bounded on both sides by low hills, apparently composed

composed of basalt and wacken; and there are dispersed thro' it several small islands, which, from their terraced appearance, seem also basaltic. We were informed that coal had been worked near Dunvegan, but the stratum was so small that it was soon given up. Pieces of wood have been also found in the rocks upon the side of the loch; probably in a breccia resembling that of the rock at the island of Canna.

Although I had no opportunity of examining the rocks upon the shore which extends from Rue-dunan to Dunvegan head; yet, from the basaltic nature of the country near it, and the general appearance of the coast, as seen from the island of Canna, I have little hesitation in saying, that the general rocks will be found basalt and wacken. It is probable, however, that this extent of country may contain many curious sporadic fossils; and veins or strata of pitchstone may also be observed.

We now walked to Kingburgh, by the end of Loch-Bay and Loch-Grifornish, through immense tracks of peat. The neighbouring hills are low; but the rocks upon the sides, and at the mouth of the lochs, are often of great height, and very rugged and broken. I saw no variety of fossils; the whole country, so far as the peat and heather would allow me to examine, being of basalt and wacken.

We remained at Kingsburgh for some days, waiting the return of Mr Campbell, who had gone upon a fishing expedition; but in the meantime I examined the neighbouring country. It proved to be little interesting, as it was entirely formed of strata of basalt and wacken, which contained beautiful fibrous and crystallised zeolite, and both kinds of strata were frequently traversed by basalt veins. The old house, in which Mr Campbell at this time lodged, is remarkable for having afforded shelter to Prince Charles, when pursued by the king's troops; and the shore is noted in history as the place where King James V. landed when he was making the tour of his kingdom. Mr Campbell having returned, we got the necessary instructions for our route to the north part of the island, for which we set off next day. After leaving Kingsburgh, we walked for a mile or two along the side of Loch-Snizort, through a basalt country, until we reached the mill which is situated upon a stream of water at the head of Loch-Uig. A considerable way above this mill there is a pretty large cascade, formed by the water which collects from the neighbouring basaltic hills; and near it we observed appearances of coal. The first was upon the side of the stream in the face of a steep rock: the coal was only a few inches thick, and covered by a stratum of basalt at least 30 feet high. Immediately at the side of the cascade there is another small stratum of coal, a few inches thick, and lying in  
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the basalt. These seams, or strata, however, are so ill-situated, and so trifling, as to be unworthy of any consideration in an economical point of view. Near to the cascade there is a considerable stratum of wacken, which is covered by basalt, and traversed by basaltic veins: it contains nodules and stratulæ of steatites, or soap-rock.

After crossing this stream, we came to a good road, which led us to the top of a basalt hill; and by continuing our walk for a quarter of an hour longer, we came in sight of the low, flat part of the island, to which we descended by a winding road. This flat is much exposed on all sides, excepting on the south, where it is defended by the lofty cliffs, which are the termination of the hilly grounds of Skye, and also form the boundary between this part of the parish of Kilmuir and the other parts of Skye. It appears very certain that this flat, at some distant period, was of an equal height with the adjacent mountains; but probably the violent agitations which took place at the Deluge, or some very remote period, may have either swept away the land which is here a-wanting, or violent earthquakes may have sunk it nearly to its present level. It could not have been carried away by the slow action of the sea, as there are no marks of the sea having lately covered it; nor can

we

we suppose that the combined meteoric influences could, in any length of time, have produced this appearance.

The most prevalent rock of this flat is basalt; but upon the shore I observed some variety of strata, of which I shall now give a short account. Upon the shore, near to the house of Mr Martin, the minister of the parish, there are cliffs of moderate height, where the lowermost stratum is basalt: above this is a stratum of blue shistose clay; then a stratum of bluish-coloured limestone, a foot and a half wide; and above this is another stratum of blue shistose clay. At some little distance from this, I observed strata of compact blue limestone, which are from 8 to 14 inches thick, alternating with layers of black-coloured shistose clay, and both are traversed by basalt veins. To the westward of this the strata are arranged in the following manner—

1. Lowermost stratum, composed of basalt.
2. Blue-coloured shistose clay.
3. Argillaceous sandstone.
4. Blue-coloured shistose clay.
5. This rock differs from the shistose clay, in wanting the shistose fracture, and being so hard as not to be touched by the knife.

6. Blue

6. Blue shistose clay. This rock is sometimes very compact, and approaches to the nature of Lydian stone.
7. Sandstone.
8. Shistose clay.
9. Basalt, which forms the upper stratum.

These strata are in general very thin, being from 4 to 12 or 14 inches thick; but the uppermost stratum, the basalt, is of vastly greater thickness.

We now walked along the coast towards Duntulme Castle, but observed no variety of strata besides what we have now mentioned: the gradual breaking-down of the rocks formed, however, a striking object. In some places, the ground on the top of the high cliffs was to be observed rent for several hundred feet, only waiting the effects of frost to separate masses of vast magnitude. Many such masses were seen near to the shore; and it was pleasing to observe how nature, by the breaking-down of these masses, and covering them with vegetation, has formed many small, green hills, which gradually become useful to man, and hide the rude and broken appearance of the country. Some hundred yards from Duntulme Castle, I observed a stratum of shelly limestone, about 6 feet thick, resting upon a thin layer of shistose clay, which again lies upon a sandstone.

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It is remarkable that this limestone contains pieces of wood slightly carbonated, being in a far less altered state than the wood found in the basalt tuff of the rock at Cana. At a little distance from these, but nearer to Duntulme, I observed three singular patches of Lydian stone, which, from their black colour and glimmering lustre, are, at a distance, much like black pitchstone. These masses, which are the remains of a stratum that has been broke away by the sea, lie upon blue-coloured limestone, and appear to be covered with sandstone: but I am not quite certain as to this latter fact. These strata are traversed by two basaltic veins, which cross each other, in such a manner, that the Lydian stone, at first sight, seems inclosed in a basaltic hollow. At Duntulme, formerly the seat of the Macdonalds, the cliffs, upon which the ruins of the castle are perched, are of considerable height, and seem to consist principally of basalt. Mr Pennant remarks that in these cliffs there are numerous small compressed ammonitæ\*. It is to be regretted that he has not mentioned, whether it was really the basalt in which they were immerged, or rather a stratum of limestone: the latter, to me, seems more probable.

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\* Pennant's Tour in Scotland, and Voyage to the Hebrides, p. 304.

As we proceed towards the north point of the island, the coast becomes high and rocky: the cliffs are seen to have been torn asunder, and great masses project in terrific grandeur from their tops. Upon the most northern point, the rocks are precipitous, and of great height. In one part they are particularly grand: we were upon the summit, and the burning of the kelp below enveloped their base in murky darkness, while the waves, broken into irregular points, were indistinctly seen lashed into foam. From this, looking northwards, the point of the Lewis retires beautifully into a low track of land; and, towards the east, the mainland melts into the horizon, and at last is distinguished only by the fleecy clouds that are attracted by it. Such an appearance must be grateful to the sailor, when his eye has been long fatigued with the weary sameness of the ocean, before land is perceptible, it is known by the appearance of the clouds on the horizon.

We now walked through a considerable extent of country to Loch Staffin, which is situated upon the east coast of the island; but in this track I observed no other rocks besides basalt and wacken, which are in some places traversed by basaltic veins. At Loch Staffin, the country on the shore is low; but on one side there is a small hill, which, at a distance, has a very reddened and burnt appearance, so that it may with all pro-

priety pass for a *Scottish* volcano : but a nearer examination discloses its structure, which is an alternation of basalt and common wacken, with red-coloured wacken. The quantity of this red wacken is very great ; indeed more so than I have observed in any other part of the Hebrides. At some distance from the shore we observed a range of hills, which rise from the low part of Kilmuir parish, and, we were told, extend to Portree. These hills, which appear entirely basaltic, are here much broken ; and the separated masses are to be seen gradually mouldering down, and at length covered with vegetation. If we examine this breaking-down of the land with more attention, we shall find a beautiful progression. First, we observe immense masses, which, by their vicinity to the cliffs, and their peaked form, indicate that they have been lately rent from the mountain. At some distance, other masses are to be seen, where the sharp, peaked form is worn away, and now they have a flat and rounded form, and are partly surrounded by debris. Still nearer the sea, the masses disappear under the covering of debris ; and now vegetation makes its appearance, which increases more as we come to the flatter parts of the country. At a little distance from Loch-Stafin we observed a beautiful freshwater lake, called Shiant, or The Sacred Lake. Its banks are covered with natural wood, and it is filled by numerous springs ; so that its water is cool, clear, and refreshing. It has  
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not escaped the particular regard of the inhabitants, who formerly frequented it in great numbers, as it was reckoned sacred, and capable of healing all diseases. From this loch we walked for a short way through corn fields, and then along a dreary moor, which was bounded, upon one side, by the range of hills which extend to Portree, and, upon the other, by the ocean, and the distant mountains of the mainland of Scotland. The silence of the scene was broken only by sounds which rendered it more dismal—the mournful whistle of the plover, or the wild notes of the curlew; while the fullen roar of the ocean came at intervals upon the ear, as it heaved its mighty surges on the shore. The day, which was for some time extremely delightful, began to lour, the wind arose, and we saw the clouds gathering upon the neighbouring mountains. To avoid the coming storm, we hastened to pass the muir, that we might reach the path which leads across the mountains. After a journey of several hours, we came to the bottom of the mountains: they were enveloped in clouds, and the rain was falling in torrents. Fatigued by a long march, and with our clothes wet and clinging about us, we had still the steep ascent of the mountains, which divide the northern part of the island, before us. We began to ascend, and persevered in climbing against the blast: the long heather, and the wetness of the ground, increased our toil; but at last we gained a considerable plain.

Sometimes we were involved in impenetrable mists; but we could look back, at intervals, upon the plain country we had left, still partially illumined by the sun, and smiling faintly through the veil that furrounded us. As we continued to ascend, the thickness of the mist was terrible. Our guide began to talk seriously of his doubts and fears; assuring us that frequently people, going in search of cattle among the mountains, were overtaken by these mists, and forced to sit quietly down, and wait for the morning. The situation forcibly impressed us with the truth of what he related; and we entered with a lively sympathy into the anxiety and despair, and vain struggles, of those who are left thus to wander alone. While we went musing on our situation, and indulging in imaginary distresses, our guide pointed to the cairn of a poor shepherd who had perished in the snow. It was the very scene that Thomson must have painted,

Where many hills ascend, of unknown, joyless brow,  
And many scenes of horrid prospect rise.

We could fancy we saw the unhappy man, with desperate effort, hurrying through the waste,

From hill to dale still more and more astray,  
Impatient—through the drifted heaps,  
Stung with the thoughts of home: the thoughts of home.



Burst on his nerves, and call their vigour forth  
In many a vain attempt——till down he sinks  
Beneath the shelter of the shapeless waste,  
Thinking o'er all the bitterness of death.

Having contemplated the unhappy fate of this poor shepherd, we paid the tribute of a stone to his cairn, and passed on. We found a narrow sheep-track, by which we scrambled upwards, but the torrents of water which were dashing upon all sides, rendered the ascent very fatiguing, and sometimes dangerous. At length we reached the summit, from which we were glad to descend quickly towards the low country. About half way down the mountain, the clouds appeared clearer, the rain was less violent, and suddenly, as by enchantment, we burst from clouds, and saw the country smiling below us. When we descended from the mountain the sun was setting; the evening was placid and serene; all the landscape was "mellowed by the gradual dusky veil." We now walked onwards when our fatigues were forgotten in the pleasures of the hospitable family of Kingsburgh.

This tract of country over which we had passed, appeared to be entirely composed of basalt and wacken. We now passed a few days at Kingsburgh, and then left with much regret  
a family,

a family, to whose extreme kindness and hospitality, we had been so much indebted, during our stay in this part of the island.

Mr Campbell, who was going to the south part of Skye, accompanied us to Portree. The hills in this direction are not of great height; but as we approach Portree, they become higher, and upon the summit of one of them there is said to be the *crater of a volcano*, where probably there may be still sufficient heat to revive the drooping spirits of some forlorn fire philosopher as he wanders through this cold, bleak country. The strata are either basalt or wacken; and the latter often contains a very great quantity of zeolite, indeed sometimes it forms nearly one half of the stone.

Portree is a harbour of considerable extent, and capable of admitting vessels of some burden; it is besides very safe, as it is well defended by the island of Raza, from which it is only about three miles distant. Here there is a considerable thorough fare; and as it is the principal market place in the island, of course there is an inn. There are in the Highlands, as in other countries, places where strangers find bad accommodation; but certainly the inn of Portree has seldom been equalled for dirtiness: a traveller from among the Hottentots  
might

might well recognise the *Kraal*, although so far removed from its customary situation. Upon the north side of the harbour, there are rocky cliffs, which increase in height from the inn to the entrance of the harbour, where they are very bold and striking. Near to the inn, the cliffs are formed of a reddish coloured argillaceous rock, which is much of the nature of sandstone, and contains pieces of basalt, and is also traversed by basaltic veins; but the higher cliffs present a sandstone which contains numerous petrefactions, and alternates with basalt. This alternation of sandstone probably continues all along the shore to the muir near Loch Staffing. Upon the south side of the harbour I observed a stratum of coal, from one to two feet wide, resting on basalt, and covered by a similar mass from 16 to 20 feet high. In the coal I saw several pieces of carbonated wood, which could not possibly be distinguished from pieces of common carbonised fir. This does not seem to be a common appearance, for Emmerling only relates two instances, the one observed by Dr Reufs, the other by Mr Flurl. As we approach the mouth of the harbour on this opposite side, the cliffs rise to a great height, and are composed of sandstone and basalt, which alternate; and the basalt, from its being the least destructible, seemed always to form the higher and more exposed parts. The sandstone at a distance has the appearance of a breccia composed of great rounded masses,

masses, but upon a nearer examination, I was surpris'd to find it in large oval or globular shaped masses, as is the case with many kinds of basalt, and some kinds of granite.

This appears also to be a rare phenomenon in other countries, as I find it only mentioned by Dr Reufs, who observed globular sandstone in the Bunzlauer circle in Bohemia\*. Having procured a boat, we sail'd along the coast to Kaimiskianeveg, where we were told that coal had been discovered. The coast all the way is apparently sandstone and basalt, being a continuation of the strata from the south side of Portree harbour. Having landed, I observed in a cliff, about 40 feet above the level of the sea, a stratum of coal, covered by basalt, but unluckily the whole cliff was so concealed with vegetation, that neither the extent nor direction of the coal could be discovered. Nearly at the bottom of this cliff I observed a great stratum of the common argillaceous sandstone, and part of it was globular, like that at the harbour of Portree. From this towards Sconser the cliffs are in general lower, but the sandstone is not now to be seen, basaltic cliffs, as far as I examined, appearing to bound the coast. I cannot omit mentioning another appearance of coal, which I examined upon the coast  
opposite

\* Reufs mineralogische geographie von Boehmen. B. 2. 45.

opposite to Clachan in the island of Rafay. It is a seam of coal about two inches wide, and visible for about 30 feet, but it is waved in its course. The upper and lower sides are bounded by shistose clay. Above this clay there is a thin stratum of Lydian stone, and this is again covered by great cliffs of basalt. From this the basaltic rock continues nearly to Sconser, where the high mountains connected with the Cullin groupe, now make their appearance immediately on the shore. Above the post-house of Sconser, rises the high hill of Glamofcard, which we ascended in order to have a view of the Cullin mountains from this side of the island. The shore and lower part of the mountain is formed of red coloured argillaceous sandstone : to this succeeds a more compact and nearly siliceous sandstone, but it continues only for a short way, for as the mountain becomes steeper, we find it formed of great strata of porphyry and wacken, and both are traversed by basalt veins. These strata continue to the summit of the hill, which has a burnt or reddish brown colour, owing to the cover of decomposed porphyry. The neighbouring mountains, as seen from this elevation, seem to rise to a great height, and are separated from each other by extensive vallies, which have a striking appearance, owing to the red colour of the bounding mountains. In descending, we were obliged to take the lea-side of the mountain on account of the violent wind ; this was a fortu-

nate accident, for while walking in this direction, I observed numerous fragments of yellowish, and green coloured pitchstone. This was to me an interesting fact, as I had never before observed pitchstone among porphyritic rocks: I therefore examined all around very carefully, in order to discover if possible whether it was disposed in strata or veins. I was not so fortunate, however, as to determine this point, on account of the great covering of debris; yet I am inclined to suspect that it is disposed either in very thin strata, or in veins, as the quantity of debris seemed too small, for supposing that great strata existed near this spot. As the determination of the geognostic relations of this fossil, is an object of much consequence, I would earnestly recommend a careful examination of this mountain to future travellers. To do this at sufficient leisure, it will be convenient to spend some days at Sconser, and from this to examine Glamafcard, and the neighbouring mountains, where most certainly they will be able to discover the relative position of the pitchstone to the other rocks. To assist in this investigation, I may mention that pitchstone has been found among similar rocks in different parts of Europe; thus in Misnia, great strata of pitchstone, are observed alternating with porphyry\*. Esmark, a well informed pupil of Mr Werner, describes

\* Emmerling Mineralogie.

describes it as alternating with porphyry in Hungary †; and Voight found it at the foot of Schneekops in the forest of Thuringia, among rocks of porphyry, but he does not mention whether it was in strata or veins.

From Sconfer to Broadford we sailed along the shore thro' the sound formed by the islands of Rafay and Scalpa, which was bounded on one side by lofty magnificent mountains. These hills, as far as the weather would permit me to examine, appeared to be composed of porphyry; and upon the shore, in place of the basalt and sandstone, was formed a compound of felspar and quartz, or what may be called granitel, which seems to rest on limestone, and is traversed by basalt veins. At Broadford, the shore is very low, and continues so to the Kyles of Skye; the country is pretty flat, affording an agreeable scene after so long wandering among mountainous ruggedness. From Broadford to Cory, the country is low, but is bounded upon both sides by hills, thus forming an irregular valley, which extends to Loch Slepín, upon the opposite side of the island. The low part of the valley, appeared to be principally composed of the above-mentioned granitel; which, as is the case with the other, sometimes contains a little chlorite; and in other instances, seems passing to porphyry. Upon one side, there is a

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range

† Neues Bergmanisches journal.

range of blue limestone hills, which rise from the shore at Broadford, and continue increasing in height to Suwardel, which is the highest part; whence they run in an irregular manner towards Loch Slepín. This limestone, which is of a blue colour, is in many places traversed by basalt veins, which are often of great size, and run in different directions. Upon the opposite side of the valley, Ben-na-callich and the neighbouring mountains, form a tremendously sublime boundary. As our time would not allow us to examine all these mountains, we agreed to ascend Ben-na-callich; we did this the more readily, as we knew from Mr Pennant, that from its summit, there was a vast display of mountainous scenery. After leaving the house of Cory, on our way up the mountain, the first object which attracted our attention, was a fine white calcareous marble, which forms a bed of considerable thickness. Upon examining particularly, I observed mixed with it, masses of white and grey marble; and these were seen in all the stages of decomposition, until they formed a substance not distinguishable from the marble. This fact renders it probable, that the whole bed is formed by the debris which has been washed from the neighbouring marble strata. As we continued our ascent, the mountains became more steep, and we observed the crop of blue and white coloured marble, which formed a striking contrast with the brown burnt-like aspect



aspect of the heath. As I could not at this place discover how these marble strata were disposed, I descended into one of the numerous ravines which furrow the side of the mountain, where we judged it probable that their position might be determined. The bottom of the ravine was formed of white marble; but upon the sides, I observed rocks different from any which had been seen in the other parts of the island; but unluckily, they were so discomposed and covered with debris, that I could neither determine their situation with regard to the marble, nor their particular nature. I therefore continued my examination along the ravine, until I discovered the marble covered with a stratum of hornblende rock, which had much the appearance of basalt: and higher up the mountain, in another ravine, it appeared nearly in contact with a granite similar to that which forms the bottom of the valley; but I could not determine whether there was any interposed hornblende rock. Besides this hornblende rock, I also observed masses of greenstone, and a porphyritic rock, which has a basis of quartz penetrated with hornblende, and immersed in it a few crystals of felspar. This part of the mountain seems also to contain either strata or veins of dark nearly leek-green-coloured pitchstone: as I picked up several fragments that were scattered among the heath—As we continued ascending, the marble disappeared, and also the heather; the mountain side being now covered  
with

with loose stones, which rendered our further progress difficult and tedious. This debris is formed by the breaking down of the granite which forms the hill to its summit; it is different in appearance from that of true granite, basalt, or granulated quartz; and although it cannot be characterized in writing, yet, an attentive examiner, is much struck with the peculiarity of its appearance. Amongst the debris, I observed masses of greenstone; but had not an opportunity of determining, whether it formed strata or veins. After scrambling over this debris, which covers so considerable a part of the mountain, we came to a green spot; from whence, the ascent is easier. We now hastened with eager step towards the summit, and soon reached the cairn, which is upon the most elevated part of the mountain. Here, our most sanguine expectations were more than realized, every faculty for a while seemed arrested, until we could burst into an exclamation on the vastness of the scene, and on the mighty and eternal power of him who framed so great a work. Before us, were many great vallies bounded by lofty mountains, whose steep sides were red, owing to the powerful influence of the elements, and furrowed by the many torrents which collect during the dreadful storms that often reign in these wilds. At a greater distance, the dark, lurid and terrible summits of the Cullin mountains retiring in majesty among the clouds; thus dimly seen, adding  
much



Engraved by R. Smith delin.

VIEW from BERNES, N. W. of MOUNTAIN in SKYE.



much to the sublimity of the scene. To the north, we observed below us the low part of the island, with the isles of Rona, Rafay, Scalpa, and Pladda: towards the east and south, the rugged mountains of the mainland appeared stretching in all the grandeur of Alpine wildness to the point of Ardnamurchan; and nearer, the isles of Eigg and Rume added to the variety of this interesting prospect.—We stood long enraptured with the wonderful scene; but the darkening of the sky admonished us to shorten our stay, and hasten again to the valley. The clouds were now seen driving through the glens, and covering the mountains with a dark veil; soon all was lost in grand confusion; what a few minutes before was clear and distinct, was now a troubled scene of tremendous mountainous peaks, shooting above the dark clouds, and reddened valleys dimly seen through the driving mist and rain. We took the lea side of the mountain, and soon reached the house of Cory\*.

As the weather continued stormy, we could not accomplish our intention of examining the mineralogy of the country about Loch Slepín, a circumstance which I regretted very much,

as

\* Upon the summit of Ben-na-callich, I picked up several pieces of porphyry, resembling that which forms the hill above Glamofcard.

as in all probability, it would have proved very interesting. We therefore left the kind and hospitable family of Coryhattican, to take a view of Sleat, which is the most southern parish in the island. Having reached Broadford, we walked through a dreary muir, to a small bay called Loch-in-daal, which is nearly opposite to the wild and romantic arm of the sea, called Loch-Huron. In this tract, we walked for several miles over a blue-coloured limestone, which by the action of the weather splits into thin rhomboidal-shaped masses, like the sandstone we observed near the Cock of Arran. To this succeeds a red-coloured argillaceous sandstone, which extends nearly to Loch-in-daal, when it is succeeded by an argillaceous breccia. This rock, however, continues only for a short way, when distinct primitive rocks, as gneiss, talcaceous schistus, and hornblende slate, are to be observed alternating with each other. The face of the country is now much altered in its appearance, the hills are low, and in place of brown heather, are covered with grass, and beautiful little tufts of natural wood, with interspersed cascades, increase much the beauty of the scenery. As we proceed onwards, the country increased much in beauty; and at Armidale, the seat of Lord Macdonald, where we terminated our journey through this island, there is a sweetly retired house and grounds, but in extremely bad order. As far as I could judge from a short excursion which I  
made

made, south from this place, the strata appear to be primitive to the extremity of the island; and these are principally talcaceous schistus, hornblende slate, and sometimes chlorite slate, and all traversed by basalt veins. The hornblende has sometimes interspersed crystals of actynolite.

VOL. II.

N

RASAY.

*RASAY, RONA AND SCALPA.*

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C H A P. XXII.

*Outline of the MINERALOGY of RASAY, RONA, and SCALPA.*

R A S A Y.

**T**HIS island, which is the property of James Macleod, Esq. is about 15 miles long, and three miles broad: it is separated from the island of Skye by a sound about three miles over: it is low towards both extremities, but rises to a considerable height in the middle, forming the hill of Dun-can. The shores are in general rocky, and in some places the cliffs rise to a considerable height; but there are no caves of any considerable magnitude, nor is there a harbour in the whole island.

*MIN-*



*MINERALOGY.* The shore below Clachan, the pleasant seat of the hospitable Mr Macleod, is formed of white-coloured argillaceous sandstone, disposed in horizontal strata; but as we walk towards Swenish, we meet with argillaceous porphyry. At Swenish point the porphyry appears to lie on sandstone, and has, in many places, an iron-brown colour, owing to the decomposition of the iron pyrites which it contains. As we proceed towards the south part of the island, the porphyry still continues; but nearly opposite to Sconser, in the island of Skye, I observed, on the shore, blue-coloured limestone cropping through the debris, and it even continues to some height in the neighbouring grounds. At Rue-clachan, the most southern part of the island, the porphyry disappears, a sandstone breccia taking its place. In this breccia, besides the fragments of quartz, I observed small stratulæ of red sandstone, and masses of a very beautiful porphyry, with a blue-coloured basis. From this, along a considerable extent of the east coast of the island, the cliffs are low; but, nearly opposite the island of Scalpa, they rise to a considerable height, and continue so to Brokel Castle. The prevailing strata in these cliffs are sandstone and breccia, which alternate. The sandstone has frequently a calcareous basis, and contains numerous impressions of shells, as pectines, &c.; and some specimens of the pectines which we observed were from 6 to 8 inches

long, and 4 or 5 broad. The sandstone, also, not unoften contains pieces of bituminated wood. Having reached the cliffs which are nearly below the hill of Dun-can, we ascended by a narrow path, and soon arrived at the top. I observed no interesting variety of rock: the strata, near the summit, being sandstone, which was in some places very hard; and upon the summit there were rocks of basalt, which had a considerable effect upon the compass. The view from this spot is very extensive; but what interested us most, was, the appearance of the north end of the island, and the isle of Rona, which, from their rugged, grey, sterile aspect, and their rising into low, irregular hills like Coll and Tirie, seemed to announce a similarity of composition. We now descended from this towards Brokel Castle, and in our course met with much red-coloured argillaceous sandstone, and in several places great masses of breccia. This castle is built upon a great rock of breccia, and is the most picturesque and striking ruin that we had observed in any of the Hebrides. A few yards from the castle, and immediately on the sea-shore, the secondary strata are terminated, when gneiss and hornblende-rock begin. At a little distance from where the sandstone disappears, I was so lucky as to observe a stratum of breccia, composed of fragments of gneiss, hornblende-rock, and quartz, lying on the gneiss: thus showing the junction of the primary with the secondary strata. The strata of  
gneiss

gneifs continue to the northern extremity of the island, sometimes alternating with hornblende slate, and traversed by basalt veins: thus confirming the conjecture we had made on the top of Dun-can, that the north part of the island is of a similar composition with the islands of Coll and Tirie. The end of the island is separated from the small island of Rona by a narrow strait, in which lies the isle of Mattea, which is composed of similar rocks with this part of Rasay. As we return along the west side, the same kinds of rock still continue; but, near to the island of Fladda, I observed a small portion of secondary rock skirting the primary. As the appearances presented by the junction of the different strata, particularly that of the primary with the secondary, are highly deserving of attention, I landed upon the shore of Rasay, in the sound of Fladda, to examine the secondary strata I have just mentioned. These strata do not extend for more than 30 or 40 feet in all directions. The uppermost stratum is an argillite, or sheifer-thon; and, below, is a species of breccia, containing fragments of hornblende slate, gneifs, quartz, and hornstone; and from under this stratum rises the gneifs, which forms this part of the island. These secondary strata appear formerly to have been connected with those in the island of Fladda, as it is entirely composed of secondary strata of argillite and red sandstone; and, in a more extended view,

Fladda

Eladda appears to have formed a part of the strata which formerly joined with the sandstone-cliffs upon the shore of Skye. After leaving this junction, the coast continues formed of the usual gneiss, &c. until we come to Loch-Arnish, where I observed great strata of breccia covering the gneiss. Nothing curious again occurred, until we landed upon that part of the island, which is, I think, about due W. from the castle: here the gneiss is covered with breccia, and the breccia is covered with red-coloured argillaceous sandstone similar to that observed near Brokel Castle. From these observations, it appears that the primitive rock occupies that part of the island which is included in the space marked A, in the map.

The red sandstone, which I have now mentioned, is elevated at an angle of  $45^{\circ}$ , and dips to the W. and continues for some miles, forming low shelving shores, or high cliffs; and as it rises into the interior of the island, the extensive, bare, exposed surface of the red sandstone has a striking appearance. As we proceed along the shore, we find it succeeded by white-coloured sandstone; but this continues but for a short way: as, nearly opposite to Portree harbour, felspar-porphry makes its appearance, forming low cliffs upon the shore, or rising upwards to within 30 or 40 feet of the summit of Dun-can, thus forming the west side, as the sandstone does the east. It continues  
also

also to form the rocks upon the shore, and the hills, until we come within half a mile of Clachan, where basalt rocks begin, and continue nearly to Mr Macleod's house. This basalt does not rise to any considerable height, and the porphyry is to be seen rising from under it; but I was not so fortunate as to observe their junction.

The whole of the porphyry is evidently of secondary formation, as it does not extend beyond the line A, which I have before mentioned as the boundary between the primary and secondary strata. It seems to form the basis of the south part of the island; and it is probably covered by the sandstone and basalt, or they may alternate with each other. A disposition of strata, pretty nearly similar, has been observed in other parts: thus, Kohler, in the Miner's Kalendar for 1790, observes, that sandstone and porphyry are sometimes connected together, and it is then of secondary formation; and, in the island of Arran, we have already observed porphyry resting upon sandstone.

RONA.

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R O N A.

THIS island, which is also the property of James Macleod, Esq. of Rafay, is about four miles long, and separated from Rafay, as I have before mentioned, by a narrow channel. It is bare and rugged, and rises into irregular hills, like those in the north part of Rafay: the shores are rocky and dangerous, and there is no harbour.

*MINERALOGY.* The strata, in general, do not differ much from those that form the north end of Rafay; being an alternation of gneiss, micaceous schistus, and hornblende-rock. Many granite veins are to be observed traversing these strata in different directions, and they are from one foot to ten feet wide. They are to be distinguished at a considerable distance; not only by their running in a cross direction to the strata, but also, by reason of the great size of the crystals of felspar, which are sometimes 12 inches long. The only other appearance of consequence, which I had an opportunity of examining, was at

Tuhumas

Tuhumas, or Blue-Bay: here there is a mass of rock, which is composed of chalcedony, hornstone, and quartz, from 12 to 15 feet wide, and extending for a long way, and bounded on both sides by gneiss. I regret that I had not sufficient leisure to determine with certainty whether it forms a stratum or a vein: the determination of this point, however, is well deserving the attention of mineralogists who may visit this island.

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S C A L P A.

THIS small island, which is the property of Lord Macdonald, is about  $2\frac{1}{2}$  miles long, and 1 mile broad: it is hilly, and the shores are low.

*MINERALOGY.* At Mr Macdonald's house, the shore is low, and is formed of blackish-coloured argillaceous sandstone, which contains numerous impressions of shells and zoophytes. This sandstone, with an alternation of limestone, continues to the northern extremity of the island: here, however, a red-coloured sandstone, alternating with common sandstone-brec-

cia, makes its appearance, and continues around the whole east and south sides of the island, until we again come to Mr Macdonald's. The higher parts of the island are entirely composed of a granite similar to that of Ben-na-cailigh; but I could not determine its situation with regard to the sandstone: it is probable, that the sandstone covers it.

SKYE,



## SKYE, RASAY AND RONA.

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### C H A P. XXIII.

*Description of the FOSSILS mentioned in the preceding Chapters.*

#### SIENITE—*Cullin Mountains, above Rue-dunan.*

The sienite of these mountains, like that of the island of Arran, is small-grained, and extremely compact, and also varies much in the proportion of its constituent parts. I shall not now give any more particular description, as it would be pretty nearly a repetition of what I mentioned when describing that of Arran; and have only to mention, that we frequently meet with beautiful nests of glassy actynolite dispersed through it.

WACKEN—*Uig Mill Water.*

This has the common character of wacken; but it has, interspersed, balls of calcareous spar, zeolite, and soap-rock, both in balls and irregular pieces.

The SOAP-ROCK, or STEATITES, has the following characters—

*Colour.* White, greenish white, dark green, and sometimes brown and blue.

*Lustre.* None.

*Transparency.* Allows light to pass freely through the edges, but is also sometimes nearly opaque.

*Fracture.* Fine splintery.

*Hardness.* Scrapes easily with the nail.

*Trace*—upon paper, is glimmering, and takes a polish with the nail; and feels greasy.

The white kind is marked by dendritical figures, and is the same with the chalk of Briançon, and, intermixed with it, are frequently beautiful white fibrous zeolites. It is used in Corn-

wall

wall for the making of porcelain; and were it found in considerable quantity in Skye, might also be of considerable value.

At a meeting of the Electoral Academy of the Useful Sciences at Erfurt, C. A. M. Baron Von Dalberg read a paper on steatites, in which he shewed, that, when cut into figures, and then burnt in a close vessel, it acquires a hardness that will resist the file. He also related a series of experiments he had made, on the method of giving a durable dye to hardened steatites; by which it appears, that it may be made to imitate the most esteemed and beautiful kinds of stone. In the specimens laid before the Society, the hardened steatites had taken a very remarkable degree of polish, and the heads that were cut on it were very beautiful.

LYDIAN STONE, *which covers the Coal, in Skye,*  
*opposite to Clackan, in Rasay.*

*Colour.* Black.

*Lustre.* Faintly glimmering.

*Transparency.* None.

*Hardness.* Gives fire very plentifully with steel.

*Fracture.* Uneven, with a tendency to the conchoidal.

This

This stone is described by Pliny, who mentions that it is found in great plenty in Lydia, in the lesser Asia. It was much used by the ancients as a touchstone for trying the purity of gold or silver. It is now known, however, that any stone, which has a black colour, and a sufficient degree of hardness, will answer equally well.

SHISTOSE CLAY, *which covers the Lydian Stone.*

*Colour.* Black.

*Lustre and Transparency.* None.

*Fracture.* Even; in the gross, flaty.

*Hardness.* Yields with difficulty to the knife.

*Streak.* Dark-brown.

PORPHYRY—*Hill of Glamofcard, Skye.*

This porphyry has, in some instances, a base of hornstone; in others, has more the appearance of indurated clay. It has crystals of white and red felspar, and also quartz, dispersed thro' it. By decomposition, it becomes white, and sometimes brown.

PITCH-

PITCHSTONE—*Hill of Glamofcard, Skye.*

*Colour.* Dark resin-brown.

*Lustre.* Resiny, and nearly strong glancing.

*Transparency.* Transmits light at the edges; but, in thin pieces, it is semi-transparent, and has a fine amber colour.

*Fracture.* Uneven, and conchoidal.

*Hardness.* Does not yield to the knife, and gives a few sparks with steel.

Interpersed there are a few crystals, which appear to be felspar.

Blackish-green PITCHSTONE—*Hill of Glamofcard, Skye.*

*Colour.* Light blackish-green.

*Lustre.* Waxy.

*Transparency.* None.

*Fracture.* Uneven, with a number of rounded, distinct concretions: in the gross, it is frequently shistose.

*Hardness.* Gives fire very difficultly with steel.

Has, dispersed, a few crystals of white felspar.

In

In some specimens this Pitchstone has the following characters—

*Colour.* Pretty dark blackish-green.

*Lustre.* None, or extremely little.

*Transparency.* None.

*Fracture.* Even, with a tendency to conchoidal.

*Hardness.* Gives fire plentifully with steel.

It is alternated with layers of a whitish-coloured substance which resembles hornstone, and a few crystals of felspar are dispersed through it. This seems to be one of the links of a gradation to hornstone, or some similar rock.

WACKEN, *which alternates with the Porphyry,*  
*upon the Hill of Glamofcard, Skye.*

*Colour.* Light greenish-grey.

*Lustre and Transparency.* None.

*Hardness.* Yields rather with difficulty to the knife.

*Streak.* Light grey.

*Smell.* Strong earthy.

It

It contains frequently yellowish-green coloured crystals, probably actynolite, and sometimes reddish crystals of felspar.

### GRANITEL.

*SAXUM MORENSI*, Lin. *GRANITES SIMPLEX*, Gmelin. *HALB GRANIT*, Germanor.

This rock, which forms the upper part of Ben-na-cailich, in Skye, is composed of white-coloured felspar, and quartz; and, intermixed, there are a few dark-green points, which appear to be chlorite. Iron pyrites is sometimes observed; and this, by decomposition, gives a reddish tinge to the mountains.

### MARBLE—*Cory, Skye.*

#### 1st SPECIES.

*Colour.* White, and veined with ash-grey.

*Lustre.* None.

*Transparency.* Transmits light at the edges.

*Fracture.* Even, fine splintery.

*Hardness.* Yields with some difficulty to the knife.

It is very heavy; and, by exposure to the air, it washes down into a powder, and forms calcareous marle.

2d SPECIES.

*Colour.* Ash-grey.

*Lustre.* Has a slight degree of lustre, from a number of very minute foliæ.

*Transparency.* Transmits very little light at the edges.

*Fracture.* Coarse splintery.

*Hardness.* Yields pretty easily to the knife.

It feels very heavy; and is variegated by beautiful citron-yellow coloured stripes, which traverse it in different directions. These yellow stripes seem to be owing to an intimate combination of chlorite, or hornblende, with the marble.



*3d SPECIES.*

*Colour.* Snow-white.

*Lustre.* None; or extremely little, from very minute foliæ.

*Transparency.* Transmits light at the edges.

*Fracture.* Even, or very minutely granularly foliated.

*Hardness.* Yields pretty easily to the knife.

Feels very heavy. Sometimes it has a brecciated appearance, from its containing masses of marble of a harder texture. By the action of the weather, it decomposes, and forms a marl.

*4th SPECIES.*

*Colour.* Pure white, mixed with bluish grey.

*Lustre.* Pretty considerable, from the number of foliæ.

*Transparency.* Allows light to pass at the edges.

*Fracture.* Granularly foliated.

*Hardness.* Yields pretty easily to the knife.

This species differs from the fine marble of Carrara, only in the slight admixture of the bluish-grey colour.

FELSPAR PORPHYRY—*Rasay*.

This porphyry has a basis which is composed of minute crystals or grains of felspar and quartz, with generally a few specks of hornblende or chlorite; and in this basis there appear pretty large crystals of reddish or white-coloured felspar, and sometimes crystals of quartz. Often it is merely a compound of crystals of felspar and quartz, forming a stone like that of Ben-na-cailich in Skye. This porphyry differs from the sienite-porphyry of Werner, in containing a greater proportion of felspar, and comparatively little hornblende. Esmark\* informs us, that the Schemnitz and Cremnitz mining-fields, in Hungary, are situated in sienite-porphyry; and also, that he observed it alternating and passing into clay-porphyry. This latter fact shows us that similar alternations and gradations may be discovered in Rasay; as I remarked clay-porphyry, in several parts of the island, intermixed with the felspar-porphyry.

Indigo-

\* Neues Bergmannisches Journal, bande 1, 2.

Indigo-blue coloured HORNSTONE PORPHYRY—*Rasay*.

*Colour.* Pretty dark indigo-blue (hoch indig blau).

*Lustre and Transparency.* None.

*Fracture.* Even, with a tendency to the conchoidal.

*Hardness.* Strikes fire very plentifully with steel.

*Smell.* Faint earthy.

It has, dispersed through it, yellowish-coloured crystals of felspar, and also quartz of the same colour, which is sometimes in the form of six-sided pyramids. This beautiful species of porphyry seems to be intermediate between clay and hornstone-porphyry, but, by reason of its hardness, it is more of the nature of hornstone.

#### CHALCEDONY—*Rona*.

*Colour.* Grey, brown, or greenish.

*Lustre.* Glimmering, with a greasy lustre.

*Transparency.* Allows light to pass easily through it.

*Fracture.*

*Fracture.* Compact; sometimes passing to the splintery.

*Hardness.* Gives fire with steel more plentifully than flint.

It is sometimes intermixed with the gneiss, in which it lies; and very thin stripes of a yellow and white-coloured substance alternate with it: so that, at first sight, such specimens are not unlike petrified wood.

#### CHALCEDONY, penetrated with Hornblende—*Rona.*

*Colour.* Siskin-green, of various shades; and sometimes dark leek, or mountain green.

*Lustre.* None, or hardly perceptible glimmering.

*Transparency.* It has more or less transparency, according to the intensity of the green colour. If the colour is very pale, the transparency does not differ from common chalcedony; but as the colour approaches to dark leek-green, it becomes less transparent, until it is quite opaque.

*Fracture.* Compact, even, and sometimes splintery.

*Hardness.* Is much the same with chalcedony, excepting when much hornblende is combined, when it is somewhat softer, and has a greater specific gravity.

QUARTZ

QUARTZ—*Rona.*

Sometimes the quartz has a beautiful green colour, owing to diffused hornblende; and frequently the nearly-transparent quartz is variegated with beautiful spots and stripes of a silken-green colour: thus forming a beautiful fossil. It is also to be observed of a red colour; and, being mixed with the common quartz, it is not unlike a granitel.

ON

## ON PEAT.

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C H A P. XXIV,

*Observations on PEAT.*

AS this substance is mentioned in all the Systems of Mineralogy, and as it occurs in great quantity in the Islands which I have just described, I do not think it necessary to apologise for the publication of the following observations and experiments. I proposed, in a former work\*, to continue my investigations with regard to this substance, and had begun a new series of experiments, when the Highland Society, by offering a prize of 50 guineas for the best account of Peat, induced me to wait the publication of these prize essays, which will,

no

\* Outline of the Mineralogy of the Shetland Islands.

no doubt, contain many new observations and experiments. If, however, the experiments, communicated in these memoirs, be different from what I had begun, I will certainly continue the plan I had laid down.

This curious and useful substance has been long known as an article of fuel to the inhabitants of the North of Europe, and used as such, in those regions where no coal has been found, to defend the inhabitants from the rigors of a frozen climate. The learned Torfœus informs us, that its use was first made known to the inhabitants of the Orkney and Shetland islands, by one Einar, a Norwegian, who, from that circumstance, was named Torf Einar. It soon after this came into very general use, and is now the only fuel of many parts, not only of the islands and Highlands of Scotland, but of other nations in the North.

In describing the general appearance of a peat moor, we may conceive an almost entire flat of several miles extent, of a brown colour, here and there marked with tufts of heather, which have taken root, owing to the more complete decomposition of the surface peat; no tree or shrub is to be seen; not a spot of grass to relieve the eye, in wandering over this dreary scene. A nearer examination discovers a wet spongy sur-

face, passable only in the driest seasons, or when all nature is locked in frost. The surface is frequently covered with a slimy black-coloured substance, which is the peat earth, so mixed with water, as to render the moss only passable by leaping from one tuft of heather to another. Sometimes, however, the surface of peat mosses has a different aspect, owing to the greater abundance of heath and other vegetables, as the *schoeni*, *scirpi*, *eriophora*, &c. but this is principally the case with some kinds of what are called Muirlands, which contain but little peat, being nearly composed of the interwoven fibres of the roots of living vegetables.

Many different species of peat might be described, but such an investigation is not suited to my present purpose; I shall therefore content myself with mentioning the substance in a general way. Quick moss (as it is called) is a substance of a more or less brown colour, forms a kneadable compound, and when good, cuts freely and clean with the spade; but when it resists the spade, by a degree of elasticity, it is found to be less compact when dried, and is of an inferior quality. The best kinds burn with a clear bright flame, leaving light coloured ashes; but the more indifferent kinds, in burning, often emit a disagreeable smell, and leave a heavy red-coloured kind of ashes. In digging the peat we observe that, when first taken  
from



from the pit, it almost immediately changes its colour, and in time becomes more or less of a deep brown or black colour; and the peat matter becomes much altered, being incapable of forming a kneadable paste with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackish-coloured powdery matter, capable of supporting vegetation, when calcareous earth is added. Peat earth is very retentive of moisture, which circumstance affords us a satisfactory explanation of the floating islands, observed in many places of Holland, as Frise, Breme, Groningue, Oldenburg, &c. These are caused by the peat earth or turf, retaining so great a proportion of water as to float immense masses of it, which are driven about upon the surface of lakes, or are floated upon the land itself. This is so well known in Holland, that tracts of moss, of great extent, are secured by means of chains, &c.

Peat is found in various situations, often in vallies or plains, where it forms very extensive deep beds, from three to forty feet deep, as those in Aberdeenshire; it also occurs upon the sides of mountains, but even there it is generally in a horizontal situation. The tops of mountains, upwards of two thousand feet high, in the Highlands of Scotland, are covered with peat of an excellent kind. In Germany, it is also found at

very great heights; thus the Blogfberg, a high mountain in Lower-Saxony, and the Brohen, the highest mountain in the Hartz, are covered to their summit with peat. It is also found in situations nearly upon a level with the sea; thus the great mofs of Cree in Galloway, lies close upon the sea, on a bed of clay, little higher than flood-mark at spring tides; Locker-mofs, hard by Dumfries, about ten miles in length, is only a few feet above high water mark; in the island of Lewis, one of the Hebrides, there is an extensive plain, about thirty miles long, covered with peat mofs, having its surface very little elevated above that of the sea. In other places, as in Holland, a kind of peat is obtained by dragging mud from the bottom of canals, and moulding it into the form of bricks; this species is also often taken up upon the flukes of anchors, on the coast of Holland, and is sometimes cast ashore in stormy weather, which has led some speculators to imagine that it is of marine origin. In the harbour of Oban in Argyleshire, one part of the bottom appears to be formed of quick mofs, which affords no sure anchorage. The depth of the sea is there about twenty fathoms\*.

Sometimes peat is to be observed alternating in thin strata with sand or clay: of this, I have observed instances in the  
Orkney

\* Anderfon's Treatise upon Peat Mofs.

Orkney islands; and in the second volume of the *Journal des Mines*, I find similar appearances noticed in France.

It appears to be peculiar to cold climates, which is one of the innumerable instances of the wisdom of nature in providing the inhabitants of a cold country, with a material so necessary for their comfort, and even their existence. Dr Anderson, in his *Treatise upon Peat*, remarks, that it is not confined to cold climates, as he had specimens of real peat sent from the island of Sumatra. It is not improbable that a substance resembling peat in some of its properties, may be found in the warmest countries, when we reflect that decayed vegetable matters, in a certain stage of their decomposition, have an appearance so like peat, that they want only compression to form a similar substance. On this account, it is not surprising, that something of this kind should occur in the warmer regions; but great masses of matter like our peat, can hardly exist in the Tropical regions. This observation is rendered more probable from the following remarks: In Scotland, it is observed, that the peat, at the bottom of a mountain, is more decomposed than at its top, and the wood of mosses is more fresh upon the higher part of a mountain than at its lower. It is also remarked, that the peat of the South of England is more decomposed than that of the North of Scotland;

land ; and the peat of France has more of the coaly appearance, than that of England. In France also, Mr Arthur Young remarks \*, that the peat is never found in the low lands, but under cover of vast size ; and it is only in the higher regions, where the climate is more temperate, that it is to be observed upon the surface. All these facts show us, in a satisfactory manner, that as we advance towards the warmer climates, the vegetable matter is more and more decomposed, until we arrive at the Tropical regions, where, in all animal and vegetable matters, putrefaction proceeds so rapidly, as to prevent the formation of any body of this substance.

It will not be foreign to my present purpose, to mention, in a cursory manner, the most remarkable undecomposed vegetable matters, which have been observed in our peat mosses, or bogs ; particularly as writers have endeavoured to draw conclusions, with regard to the time and mode of formation of peat, from the appearances which these bodies present.

1. FIR or PINE. This tree more frequently occurs, than any other ; it is found of various sizes, some having been dug about one hundred feet long, perfectly strait, with branches growing  
in

\* Travels through France.

in a circular form; as is the case with the pine tribe. It is remarkable, that in such situations the wood has often lost its latitudinal adhesion, which renders it soft; but that the longitudinal fibres are strong and tough, so that they are split, and twisted, to form halters for cattle, as in Aberdeenshire.

2. OAK. In all the low moorlands, in Scotland, this tree is the principal one which is to be observed, and is generally found wanting the bark, which shews that the wood had been long dead before it had been enveloped in the moss. In draining Hartfell level, in Yorkshire, oak trees were found, not less than 100 feet long. They were black as ebony, in excellent preservation, and some of them sold, in the middle of the last century for 15l. a tree. One of them, which is particularly described, was about one hundred and twenty feet long, twelve in diameter, at one end, and six at the other; and 20l. was offered for it. Beckman also informs us, that wood which has long lain under water becomes black, and looks as if charred; it however loses none of its toughness or compactness; and many trees, dug up in Holland from the turf earth, are employed there for ship-building.\* Dr Anderson remarks, that he never saw a piece of oak taken from a peat moss,

\* Beckman, 6 vol. New Transactions of the Royal Society of Gottingen.

moss, which could be used in workmanship, like the stakes which were lately taken from the Thames, and said to have been placed there by Julius Cæsar; from this he concludes that moss does not preserve wood so long as water. This, however, is contradicted from the facts observed at Hartfell level, and that mentioned by Beckman.

3. BIRCH. This tree also frequently occurs in our peat mosses, but its wood is not so resinous as that of the fir, nor has it the hardness of the oak; on these accounts it is seldom found in a state of good preservation; the bark is generally the most entire, which may depend upon the great quantity of resin which it contains, which enables it to resist the all powerful hand of time.

The alder, yew, willow, ash, and several other trees, have been dug out of our mosses; but any detailed account of these would lead me to a great deal of unnecessary description: I may here mention, however, that, besides trunks and branches of trees, we also sometimes discover their more delicate parts in a state of preservation: thus, the leaves have been observed well preserved. Seeds, which have a remarkable power in resisting the influence of the weather, have been found in peat mosses; thus we have instances of fir cones and hazel nuts;

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the kernel of this last was destroyed, and the shell, which is very indestructible, was fresh.

Besides trees and herbaceous plants, another tribe deserve to be particularly noticed, which are the musci. These plants are fond of moisture, and, with a sufficiency of room to spread upon, and a cold climate, grow very fast and luxuriantly. Of these the most remarkable is the sphagnum palustre of Linnæus, which is found in great abundance in all peat districts, particularly in those places where the soft white peat abounds; this peat is found several feet deep, and is nothing but a collection of the sphagnum; which we can observe more or less decomposed as we go downwards; at last its texture disappears, its colour changes, and it cannot be distinguished from the common brown peat.

I have in my possession specimens of a substance, which was found in the peat mosses of the Highlands; it answers to the Bergfet of the Germans, the Mineral Tallow of Mr Kirwan.

*Description.* Colour, white; has nearly the resemblance of tallow, feels greasy, and stains paper as tallow does; flames with much smoke, leaving a pretty light coaly matter. It is brittle like tallow, but its specific gravity is considerably less.

A substance similar to this was found some years ago by peasants on the coast of Finland, afterwards in one of the Swedish lakes; and, more lately, Dr Babington informs us that it is found in great quantities in New Holland. Some have imagined that it is tallow which has been accidentally deposited along with the peat, and, by long exposure to the influence of the vegetable juices, may have been altered. This cannot be the case, as we are utterly unacquainted with any such changes; and besides, the circumstance of its being found in great quantity in New Holland, leads us to suppose that it is not accidental. The editor of the *Bibliothèque Britannique* supposes that it is a substance similar to the fatty matter into which the muscular fibre is converted, when long exposed in particular situations.

A great number of extraneous substances have also been found in peat mosses, sometimes at considerable depths; from their appearance, declaring, in certain characters, the great antiquity of such mosses. Many curious instances of this kind might be mentioned; one in particular deserves to be noticed. In digging a moss at Axholm, in Lincolnshire, the body of a woman was found pretty fresh, her hair was unaltered, her nails were rounded, and her skin was tanned, soft and pliable; she had antique sandals upon her feet, which renders it probable



ble that she was of the Roman æra. Another curious instance occurred in Shetland; in digging a peat moss, the body of a man was found well preserved, which, it was supposed, could not have been in the moss less than eighty years. In the Irish-mosses the horns of the moose deer have been found; in our own, the head and horns of the urus occur. Dr Walker has in his possession a drawing of the head and horns of a deer, found in a peat moss, of a species now no longer found in Britain. Other substances occur in mosses; thus, fragments of very ancient dress, and many instruments of human industry have, at different times, been discovered.

*ANALYSIS OF THE PEAT OF GLEN-CLOY,  
ISLAND OF ARRAN.*

*Character.*

It is of a blackish brown colour, pretty much intermixed with undecomposed vegetable matter, which renders it rather loose in its texture.

*Riz.*

*Solution.*

*Solution in Water.\**

1. I took one thousand grains of powdered peat, boiled it repeatedly with distilled water, until no more could be dissolved, then dried, weighed, and found eight hundred grains remaining.

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\* Lord Dundonald remarks, † that “ the sulphuric acid, when concentrated, acts in a similar manner to that of alkaline substances, in the resolution or destruction of animal and vegetable substances, disengaging from them certain gasses, and forming therewith certain saponaceous and saline compounds. These solutions or extracts are of a reddish-brown colour, similar to that produced by the action of alkaline salts on oxygenated peat. On the principles already stated, the vitriolic acid may be used beneficially to decompose, and bring into action the insoluble matter accumulated in soils, by the combination of the phosphoric and foreign acids, with calcareous matter.” The action of the sulphuric acid upon vegetable substances engaged my attention five years ago, and in a paper read to the Royal Medical Society of Edinburgh, I endeavoured to shew (what has been since done more satisfactorily by Vauquelin and Fourcroy) that acetic acid is formed; that a portion of carbonaceous matter, deprived of hydrogen, remains in solution, and that carbon is separated. It is certain that alkalies exert no such influence upon  
vegetable

† A Treatise of the connection of Agriculture with Chemistry, 4to, by the Earl of Dundonald.

The solution had a deep brown colour, with a slightly bitter taste; tinged litmus paper; and, by exposure to the air for some time, part was precipitated in an insoluble state.

2. By passing the oxygenated muriatic acid through this solution, a precipitation of a dark-brownish matter immediately takes place, similar to what we observe by passing this acid through other vegetable infusions.

### 3. Caustic

vegetable substances; in the present instance, they only dissolve a portion of brown dehydrogenated matter, without causing any alteration in the proportion of the constituent parts. Their action upon animal substances, however, is more nearly allied: Vauquelin found, that ammonia was formed by the action of this acid; and I have reason for suspecting that a similar change is produced by the agency of potash or soda upon the muscular fibre. A series of experiments, which my father was lately engaged in, at the desire of the honourable Board of Trustees, led me to make this observation. We found that the muscular fibre of fish, formed a brown-coloured solution, by treating it with the caustic potash or soda: during the solution, a small quantity of ammonia was formed, but in a far greater proportion, when tallow is added and the boiling continued. During this extrication of ammonia, a blackish-coloured matter falls to the bottom, which is not acted upon by alkalies; in short, it appears to be the carbonaceous matter of the muscular fibre. This change appears to be a nearly complete decomposition of the muscular fibre, its hydrogen and azote forming the ammonia, whilst the carbonaceous matter is left behind, forming the insoluble matter. Vide Nicholson's Journal.

3. Caustic ammonia, or carbonat of potash, did not cause any precipitation in the space of twelve hours.

4. Prussian alkali did not afford any traces of the combinations of iron, copper, or zinc.

5. Lime water formed a copious brown-coloured precipitate.

6. Muriat of barytes, nitrat of silver, fulphat of iron, fulphat of copper, caused considerable precipitations; but nitrat of ammonia, muriat of soda, muriat of ammonia, did not produce any change.

The solution, being evaporated, left a blackish-brown coloured residuum, which had no peculiar smell. It presents the following characters:—

*a.* Not soluble in spirit of wine, except by a boiling heat.

*b.* Difficultly soluble in water, without the assistance of heat.

*c.* Soluble

c. Soluble in caustic soda, at the common temperature, or when heated.

d. Soluble in caustic ammonia, in the same manner.

7. A quantity of the residue being put into a retort, connected with a pneumatic apparatus, a gradually-increasing heat was applied, when the following appearances were observed. At first, water passed over, quite colourless; after some time, it was tinged brown; and towards the end of the operation, when no more brown liquor came over, carbonic acid, and carbonated hydrogen, passed in considerable quantity. No oil or saline matter could be detected, and not the least traces of ammonia could be perceived. The carbonaceous residue was of a blackish-brown colour; insoluble either in hot or cold water, but easily soluble in a weak solution of caustic soda.

The ease with which this carbonaceous matter is dissolved in weak solutions of alkali shows, that it contains a considerable portion of hydrogen; (at least this is the explanation given by modern chemistry :) for I find it impossible to dissolve any perceptible quantity of charcoal with such solutions.

8. The residue, by burning, affords a grey-coloured ash; which I examined, in order to ascertain the nature of the saline  
line

line matters. It did not afford sulphat of potash or soda, phosphat of lime, or phosphat of iron; only *sulphat of magnesia*, and *oxyd of iron*.

To the eight hundred grains, which I found insoluble in water, I added a solution of caustic soda, which acquired a brown tinge at the common temperature; but, when heated, a very deep-brown coloured solution was formed. After repeated digestion with the alkali, I was able to dissolve four hundred grains: the remainder was undecomposed vegetable matter, which was quite insoluble in the alkali I used.

I next added muriatic acid to this alkaline solution; the dissolved matter was precipitated of a brown colour, and did not appear to be altered by its combination with the alkali: for it was still soluble in caustic soda and ammonia, insoluble in water by boiling, but soluble in spirit of wine. When burnt, a brown-coloured ash is left, which afforded sulphat of lime and oxyd of iron; but in no instance did I find phosphat of iron, or phosphat of lime.

*Properties*

*Properties of the Acid contained in Peat.*

In relating the characters of the aqueous solution, I observed that it tinged litmus paper red. This shows the presence of an acid, which I found to possess the following characters:—

1. It is not crystallizable, but may be obtained by evaporation, in the form of thin crusts.

2. Taste, slightly acid.

3. Forms compounds with lime, barytes, and soda; which I have not particularly examined. The compound of lime and this acid is difficultly soluble in water; which distinguishes it, on the one hand, from the Gallic acid, as it forms a very soluble compound with lime; on the other, from the oxalic, which forms an insoluble salt with lime\*.

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\* Lord Dundonald affirms, that peat contains the oxalic and phosphoric acids, which, according to his explanation, are of great use in several of the operations of nature: thus, when lime is added to peat, it is imagined that an oxalat of lime is formed; which, by the addition of sulphuric acid, is decomposed, and a gypsum formed;

4. Decomposes the acetite and nitrat of lead.
5. With fulphat of copper, a copious brown-coloured precipitate is formed, having a beautiful green supernatant liquor.
6. With fulphat of iron, it forms a brown precipitate, and a nearly colourless supernatant liquor.
7. Nitrat of copper changes the solution to a beautiful green, without causing any precipitation. In this it also differs from the oxalic acid, which causes a copious precipitation.
8. Muriat and nitrat of barytes are decomposed by it.
9. With a solution of fulphat of indigo, it forms a beautiful green colour: in this it also differs from the oxalic acid, which does not produce any change of colour.

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formed; while the oxalic acid enters into new combinations, useful in promoting the growth of plants. We have already shown, however, that this acid of peat is very different from the oxalic; but, allowing it to be the same, it is contrary to well known chemical affinity, to suppose, that the sulphuric acid can decompose the oxalate of lime. In the experiments I have made, none of the combinations of phosphoric acid appeared.



This acid appears to be the same with the fuberique acid, lately discovered by Buillion La Grange, and which he imagines to be a compound of carbon, hydrogen and oxygen.

*Distillation of Peat.*

A quantity of this peat was carefully distilled, when a deep yellowish-brown coloured liquor was obtained: it had a strong empyreumatic smell, and, by exposure to the air, it acquired a considerable consistence. I did not examine particularly this liquor: I only found that, by the addition of quicklime, much ammonia was separated. Giroud, in the first volume of the Journal des Mines, mentions pretty fully the properties of this liquor. He finds that it is an ammoniacal soap; which, from the many experiments he made, he thinks, may become of considerable use: thus, the ammoniacal soap, being decomposed by sea salt, would form a cheap muriat of ammoniac, and the oily matter, by proper management, may answer for some purposes in the arts.

*CARBONIZATION OF PEAT.*

The late improvements in agriculture have pointed out a method of converting much of the peat, which is so abundantly spread over the Highlands, into a good and productive soil: yet still there is a great deal of it lost, not only in these operations, but also from its being situated where the labours of the farmer would be employed with little advantage. From these circumstances, it is certainly deserving of attention, to endeavour to discover some means of employing this waste vegetable matter; and thus to raise new sources of industry in parts of the country where there are now only extensive and dreary wastes, without an inhabitant. As the want of common coal and charcoal, in most parts of the Highlands, appears to have been the cause why many promising mineral appearances have been abandoned; I think that it is not improbable that charcoal, from peat, may, if carefully prepared, be used with common charcoal, or even by itself, in the working of ores. This is not an opinion founded upon mere speculation, for it has been actually put in practice in different parts of Europe: thus Baron Dietrich informs us that it is used in the Hartz for the smelting of iron ores. As the successful prosecution of this practice would be of much consequence to the Highlands of  
Scotland,

Scotland, I think it of importance to state shortly the different methods that have been followed to obtain a good charcoal from peat.

Two methods have been followed in these trials: the one, by exposing the peat to a smothering heat, as is practised in the making of charcoal from wood; the other, by exposing it to heat in close vessels or furnaces, and thus subjecting it to a kind of distillation.

So long ago as 1631, Lamberville † seems to have used the first process; but his attempts were not ultimately successful, as his charcoal was too friable; consequently, of no use in the forge, and other similar operations. In the Hartz, Dietrich observed that they carbonised the peat in large cylindrical iron vessels: but this was found to be too expensive; besides, the volatile matter, separated from the peat, was said greatly to injure the vessels. At Villeroy, in France, peat was carbonised by burning it in a furnace not unlike the common lime-kilns of this country: this method, like the other, was also found to be unprofitable. These different methods, as Ribacourt † remarks, are very objectionable; as they do not allow the watery, oily, volatile  
and

† Journal des Mines, vol. 1.

and saline matters of the peat to separate, without, at the same time, consuming a portion of the carbonaceous matter, which causes a great diminution of the peat: besides this inconvenience, the peat is always irregularly burnt; one portion being in the state of charcoal, the other, with a considerable portion of the watery and other matters, not separated.

The second process, which is the subjecting the peat to a kind of distillation, seems from all the trials which have been made to be the most promising. Pfeiffer, in a work entitled, *Histoire de Charbon de terre et de la tourbe, &c.* published in 1777, describes a furnace, in which he distilled peat, and obtained a solid charcoal. Thorin, in 1791, obtained a recompence from the French government for a method of carbonizing peat in an improved iron furnace, by which he obtained a firm and useful charcoal. This method, however, was soon found to be unprofitable, on account of the great waste of the iron vessels by the fire, and the action of the volatile matters of the peat on them. More lately, Blavier † has published an account of a furnace, which is constructed of stone, and at little expence, and is said to answer excellently for the carbonization of peat; and, besides, it has this advantage, that all the  
volatile,

† *Journal des Mines*, vol. 1.

volatile, oily, and alkaline, matters are easily collected. I at one time intended to give drawings of this furnace, but I am confident that the importance of this subject will lead the authors for the prize question, to make this the object of experimental enquiry. From this short account which I have given we have reason to suppose, that by the adoption of a furnace somewhat similar to that of Blavier, peat, at little expence, may be carbonized with advantage in the most remote corner of the Highlands.

Before leaving this subject, I will shortly mention the various trials that have been made with charcoal of peat, with a view of determining the difference between it and that obtained from wood. Sage\* found that the charcoal of peat gave a stronger and longer continued heat than the charcoal of wood; and, further, that the charcoal of wood gives only a third of the heat of that of peat. Two furnaces of equal size, and in every other respect alike, were employed to melt a quantity of silver, when it was found that it required a greater quantity of charcoal of wood than that of peat to bring it into fusion. An experiment was also made in the great way at Paris to ascertain the utility of peat charcoal in the boiling of liquids,

\* Journal de Physique, 1786.

quids, when it was here also found to have great advantages over that of wood. †

In metallurgic operations peat has been by some considered as very pernicious, while others find it not less useful than charcoal from wood. Dr Lind, in the Edinburgh Physical Essays, remarks, “ that there exists in peat an inflammable substance, “ which produces upon metals the same effect as sulphur, rendering them brittle. Another inconvenience which I have “ had the misfortune to experience is this, that a strong heat “ converts the charcoal of peat into a glassy substance, which “ collects along the sides of the furnace, obstructs it, stops up “ the passage by which the melted metal should run, and hinders it from collecting in the lower part of the furnace.” This observation, which seems very unfavourable for the employment of the charcoal of peat in the smelting of ores, probably deserves little credit; or if it be true, it only shews us that it is necessary that the nature of the peat should be known before it is employed, for, by its admixture with various extraneous matters, it may possibly become pernicious. That it is innoxious and useful, Dietrich has proved; and even Lamberville, in 1626, assures us that it was successfully used in  
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† Journal des Mines, vol. 1.

the working of iron. More lately, experiments were made at Paris, when even the temper of steel was not in the least hurt by it. \*

*SOAP FROM PEAT.*

I endeavoured in various ways to make a soap from peat, but always found that it gave a brown colour to the cloth. See *Nicholson's Journal, Vol. III.*

*THEORY OF THE FORMATION OF PEAT.*

The frequent occurrence of peat in many countries has naturally attracted the attention of philosophers, who have endeavoured to discover the mode of its formation. One class of observers have contented themselves by endeavouring to show that it is of vegetable origin, and have only differed as to the probability of wood, or moss alone, or jointly, having formed it; others again, having admitted its vegetable origin, differ only in the explanation of the means which nature uses

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\* *Journal des Mines, vol. x.*

in the preservation of the vegetable remains. Lastly, it has been conjectured, that it is a *live vegetable, sui generis*; and an elegant poet having admitted its vegetable origin, has supposed some changes it undergoes by elutriation, &c.

There can be no question of the vegetable origin of this substance: any other opinion is but vain and frivolous: and, it is also inconsistent with fact, to assert, that either wood or moss singly are the only substances that form peat; for we know that in most cases they both contribute to its formation. In considering the peculiar state of preservation of the vegetable matter in peat, it is very generally believed that fallen wood, when it begins to putrify, produces an extract of the nature of tan, which preserves the moss that grows up among the trees, and converts it into peat. This opinion is founded upon the known action of astringent substances in preserving animal substances from decay; it will therefore be necessary to examine this process, to discover if it will help us to explain the phenomena of peat. It is but lately that we have had any probable explanation of the tanning process; and we are indebted to an excellent chemist, Seguin, for some interesting experiments and observations upon this subject.\* He informs

us,

\* Journal of the Polytechnic School of France.



us, that oak bark, &c. contains two substances, the tanning principle, which has a great affinity for gluten, and the gallic acid, which has a powerful attraction for oxygen. When a solution of bark is applied to skins, he supposes that the gallic acid abstracts oxygen from the muscular fibre and reduces it to the state of gluten, when it immediately combines with the tanning principle, forming a compound, which is the cause of the indestructibility of leather. We have already shewn that peat does not contain the gallic acid; but, allowing that it does, it is impossible to conceive such an action to take place with regard to vegetable matters, particularly in peat, which I have found from experiment to contain no tanning principle. It will therefore be necessary to investigate the influence of vegetable acids, &c. upon vegetable matters, before any probable opinion of this kind can be formed.

The singularity of the appearance which peat presents, has led Dr Anderson to conclude, that it is a *live vegetable, sui generis*. This he imagines to be very satisfactorily proved, from the supposed impossibility of decaying vegetables possessing properties similar to peat. He remarks, “ That in vegetables, “ which have once fallen into a state of putrescency, their in- “ flammability decreases in proportion as that putrescency “ augments; and that their chemical qualities suffer an alter-

“ tion proportioned to the same circumstance. But by the  
“ hypothesis of every person who supposes that sphagnum is  
“ the original constituent matter of moss, it is always under-  
“ stood that the foggy peat, by their hypothesis, is the sphag-  
“ num still so little decayed, as not yet to have become per-  
“ fect moss; and, that in process of time, it gradually be-  
“ comes more and more perfect moss, as it gradually becomes  
“ more thoroughly putrid, till at last, it loses even the appear-  
“ ance of sphagnum, and becomes hard, and perfect peat;  
“ that is to say, in other words, as it becomes more putrid, it  
“ becomes more inflammable, which is directly the reverse of  
“ the well known progress of nature in every other case.” It  
is upon this and some similar arguments, that the Doctor re-  
jects the opinion of moss being a collection of decaying vege-  
table matters. But to these we may shortly answer, that de-  
caying vegetables only lose their power of burning, with the  
destruction of their carbonaceous matter; but this we know  
requires a very long series of years, and when the vegetable  
matters are in a moist situation, as is the case with peat, such  
a decomposition may be prevented for hundreds of years.

The last theoretical opinion with regard to peat, which I  
shall mention, is contained in a note of Dr Darwin's beautiful  
poem, the Botanic Garden. He there gives us a truly strange  
account

account of the changes which peat moss undergoes by elutriation, fermentation, and the consequent heat. As this is little else than a *dream*, it might be passed over; but it is detailed in the form of matter of fact, and therefore requires to be noticed. He remarks, "That morasses, in great length of time, undergo a variety of changes; first by elutriation, and afterwards by fermentation, and the consequent heat. By water perpetually oozing through them, the most soluble parts are washed away, as the essential salts; these, together with the salts from animal recrements, are carried down the rivers into the sea, where all of them seem to decompose each other, except the marine salt. Hence the ashes of peat contain no alkali; and are not used in the countries where peat is used as the fuel of the lower orders, for the purpose of washing linen. The second thing which is always seen oozing from morasses, is iron in solution, which produces chalybeate springs, from whence depositions of ochre and variety of iron ores. The third elutriation seems to consist of vegetable acid, which, by means unknown, is converted into all the other acids. 1st, Into marine and nitrous acids; 2d, into vitriolic acid, which is found in some morasses so plentifully, as to preserve the bodies of animals from putrefaction, which have been buried in them; and this acid, carried away by rains and dews, and meeting with calcareous earth, produces gypsum or alabaster,

with

with clay it produces alum, and, deprived of its vital air, produces sulphur. 3d, Fluor acid, which being washed away, and meeting with calcareous earth, produces fluor or cubic spar. 4th, The filiceous acid, which seems to have been disseminated in great quantity, either by solution in water, or by solution in air, and appears to have produced the sand in the sea, uniting with calcareous earth previously dissolved in that element, from which have been afterwards formed some of the gritstone rocks, by means of a filiceous or calcareous cement. By its union with calcareous earth in the morafs, other strata of filiceous sand have been produced; and by the mixture of this earth with clay and lime arose the beds of marl." After this follow some whimsical notions about the formation of coal, which are connected with some supposed changes produced by fermentation and heat. We shall now, in as few words as possible, examine the truth of the supposed change by elutriation, which is all that interests us at present. As to the first position, that the salts are carried to the sea and decompose each other, we have no manner of probability, far less proof. The third stage of elutriation, where a vegetable acid makes its appearance, should have been confirmed by experiment; its supposed conversion into marine and nitrous acids is perfectly chimerical. I have not found sulphuric acid in peat, nor does Dr Darwin inform us that he had detected it;

it; therefore any reasoning founded on its action must be ideal.\* The existence of the fluor acid in morasses, and the speculations about the siliceous acid, are all conjectures as odd and improbable as could be contrived.

Having now mentioned the principal opinions with regard to the formation of peat; and having stated such objections as occurred to me; I will now endeavour to ascertain, upon chemical principles, the peculiar state of the vegetable matter when in the form of peat. In viewing the various phenomena of decaying vegetables, two distinct stages may be observed—

\* “The common vitriolic acid, I believe, has never been found in nature, free from all combination, though it may unite with some bodies beyond the point of saturation. It is true, Mr Baltaffari says, he found some dry concentrated vitriolic acid adhering to selenite, in a grotto in Monte Zaccolina, near Sienna; but this has been fully disproved by the subsequent observations of Mr Murray, in the 7th volume of the Memoirs of Stockholm, and of Mr Dolomieu, in his Notes upon Bergmann de Prod. Volcan. page 88.” *Kirwan's Mineralogy, Vol. II. p. 2.*

More lately, however, in the eighth volume of the *Bibliothèque Britannique*, we are informed, that, upon examining a water from Savoy, it was found to contain a considerable quantity of uncombined sulphuric acid.

ferred—the acetous and putrefactive fermentations. These processes are much modified by circumstances; depending upon the degree of heat, moisture, the presence of air, and the greater or longer continuance of the action of these agents. The putrefactive fermentation is the one which here claims our chief notice; for, attention to the appearances it presents will enable us to judge better of the state of vegetable matter in peat.

In the putrefactive process, if the heat be considerable, the destruction of the vegetable matter is soon accomplished: the whole is dissipated in the form of carbonic acid, carbonated hydrogen, and sometimes ammonia; a small portion of charcoal and ashes being left behind\*. A more moderate degree of

\* It is plain, that, in general, wherever carbonic acid and carbonated hydrogen gases are formed, both earthy and saline matters will be left behind; for carbon, which enters into the composition of these gases, contains neither earthy nor saline matters. This being admitted, we can account for the presence of saline matters in plants, without any great stretch of hypothesis. It has been discovered by Lampadius, professor of chemistry at Friburg, that charcoal decomposes water at the common temperature; and as all soils contain carbonaceous matter, it is plain, that, during the formation of these gases by the action of the sun's rays, a quantity of saline matter will be left in the soil for the use of vegetables.

of heat, with moisture, allows the matters to decompose more slowly, and to present the vegetable matter in several other intermediate stages, such as we observe with regard to peat when more or less decomposed. A very great proportion of moisture has a powerful influence in retarding this process: thus, the trees, which are found at the bottom of mosses, are fresher than those at the top, owing to the bottom containing a greater quantity of water; and the stakes, lately taken out of the Thames, are another remarkable instance of this.

From these circumstances, it is plain, that peat is a vegetable substance, which has undergone in part, and is still undergoing, the changes which have been just mentioned; and many facts lead me to conclude, that the common peat, or quick moss, is the vegetable matter, deprived of a considerable portion of its hydrogen. Not only the circumstances attending the situation and appearance of peat, but also other facts, render this opinion probable.

1. Sulphuric acid being added slowly to oils, and triturated, they gradually become brown, when the oil is rendered soluble in water and spirit of wine; but, if the acid be added in too great quantity, a black insoluble matter is formed.

2. If oleum animale be exposed to the action of oxygenous gases, water is formed, and carbon precipitated.

In this last experiment, we perceive, that the separation of hydrogen causes the precipitation of carbon: and, in the experiment with the sulphuric acid, we observe, that, in proportion as the hydrogen is dissipated, the carbonaceous basis becomes more or less soluble in water; and when the whole of the hydrogen disappears, a true carbon is left behind. In the same manner, with regard to peat, the woody, or other vegetable matters, are slowly deprived of a portion of their hydrogen, become brown, and somewhat soluble in water and spirit of wine; thus forming a kind of bituminous matter\*. By a further decomposition, more hydrogen is separated, when the vegetable matter becomes insoluble in water, but still soluble in alkali; lastly, nearly the whole of the hydrogen is separated, when a black substance is left, what is called Peat Earth. This last, by exposure to the air, combines with a portion of oxygen, forming suberic acid; and appears to be what Lord Dundonald calls Oxygenated Peat.

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\* Vide Mr Hatchett's excellent paper on Bituminous Substances, inserted in the 4th volume of the Linnæan Transactions.



If this explanation be thought to have probability in its favour, we may explain some other facts in a pretty satisfactory manner. Thus the great Captain Cook remarks, that the coast of Tierra del Fuego is covered with peat-mosses, and the water which runs from it has a brown turbid appearance. At one time, he was obliged to water upon this dreary spot, and could obtain no other water but that from the peat mosses, which made him very suspicious of its good qualities, so that at first it was but sparingly used. Having soon got into the warmer regions of the Pacific Ocean, he found that this water deposited a small sediment, became pellucid, and was the most wholesome and freest from putrefaction of any he had on board. It is probable that the infusion of peat acted, in this case, in a similar manner with charcoal, (from which it differs but little,) by abstracting the putrescent matter. Another curious fact is mentioned by Dr. Plott—that intermittent fevers never occur in the neighbourhood of peat-mosses. This appears to be owing either to the slower decomposition of the organised matter in peat-mosses than in fens, by which a smaller portion of noxious gas is formed; or to the absorption of these gasses by the peat matter approaching to the state of charcoal. This last explanation is rendered the more probable from a well-known fact, that in church-yards, where a great number of dead bodies are buried, no bad smell is to be perceived; evi-

dently owing to the absorption of the noxious gasses, by the carbonaceous matter of the soil.

#### *IMPROVEMENT OF MOSS LAND.*

The method of improving peat mofs, by means of calcareous earth, is certainly one of the most useful discoveries of the present day, and will, no doubt, form an important era in the annals of agriculture. Not long since, peat lands were only considered as useful on account of the fuel which they afforded. The case is now widely altered: the mofs grounds are eagerly sought after: and, in the west of Scotland, this method of improvement is carried on with great spirit, and is repaying the judicious manager very amply. To give a detailed account of the methods which are followed, (and that is the only one that can properly be given,) would require a volume; and, after all, would be little more than a repetition of what is already known. I shall therefore content myself with endeavouring to apply the preceding experiments, to explain the mode of action of the calcareous earth.

We have already observed that peat contains the fuberique acid, or one nearly allied to it, which appears to be formed in greater quantity the longer the peat is exposed to the action of the

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the air; thus assisting in retarding the decomposition of the peat, of course preventing its being useful in vegetation. Marle, shells and limestone are useful, in a triple capacity: in the first place, by removing the acid, the vegetable matter is allowed to decompose more rapidly; secondly, the combination of this acid with the lime, forms a compound, which may assist in vegetation; and, lastly, this acid having a stronger attraction for lime than the carbonic, will disengage it in considerable quantity, when it will assist vegetation.

I shall conclude, with remarking, that there is a considerable prejudice in favour of quicklime: if the explanation now given have any plausibility, it is plain that carbonat will answer as well, if not better, in the improvement of mofs lands.

FROM

FROM BERNERA TO THE FRITH OF FORTH.

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C H A P. XXV.

*Journey from BERNERA, by Fort-Augustus, Garvimore, Dalwhynnie, Dalnacardoch, Blair in Athol, Dunkeld, and Perth, to the Frith of FORTH.*

HAVING visited all the islands that lie immediately along the west coast of Scotland, from the Craig of Ailfa to the island of Skye; we agreed to defer, till another season, our expedition to the chain of islands that lie farther to the westward. We therefore left Armidale, in the island of Skye, and sailed up the fount to Elean-reach, which is situated upon the mainland of Scotland. Here we landed, after a pleasant passage of three hours. The scenery, upon both sides of the fount, was grand, and particularly about Loch-Houron. Though the mountains are peculiarly rugged and sterile, yet this ruggedness

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ness was softened in the distance; and the airy tints of their summits, with the deep shadows on their base, marking strongly their vallies and furrowed sides, formed a beautiful mountain scene. As we passed the mouth of Loch-Houron, the day was serene; and the placid waters beautifully reflected the mountain screens, which successively burst forth, and retired as we sailed along. The house of Mr Macleod is a sheltered retreat, almost hid among trees: it lies on the sea-shore, on the side of a grand amphitheatre of rocks, which opens to the sound of Skye. As our stay here was very short, I can say little with regard to its mineralogy; yet, from what I saw, I have little doubt that, upon attentive examination, many interesting appearances might be discovered. The rocks are entirely of primitive formation, and are composed of micaceous schistus, gneiss and hornblende-rock, and are traversed by great veins of granite. In several places, I observed great masses of lapis ollaris, which contained beautiful specimens of green actynolite, and green hornblende. We remained all night at this place, and in the morning set out on our journey homewards. We walked along the shore for about 2 miles to Bernera, where there are the remains of barracks that were built in this sequestered spot after the troubles in 1745. The rocks in this direction are still of the same nature with those at Elean-reach, but principally of gneiss. From this we entered into Glen-elg;  
which

which is an extensive valley bounded on both sides by great mountains. The lower part is cultivated, and vegetation is even observed covering the tops of the hills. The prevailing rock is micaceous schistus, but gneiss is sometimes to be observed in the higher parts; and both kinds of strata are traversed by granite veins. In our walk towards the upper part of the glen, I picked up several specimens of tremolite, which adhered to masses of quartz, and seemed to be derived from the strata or veins in the neighbouring mountains. Having reached nearly to the upper part of this glen, we ascended, by a broken military road, to the top of a hill, which seems to be principally composed of sienite. From this elevated point, we had a grand view of mountain scenery; vallies beautifully retiring, in misty colours, among screens of mountains, lightened with catching gleams: below us, appeared a pretty extensive loch, apparently surrounded by lofty mountains. We now descended to the side of the loch, by many windings down a very rugged and steep road, when we observed that the loch communicated with the sea, and its sides were adorned with gentlemen's seats. Although the scene was still beautiful, yet our ideas altered strangely, when, instead of the calm and cultivated retreat on the banks of an inland lake, we found an oozy bank, covered with slime and sea-weed, left by the retiring tide. The same sienite rock continues to the side of the loch;

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and from this to Ratachan Inn, which is situated at the upper part of the loch, the country is low, presenting strata of micaceous schistus.

As we were obliged to remain here the rest of the day, we examined slightly the hills in the vicinity. They rise to a great height, are bare and rugged toward their summits, and, so far as my examination went, appeared to be composed of micaceous schistus, which sometimes passes into gneiss, and is traversed by veins of granite.

We left the inn next morning before sun-rise, as we had to perform a long and dreary journey of nearly forty miles before the evening. Immediately after leaving the inn, we entered, by a narrow, abrupt pass, into Glen-Sheill. Tremendous mountains rose on each side, but, farther distant, all was dark and indistinct: it was but twilight; the obscurity thus thrown over the scene was peculiarly impressive. Before us, towards the head of the glen, the clouds were cleared away as the day advanced, and the opening, the modest, mellow tints of the morning cheered us with the prospect of a charming day for a journey through a country so dreary and wild. We were soon grievously disappointed: the clouds were seen rapidly covering the mountains; the ravines, situated near the sum-

mits, appeared white, from the water rushing over their rugged bottom; and soon the whole glen was obscured, and the rain poured down with great violence. We continued our disagreeable journey, which had but little diversity: only, now and then, a partial dispersion of the clouds allowed us to observe many grand, peaked mountains, rising to a tremendous height, far beyond the boundaries of the glen. At length, having reached far up the glen, we came to a narrow pass, where the waters were collected from the neighbouring mountains. They were precipitated over rude fragments of the rocks; and, swollen and pent up in a narrow channel, rushed impetuously forth until they gained the level bottom of the glen, where the river flowed "calm, sluggish, silent." Such scenes are the greatest ornament of the Scottish glens—where the stream, collected from the rude mountains, glides thro' the mossy wilds, and descends, by successive falls, thro' the rocks, shadowed by the overhanging woods, till gathering strength, "it boils, and wheels, and foams, and thunders thro." Indeed, in the course of this glen, we saw all the various beauties which a river displays in a wild and mountainous country. The tumultuous noise of the waters was reverberated from the neighbouring mountains, and continued to be heard long after we had lost sight of them. The road was now nearly impassable, torrents crossing it every few yards; which, in some places, were so rapid and

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and deep, as to endanger our lives in crossing them: our guide having stumbled, with great difficulty saved himself. Having forded these torrents, we at length advanced into a more open part of the glen, where the road was better: here the storm began to abate; the clouds gradually rose; and in a few hours the sun again beamed upon us. When we looked back to the mountainous scene of Glen-Sheill, still obscured by dark clouds, it formed a striking contrast with the scene before us.

We now travelled, by a broken and winding road, to the side of a loch called Clouny, which is of considerable extent, and bounded on both sides by lofty mountains. On their lower parts, these mountains are skirted by natural wood. We walked along the side of this loch, to its farther extremity, which brought us nearly to the entrance of Glen-Morison. This glen is considerably different, in appearance, from Glen-Sheill: the hills which bound it are lower, and have much of the round-backed shape. We descended into this glen, and walked several miles, when we reached a dirty black house, called Unach Inn.

The country through which we had passed in coming from Ratachan inn, will afford much instruction to future travellers; but as my journey was rapid and attended with every

inconvenience, I can give but little information as to its peculiar nature. The mountains of Glensheill appear to be composed of micaceous schistus, which is sometimes alternated with hornblende slate, and veins of granite appear traversing these strata in various places. At Loch Clouny, however, the micaceous schistus disappears, when great hills of red granite are to be observed; and this rock seems to bound both sides of the loch, as is well marked, not only by the red colour of the debris along its banks, but also by the appearance of the broad flat faces, similar to what we observe in the great granite glen Rosa in the island of Arran. This granite continues for about a mile, when the micaceous schistus again makes its appearance; and near the junction of the granite and micaceous strata, great veins of granite are to be observed traversing the micaceous schistus, and several of the veins seem to issue from the granite itself. The greater part of these granite veins, however, have a different appearance from that of the great body of stratified granite, its constituent parts being of a great size. The micaceous schistus continues to Unach inn, but it is in several places alternated with hornblende-rock, and traversed by granite veins.

As the appearance of the granite veins shooting from the granitical strata into the micaceous schistus, &c. has been considered

considered by the late Dr Hutton as a proof of the posterior origin of granite to the strata which cover it; I think it necessary now to consider the plausibility of an opinion so contrary to that of the best informed geologists.

Dr Hutton maintains, "that all the solid strata of the earth have been consolidated by means of subterranean heat; softening the hard materials of these bodies; and that in many places these consolidated strata have been invaded by huge masses of fluid matter similar to lava, but for the most part perfectly distinguishable from it †." Granite he considers as a body which has been transfused in a fluid state from the subterranean regions, and made to break and invade the strata in the manner of basalt. His evidence for this opinion is as follows: He observed in the bed of the river Tilt, near to Blair in Athol, that the granite and schistus were much intermixed at their junction; and in the shire of Galloway and the island of Arran, veins of granite seemed to issue from the strata of granite and traverse the schistus; from this he concluded, as all veins are of a posterior origin to the strata which they traverse, that the veins of granite which traverse the schistus, being continuous with the granite, make the whole after formation.

† Philosophical Transactions of the Royal Society of Edinburgh, Vol. III.

mation to the schistus. Many objections occur to this hypothesis, and I shall now mention a few of them.

1<sup>st</sup>, If granite had flowed from below, how does it happen that after it had burst through the strata of micaceous schistus, &c. it did not overflow the neighbouring country? If this hypothesis were true, Mont Blanc could never have existed.

2<sup>d</sup>, If the granite had been forced up with the violence which Dr Hutton supposes, we should expect that the strata of micaceous schistus, or other strata that cover granite, should be invariably disturbed and broken in every direction, but more particularly at their junction. This is by no means the case; Saussure, Charpentier, and others, have examined vast tracts of granite country without observing such appearances; and in Scotland I have examined great tracts of granite, but the appearances described by Dr Hutton occurred rarely.

3<sup>d</sup>, If all kinds of granite have been ejected from below, and if all veins of granite communicate with a central mass of granite, how shall we explain the appearance of granite veins in countries where no strata of granite have been observed? nay, where these veins have been traced from their beginning to  
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their termination in the schistus, a sufficient proof that they are not connected with any granite underneath?

*4th*, The general observation that the granite which runs in veins has a character different from that found in strata, intimates strongly that it has been found at a different period from the granite in strata.

These objections bear much against Dr Hutton's opinion, and may probably appear, in a considerable degree, to disprove it. I shall not stop here, however, but shall now mention a fact, which to me seems to remove in a considerable degree the doubts with respect to the connection of the granite with the other strata. The observations of Werner, Charpentier, Sauffure, Reufs, and other geologists of the highest character, have demonstrated that granite, when it is covered by strata of gneiss, gradually acquires a schistose fracture, and at length is not to be distinguished from it; the gneiss, when covered by micaceous schistus, gradually passes into it by the loss of its felspar; and lastly, when ardesia, or primitive argillaceous schistus covers the micaceous schistus, a distinct gradation is to be observed by the disappearance of the quartz, and the increase of the argillaceous ingredient. Here then we have a demonstration that these different strata have been formed in  
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the same manner, and nearly at the same time ; therefore any speculations which refer to one of these kinds of strata are equally applicable to the others ; consequently the hypothesis of Dr Hutton is to be considered as unsatisfactory. The transition of these strata into each other is not an appearance confined to one country ; it has attracted the notice of geologists in all parts of the globe, and has been universally considered as a proof of the identity of the formation of these different strata. The appearance of the veins of granite shooting from the strata of granite into the schistus, may be explained in the same manner as common veins. Granite strata are frequently traversed by veins of granite, and these veins, although in general of a different grain from the rock through which they run, yet, in some instances, it is with great difficulty that we can distinguish them from the stratified rock. Now, as it is nearly demonstrated that granite, gneiss, micaceous schistus, and ardesia, are of the same formation, it is not at all improbable that rents would as readily extend through the gneiss and granite, as through the gneiss and micaceous schistus ; and that these rents would be afterwards filled up with granite similar to that of the strata, and thus form the appearance of the granite invading the schistus. The masses of granite enclosed in the schistus, and of schistus enclosed in the granite which are observed where

where the granite and shistus meet together have been explained in another part of the work.

I cannot leave this subject without mentioning that Dr Hutton asserts that granite is not stratified, and consequently that this is a proof that it has been formed at a different time and in a different manner from the other strata which cover it; and he applies the same reasoning to porphyry and basalt, which he says are not stratified. It is now well proved, however, as I have mentioned in a former part of the work, that granite is disposed in strata; and no one, I think, can doubt that porphyry and basalt occur in strata in many parts of the world. Indeed these are very common appearances. The ingenious Sir James Hall, a supporter of the Huttonian theory, remarks, that the mineral kingdom is divided into stratified and unstratified bodies, the latter comprehending granite, porphyry, and basalt\*; but he understands by stratification, the flat fracture of the stone. He is here in an error, as we have great mountains of shistose porphyry †;

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\* Edinburgh Philosophical Transactions, Vol. III.

† Although porphyry, in general, does present a uniform and compact structure, yet, when it is quarried, it rises in large flat masses, or when broke by a hammer, it yields more easily in one direction than another; consequently it has the shistose structure, but in a less perfect degree than micaceous shistus or ardesia.

and shistose basalt || and granite, have been frequently observed.

Having rested a little at Unach inn, we set out for Fort Augustus. The road was first up a steep hill, which is composed of micaceous shistus alternating with hornblende slate, and traversed by granite veins. Having reached the top of the hill, we had a good view of Glen-Morrison nearly to its further extremity, bounded on both sides by grey hills, all apparently of a similar composition with that on which we were standing. We now walked pleasantly along for several miles through a muirland, when we came to a hill upon one side of the

|| Reufs observed, near to Teplitz, the top of a hill composed of basaltic columns; under these he observed basalt in very thin tables; and, lower down, the basalt was observed passing completely into shistose porphyry. He also observed the shistose basalt forming a vein, which traverses common sandstone. Reufs *Mineralogische Geographie von Boehmen*.—And Charpentier has observed granite decidedly shistose, and even where it had not externally the shistose texture, he found that it always broke in a certain direction, and when raised from the quarries, that it rises in great flat blocks; but it is only in a particular direction that these masses could be raised. At Aberdeen, where there are immense granite quarries, the workmen have the daily experience that the granite rises more easily in one direction than another, and also that in dressing it, their work is much hastened by breaking the stone in a particular direction.

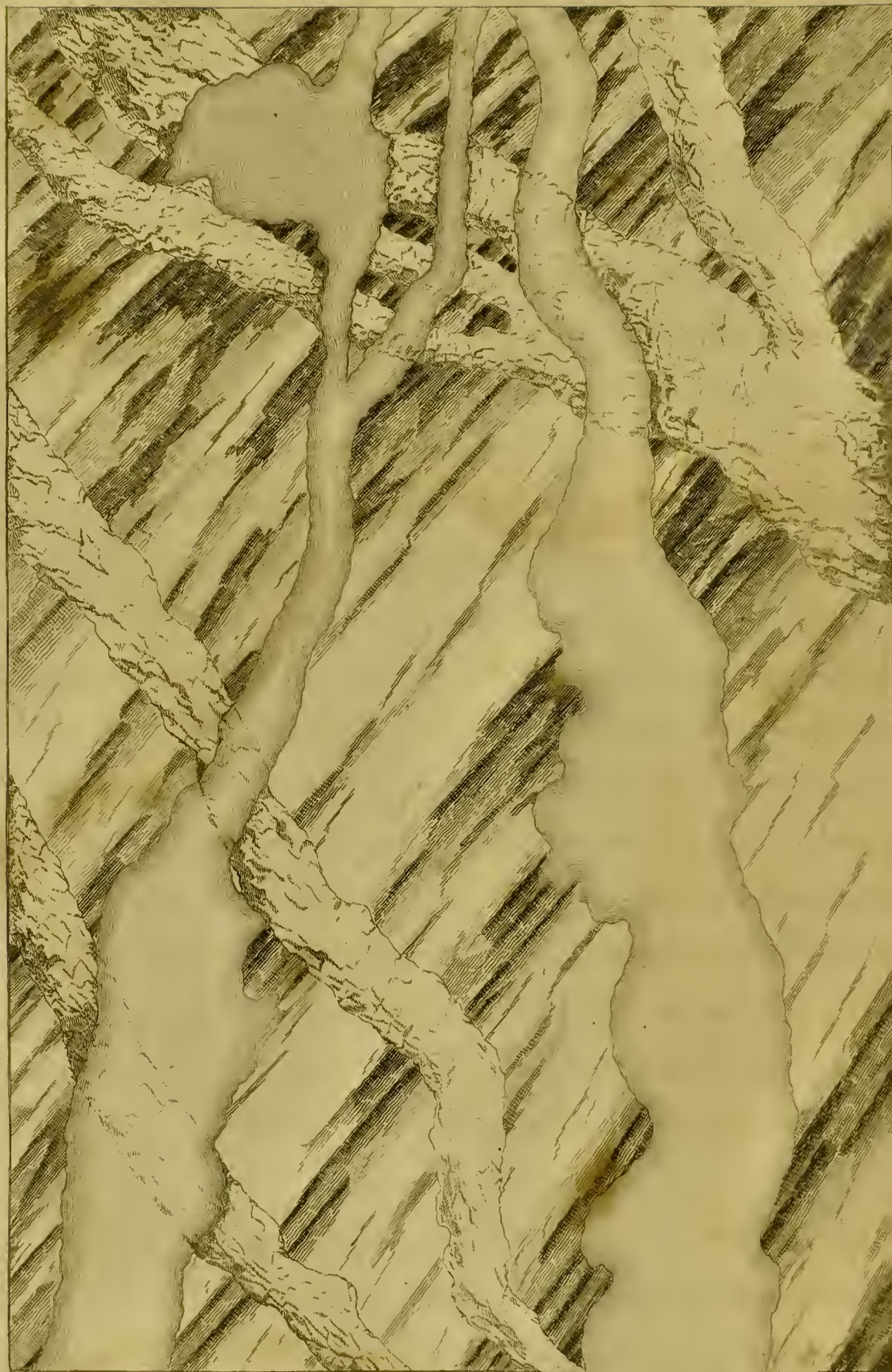


the valley, in which Fort Augustus is situated. Below appeared the Fort, which has more the appearance of a mansion-house than a place of strength, but is charmingly situated upon the extremity of Loch Ness; and at a distance the great mountain of Ben-Nevis, the Mont Blanc of Scotland, was seen half wrapped in the clouds, which almost perpetually encircle its lofty summit. We now descended by a winding road over strata of micaceous schistus, traversed by granite veins, and in a little time reached a comfortable inn, which was the more agreeable after our long walk from Ratachan inn.

Having rested all night, we set out in the morning for Garvimore, preferring it to the route by Fort-William. The road continues for a considerable way to be very steep. It leads over a hill, which is composed of micaceous schistus, and is probably traversed by granite veins, as I remarked upon places of the road great masses of granite, that seem to have come from the neighbouring rocks. Having reached the summit, we walked for several miles among heathy mountains, composed principally of micaceous schistus, until we came to the foot of the mountain called Coriariach. We ascended it by a long, winding, tedious road of six miles: it was extremely dreary and desolate; not a human being, not a bird was to be seen; and the long bleached poles that are erected along the road to

direct the traveller during the snow had a singular appearance. From the summit, we had a very magnificent spectacle of the tremendous peaked mountains extending along the west coast of Scotland. This hill, and the neighbouring one, as far as I could judge, are entirely of primitive rock, and appear to be principally formed of different species of micaceous schistus. I observed upon the road masses of quartz of a nearly black colour, thus approaching in external character to the obsidian. Reufs, in his mineralogical history of Bohemia, informs us, that he found specimens of obsidian passing into quartz, and that he has in his possession a crystal, where the one half is obsidian, and the other quartz. These appearances observed by Reufs, as also the black quartz of Coriaraich, are probably no real gradation to obsidian, but merely quartz coloured deeply with iron or inflammable matter; the trial of its fusibility will help to determine this point. I also observed upon the top of the mountain fragments of compact felspar, which must either form veins traversing the strata, or alternate in the manner of strata; the latter supposition is the more probable. We now descended by a very zigzag and steep road, to the bottom of the mountain, when we entered into Glen-Drummond, through which runs the river Spey, having its origin in the neighbouring mountains. Many small heather-covered hills were scattered below the lofty precipices; and, upon examination





GRANITE VEINS TRÁVERSING MICACEOUS SHISTUS GLEN DRUMMOND BADENOCH

ination, appeared to be formed of the debris washed from the mountains. We now continued our dreary journey through this desolate country. As we approached to Garvimore the strata of micaceous schistus were succeeded by considerable hills of granite, but these continue only for a little way, when micaceous schistus is again the prevailing rock, and continues to the inn at Garvimore. The micaceous schistus, however, is much traversed by veins of granite, which are from an inch to 12 feet wide. At the bridge which crosses the Spey, at a little distance from the inn, we observed in the bottom of the river a fine display of the granite veins, a small part of which is represented in the plate. These veins traverse the strata in various directions, and sometimes they appear to inclose masses of the micaceous schistus, as is well expressed in the engraving. In several of the blocks of granite that lie scattered about, I observed masses of micaceous schistus inclosed, and also in the masses of the micaceous schistus, pieces of granite were included. The hills in the neighbourhood of this house are of considerable height, and are generally composed of micaceous schistus, traversed with granite veins.

We left Garvimore by sun-rise; the morning was cool and pleasant, so that our journey was very agreeable. We walked for some time along the banks of the Spey, which are here included

cluded between great banks of boulder stones, that have been carried from the upper part of the glen. We soon left the banks of the river, and journeyed along by the foot of the hills that form the side of the valley; these hills are in general heath-clad, but often also present broken, rough, gray, surfaces, announcing them to be composed of micaceous schistus. This schistus appears in some places to be traversed by granite veins, as I observed upon the road masses of a granite, whose constituent parts are of great size, similar to that which is only to be found in veins. In some of the granite masses I observed pieces of micaceous schistus inclosed, similar to the appearance of the bridge near Garvimore. Having walked near to the further extremity of Glen-Drummond, we expected that we were near to Dalwhiny, the next stage, but to our mortification, we found that we had taken a wrong road, being near to Pitmain on the Inverness road; we were therefore obliged to walk back for about 12 miles, and did not reach Dalwhiny until the afternoon. The strata in this direction are still primitive, and composed of micaceous schistus; and, in the beds of the rivulets, I often remarked it traversed by granite veins.

Having refreshed ourselves after the long and circuitous walk from Garvimore, we set out for Dalnacardoch, as we wished to reach it before the close of the evening. The road

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was good, and led through a valley bounded on both sides by lofty heath-clad hills, which are in general of micaceous schistus. Their shape is lumpish, with steep sides; and the strata are only to be seen where the rains have worn deep ravines, owing to the thick covering of heath. At a turn of the road, where we met with the river Carie, the strata are well exposed, but are still of micaceous schistus: but, upon the road, I remarked large masses of green hornblende, which approaches to actynolite; also, sienite, which is composed of white felspar, quartz, and hornblende: but I had not any leisure to determine their situation with regard to the other strata, as night was fast approaching, and we were happy to reach Dalnacardoch after our tiresome journey.

As the weather still continued extremely pleasing, we set out early in the morning for Blair in Athol, which is the next stage to Dalnacardoch. The road continued for several miles thro' a dreary country, similar to that which we had passed the preceding days, and the strata were not much different; micaceous schistus, in some places alternating with blue-coloured granularly-foliated limestone, being the prevalent rock. A few hundred yards before we enter into a birch wood that stretches near to Blair in Athol, I observed a large stratum of felspar porphyry? inclined at an angle of  $45^{\circ}$ , and resting on, and covered by,  
strata

strata of micaceous schistus, which have a similar elevation. The stratum of porphyry, where I observed it, is from 12 to 15 feet wide, and is to be observed rising to the tops of the hills on both sides of the river; and, even at a distance, is easily distinguishable from the micaceous schistus, by its colour, and the peculiar manner in which it decomposes. As we approach to Blair, the banks of the river become lower; and in several places I observed porphyry, but it was sometimes difficult to determine whether it formed strata or veins. The mountains now recede, and range themselves on each side of the delightful valley which extends to Dunkeld: the banks of the river are skirted by natural wood, and to this immediately succeed lofty woods, that extend even to the summit of the hills. The country now increases in beauty every step; and we are led, by a delightful road, thro' a rich diversity of wood, to Blair, where there is a summer seat belonging to the Duke of Athol. The rapid change, from the brown, barren heaths of Dalnacardoch, to the richly-cultivated valley of Blair, is very striking to the traveller; and it is farther pleasing, from the probability that the other valleys, thro' which he has passed, may, one day, like the valley of Blair, attract admiration.

Having rested a little, we took the charming road which leads to Dunkeld, through a valley that is not to be exceeded  
for



for the richness, or the variety and beauty of its scenery. The hills, which form the sides of the valley, are not of great height; and are, in general, formed of micaceous schistus, which has sometimes interspersed crystals of hornblende; yet there are also other rocks. Thus, a porphyry, similar to that which we have before observed between Dalnacardoch and Blair in Athol, appears to form a considerable hill among the micaceous schistus; but I regret that I had not leisure to examine their relative position. I also observed masses of sienite upon different parts of the road, and calcareous micaceous schistus. The micaceous schistus is sometimes to be observed passing into talcaceous schistus; and not unfrequently I observed crystals of hornblende shooting thro' it. At Dunkeld, the hills are of considerable height, and afford a considerable variety of rock; but I shall not at present stop to mention them particularly. I may only remark in general, that I found micaceous schistus; this is to be observed passing, by various steps, to chlorite schistus; and, lastly, the chlorite schistus is to be traced into ardesia. I also observed much quartz penetrated with the chlorite, in various proportions; and frequently I remarked a granular quartz rock, which has a basis of chlorite.\*

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\* As the country from Dunkeld to Dunbarton is frequently visited by strangers, I will in this note mention a few facts with respect to the general nature of

We set out early in the morning for Perth; and on the road, at a little distance from Dunkeld, I examined a pretty extensive quarry of roof slate, (*ardesia tegularis*,) which is intermixed with chlorite, and beautiful specimens of micaceous iron ore.

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the rocks in that route. From Dunkeld to Taymouth the road is skirted by lofty mountains of micaceous schistus; and near to Taymouth there are quarries of talcaeous schistus, or lapis ollaris, which also afford fine specimens of asbestos. The rocks in the immediate vicinity of Taymouth are of micaceous schistus, but Mr Hatchett, with whom I made this journey, pointed out to me chlorite schistus passing into micaceous schistus, and the chlorite schistus approaching to lapis ollaris, and even making a passage into it. The micaceous schistus has frequently intermixed with it little rounded masses, having at first the appearance of garnets, but when cut with the knife, appear to be rounded pieces of the micaceous schistus. In the mountain we also picked up fragments of clay porphyry, but had not an opportunity of determining its situation with regard to the other rocks. From Taymouth along the banks of Loch Tay, the principal rock is micaceous schistus; and from the delightful retreat of Killin to the dreary and bleak Tyndrum we meet micaceous schistus, which is in some places stratified with limestone. At Tyndrum the mineralogist will be amused in examining the remains of the old lead mine. The next stages to Dalnally and Inveraray lead through a mountainous country composed of micaceous schistus, chlorite, &c. At Inveraray, there are quarries of lapis ollaris, and a considerable stratum of hornstone porphyry, and this porphyry is covered by a stratum of marble. From Inveraray to Carindow, the rocks are principally of micaceous schistus. At Carindow there is a beautiful kind of sienite, containing pretty considerable crystals of hornblende, and pink-coloured crystals of felspar. From Carindow to Ar-

rochar,

I observed a breccia covering the micaceous shistus, thus announcing the termination of the primary strata; which we found to be the case. As the country now became much lower, its general appearance was quite changed; and to the strata of breccia, argillaceous sandstone succeeded.

I now took leave of the Highlands, where I had spent three months very actively; and have only to regret, that my little experience, and want of knowledge, in many important parts of mineralogy, may have caused me to over-

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look

rochar, through the wild Glen Croe, the mountains are principally of micaceous shistus. From Arrochar to Lufs, which leads along the charming banks of Loch Lomond, micaceous shistus is the principal rock that occurs. Ben-Lomond, the highest mountain that rises from the side of the Loch, is composed of micaceous shistus on its lower part, but, towards the summit it is composed of gneifs. At Lufs, there is a quarry of ardesia or primitive argillaceous shistus; here Mr Hatchett pointed out to me the distinct gradation from indurated chlorite to chlorite slate, and from chlorite slate to ardesia. Masses of porphyry are to be seen in different places; and a rock, which is composed of rounded fragments of quartz, cemented by a basis of chlorite, lies scattered near to the quarry of ardesia. From Lufs to Dunbarton, we have not only a complete change in the appearance of the country, but also of the strata, as the primitive rocks near to Lufs are soon succeeded by the secondary sandstone, limestone, basalt, &c. which extend towards Dunbarton.

look interesting appearances, or to describe those, which I did observe, but imperfectly, and probably, in some instances, without sufficient accuracy. But, if after travellers shall experience as much pleasure in their journey as I did, they will have cause to think their time usefully employed.

The secondary strata, which are principally sandstone and basalt, continue to the flourishing and pleasant town of Perth. In the neighbourhood of the town, is the hill of Kinnoul, which is remarkable for the charming prospect from its summit, and the numerous beautiful pebbles of onyx, sardonyx, &c. which are found in a basis of indurated wacken.

From this, by Kinross, to North Queensferry, the country is entirely formed of secondary strata, as, sandstone, limestone, basalt, wacken, and greenstone; and in several places, as at Inverkeithing and St. David's, there are strata of coal, which are worked to a great extent.

A particular description of all this tract of country, from Dunkeld to the Frith of Forth, with an account of the coal  
mines,

mines, would form a work that would afford much instruction and entertainment. The intelligent mineralogist would here have an opportunity of giving a minute description of an extensive Scottish coal-field, which would be an acquisition of much value to geology.

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*[I am happy to have it in my power to communicate to the public the following observations upon the mineralogy of the country between Fort-Augustus and Inverness, which were politely communicated to me by Lord Webb Seymour and Professor Playfair. In strict order, they should have been inserted in a preceding part of this chapter, but the sheet happened unluckily to be printed off before I was favoured with them.]*

THE road, soon after it leaves the Fort, ascends, on the south side of the lake (Loch-Nefs), into an elevated, moorish tract, and continues on this high level for many miles.

For the first five or six miles, the rock is all micaceous schistus, with a considerable admixture of quartz.

Rising

Rising from this high level, there are several hills, along the sides of which the road passes: the valleys between are tolerably wooded. There are also a great many small lakes.

From about the point where the level begins to descend toward the east, the micaceous schist ends, and a granitic sandstone begins, which continues for a mile or two.

The river Fyers rises on the right; and where the road first comes on the banks of it, you see micaceous schist again, with a large dyke or vein of granite intersecting it.

We soon after come to granitelle, in great masses, some of it containing minute veins of much indurated steatites.

This kind of rock continues till near the uppermost of the two falls.

The high plain, in which we had been travelling all this while, is interesting, not only from its being on a level so much above other plains, but because the hills, that have their base in it, are of considerable beauty, as well as wildness, with valleys between them, abounding in pasturage, and interspersed with wood.

The

The Fyers runs, in the middle of the great valley, with much rapidity; the ground declines fast toward the E.; the bed of the torrent rocky, and the banks wild.

The vale of Fyers opens into a meadow between fine granite rocks, before you come to the first fall, which is above a little bridge.

At this fall, the rocks are all of granite. The whole scene striking and grand.

Below the bridge, which is close to the fall, you see marks of the wearing and scooping out of the granite rocks, 30 or 40 feet above the present level of the river.

About a mile farther down, is the great fall, by which the river descends at once to the level of the lake. This fall has been often described: it could scarcely be seen in a more favourable state than it was by us. The rock is still granite.

From the General's Hut, a mile eastward of the fall, the rock is granite; but is soon, on proceeding eastward, succeeded by a pudding stone, containing large rounded blocks

of

of reddish quartz and of granite shists, united by a cement of sandstone.

This pudding-stone begins at the first torrent beyond the inn, which runs in a very deep channel, and exposes a fine section of the rock.

This pudding-stone accompanied us to near the end of the lake, when day-light forsook us, and prevented us from seeing distinctly the steps by which the highland country softens down into the plain.

The stones that we picked up on the road continued, however, to be primitive, all the way to Inverness. At Inverness, the same continues; and the freestone used in building is brought from quarries on the sea-shore not far from Elgin.

[It



[It is now several years since I wrote the following account of the SHETLAND ISLANDS. Since that time, I have been almost continually and actively employed in mineralogical pursuits; and have learned, at least, how very deficient this outline must appear. That knowledge of the subject, which enables a man to examine the mineralogy of a country with accuracy, is not merely the knowledge of fossils as specimens in a cabinet: it is to be gained only by an actual and very careful survey of different countries. This, I hope, will be my apology. I have republished this account, though imperfect, because these islands are remote, difficult of access, and interesting both to the geologist and the mineralogist.]

## SHETLAND ISLANDS.

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### C H A P. XXVI.

*Outline of the MINERALOGY of the SHETLAND ISLANDS. General Observations. Mineralogy of the MAINLAND, FOULA, PAPA-STOUR, VEMENTRY, MUCKLE-RHOE, UNST, FETLAR, YELL, and WHALSEY.*

THE Shetland Islands lie N. E. from Orkney, between lat.  $59^{\circ}$  and  $61^{\circ}$ . The nearest are distant, from Buchan-nefs, 46 leagues; 16 or 18 leagues N. from the island of Sanda, one of the Orkney Islands; 6 or 7 leagues N. E. from the Fair Island; 58 leagues E. from the Faroe Islands, and nearly the same distance N. W. from the Lewis.

These islands are very numerous, but few of them are of any considerable magnitude: thirty-three are said to be inhabited, of which the largest is called the Mainland.

On a general view of these islands, a wonderful scene of rugged, bleak and barren rocks, presents itself. No tree, nor shrub, relieves the eye, in wandering over the dreary waste. Sometimes, however, a few scanty portions of cultivated ground catch the eye of the traveller, exciting emotions of pleasure, and forming a striking contrast with the barren heath-covered mountains which skirt them. The western part presents many scenes, wild and sterile as can well be conceived; where grey rocks, rising from the midst of marshes or pools, and shores bounded by awful sea-beat precipices, suggest to the mind ideas of desolation and danger.

The coasts are in general rugged and precipitous. Frequently the scenes are truly sublime: vast rocks, of various heights, dreadfully rugged and broken, oppose their rude fronts to all the fury of a tempestuous ocean; which in some places has formed great detached pillars, in others has excavated grand natural arches and caverns, that mock all human magnificence.

The east side of the Mainland (it is also the case in the other larger islands) is comparatively low; but the west is remarkably lofty, rugged and broken. Many of the mountains are sensibly more steep on the west, than on the east side. This

geological fact was long ago discovered by Dr Walker. It first occurred to him in the hills in the vicinity of Edinburgh; but he also found it to hold true in the Lomonds, and in all the other hills in the Highlands of Scotland. We also know that the west coasts of Scotland and of England have a gradual slope towards the east; and the course of all the great rivers, as the Spey, Tay, Tyne, Trent, and Thames, is from east to west. Upon examining other countries, the same phenomenon presents itself. Thus, the west coasts of Norway are precipitous, high and rocky. In the interior of Norway, the Lapland Alps present a precipitous west side, and the east shelves away, forming extensive plains. It is also very remarkable in the continent of America; where several of the largest rivers, as St. Laurence, La Plata and the Amazons run nearly from east to west.

Another observation may be made with regard to the hills—that they all run in the longest direction of the islands. This is a general fact, to be observed all over the globe. Thus, the mountains in Britain run from N. to S.; the Scandinavian mountains follow the same direction; as also the great ridges of the Norwegian and Swedish Alps. In America, the long-extended chain of the Andes runs from N. to S. which is the greatest length of the continent.

The

The hills in Shetland have seldom the strikingly rugged aspect of the island of Arran. They are greatly lower, and not so much worn by rains and torrents: the principal scenery of Shetland being produced by the action of the waves upon sea-coast.

The hills are generally round-backed, running in ridges: some approach to the conical shape, and are detached. None are remarkably high: the highest, which is Ronas Hill, is only about 1500 feet above the level of the sea.

To make general remarks upon the climate of a country, requires a long and careful series of observations, with a multiplicity of apparatus, which few have an opportunity of obtaining: and although a good deal may be done by means of careful observation with the thermometer and barometer, the proper use of these requires no common share of skill. To the exertions of the celebrated Mr Kirwan of Dublin, we are indebted for a great deal upon this subject. With the liberality which characterises a great mind, he has, at much expence, distributed meteorological instruments thro' Ireland; and we are now beginning to see the good effects of his endeavours. In this distant quarter of the globe, no accurate register of the weather has been kept; so that all I can do, will be, to make  
a few

a few general observations, which apply pretty generally to all the northern isles of Britain.

The weather is extremely variable, there being a great deal of rain, and thick fogs, which occasion the loss of many vessels on these terrible shores. During the winter, there are considerable falls of snow, which lies, however, but a short time, on account of the vicinity of the sea. The frosts, which are seldom severe, and never long, produce little inconvenience: were they to continue for any considerable time, this situation, already sufficiently dreary, would be comfortless indeed. The thermometer has been observed  $20^{\circ}$  below the freezing point, but this continued for a very short time; a thaw soon followed, with hail, and violent gales of wind. Frequently, during the winter, dreadful storms prevail, particularly from the W. accompanied with thunder and lightning: an appearance seldom observed at that season in other parts of Britain.

Many instances might be mentioned, of the fatal effects, and extreme violence of the storms, which frequently happen among these islands; but I shall only mention one, which is still fresh in the memory of many.

During

During the three first days of January 1784, it blew a violent gale, and continued with increasing violence until eight o'clock in the evening of the third day. The storm was so furious, that the sea broke over headlands 120 feet high; and, at one place, a stone, computed at 12 tons weight, which lay ninety feet from the sea, was raised out of its place, and thrown two fathoms farther from the shore. Many vessels were wrecked, and vast quantities of fish thrown upon the shore. In the island of Moufa, I observed many great masses of sandstone, which had been torn off by the violence of the storm, and thrown far inland.

The aurora borealis, or what is usually called streamers, illuminates the sky with uncommon brilliancy, and helps greatly to alleviate the gloom of the long winter nights.

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#### MAINLAND.

THIS is by far the largest of the Shetland Islands, being about seventy miles long, and from twenty to half a mile broad.

The

The cliffs around the whole island are very rugged, but more so on the west than on the east side; and the bays or voes, islands and rocks, are also more numerous on the west than on the east coast.

There are few mountains of any considerable height, being generally from a thousand to fifteen hundred feet high. Few of them are unconnected; but they generally run from N. to S. in the form of chains, having round-backed summits, approaching more or less to the conical form. Several considerable ridges can be traced along the whole of their course; and of these the most remarkable are the following:

1. *CLIFF HILLS.* This range commences opposite to the island of St. Ranens, where it is of considerable height, and runs by Scalloway to Deal-Voe, and from that to the sea, where it becomes gradually lower.

2. A range, which has no particular name, rises from West-shore, and runs, with little variation in height, S. W. and N. E. to Lunnesting, terminating on the sea-shore.

3. A range rises upon the east side of Weefeldale-Voe from  
Buneness,



Bunenefs, and runs from 16 to 18 miles, terminating on the south side of Deal-Voe, in the parish of Delting.

4. The highest range rises from the west side of Weesdale-Voe from Ruftanefs, and terminates at Friskinefs in Delting.

The Mainland is divided into several parishes, some of them of considerable extent: the parish of Lerwick, which gives name to the principal village in the island, is the smallest. This village contains about 2000 inhabitants, and is built upon the shore of Brassay Sound, which is near the middle of the island. The houses in general are but indifferent; here and there, however, there are some commodious dwellings: and they are built of sandstone and sandstone breccia, forming one street, which is terminated by Fort-Charlotte. This fort was built during the time of Oliver Cromwell, and was for a long time in a state of ruin, until lately that it has been repaired at great expence, and garrisoned by a corps under the command of a captain.

Brassay Sound, which is the harbour of Lerwick, is one of the most extensive and safe harbours in the British dominions; and has its name, and is formed in part by the island of Brassay. This island is about 5 miles long, and between 2 and 3 broad, but very irregular in its shape. It is high and rugged

on the S. and E. where it is much exposed to the action of the sea; but it is comparatively low on the W. and N. where it forms part of the sound. The highest hill, which is called the Ord of Brassay, forms, towards the sea, frightful precipices, several hundred feet high; all composed of sandstone, sandstone flag and breccia: and the whole island is composed of the same materials. A great mass has been separated from the east side by the violent action of the sea, and forms what is called the isle of Nofs, remarkable for its tremendous cliffs and holm, where the natives encounter many dangers in fowling. This famous holm\* is separated about 34 fathoms from the isle, and is perfectly mural on all sides, so as to present a most terrific aspect when viewed from below. Inaccessible as it appears, it has not prevented the daring islanders from gaining its summit, which exploit was performed many years ago, by a fearless fowler, who, having climbed to the top, drove stakes into the ground, and ropes being thrown around them from the opposite side, were fastened to corresponding stakes upon the bank of the island; a machine of wood, which they call

\* Mr Pennant, in the elegant introduction to his Arctic Zoology, has given a drawing of Low's, which expresses the appearance of the holm very indifferently. The holm is said, by Mr Pennant, to be 480 feet in height: this is certainly too high.

call a *cradle*, was then fastened upon the ropes, so that it could be pulled backwards and forwards: and in this way they go in quest of the numberless sea-fowl that inhabit these cliffs. The fowler who first planted the stakes, flushed with his success, would not take advantage of the cradle, but, braving every aid, attempted to descend, and was dashed to pieces upon the rocks below. The island and the holm do not differ from Braffay in their composition; being formed of sandstone, sandstone flag, and breccia: but the sandstone is of various colours, a considerable extent of the cliffs being of a reddish hue.

The opposite side of the sound, where Lerwick is situated, is composed of the same sandstone and breccia which we observe at Braffay. The fort, already mentioned, forming one extremity of the town, is built upon a rock of breccia; which soon gives place to a horizontal stratum of sandstone, running to the opposite extremity of the town, called the Nab. The hills in the neighbourhood are not high, and are composed of sandstone and breccia. This sandstone is the same we observe in all the other parts of the island. The breccia is composed of fragments of red granite, micaceous shistus, quartz, felspar, and green mica: the fragments are either rounded or angular; of various sizes, from that of a grain, to masses of several hundred weight. The substramen, or basis,

is hardly discernible, excepting in large masses, when a paste is formed by the smaller fragments. I also observed, in general, that, where the fragments are large, the strata are distinguished with difficulty, and are horizontal; but as the particles become smaller, the strata are more distinct and inclined.

The coast, from Lerwick to Quarf, is composed of sandstone: in some places, however, there are great rocks of breccia, which have a very singular appearance, owing to the immense size of the concretions.

On this part of the coast there are several extensive caves. We rowed a considerable way into one of them, then landed, and walked to its farther extremity. At the entrance, it is a natural arch, which becomes gradually lower until it is lost in darkness, where nothing is to be heard but the dropping of water from the damp, black roofs, and now and then the silence is disturbed by the snorting of seals, or the flutter of the pelicans or columbæ. But the most beautiful part of these rocky scenes, is the wonderful transparency of the water, which discloses, to our view, rocks of various fantastic forms, covered with the beautiful millepora rubra, and adorned with fuci of a great variety of colours. These fuci, when moved by the gentle

the motion of the water, discover numerous species of spongiæ, actiniæ and echini, of the most exquisite colours, altogether forming an admirable submarine picture.

At Quarf, the island is only about two miles broad, forming the isthmus which connects the southern parishes with the mainland. It forms a kind of valley, which is bounded on both sides by mountains of considerable height, composed of micaceous schistus. Here, there is a small fishing station, from which boats go to the *Haafæ*, or fishing ground, in search of tusk and ling.

The land from this again becomes broader, forming one side of Æthvoe, and is composed of sandstone, and breccia; in several places, however, there are considerable strata of limestone, which is worked for building and manuring the ground. This voe is a large open bay, having the flat and cliffs of Coningsburgh on the north and west, with Sandlodge, and Moufa on the south. The cliffs of Coningsburgh, which form part of the range of hills that rise opposite to St. Ranens, are composed of micaceous schistus; and in several places it is to be observed, with the common argillaceous sandstone covering it.

Among

Among the strata of micaceous shistus, I observed beautiful specimens of crystallised sienite.

Having passed these cliffs, we come to Sandlodge, one of the seats of the ancient and most hospitable family of Bruce of Sumburgh. It is situated upon the sea shore; having a pretty extensive flat near it. At a little distance from the shore, in the sandstone, which is here still continued, there is a vein of copper pyrites, or sulphuret of copper, which was worked for some time, by a party of miners, from Wales, with very flattering prospects; but the vein gradually decreased in width, until it was not above an inch broad, when it was thought proper to leave it †. On the opposite side of the house, there is another large vein of iron ore, above six feet wide, having a very scorified aspect. This was also worked for some time, but the great expence, and the small proportion of copper obtained, soon made it to be given up. The sandstone continues from this, all around to the bay of Sandwick, here and there intersected with calcareous spar, and much impregnated with oxyd of iron. Betwixt Sandlodge and Sandwick bay, lies the small island of Moufa, or Queen island, about

† I am happy to learn, that these mineral appearances have again attracted the attention of some Welsh miners, and they are now busy raising the ore.

which is about a mile and a half long, and upwards of a quarter of a mile broad. It is rather low, composed entirely of sandstone, and sandstone flag, with several strata of limestone, which run in the sandstone from east to west.

The whole coast from Sandwick to Sumburgh head, the most southern point of the island, is almost entirely composed of sandstone, and breccia, lying upon the mountains of gneiss and micaceous schistus, which run through this part of the island; there are also in several places considerable strata of limestone. From Sumburgh head, which is entirely composed of sandstone, we have an extensive and beautiful view of a great part of the Mainland, island of Brassay, and stupendous Nofs; on the one hand the far distant Fair isle rises gently in the horizon, and on the other the secluded Fula forms a tremendous object. Below us we have a direful example of the blowing of loose sand, or what is called the *Sand Flood*; for an estate which belongs to Sinclair of Brue is now rendered a forlorn waste, which, before this calamity, was one of the most productive parts of the island. I could not learn the cause of this disaster, but it was probably owing to the tearing up some of the plants which are known to prevent the blowing of sand. This practice cannot be too severely reprobated, when it is known that the consequences are so pernicious; thus, in many of the Western

tern.

tern Islands Dr. Walker has observed, that if the smallest aperture be made in the sand, the flood instantly commences ; and we know that, in Suffolk, a quantity of sand, which at first only covered about ten acres, has now spread itself, and covers several thousand. The sowing of plants, which grow in loose sand, is the only remedy which can be recommended to stop the baneful progress of those floods. Of these several have been recommended ; but the most efficacious, are the *Galium luteum*, *Elymus arenarius*, *Triticum junceum*, and *Arundo arenaria* ; this last the Dutch plant with great benefit. From Sumburgh head across the large open Quendal bay, little is to be seen, except a few rocks of an extremely coarse breccia, of the common kind. At the next head-land, Fitful head, the primary mountains make their appearance, without any covering of the secondary breccia or sandstone, which disappears at one side of Quendal bay, and is not to be observed again until we come to Sandness hill on the north west part of the island. This immense head-land is almost entirely composed of a lead-coloured micaceous schistus, of which the greater part is mica, in very minute scales ; and in the fissures of the rock I observed several small portions of micaceous iron ore. The micaceous schistus is here to be observed passing to chlorite schistus, and intermixed with the talcite of Mr Kirwan, and considerable quantities of quartz. Below this at Garthness, there is a large



vein of sulphuret of iron, about seven feet thick, running in a stone intermediate between micaceous shistus and chlorite shistus. It lies exposed to the day for twenty or thirty feet, and was worked for some time, but was also given up.

The coast from this all along the west side by Bigtoun to Scalloway, including Colfa isle, and the island of Saint Ranens, is composed of granite, micaceous shistus, chlorite shistus, talcite of Mr Kirwan and quartz.

The island of Saint Ranens is small, very rugged, and connected with the Mainland by a bank of decomposed micaceous shistus. Captain Preston, in his chart of the Shetland Islands, has placed this bank at one end of the island, in place of the middle. The coast from this to Cliff Sound is very rugged, owing to its exposure to the Atlantic Ocean; but in the Sound the land is defended by the islands of House, Burra, and Trondray, and is neither rugged nor very abrupt.

The island of House is about three miles long, narrow and flat, composed of micaceous shistus, granite and quartz. Near to the north end I observed a vein of granite two or three feet wide, running in the micaceous shistus; the granite had the

usual appearance, and where in contact with the stratified matter was not at all altered in hardness.

The island of Burra, which is separated from the island of Housé by a small sound, is also more rugged on the west, where it is much exposed to the action of the sea, and is composed of granite, micaceous schistus and quartz.

The coast and hills from Scalloway by Uftnefs Voe, Stromnefs Voe to Weefdale Voe, are composed of the usual alpine rocks. At Weefdale Voe there is a great stratum of limestone, which can be traced for several miles running in the micaceous schistus. All the hills in the neighbourhood are composed of micaceous schistus, talcite and gneifs; this last by decomposition forms a clay-like mass, which the inhabitants use for fullers earth. A great section of the gneifs is to be seen amongst these hills, in various stages of decomposition\*. From Weefdale through Æthsting and Sandsting, the alpine rocks continue,

\* The late Mr Wedgewood, upon analyzing an earthy substance from Sidney Cove, New Holland, was led from several circumstances to conclude, that it contained a new earth which he called Sydneia. Lately, however, Mr Hatchet, in a paper read to the Royal Society of London, [has] demonstrated, in a  
most

tinue, forming in many places considerable hills, and upon the sea-shore immense precipices of red granite. The scenery upon this coast is awfully grand; a great extent of coast, dreadfully rugged and broken, presents to our view vast detached pillars, and numberless magnificent arches, through which the tides rush with inconceivable fury, and the whole being tinged with a reddish hue, produces a grand effect, when contrasted with the lurid appearance of a stormy sky.

The next parish, which is named Walls, I had but little opportunity of examining, so that I can say nothing with certainty of its composition. In the neighbouring parish of Sandness, the sandstone again makes its appearance at Sandness hill, which is of considerable height. From this the coast becomes gradually lower, and is in many places peculiarly sterile and iron-like; the land again rises in height, and so on alternately all around the island, forming many considerable voes, with very magnificent pieces of scenery, particularly the Doreholm off the parish of North Maving, which is a vast detached rock, perforated by a great natural arch, very similar

C c 2

to

most satisfactory manner, that this supposed earth is a compound of siliceous, argillaceous, and oxyd of iron; and he supposes that it is derived from a decomposed granite, or gneiss, similar to what has been mentioned above.

to some of those observed by Captain Cook among the South-Sea Islands. The immense rocks, the Ossa, Skerries, and Ramna Stalks, present a most tremendous appearance in stormy weather: but to particularize the many rocky scenes, that occur around this island, would be foreign to my present purpose. I shall therefore conclude this sketch, by remarking, that the rocks (so far as I have examined) are either granite, gneifs, micaceous schistus, chlorite schistus, limestone, or sandstone; but I did not observe this last in any quantity till we came to the east coast.

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#### F O U L A \*.

THIS island is about three miles along, and half a mile broad, situated in the Atlantic Ocean, about twenty-four miles from  
Main-

\* As the Orkney Islands are visible from the heights of Foula in clear weather, there can be little doubt of its being the Ultima Thule of Tacitus: that of Pythias the Marfeillian, who was contemporary with Aristotle, is thought, by Mr Pennant †, to be Iceland, while Dr Foster ‡ is decidedly of opinion that it is some part of the Shetland Islands.

† Arctic Zoology, vol. i. p. lvii.

‡ Voyage to the North, p. 15, 30.

Mainland ; holding the same situation with regard to Shetland, which St. Kilda does to the Hebrides. It contains but little level ground, being chiefly formed of three hills, of a nearly conical shape ; the highest of these is between 800 and 900 feet in height. Here there is but one landing-place, and in bad weather it cannot be approached. The east side, which is much lower than the west is composed of granite, micaceous schistus, and quartz. The micaceous schistus covers the granite ; but in some places the sea has washed it away, and left the granite exposed, which is of a red colour, and is frequently traversed with considerable veins of quartz. The micaceous schistus also contains nests of green actynolite, and garnets are often dispersed thro' it. The south, west, and north sides of the island are composed of sandstone, and sandstone flag, of the same species with that we have observed in the other parts of Shetland. Upon the west side there are most hideous precipices, inhabited by numberless sea-fowl, which the people run incredible risks in catching.

The account which Pontopiddan has given of the fowlers in Norway, is realized, and even exceeded by the inhabitants of this secluded spot. It is not many years since it was a common observation, that few died a natural death, being either drowned or dashed to pieces among these terrible precipices :

now

now they are more cautious, and comparatively few are destroyed.

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### P A P A - S T O U R.

THIS island is of a very irregular shape, about a mile long, and half a mile broad, lying in the mouth of St. Magnus Bay, at a little distance from the shore of Mainland. It is low, but one of the most fertile of the Shetland Islands; and it has several tolerable harbours, of which Hamna Voe is the best: but the entry is difficult, on account of a great ridge of rocks, which runs across the entrance. At House Voe, which is the usual landing-place in coming from Mainland, sandstone, sandstone flag and breccia form one side of the voe, which is low, and not rugged. In going round the island toward the next harbour, called Olis Voe, the sandstone disappears, when a fossil, nearly similar to wacken, presents itself, forming cliffs of considerable height, without any marks of stratification; and it continues with little interruption all around the island, until it meets with the sandstone strata on the opposite side. From this, it appears, that these two genera of rock form the  
greater

greater part of the island. Several other fossils, however, are to be observed, either in strata below the wacken, in veins, or sporadic. Thus, upon the north side of the island, the wacken lies upon a kind of breccia, much resembling that of the Calton Hill, near Edinburgh. It is also traversed by veins of different kinds, which run in different directions, and vary considerably in their magnitude. The following are those which I observed. 1. Veins of greenstone and basalt: the basalt sometimes contains small crystals of fluor spar. The appearance of fluat of lime in basaltic rocks is rare; the only similar instance I am acquainted with, is detailed in the 6th volume of the *Journal des Mines*, where it is mentioned that grains of fluor spar had been observed in a basaltic rock. 2. Veins of semi-indurated steatites, which often contain hollow nodules of chalcedony and jasper, which are lined with crystals of quartz. 3. Veins of red sinople, which are intermixed with chalcedony and quartz.

I cannot finish this short account, without mentioning, that various species of pumice are to be gathered in several of the voes of this island, and some of the pieces are of very considerable size. Similar kinds of pumice are got near the Giant's Causeway, in Ireland, and upon the shores of the Western Islands, which volcanists have reckoned a very satisfactory  
proof

proof of their chimera. An examination of the rocks would soon satisfy any one but a volcanist that these were adventitious matters. Accordingly, their origin is now plainly traced from the famous island of Iceland; and this is rendered the more probable, when we consider, that many light substances are floated, from the West India Islands, upon the shores of the Shetland and Western Islands.

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#### VEMENTRY.

THIS island is situated in St. Magnus Bay, at a considerable distance from Papa-stour. It is much intersected by the sea, and rises high in the middle, forming what is called the Wart of Vementry, upon the top of which there are the remains of a burgh. From this hill, we have a view of the whole island, and the adjacent coast of Mainland; than which nothing can be a more dreary prospect.

From the short time I was upon this island, I can only say, in general, that it appeared to be composed of granite, diffe-

rent



rent kinds of micaceous schistus, and a beautiful species of hornstone porphyry, which I observed in various stages of decomposition; in some specimens the felspar appeared to be decomposed first, in others the hornstone.

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#### M U C K L E - R H O E.

THIS island is about twenty-four miles in circumference, the east and south sides are low, owing to their being defended from the violent action of the sea by the Mainland, but the west side is very rugged and broken. From the little opportunity I had of examining it, I can only say that a considerable part appeared to be composed of granite. Another island in the same bay, called Papa Little, appears to be composed of granite and micaceous schistus, of various kinds.

## U N S T.

THIS is the most northern of the Shetland islands; it is about eight miles long, and from two to two and a half miles broad. Its form is that of a lengthened square; the sea coast is as usual very rugged, and the island is hilly; the highest hill which is named Valley-field, is about seven hundred feet. There are two excellent harbours, Balta and Uyea Sound, which are often of the greatest service in sheltering vessels that pass to and from the Greenland seas; but the first is generally preferred as being more convenient and safe. Balta Sound is a pretty deep inlet, formed into an excellent harbour by the island of Balta that lies across its entrance, thus forming two passages; one from the north is rocky and only fit for small vessels, but the other from the south will allow large ships to enter.

The hills upon the north side of this sound are of considerable height, composed of serpentine, but present an extremely bleak and barren aspect, owing to the iron-brown covering, which it acquires by the action of the weather. The serpentine is of a green colour, is frequently traversed with small veins

of

of iron ore, and often assumes a fibrous appearance, forming what Wallerius calls talcite; a stone very different however from the talcite of Mr Kirwan. It also contains lamellar actynolite, labrador hornblende, tremolite, and veins of shistose talc traverse it.

This serpentine continues to form the hills and cliffs, until we arrive at the beautiful bay of Norwick, when a singular striated micaceous shistus takes its place, forming one side of the bay; this also constitutes a great part of the coast until a species of gneiss (remarkable for the large size of its crystals of felspar) makes its appearance, the micaceous shistus which covered it being washed away. Near to this place an immense mass has been separated from the land, forming a great hollow called Saxen Kettle, from the sea rushing through a narrow aperture at the bottom, which causes it to boil up with great violence.\*

D d 2

The

\* Here the Shetland Giant Saxe used to boil his prey, and terrify the affrighted natives; but more surprising than this is a famous well at a little distance, where the inhabitants say their ancestors used to get boiled or roasted fish, in proportion to the depth they went. This is a fact truly Plutonic, well deserving the attention of world makers.—*Brand's History of the Orkney and Shetland Islands.*

The land from this runs out to form what is called the point of Lambanefs, equally steep, but not so high as the sides of the bay, and from this to the Sha, the most northern point of the island, and of his Majesty's dominions, the gneifs continues, and does not disappear until we approach to the deep bay of Bura-firth, where the land becomes higher, forming lofty cliffs of micaceous schistus. At the bottom of this bay the land is low, presenting beautiful rocks of undulated micaceous schistus †; but after crossing the bay we find the land rise gradually, forming the lofty cliffs of Hermonefs, which are composed of similar rocks. At the bottom of these cliffs there are immense caves excavated by the sea, into which a boat can row many hundred feet in calm weather; the entrance is said to be ornamented with regular octogonal pillars, but what their nature is I could not determine, as the surf prevented me from approaching. Is it probable that they are formed of gneifs? for there is no other fossil near but micaceous schistus. From this the whole west coast is very lofty and rugged, composed of micaceous schistus, and this last often contains extremely beautiful regularly crystallized garnets of  
great

† This species is entirely composed of mica without any admixture of quartz, which Karsten in his catalogue of the Leskean cabinet reckons a rare production.

great size. As we approach the south west extremity, the land becomes lower, and towards Belmont, the seat of Thomas Mouat, Esq. of Garth, strata of ardesia, or primitive argillaceous schistus, are to be observed in the neighbourhood of the micaceous schistus. The serpentine now again makes its appearance, and forms in several places considerable hills, which have as usual a barren and bleak aspect. On the sea shore, between Uyea Sound and the castle of Mounis, there are strata of sandstone; and from this to Balta Sound the hills and shores are low, formed of micaceous schistus with a compound rock of green hornblende and quartz, and in some places we observe rocks of a compact felspar with hornblende.

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#### F E T L A R.

THIS island is about four miles long, and three and a half broad, of an irregular shape, owing to its being much exposed to the action of the sea. Its mineral productions are not very different from those in Unst; indeed it is probable that at one time they were joined. There are no harbours of any consequence; the bay of Trefta is one of the largest, but is not safe  
in

in stormy weather. One side of this bay is composed of micaceous schistus, quartz, in which large crystals of fluor are to be observed, with strata of alpine or primary limestone. On the opposite side of the bay there are appearances of plumbago; in one place particularly there is a vein of a matter resembling an impure plumbago, which is between two and three feet wide, running to all appearance in micaceous schistus. This latter fossil forms the coast for a considerable way. It however disappears, when immense cliffs of serpentine are to be observed, which often afford beautiful masses of rock crystal, also fine specimens of asbestos and amianthus. The serpentine, having formed a considerable extent of cliffs, disappears, when a curious species of micaceous schistus presents itself, composed of rounded masses of quartz, of considerable size, connected by means of mica, thus forming a rock not unlike to breccia. This rock, however, is only to be considered as a species of micaceous schistus, where the quartz masses are of a greater size than usual. Similar appearances, but not so striking, have been observed in other countries: thus the great road which traverses Moravia, is made, in the environs of Mark-Stannern, with a species of gneiss, which has disseminated globules of quartz, about half an inch in diameter †. This curious

† Journal des Mines, No. 23. p. 69.; from Trebra's catalogue of fossils.

rious rock forms a considerable extent of cliffs ; but at Strandburgh, a micaceous shistus, which seems passing to ardesia, takes its place. This micaceous shistus also forms a considerable extent of coast, which is low, presenting a most splendid appearance when the sun shines, his rays being reflected from the micaceous rock as from immense mirrors. As the coast rises, the serpentine again makes its appearance, having the usual brown, iron-like aspect, and forming lofty cliffs upon the shore ; but these continue only for a short way, when the micaceous shistus is again to be observed, and continues forming low cliffs to the house of Urie. From this, round to the bay of Tresta, the coast is lofty and precipitous, formed of micaceous shistus ; but at one place there are immense cliffs of gneifs, which, by decomposition, form a matter similar to that observed at Weefdale Voe, which is here also used as fullers earth.

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#### Y E L L.

THIS island is about 4 miles from Mainland, is about 16 long, and 8 broad, and is, next to Mainland, the largest in Shetland.

Shetland. There are several harbours, but none of them large or commodious. It is in general pretty hilly, very much covered with peat mosses: this, with its tremendous broken coasts, renders the island wild and gloomy. The hills, as far as I could determine, are composed of granite, micaceous schistus, and quartz. On the west side, which is extremely broken and rugged, there are several veins of granite, about 5 or 6 feet wide, that run in the micaceous schistus. They are sometimes much curved, but generally run at an angle of about  $70^{\circ}$ . The granite is composed of quartz, felspar, and mica; but all these are larger than in the granite which is found in strata.

In several places I observed bitumen, sticking upon stones, or floating in small spring wells.

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#### W H A L S E Y.

THIS island is about 6 miles long, and 4 broad, and is 3 miles distant from Mainland. The shores are low on both sides, and,



as far as I could observe, composed of micaceous schistus and granite. The highest hill is the Wart, which I found to be composed of micaceous schistus to the top.

At a considerable distance lie the Grief and Out-Skerries; dreary and desolate rocks, inhabited by a few fishermen, and composed of the same materials as Whalsay.

## SHETLAND ISLANDS.

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### C H A P. XXVII.

*Description of the FOSSILS mentioned in the preceding Chapter.*

#### C I A N I T E.

SAPPARE, Kirwan. BLAUER TALC, GLIMMER, SCHORL, Germanor.

*Colour.* White, finely tinged with azure blue. The detached crystals reflect a silver-white light.

*Crystallization.* Is crystallized in the form of compressed prisms, more or less feamed across. Presents two narrow, and slightly streaked, and two broad and smooth sides. The crystals are frequently disposed in a radiated form.

*Cross Fracture.* Striated, and destitute of lustre.

*Longi-*

*Longitudinal Fracture.* Foliated, with a lustre like that of crystals, or metals not much polished.

*Hardness.* When struck parallel to its length, yields difficultly to the knife; when perpendicular to its length, gives fire with steel: scratches glass.

*Specific Gravity.* 3.618.

Becomes electric by friction, and this electricity is negative.

Another species of this beautiful fossil was discovered many years ago at Botrephny in Banffshire, and it has since been discovered in various parts of Europe. Mr. Werner thinks that it is nearly allied to the indurated talc, and that it makes an intermediate fossil between talc and hornblende.

#### WACKEN—*Papa-Stour.*

*Colour.* Brick-red of various shades, also dark-brown.

*Lustre and Transparency.* None.

*Fracture.* Smooth, earthy; but, when compact, it has a tendency to the fine splintery.

*Fusibility.* Melted at 120° of Wedgwood.

It frequently contains felspar, forming a species of porphyry; sometimes it is intermixed with green earth: it often also is cellular, and the cells are encrusted with dark-brown chalcédony, covered with crystallized quartz; and nodules of onyx and sardonix are sometimes found in it.

#### Common SERPENTINE\*.

*Colour.* Blackish green.

*Lustre.* None, or faint glimmering.

*Transparency.* A little at the edges.

*Fracture.* Sometimes fine, sometimes coarse splintery.

*Hardness.* Yields with difficulty to the knife.

This fossil is used in many countries for the building of ovens, as it resists the action of the fire very much; and, when powdered and burnt along with potter's clay, it can be made into

\* Werner has lately divided the Serpentine into two kinds, the Common and Noble Serpentine: the last mentioned has a conchoidal fracture, with a greater degree of lustre and transparency, and has generally a finer green colour than the first.

into light, solid vessels, which take a fine glazing, and resist the fire very well. In Italy it is used for the finest buildings. What the Italians call the Verde antico, is the noble serpentine mixed with marble or granular limestone.

#### Lamellar ACTYNOLITE—Kirwan.

This corresponds with the specimen I examined in the Lefkean cabinet at Dublin, from which Mr Kirwan's description is taken. It appears to be an intermediate fossil between actynolite, or strahlstein, and hornblende.

#### Common TREMOLIT.

#### ASBESTINITE, Kirwan.

*Colour.* Pale green.

*Lustre.* Silky.

*Transparency.* A little at the edges.

*Fracture.* Broad striated, the striæ frequently diverging as from a centre. Its fracture also presents distinct concretions, and it is from these that the striæ appear to diverge.

*Hardness.* Yields easily to the knife.

By decomposition it acquires an iron-brown colour.

Mr

Mr Kirwan found that this species melted into a green glass at 150° Wedgewood; and Klaproth has lately found, that, in a coal crucible, it gives a greyish-white, opaque slag, with the loss of 0.05; and in a clay crucible a compact greenish-white slag is formed. He finds that two parts contain,

Silix,	-	-	0.65
Lime,	-	-	0.18
Magnesia,	-	-	0.103
Carbonic acid and water			0.065
Oxyd of iron	-	-	0.005

The phosphorescence of the tremolit is very remarkable, and it has been found that the degree of effect is inversely as their hardness: thus the soft silky species gives a more vivid and red light, with a less degree of friction, than the harder kind. The phosphorescence can even be produced by means of a feather.

#### SCHILLER SPAR; or

#### LABRADOR HORNBLENDE.

This beautiful fossil is found in the serpentine rocks of the island of Unst. It was first discovered on the coast of Labrador;

dor; afterwards in Germany; and since in Cornwall, by Mr Hatchett. It is considered to be nearly allied to mica and talc; indeed it passes, on the one hand, into green mica, and, on the other, the yellow varieties pass into common talc.

### M I C A

Is found in several of the Shetland Islands; and sometimes the plates are of considerable size; but they are not so large as those that I have seen brought from Russia. A considerable quantity of mica is used in the Russian navy, for the making of lanterns and cabin windows. It is preferred to glass, from its not breaking by the discharge of cannon. It has a considerable inconvenience, however, that it soon loses its transparency by the action of the air and sea-water.

As there are several fossils that have a very near resemblance to mica in their external appearance, I will here shortly state the characters by which they may be readily distinguished, as stated by the Abbé Huay\*.

Mica

\* Journal des Mines.

Mica is distinguished from talc, by its communicating, by rubbing, the resinous electricity to wax, while talc communicates the vitreous; and farther, mica has not the unctuousness of talc. It is distinguished from cyanite, by its softness; the cyanite being vastly harder. It may be confounded with sulphure of molybdæna; but the sulphure of molybdæna foils paper, while mica does not: the same distinction with regard to carbure of iron. It is distinguished from the green crystallized uranite, by its pliability, the uranite being very fragile: the blow-pipe also affords a good distinction, the mica being converted into enamel, while the uranite is changed into a black scoria. The greyish-black mica may be confounded with the micaceous iron ore, or eisenman; but the latter is friable, and adheres to the fingers, often acts on the magnet, and melts into a black scoria.







## ORKNEY ISLANDS.

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### CHAP. XXVIII.

*Outline of the MINERALOGY of the ORKNEY ISLANDS; comprehending FLOTTA, SOUTH RONALDSHA, BURRA, POMONA, SHAPINSHA, STRONSA, SANDA, EDDA, WESTRA, EGLISHA, ROUSSA, and Hoy.*

HAVING, in my former journeys, traversed the greater part of the Scottish Isles, I was anxious to visit the Orkneys, and thus to make my tour more complete; and therefore, last summer, 1799, I embraced the opportunity of a vessel going to the island of Hoy, and sailed from Leith upon the 9th of June. The weather, however, proved stormy, and the wind contrary, so that we did not reach Orkney until the 20th, heartily tired of our voyage.

As soon as the vessel anchored, we landed upon the island of Hoy, immediately below the house of Mr Bremner, the minister of the parish, who received us very kindly. Having breakfasted, Mr Bremner was so good as to accompany us to the Berryhead, which is one of the most tremendous rocky precipices in Orkney. The walk was at first pretty easy; but as we came higher up the hill, it was fatiguing. Having reached to the summit of a high hill, we had still to ascend a considerable height, which brought us to the Berryhead. Here, indeed, a most sublime scene burst upon our view. Below us, and extending along the west coast of the island for several miles, were tremendous precipices of red-coloured sandstone, which rose to a great height. We crept towards the edge of the precipice, and beheld with terror a perpendicular descent of more than 1000 feet deep. When our attention could be withdrawn from the sight of these vast precipices, a scene of a different kind presented itself to our view. The sky was clear; the sea calm, and still as a lake; and the whole extent of the sea, and Pentland Frith, from Cape Wrath to Duncansbay Head, was before us: the wild mountains of Sutherland and Caithness, of an ethereal blue, added to the grandeur of the scene, retiring from the eye till at length they seemed to be blended with the ocean. We returned to the manse, well pleased with our excursion;

excursion; but found no variety of rock, sandstone being the only rock we observed.

We remained at Mr Bremner's all night, and took a boat next day for the island of South Ronaldsha; but, in our way, examined the small island of

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#### F L O T T A.

THIS isle is of little extent, low, but in several places there are cliffs upon the sea-shore which are of considerable height. It is entirely composed of sandstone and sandstone flag; nor is it remarkable, excepting for its former celebrity, being the residence of the historiographer appointed by the crown of Norway to collect information with regard to the north of Scotland. These narrations formed a work called Codex Flotticenfis; to which Torfæus is indebted for much of his history of the northern parts of Scotland.

We crossed from this isle to the island of

## SOUTH RONALDSHA.

THIS island is about seven miles long, and one and a half broad. It is low, excepting upon the shores, where there are tremendous precipices, which have proved fatal to many an unfortunate mariner. The whole island is composed of sandstone, sandstone flag, and in some places shistose clay is to be seen. It appears, like all the other Orkney Isles, to have been formerly joined to Caithness, as the strata are similar. Mr Watson, the minister of the parish, told me, that the sandstone, in different parts of the island, has been dug, in expectation of finding good veins of lead ore (galena), but always without success. This is very probable, for Emmerling informs us that sandstone is very unfavourable to ores\*. (Mineralogie, B. 3. S. 119.) In one part of the island we observed a stratum of shell marl lying under the peat, and in different parts of the island we observed bog-iron ore.

As

\* It is said, however, that the mountain Verapatal, in Mexico, is composed of sandstone, which is traversed by numerous veins, in which gold is found; Gerhard mentions similar rocks.

As the weather was boisterous, we remained in this island several days; at length the wind subsided, when we were enabled to cross to the island of

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### B U R R A.

THIS island is of little extent, low, and composed of similar argillaceous sandstone with that of Ronaldsha; and in one place I observed strata of shistose clay alternating with it. The shistose clay is of a black colour, and has frequently interspersed bitumen; and veins of calcareous spar are to be observed traversing it. This is a favourable appearance for coal, and deserves to be tried.

As this island afforded nothing particularly interesting, we crossed to the Mainland, or what is called the island of

### POMONA.

## P O M O N A.

THIS island is about 22 miles long, and in some places about 20 broad. It is in general low; the hill of Wideford, near to Kirkwall, and those in the parish of Orphir, being the highest in the island. The shores in some parts of the island are pretty high, yet in general they are low. There are two good harbours: the one at the principal town, called Kirkwall; the other upon the opposite side of the island, at Stromness.

The mineralogy of this island is by no means interesting; the whole of the island, excepting a small portion near to Stromness, being entirely composed of sandstone, sandstone flag, shistose clay, and in one place limestone and basalt make their appearance. The strata are generally horizontal, and are of various breadths; and the sandstone and shistose clay alternate with each other. As it would be of little consequence to trace my steps in the walk which I made around this island, I shall mention only the peculiarities of the different rocks.



1. *Sandstone.* This rock is of various colours, grey, red, or whitish; has generally an argillaceous cement: yet, in particular kinds, this is but in small quantity. It is frequently shistose, forming sandstone flag. It is used for building in all parts of the island; and in some places, as at Skail, where it is very hard, being a siliceous sandstone, it is cut for millstones, and is said to answer the purpose very well. A stratum of siliceous sandstone, similar to that at Skail, I observed among the soft sandstone strata near to Scapa; and I have not the least doubt, if well quarried, that it would answer equally well for millstones\*. Sometimes masses of iron pyrites, of a globular or irregular form, are dispersed through it; and of this

\* Different kinds of rock are used in Scotland for the making of millstones. Thus, in some places, as in the island of Raſay, I found porphyry used for millstones; and in Shetland, a compact species of micaceous shistus, is used for the same purpose. It has been a great desideratum to discover in Great Britain, a millstone equal to the French bur; indeed it is of such importance, that, the Society for the Improvement of Arts and Manufactures, at London, have offered a reward of 100 guineas, to him who shall discover a similar rock in Great Britain. As this rock may not be generally known, I think it proper here to mention that it is a cellular hornstone, and is found in vertical strata, according to Wallerius. As this famous stone is of a porous nature, and very hard; it is very probable that these properties must reside in all good millstones.—See Townson's Tracts, paper on Millstones.

this we have an example in the sandstone rocks upon the shore between Scapa and Orphir kirk. Trials have been made in the south part of the island with a view to find lead, but without success. At Yestneby, near to Skail, I observed veins of barytes traversing the sandstone; and, intermixed with this barytes, there was calcareous spar, iron pyrites and galena. At Skail, the sandstone, by the action of the weather, splits into many singular forms, similar to the sandstone I have described in the island of Arran.

2. *Shistose Clay.* This rock has a black colour; is always intermixed with mica; and passes, on the one hand, into sandstone slate, and, on the other, into clay, where the shistose character is more difficultly distinguishable. It acquires, by the action of the weather, an iron-brown covering; so that the rocks, at a distance, have much the appearance of the weathered serpentine rock in the islands of Unst and Fetlar, in the Shetland islands. In some places, as near to Stromness, I observed a red-coloured clay, which seemed to be clearly derived from the decomposing shistose clay. It is quarried to a considerable extent in different parts of the island, particularly near to Stromness, and the slates are used for roofing houses; but they are vastly inferior, in every respect, to the ardesia which is raised at Ballyhulish and Easdale.—Upon the sea-shore, near

to

to Brinnigar manse, which is about a mile from Stromness, in a kind of rock intermediate between shistose and indurated clay, there are many pieces of galena dispersed. Several years ago, a party of miners examined this appearance, and, having judged it probable that lead would be found in abundance, continued working for some time, but at length desisted, having, as they say, found it not worthy of farther labour. Near to the manse of Brinnigar, I observed masses of Lydian stone immersed in the shistose clay: in the Lydian stone there were several cavities filled with bitumen.

3. *Limestone.* At Yeskneby there is a considerable stratum of black-coloured limestone, which alternates with a rock intermediate between sandstone flag and shistose clay. It is much impregnated with bitumen, forming what is called stinkstein; and in several places I observed masses of bitumen dispersed through it.

4. *Basalt.* At Yeskneby is the only basaltic rock which I observed in the whole island. It forms veins, which traverse the common argillaceous sandstone. The crystals of hornblende, which are contained in it, are larger than usual in such rocks, being more than an inch long, and half an inch broad. I sometimes observed small cavities filled with bitumen.

The rocks of sandstone, shistose clay, &c. which I have just described, form the whole island, excepting an extent of a few miles around Stromness, which is of primary strata. These strata are, granite, gneiss, micaceous shistus, and hornblende rock; and all are traversed by veins of great-grained granite. The granite seems to form the central part, and is covered by gneiss, micaceous shistus and hornblende slate. At the mill water of Cairston, which is not far from Stromness, I observed the junction of the primary with the secondary strata. The micaceous shistus is covered by a breccia which is composed of fragments of granite and quartz, cemented by a basis of smaller particles of the same rocks; and, in the breccia, I observed pieces of galena immersed. This breccia is to be observed, in some places, covered by the shistose clay. From some appearances in the neighbourhood of Brinnigar, it is not very improbable that the shistose clay may lie upon the primary rock, without any interposed stratum of breccia?

Having seen every thing that was worthy of notice, we crossed to the island of

## SHAPINSHA.

THIS island is about 7 miles long, and 5 broad. The shores around the whole island are in general low.

The strata do not differ from those of Pomona; being principally composed of sandstone, sandstone flag, shistose clay, limestone, and basalt. The limestone is covered by a very hard, nearly siliceous sandstone, and it is also traversed by veins of the same sandstone. The basalt, which is only to be observed at the southern extremity of the island, seems to be covered with sandstone. In the sandstone isles of Copinsha, which lie at the southern extremity of the Mainland, or Pomona, I also observed a basalt, or rather wacken, traversed by veins of hornstone, and covered by a very hard sandstone: these, with the basalt veins at Yeskneby, are the only appearances of basalt which I have observed in the Orkney Islands.

As this island afforded nothing interesting, we sailed for the island of

## S T R O N S A.

THIS island is about six miles and a half long, and six miles broad. It is low, but upon several parts of the coast there are cliffs of considerable height. The rocks are entirely of sandstone and sandstone flag; which latter sometimes passes to shiftofe clay.

Having spent two days in traversing this island, we crossed to the island of

## S A N D A.

THIS island is about 12 miles long, and in some places nearly 3 miles broad. Upon the western extremity there are hills about 500 feet high, but all the other parts of the island are low and flat. Large shoals extend a great way from the coast, which is one of the causes of so many vessels being wrecked upon this island.

The

The mineralogy, like that of all the other islands, is very uninteresting; it being, as far as I examined it, composed entirely of sandstone and shistose clay; excepting a rock of sandstone breccia, which I observed at a place called Hecla-bor: hence the rock has been considered as volcanic.

Having spent several days in traversing this island, we crossed to

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### E D D A.

THIS island is about 7 miles long, and in some places about 2 miles broad. It is hilly, and, like Sanda, entirely composed of sandstone, which is of a red colour.

We crossed from this to the island of

W. E. S.

## WESTRAY,

and landed at the hospitable mansion of Mr Stewart of Brough. This island is about 9 miles long, and 6 broad. It rises, in some places, to a considerable height; and upon the north-west part of the sea-coast there is very magnificent rocky scenery. It is entirely composed of sandstone and sandstone flag; so that to a mineralogist it affords no variety.

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 PAPA-WESTRAY.

ABOUT two miles north from Westray, is the small, but pleasant isle of Papa-Westray. It is about three miles and a half long, and about a mile broad. It is principally composed of sandstone, sandstone flag, shistose clay, and in some places I observed fragments of breccia.

We now crossed, by a dangerous ferry, nine miles in breadth, called Westra Frith, to the small island of



## EGLISHAY,

where we were very kindly received by Capt. Baike. It is about two miles and a half long, and one broad; and is entirely composed of sandstone and sandstone flag, and in some places the strata seemed to be very much elevated.

As the weather was stormy, we could not leave this isle for several days: it having become more moderate, we crossed to the island of

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## RONSAY.

THIS island is about four miles long, and three broad, and, excepting Hoy, is the most hilly of the Orkney Islands. The coast, in some places, is of great height, and presents many sublime rocky scenes. It affords no variety of fossils, being, like the other islands, entirely composed of sandstone and sandstone flag; which last sometimes passes to shistose clay.

Having

Having traversed the whole of this island, we crossed again to Pomona, and walked by Stromness, and again crossed to the island of

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### H O Y.

THIS island is about 12 miles long, and 5 broad; is the most mountainous of all the Orkney Islands; and its shores, as I have already remarked, rise, in many places, to a most terrific height. This island is remarkable for its excellent harbour, called the Long-Hope, where great fleets can rendezvous, and in complete safety.

This island is entirely composed of sandstone, sandstone flag, shistose clay, and in many places I observed a rock of wacken. The strata are generally horizontal, and sometimes they alternate. The sandstone has been dug, in various places, in search of iron ore; and the attempts seem to have been attended with some success, as rich hematitical iron ore was obtained. I am of opinion, however, that, in the trials which have been  
made

made near to Melfetter, upon the estate of Major Moodie, the proper bed of ore has not been fairly discovered; and that which has been obtained, is merely an admixture of sandstone and ore. In other countries, this admixture, of the ore and the stratified matter, has been taken for the true bed, and much unnecessary expence incurred, which might have been avoided by digging in a proper direction, so as to meet with the bed of ore. The shistose clay, where it alternates with the sandstone, has sometimes that shining appearance which is characteristic of the species found above, or in the vicinity of, coal strata: a circumstance which is to be considered as favourable for the discovery of coal in the lower parts of this island.

The wacken, which I have mentioned, is upon the sea-shore, at a little distance from Melfetter. It has, intermixed with it, calcareous spar, either in little veins or nodules: pieces of silicious sandstone are found in it, and even veins of a similar sandstone traverse it.

We now took leave of Major Moodie, and sailed down the harbour of Long Hope to the island of Ronaldsha, where we spent a few days very agreeably with Mr Watson, waiting favourable weather to cross the Pentland Frith.

## ON KELP.

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### CHAP. XXIX.

#### *Observations on KELP.*

AS this substance is of the greatest importance to the Orkney Islands, I hope the following observations will not be considered as out of place.

This useful material does not appear to have been known as a manufacture in Britain, until some time after the beginning of the present century; owing to the backward state of the soap and glass manufactures, which, particularly in Scotland, have not been carried on with spirit above thirty years. It will not then surprize us, when we learn, that its first introduction

duction was about the year 1730, into the island of Uist, by a Highland gentleman, of the name of M'Leod, who brought the art from Ireland, where it had been carried on many years before. The method he followed was a bad one, as he was satisfied by merely reducing the sea-ware, or fuci, to ashes. This practice was soon discontinued, and the method of fusion was adopted. This manufacture soon found its way into all the other islands; for we find it forming an article of trade in Shetland, soon after its introduction into the Hebrides. The quantity of kelp, at first made, was trifling; but the great increase, and the rapid progress, of the manufactures depending on it, soon raised the price and increased the quantity: the following being, as far as I can collect, pretty nearly the price of kelp from the year 1740 to the present time.

From 1740 to 1760,	average price about	2l. 5s. a ton.
1760 to 1770	- -	4l. 4s. a ton.
1770 to 1780	- -	5l. 0s. a ton.
1780 to 1790	- -	6l. 0s. a ton.

Since the year 1791, its value has greatly increased, and has now risen to a greater height than was ever known before, owing to the war, which has prevented the importation of the

usual quantity of barilla, and has thus raised kelp to the enormous price of 111. a ton\*.

In Shetland, from 250 to 300 tons are made annually, but this quantity bears so small a proportion to the extent of the lands, as not to have affected the rent in an equal degree to that of Orkney; where, within these seven years past, small farms of about 40l. yearly rent, have risen to 300l. a year.

In Shetland, the cost of manufacturing is from 2l. to 2l. 10s. a ton; but in the west Highlands, the price of labour is greatly lower, being from 1l. to 1l. 10s. a ton. The method of manufacturing, though rude, is sufficiently simple. The different species of fuci, particularly the *vesiculofus*, *ferratus*, and *nodofus*, are cut from the rocks in the months of May, June, and July, and spread out and dried so as to enable them to burn more easily. In drying the ware, they are very cautious to prevent any fermentation from taking place, or to suffer it to be exposed to rain; as kelp, made from such damaged ware, is necessarily of a very inferior quality.

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\* Even this price might be still further increased in a very considerable degree, if proper methods of manufacturing the kelp were followed.

The ware being well dried, a small quantity is kindled in a pit dug in the sand, or upon a piece of ground which is surrounded with loose stones, so as to form what is called a kiln. They continue adding fresh quantities, until the pit or kiln is nearly filled, when the whole is frequently stirred towards the evening, when it gets into a semifluid state; it is allowed to cool, and afterwards taken out of the pit ready for the market. This method of burning the ware, is liable to many inconveniences. Of these, the following are not the least considerable: 1. As the sides of the kiln become heated, considerable masses of stone split off, and are mixed with the melted matter, which reduces the value of the kelp very much. 2. From the heat not being sufficiently confined, the ware is always very imperfectly burnt. 3. By the fusion being made upon the ground, a very considerable portion of siliceous earth is mixed with the melting materials; and this earth uniting with the alkali, renders a portion of it useless; because, though it increases the weight of the kelp, it deteriorates its quality.

These facts engaged the attention of my father some years ago, who endeavoured, by a series of experiments, to ascertain the value of kelp burnt in this rude way, and that made in furnaces. He erected several different kinds of furnaces, in which he burnt the ware, and afterwards examined the kelps; which  
were

were very solid; free of foreign earthy substances of masses of carbonaceous matter; and contained a greater quantity of alkali than common kelp—A recapitulation of all these experiments would be inconsistent with the intended brevity of this publication. I shall, therefore, only mention what he conceived to be the best form of a furnace.

It consists of one fire-place, covered with an arch, which communicates with four reverberating cavities, into which the ware is to be thrown. This fire-place, with a small quantity of fuel, produced a kelp of greater strength than any he had examined during his long practice; and, upon calculation, it was found that the expence of furnaces and fuel, was greatly more than repaid by the increased value of the kelp.

I find, that a special committee of the Highland Society, assisted by the late celebrated Dr. Black, had examined these furnaces, and reported to the Society their approbation of them. They also mention several other particulars, which are of importance to be more generally known.

“ Mr Jameson further stated, that the expence of these kilns would be of moderate amount; that of the single 7l. or 8l. and of the four united, (which is the one I have described),  
about



about 30l, with the addition of a small sum for a shade or cover, to protect the article when made, from the weather; but that such an expence would be repaid by the additional quantity of good kelp, produced from the sea weed, burnt into 10 tons; which the kilns would produce in a very short time, the single one burning one ton, and the quadruple four tons a day †.”

Merchants, in their examination of kelps, are possessed of a few rules, which they generally follow, in determining their relative value; these are, taste, smell, colour, and compactness. These will give us a very vague idea of their value; and it requires no foresight to perceive, that trusting to external characters, in so heterogeneous a mass as kelp, must often lead the unwary buyer into a disagreeable predicament, in purchasing as good, what upon actual trial he finds of comparatively little value. These remarks are not idle conjectures; for I have often seen them verified, to the no small detriment of the manufacturer, and have as often regretted that so little attention should be paid to the ascertaining the proportion of alkali, &c.

Mr Kirwan of Dublin, whose active industry is now well known to all Europe, is the first who has engaged seriously in  
this

† Transactions of the Highland Society, Vol. 1. p. xxiv, xxv.

this investigation; and the results of his labours are detailed in the 3d vol. of the Transactions of the Royal Irish Academy.

Having favourable opportunities, through the good services of some of my friends, of procuring kelps and barillas, I ascertained the proportion of pure alkali in each of them: in some by the test of sulphat of argill, which is employed by Mr Kirwan; in others, by using an acid of known strength, the method recommended by Dr. Black.

*Table of the Proportion of ALKALI contained in different kinds of  
BARILLA and KELP.*

	In the 100lb.
Barilla and Alicant—good	23½.
Teneriff—bad	8 lb. 7 oz. 120 gr.
Kelp from Norway indifferent	2 lb. 11 oz.
Shetland—indifferent	2 lb. 6 oz.
Lewis—indifferent	2 lb. 11 oz.
Ibid—indifferent	2 lb. 6 oz.
West Highlands—much damaged	1-3d. of lb.

Arran

Arran	-	-	-	3½ lb.
Isla—good	-	-		4 lb.
Mull—good	-	-		4½ lb.
Morven—good	-			4½ lb.
Inland Skye—good		-		5 lb.
Leith shores	-	-		4 lb.

In judging of the value of kelp, it is not sufficient that we have ascertained the proportion of soda; several other circumstances must be attended to. In the first place, in judging of the value of a cargo, we must carefully examine its general appearance, which comprehends the size of the masses, the greater or less quantity of mixed stony matter, the degree of compactness, the proportion of diffused charcoal, the causticity, its wetness or dryness, &c. We then take pieces as different as possible from each other, and as expressive of the character of the whole as we can, pound them, and take any intermediate quantity, as an ounce, and ascertain the proportion of soda, which being done, will afford us as just an idea of its value, as from the nature of circumstances we can obtain.

*Chemical Analysis of Fuci.*

Our knowledge of the saline and earthy matters contained in fuci, is as yet very limited, which is to be regretted, when we consider the utility and importance of such an investigation. Bouvier, in the *Annales des Chymie* for 1791, has given us an analysis of what he names *Fucus Helmenthorcoton*. From his experiments, it appears, that no uncombined alkali is present, and that the principal saline compound is muriat of soda, (common salt.)

Vauquelin has found soda ready formed in some maritime plants. The plants which give most alkali by combustion, are not those that grow under the sea-water as fuci, but those that grow upon the land near to the shore, as *salsola kali*, *soda*, *fativa*. The *salsola fativa* is the species which is cultivated in Spain for the making of barilla, and the exportation of the seeds is punished by death.

*Cultivation of Fuci.*

The cultivation of fuci upon shores, is now become an object of some consequence, not only from their value, as affording kelp, but also on account of their successful use as a manure.

nure. It has, therefore, been recommended to place stones upon the shores, which, in many places can be done at small expence; and these in two years, become covered with fuci, in such a state, as to admit of cutting. Various kinds of stones have been tried, as basalt, sandstone, and limestone; this last is by many reckoned the best, and, next to it, basalt.

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FROM

FROM HUNA TO THE FRITH OF FORTH.

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C H A P. XXX.

*Journey from HUNA, upon the shore of the Pentland Frith, by Wick, Berrydale, Dornoch, Tain, Cromarty, Fort-George, Nairn, Forres, Elgin, Lossiemouth, Cullen, Portsoy, Banff, Aberdeen, Stonehaven, Dundee, to the Frith of FORTH.*

ALTHO' it required nearly six weeks to traverse the Orkney Islands, and that journey proved the most uninteresting I had ever made; yet I had the pleasing reflection of having examined a country, the mineralogy of which was before unknown, and of having now finished my journey thro' the greater part of the Scottish Isles. But I cannot leave them, without acknowledging, in the warmest manner, my sense of  
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the hospitality of the inhabitants : a kindness the more agreeable, that it seemed, on their part, to look for no return, and to proceed from feelings so consonant and natural, that they had forgot that it was unusual, and confined to those remote highlands, where the better feelings of the heart more freely expand themselves.

The weather being favourable, Mr Watson accompanied us to the ferry, which is at a place called Burwick, situated upon the south-west end of the island of South Ronaldsha. We bade him adieu, and left with regret a friend to whose kind attentions we had been so much indebted. Altho' the boat was excellent, we did not embark without some dread, from the recollection of the many terrible accidents which have happened in crossing the frith. Luckily the weather proved fine ; so that we landed at Huna, upon the coast of Caithness, after a passage of about two hours and a half. In crossing, we came close to the small, low island of Stroma, which appears to be composed of sandstone and sandstone flag : indeed we were informed that a great number of flags are annually quarried in this island, and carried to the coast of Caithness. At Huna, the shore is low, and is composed of coarse argillaceous sandstone ; and the coast and country, from Duncan's Bay Head to Dunnet Head, are evidently formed of similar rocks. As the postman was just setting out for Wick, which is the first town we meet with  
in

in going southward, we embraced the opportunity of having him as a guide. The country continues low and flat, only in a few places varied by considerable hills; and cultivation seems very sparing. Near to Kies Castle we encountered a tedious sandy beach, over which we walked; and in several places we observed that the peat had been dug from under the sand. At the extremity of this beach, we passed a formal tower, a feat of Sir Benjamin Dunbar; and further on, towards the Nofs Head, the castles of Guernigo and Sinclair were seen perched upon lofty sea-cliffs; and soon afterwards we came to the small borough town of Wick. The country, thro' which we had passed, is composed of sandstone and sandstone flag; but, in many places, I observed masses of breccia, composed of fragments of red granite, micaceous shistus, and quartz, cemented by an arenaceous basis: but I could not discover how it is connected with the other strata of the county.

Wick is the chief county town in Caithness; is of little extent; and lies upon the north-east side of what is called Wick river. The strata, upon both sides of the river, and in the neighbourhood of the town, are composed of sandstone flag, which is disposed in strata nearly horizontal; and, in the bed of the river, I also observed great masses of the breccia just mentioned.



We left Wick in the morning for the house of Berridale. We continued our journey for several miles thro' a heath-covered country, pretty level, but brown and bleak, with little cultivation, and no variety of strata; sandstone and sandstone flag being the only rocks. At Poakmaist the country is more hilly; and now and then the great mountains, the Paps of Caithness, and the lofty Morven, appeared at a considerable distance, forming a striking contrast with the low, mean-looking country thro' which we were passing. From Poakmaist to Dunbeath we had still the same bleak scene; and this tedious uniformity was only varied by the appearance of old, ruinous castles, perched upon the rocky cliffs on the sea-shore, or reclusive gentlemen's seats situated amid brown desert heaths.

After passing Dunbeath, we continued walking for about four miles, along the sea-shore, thro' a heath-covered country, when we came upon the side of a valley beautifully covered with natural wood; and we observed, situated in its bottom, the neat inn of Berridale, for which travellers have to thank the generosity of Sir John Sinclair. As we descended, by a winding road, to the house, the valley became more reclusive: the distant mountains being hid by the sides of the valley, and a bridge thrown across a water which runs over a broken channel overhung with natural wood, added much to its beauty.

This

This is indeed a scene that might be admired under a milder climate. The strata, from Dunbeath to this valley, are formed of sandstone, sandstone flag, and a blue species of secondary ardesia: the higher grounds appear to be entirely of primitive rocks.

As the weather was delightful, we did not proceed on our journey homewards, but next morning we agreed to ascend the mountains in the neighbourhood, so that we might obtain some information as to the structure and composition of the high parts of the country. After breakfast, we took a winding and pretty steep road upon the south side of the valley, which led thro' the natural wood, and soon reached the summit of the valley. From this, we had a fine view of Morven, Scuraben, and the neighbouring mountains; yet we were separated from them by a long, dreary peat muir. Having crossed the muir, which was very fatiguing, (owing to its broken surface,) we at length reached the bottom of Scuraben. We here found a tolerable tract, which led us a considerable way up the mountain. At the termination of this tract, we turned westward, and walked over a wilderness of stones, and thro' a thick fog, to the summit of the mountain of Scuraben. The thick mist entirely prevented us from seeing the neighbouring country; and we were forced to descend into a hollow  
upon

upon the lea side of the mountain, to shelter ourselves from the piercing cold and drizzling rain. We laid ourselves down behind a great mass of rock, anxiously waiting for the dispersion of the fog; and, being much fatigued, fell asleep, but awaked soon afterwards, cold and wet, and still involved in a thick mist. As our situation was now by no means agreeable, we quitted the hollow in which we had taken shelter, and descended by the north-west side of the mountain, and, after a long walk, we were happy again to reach the sweet retreat of Berridale.

From the observations which I made upon the summit of the hill, and in the ascent, the following appears to be the nature of the strata. The lower part of the country is common argillaceous sandstone, and sand sandstone flag; but, as we ascend, the next rock is an arenaceous breccia, which has, immersed in it, fragments, of various sizes and shapes, of red granite, micaceous schistus, and quartz; and to this succeeds a rock of quartz, which reaches to the summit of the mountain. This quartz is sometimes so intermixed with the mica, as to form micaceous schistus; and very often it has a brecciated appearance. Moreover, with the other neighbouring mountains, from their white colour, appear to be composed of a similar quartz rock. It would be an object well worthy the attention of the mineralo-

gift, to examine the junction of this quartzzy rock with the sandstone strata, and also to determine with accuracy the angle of elevation, &c. of these strata.

Having rested after the fatigues of our journey to Scuraben, we left Berridale early in the morning. The weather was charming; and the perfume of the wild flowers, which was diffused all around, rendered the beginning of our journey very agreeable. We ascended first by a steep, winding road, which was covered with masses of sandstone breccia; and considerable blocks of granite and micaceous shistus lay scattered upon the road. From this, to the valley which is formed upon one side of the Ord of Caithness, the same strata continues: that is, upon the sea-shore, red argillaceous sandstone; and, farther up, sandstone breccia, which contains fragments of granite, micaceous shistus, and quartz, immersed in an arenaceous basis; and to this succeed the primitive strata. As we descended into this valley, we observed the road covered with great masses of granite; and the hills above (which are heath-covered) appeared also to be formed of granite.

We now ascended from this valley by the steep mountain called the Ord of Caithness, and, after a fatiguing walk, we reached the narrow pass which forms the entrance into Sutherlandshire

landshire from the north. Before, were the distant mountains of Ross and Inverness shires; but, below, was the sea-coast of Sutherland, which had a singular appearance: the cultivated ground forming a low and nearly level bank, which is skirted by dark mountains of a considerable height. The pass itself was bounded upon one side by a steep mountain of granite †; on the other, was a frightful precipice hanging into the sea, and composed of a species of breccia, which, as far as my short time would allow me to determine, seems to lie upon the granite. We now descended, by a winding road, to the bank we have just mentioned, and walked along it to a village called Helmsdale, where unluckily we could get little to satisfy our craving hunger. This village, or kraal, is situated in a valley of considerable magnitude, and is bounded on both sides by mountains of granite. We now crossed the water of Helmsdale, and walked along the shore, by the side of the bank which is continued from Helmsdale, to a dirty hut, which passes for an inn, and is called Wilk House. This bank is composed of strata of red and white-coloured sandstone; but upon the shore, at a little distance from this sandstone, there are low, shelving rocks, of an argillaceous breccia, which is composed of fragments of sandstone and quartz immersed in an argillaceous breccia. These secondary strata are bounded by higher mountains, which are primitive, and probably of granite.

K k 2

After

† This granite is compact, and composed of felspar and quartz.

After leaving Wilk house, the bank, which had accompanied us from the Ord of Caithness, was now succeeded by flat ground; but our general course was thro' sandy beaches: and this, with the great heat of the day, rendered our journey very fatiguing. As we approached near to Dunrobin Castle, the fine seat of the Countess of Sutherland, the country becomes wooded; and at length we observed the castle rising with much dignity among the fine wood with which it is so richly ornamented. Soon afterwards, we reached the kirk of Golfpie. Having rested a little, we continued our journey over a flat sandy tract of country, which is bounded by high primitive mountains. About three miles from Golfpie, we came to a river, and were here detained for nearly an hour until the obstinate boatmen would ferry us across; and then walked among sand banks, and over heath muirs, to Dornoch, where we arrived in the evening, completely fatigued, after a walk of nearly 20 hours. I was a good deal surpris'd to meet with many pieces of pumice stone among the sand banks between Golfpie and Dornoch: these have assuredly been driven on shore from the sea, as I have already mention'd to be the case with regard to the pumice found upon the shores of the Shetland Islands.

Dornoch is an old, desolate-looking town, only remarkable for the ruins of its cathedral.

We left Dornoch in the morning, for the village of Tain. The road to the ferry, which is upon the north side of the frith of Dornoch, is thro' a low, level, and pleafant country. It is in many places well cultivated, and ornamented with wood, that extends to a confiderable height upon fome of the hills bounding the low country. The strata of the lower parts are of red fandstone; and I obferved many fragments of micaceous fhiftus, and granite, which have been washed from the neighbouring mountains. We now crossed the ferry, which is about three quarters of a mile broad. In our paffage, looking downwards, we had a pretty extenfive view of the low fandty country on both fides of the frith; a profpect not unlike the views we have on many of the low fhores on the Englifh coaft. The view upwards was of a very different kind: it was the wild and rugged mountains of Ross-shire, which in fome places appeared white with fnow, in others richly covered with wood. The road from this to Tain led firft thro' a fweet flat adorned with broom; then along a road bounded by trees; and the fcene was again varied, before we reached the town, by a difagreeable tract of heathy and fandty ground. The strata, in this tract, appeared to be principally red-coloured argillaceous fandstone: but, as we approached the town of Tain, I obferved confiderable mafles of granitic porphyry, gneifs, micaceous fhiftus, and hornblende fhiftus. Whether all these

rocks

rocks form strata in the neighbouring hills, or are only masses derived from a breccia which I observed lying upon different parts of the road, I had not an opportunity of determining.

After dinner, we walked to the ferry of Cromarty. The road led thro' a pretty flat country, and the strata seemed to be entirely of red-coloured argillaceous sandstone; and, in several places, I observed great masses of breccia, which is formed of fragments of granite, gneiss, micaceous schistus, hornblende rock, and quartz. We now crossed a ferry, of about one mile and a half broad, to the town of Cromarty. This is a neat highland town, and is much beautified by the fine grounds and handsome seat of the Earls of Cromarty. The prevailing strata in the neighbourhood of this town, and what forms both sides of the entrance of the Cromarty frith, is a red-coloured argillaceous sandstone.

We left Cromarty early in the morning, for Fort-George. The country is, all the way, pretty flat. We could not observe the strata, owing to the covering of heath, until we came near to Fortrose; but in several places I observed masses of granite, gneiss, micaceous schistus, hornblende rock, and also masses of arenaceous breccia. As we descended to Fortrose, strata of arenaceous breccia made its appearance; and the coast  
of



of the Murray frith, from Fortrose to the entrance of the Cromarty frith, seemed to be composed of red-coloured argillaceous sandstone, with strata of arenaceous breccia. We now walked down to the ferry-place, and crossed the frith, which is about two miles broad, to Fort-George. This fort, the most complete piece of fortification in Great Britain, is situated upon a low point of land which juts across the Murray frith, and is built of red and white-coloured argillaceous sandstone. From it, we have a fine view of the frith, which expands beyond the fort, and is bounded by lofty hills ; and this prospect is terminated by the capital of the highlands, the picturesque town of Inverness, with great mountains rising on both sides of it.

If we look at the map, we shall observe that Scotland is deeply indented both on its east and west side. In the east, the spacious Murray frith intersects the country as far up as Inverness ; while, upon the west side, Linnhe Loch reaches to Fort-William. A great valley, about 60 miles long, extends between these arms of the sea : it is bounded by lofty mountains ; and its bottom is covered, excepting for about 17 miles, with deep lakes. The land between the lakes is level, and composed entirely of alluvial strata, excepting some rocks to the south-west of Fort-Augustus †. It has been proposed to connect the lakes by  
a canal,

† Transactions of the Highland Society, vol. i.

a canal, and thus to save the tedious and dangerous passage by the Pentland frith; and, as the ground is level and soft, the expence would not be very great. This plan has much plausibility; yet it would be more likely to meet with attention, if the mineralogy of the great glen was carefully examined. It is not improbable that promising appearances of ore may be discovered; and these, if worked with spirit, would employ many hands, and render a canal of vastly more importance. The few satisfactory mineralogical observations which have been made on this glen, have not been made with a view of discovering veins or beds of ore; so that we are, as yet, entirely ignorant of the mineral treasures which it may contain.

We left Fort-George. The road led thro' a low, heathy country. On one hand was a sandy flat, partly overgrown with heath, which seemed to have been formely covered by the sea: on the other was a heathy country, and at a distance hills. I observed, upon the road, masses of granite, micaceous schistus, quartz, and sandstone. The sandstone strata, which I observed cropping near to Nairn, seem to form the level part of the country; but the hilly part, from its general appearance, and the masses of micaceous schistus which are scattered about, seem to be of primitive rock.

We

We dined at Nairn, and set out for Forres. At a little distance from the town, we observed great sand hills, and a terrible sandy coast stretching towards the ocean. This scene was very striking: the whole sky was covered with dark clouds; yet the whiteness of the sand caused the light to be so strongly reflected, particularly from the hills, that they appeared as if the sun was shining upon them. We stooped to examine them, and found that they were composed of fine white sand, which does not lie in beds, but is irregularly heaped: a circumstance sufficiently conclusive that these accumulations have been produced by the blowing of the sand. The whole of the neighbouring country is much covered with sand, and some great estates have been almost destroyed by this sand flood. We now continued our journey; and as we retired from the sand hills, their appearance became the more striking, as every object was clothed in a sable hue, while their bright surfaces at length shone like luminous points upon the horizon. The road continues for a considerable way through a bleak country, but as we approach to the pleasant town of Forres it assumes a rich and lovely aspect. The strata, all the way, are decidedly secondary, being of sandstone and basalt; but the rocks in the higher parts of the country are probably of primitive rock, as is intimated by the fragments of granite and micaceous schistus which lie scattered about.

Forres is a neat, well-built town, pleasantly situated between two little hills; but we could not enjoy the pleasure of examining it more at leisure, as the evening was at a close: and we were forced to proceed to Elgin, a distance of 12 miles. At a little distance from Forres, we examined, in the twilight, the famous pillar mentioned by Mr Pennant; and then continued our journey to Elgin in the dark. In the middle of the night, we crossed the blasted heath on which the weird sisters met Macbeth in the day of his success, and stopt him with their prophetic greeting. The solitary hour of the night, the melancholy noise of the wind rushing across the heath, the glimmering of the Will-o'-the-wisp, excited in us that strange feeling of superstitious alarm of which every man must at some time or other have been conscious.

Although much fatigued with our long journey from Cromarty to Elgin, we rose up early in the morning, and examined the magnificent ruins of Elgin cathedral.

We now continued our journey from Elgin towards Lossiemouth, which is situated upon the sea-coast. The country, for a short way, was very pleasing; but having reached an eminence above the town, we descended into a flat, indifferently-cultivated country. As we approached Lossiemouth,  
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the whole of the country appeared to be formed of boulder stones; and, near to the town, great banks, evidently left by the retiring of the sea, make their appearance. These boulder stones are of granite, granitic porphyry, micaceous schist, quartz, limestone, and arenaceous breccia. At Loffiemouth, which is a trifling village, I observed strata of red-coloured argillaceous sandstone; but no other rock was to be observed in the neighbourhood. We now walked along the shore for a considerable way, still over boulder stones; we then changed our course, and continued walking for several miles upon the road to Fochabers, when we found the country to improve very much in beauty. As this route did not seem very interesting, we again traversed the country until we came nearly to the mouth of the river Spey, which we crossed in a small boat. Here we walked along a beach of boulder stones, which was without any covering of heath, and was extremely fatiguing. Having reached its farther extremity, we walked, by a better road, to the fishing town of Buckie. Upon several parts of the shore, I observed the red-coloured argillaceous sandstone; and at Buckie the strata became nearly vertical. At this place, as far as I had leisure to determine, the secondary sandstone, which we had traced along the shore all the way from the Pentland frith, disappeared, the sea-coast being formed of primary strata. We now left the coast, and ascended for a lit-

tle, when we came upon a level, which continues for a considerable way either bare or heath-covered, and at a little distance is bounded by mountains of considerable height. As we approach to Cullen, the country becomes well cultivated; and we pass, to this sweet village, thro' very fine and rich plantations. It was almost dark before we reached Cullen, so that we probably passed richly-wooded scenes. The strata, all the way from Buckie, are entirely primitive, and are principally micaceous schistus, traversed by quartz veins. In some places I observed masses of granite: but I had not time to determine its position with regard to the other rocks.

In the morning, we left with regret the delightfully-situated village of Cullen, and took the road which leads to Portsoy. A little way from the town, the country loses much of its beauty, and the wood gradually disappears. About two miles from Cullen, we forsook the road, and walked towards the shore, to view the old castle, once the seat of Lord Oliphant. The castle is built upon the summit of a cliff about 80 feet high, which projects into the sea; and its ruins shew that formerly it must have been a place of considerable strength. The times are now happily changed. In place of the fortress perched upon the almost inaccessible sea-cliff, the seats of our chieftains are now placed in the most enchanting situations, and adorned with all  
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the richness and luxurious variety of nature and art combined. It is a character which strongly marks the barbarism of former times, and the present happy change of manners and government. The rock, upon which this castle is situated, is composed of talcaceous schistus, which is disposed in strata that are nearly vertical, and is more or less intermixed with quartz. I also observed a great stratum of compact quartz, which is in some places between 16 and 17 feet wide. What is curious, this stratum has, in some places, the character of granular quartz; and it is often so intermixed with talc, as to form a species of talcaceous schistus. The strata of talcaceous schistus, upon one side of the stratum of quartz, are much twisted, while on the other they are perfectly regular.

We now continued journeying along By the sea-shore, that we might have a better opportunity of discovering any interesting appearances which were to be observed. The cliffs continue to Sandside to be composed of nearly vertical strata of talcaceous and micaceous schistus; but, upon the south side of Sandside, I observed a considerable stratum of steel-grey, foliated limestone, which lies upon an ardesia, or primitive argillaceous schistus, and this ardesia appears to be covered by a breccia. As the sea covered the greater part of this rock of breccia, I could not determine with certainty its position with regard to  
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the limestone. After passing this stratum of limestone, which, we were informed, runs a considerable way into the country, we came to an immense mass of breccia, which seemed to be quite insulated: it is not improbable; however, that, before the sea had washed away the talcaceous schistus, the breccia would have been observed covering it. We still continued our journey along the shore, until we came within a quarter of a mile of Portfooy; and, in that extent, I observed strata of talcaceous, micaceous and hornblende schistus alternating with each other. We now walked to the town, which we found to be irregular and dirty.

As the rocks upon the sea-shore, near to this town, are very interesting, we agreed to stay a day or two, and examine them particularly. I was the more anxious to do this, as they have long attracted the attention of mineralogists; but their particular geognostic characters have never been detailed in any publication. After having examined these rocks, the following is the result of the observations which I made.

About a quarter of a mile from Portfooy, at the place to which I had traced the strata in coming into the town, the talcaceous schistus appeared, in vertical strata; and, nearly at the same place, I observed a stratum of white marble, which is  
marked



marked E, in the plan at the end of this volume. It is about 12 feet wide, and runs S. W. and N. E. which is in the same direction with the bounding strata\*. It appears to have been worked for ornamental purposes, as I observed several blocks upon the beach which seem to have been sawed. To this stratum succeeds a vertical stratum of micaceous shistus †, marked F, which is compact, and of a blackish colour where in contact with the marble, but of a green colour where it is in contact with the next stratum, which is serpentine ‡. The stratum of serpentine, marked G, which succeeds to the talcaceous shistus, is of great width, and, like the other strata,

\* This marble is white, or clouded with steel-gray, but it is much mixed with scales of talc.

† The talcaceous shistus, which alternates with these strata, has sometimes so much the appearance of compact micaceous shistus, that it cannot be distinguished from it; and as it approaches the marble, it is to be observed mixed with it, and passing into it.

‡ This serpentine is of various shades of olive and blackish green. Its fracture, which is either uneven, coarse splintery, or even fine splintery, presents canary-green scales. It is intermixed with various fossils, as asbestos, indurated steatites, talcite of Wallerius, calcaceous spar, and iron pyrites.

strata, is nearly vertical, and runs in a similar direction. It runs out into the sea like a great wall; and this, with its green colour, gives it a singular aspect. This stratum is bounded by a stratum of talcaceous schistus, H, which is almost entirely composed of quartz, where it is in contact with the serpentine; but as it approaches the next stratum which is marble, it has more of the talcaceous character, and is also traversed by veins of quartz. The stratum of marble, I, is from 15 to 20 feet wide; is also vertical; but is of a bad quality, and will not serve for any ornamental purpose. It has, immersed in it, pieces of quartz and talcaceous schistus. To this stratum succeeds a thin stratum of quartz; and this again is bounded by a thin stratum of talcaceous schistus, K. Both these strata are only a few feet wide; and are succeeded by a stratum of marble, L, nearly of the same width with the former stratum, I. To this marble succeeds a great stratum of serpentine, M, which is of the same nature with the stratum we have before described. This stratum is bounded by hornblende rock \*, N, which forms the rocks that surround the harbour of Portfooy, and continues beyond it towards a bay, the name of which I do not recollect.

\* The hornblende rock is generally schistose, and has sometimes scales of brown mica intermixed with it.

collect \*. It is traversed in several places by veins of granite, which run in different directions, and vary in breadth from one to eight or nine feet. At a little distance from the side of the bay I have just mentioned, another stratum of serpentine, marked O, makes its appearance; and to it again succeeds the hornblende rock, P, which is traversed by veins of granite †.

We now walked along the shore by the bottom of this bay; and, upon its opposite side, in place of the hornblende rock, there are rugged cliffs of micaceous schistus, which is in some places alternated with quartz, and in others traversed by considerable granite veins. The micaceous schistus sometimes contains garnets; and the granite, which is great-grained, frequently contains crystals of horn and mica, and sometimes it has the appearance that is called pierre graphique.

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\* The serpentine, as it approaches the hornblende rock, becomes gradually intermixed with it, and at last is not to be distinguished from it.

† Betwixt Portfooy harbour and the bay, I observed marble; but I could not determine how it lay with respect to the other rocks; so that I have not represented it in the plan.

Such appears to me the disposition and nature of the strata upon the shore at Portfooy\*.

As the geognostic characters of the serpentine, at this place, are interesting, I shall here mention, for the information of my readers, a few facts, which shew that pretty nearly similar appearances have been observed in other countries. Zobtenberg, in lower Silesia, consists entirely of serpentine, in which some hornblende is found, and its strata are nearly vertical †. In the Miner's Kalendar for 1790, Kohler informs us, that serpentine and primitive limestone (marble) are nearly allied in their geognostic characters, and that sometimes they are disposed in strata which alternate. We are also informed that serpentine rests upon gneiss, and even alternates with it ‡, and also with quartzzy talcaceous schistus ||.

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\* Some travellers are of opinion that the serpentine and marble form great veins, rather than vertical strata.

† 4 Berl. Beobacht. 353.

‡ Charpentier Mineralogische Geographie von Churfachsichen Lande.

|| N. Nord. Beytrage. 149.

The appearance of the veins of granite traversing hornblende rock and micaceous schistus, is by no means uncommon in Scotland; and in other countries similar appearances have been very often observed. The pierre graphique has been observed, in Siberia, to form the sides of veins where the topaz is found\*; but at Sebnitz it is disposed in beds with the common granite †; and, in the Uralian mountains, Herman observed it mixed with the common granite ‡. Patrin, who found it in Siberia with the topaz, conjectures that it may generally be considered as indicative of the presence of these gems.

Having thus examined the strata upon the shore, I walked into the country for about two miles; but could observe no trace of the serpentine, or marble, or talcaceous schistus, but in several places I observed the hornblende rock. I ascended a hill a few hundred feet high; upon the side of it were masses of hornblende rock and gneiss scattered about, but towards the summit it was entirely composed of schistose quartz. This

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\* J. de Physique. Ann. 1791.

† N. Bergmannisches Journal, B. 2. 443.

‡ Herman Mineralogische Beschreibung des Uralischen Geburges. B. 1. S. 144.

is a rare rock in Scotland; nor has it been observed but in a very few places upon the continent.

We now left Portfooy, and continued our journey by a good road which leads thro' the country towards the town of Banff. At the bridge of Boyne, I observed a stratum of foliated limestone inclosed in the micaceous shistus, which is continued to this from Portfooy. We here observed a beautiful wooded dell, with a small river running thro' it, extending below the bridge, and we were told that it continued to the sea-shore. As it is in these places that good sections of the strata are often to be observed, we forsook the high road, and walked thro' it. At a little distance from the entrance, I again observed the limestone cropping thro' the strata of micaceous shistus; and, farther down, our attention was arrested by the extensive ruins of the castle of Boyne, which is situated upon one side of the dell, and richly surrounded with wood. We continued our walk, and soon reached the opening of the dell, upon the sea-shore, where we observed considerable quarries of the primitive limestone. From this to Banff, we walked along the sea-shore, which is low and rocky; and the strata, as far as I recollect, are principally composed of micaceous shistus, which passes, on one hand, to ardesia, and, on the other, to talcaceous shistus, and

and sometimes it is to be observed alternating with hornblende rock †.

Banff is pleasantly situated upon the side of a hill, which declines towards the sea-shore. It has a harbour, which is protected by a good pier. The whole town has a neat appearance; and the bustle of industry formed a striking contrast with the other towns we had passed thro'.

We intended to have continued our journey along the coast towards Peterhead; but, the weather being fine, we were desirous to reach Aberdeen, so that I might examine the granite, and its connection with the other strata. We therefore changed our route, and took the road to Turreff, which we reached before the close of the evening. The strata are, all the way, of primary formation, and principally of micaceous schistus and ardesia.

Having rested all night at Turreff, we left it early in the morning; but unluckily a thick fog was spread all around,  
and

† I have to regret the loss, both of the notes, and of the specimens which illustrate this part of my journey; so that what I here write is from memory.

and soon the rain began to pour upon us, and continued without intermission the whole day. We reached Aberdeen in the afternoon, drenched with rain, and much fatigued with our journey. The strata are, all the way, of primary formation, and similar to those I observed between Banff and Turreff.

We remained here several days, expecting the weather to moderate, so that I might have an opportunity of examining the structure and nature of the strata for five or six miles around the city, and thus to acquire a knowledge of the position and different appearances of the granite. In the meantime, I examined the granite which is in the neighbourhood of the town, and observed, in the bed of the river Don, that it is covered by micaceous schistus, and that it seemed to be disposed in great strata, or beds. It has very often crystals of hornblende intermixed with the felspar and quartz.

As the weather still continued stormy, we were obliged to defer the examination of this country until another season. Having taken leave of our friends, to whose kind attention we had been so much indebted during our stay at Aberdeen, we set out for the banks of the Forth.

The primary strata of micaceous schistus continues for two  
or



or three miles after leaving the town; when it is succeeded by red-coloured argillaceous sandstone, and sandstone breccia.

At Stonehaven, which is about 14 miles from Aberdeen, we observed the ruins of the castle of Dunotter, situated upon a rock of breccia.

From this, by Montrose, Dundee, through a fine country called the Carse of Gowrie, to Perth; and from that, by Cupar in Fife, to the banks of the Forth; the whole strata are of secondary formation, and belong either to the transition or stratified rocks.



*Plan of the Strata near Portsoy Harbour.*

The first part of the report is devoted to a general description of the country, and to a statement of the progress of the survey. It is followed by a detailed description of the various localities visited, and of the results of the observations made at each. The report concludes with a summary of the principal facts observed, and a list of the names of the various localities.



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# I N D E X.

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