MINERALOGY

OF THE

SCOTTISH ISLES;

WITH

MINERALOGICAL OBSERVATIONS

MADE IN A *TOUR* THROUGH DIFFERENT PARTS OF

THE MAINLAND OF SCOTLAND,

AND

DISSERTATIONS

UPON

PEAT AND KELP.

IN TWO VOLUMES.

Illustrated with Maps and Plates.

BY

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OF JENA IN SAXONY, &c.

Observationes veras, quam ingeniosissimas fictiones sequi præstat; Naturæ mysteria potius indagare quam divinare.

BERG. De Form. Crystallor.

VOL. I.

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1800.

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 TETIMONY OF THE GREAT REGARD AND ESTEEM

OF HIS MUCH OBLIGED PUPIL,

AND OBEDIENT

HUMBLE SERVANT,

THE AUTHOR.

SHERIFF-BRAE, LEITH,
20. JULY, 1800.

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

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

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 moſt 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

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VOLUME I.

CHAP.

INTRO-

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.

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

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, (Urgeburge); the Tranſition, (Ubergangsgeburge); the Stratified, which comprehends what are called the ſecondary ſtrata, (Flotzgeburge); 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. Humbold 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 ſhiſtus, ardeſia, ſienite, porphyry, primitive limeſtone, primitive greenſtone, greenſtone ſhiſtus, 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 flotzgeburge. The

TRANSITION, OR UBERGANGSGEBURGE

comprehend all thoſe rocks, the lowermoſt ſtrata of which contain few or no petrifactions; in the higher they are more abundant; but only petrifactions, 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 (flotzgeburge) rock. The ſtrata of this formation are the following: grawacken, grawacken ſlate, ſandſtone, ſome ſpecies of ardeſia, greenſtone, mandelſtone, limeſtone, and Dr Reuſs conjectures that ſome ſpecies of ſienite and porphyry * may belong to this claſs of rocks. The

STRATIFIED (*Flotzegeburge*)

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

* Mineralogiſche Geographie von Bohmen, 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, vocanic 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

PRI-

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 Roſs, 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, gneiſs, 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, Raſay, 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 ſhiſtus is the prevalent rock. Upon the eaſt coaſt it is frequent among the other primary ſtrata. It alternates with ſhiſtoſe 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 ſhiſtus. 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 it 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 Ailſa; it alſo forms part of the iſland of Arran, and the lofty Cullin moutains in the iſland of Skye.

Por-

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 Glamoſcard in Skye, ſeems to be of primitive formation.

Primitive Limestone, or Marble. This rock 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 Portſoy, where it is in vertical ſtrata and alternates with talcaceous ſhiſtus 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, Portſoy, there are great vertical ſtrata of ſerpentine alternating with marble, talcaceous, and hornblende ſhiſtus.

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 ſhiſtus. 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 ſhiſtus and hornblende ſlate. In Caithneſs the mountain of Scaraban is compoſed of quartz; and at Portſoy there is a hill which affords ſhiſtoſe 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 irreconcileable 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 Glamoſcard 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, *(Ubergangſgeburge.)*

Graw'acken. This is a rare rock in the diſtricts through which I paſſed. The only appearance I ever noticed was a ſmall portion lying on ardeſia 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, *(Flotzgeburge.)*

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 ſouth extremities of Bute and Arran; and it alſo appears in the iſlands of Seil, Mull, Eigg, Skye, Raſay 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,

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 ſhiſtus, 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 ſtotz 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.

VOL-

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 Dyſart and Eaſter Wemyſs I picked up ſeveral fine ſpecimens of porcellanite, which ſeems to be the clay that accompanies the coal altered by fire, as maſſes of ſcoriæ and charcoal ſtill adhered to it.

MINERALOGY

OF THE

SCOTTISH ISLES.

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,

 however,

however, theſe moſſes 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, wacken, 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 continues

* 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 rout, 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 ſhiſtus, 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 Gouroch 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 ſhiſtus, 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.

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.

CHAP.

CHAP. II.

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

PREHNITE—*Friſky-Hall.*

Silex Prehnites, Wern. *Halb Zeolith*, Eſthner. *Bostrichites*, 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.

 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, ſiliceous zeolith, cape-chryſolith, emerald, praſe, and cryſopraſe:—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 cri- "ſtal 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.

‡ Th orie de la Terre, tom. 2de, p. 308.

SIENITE—*Craig of Ailsa.*

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.

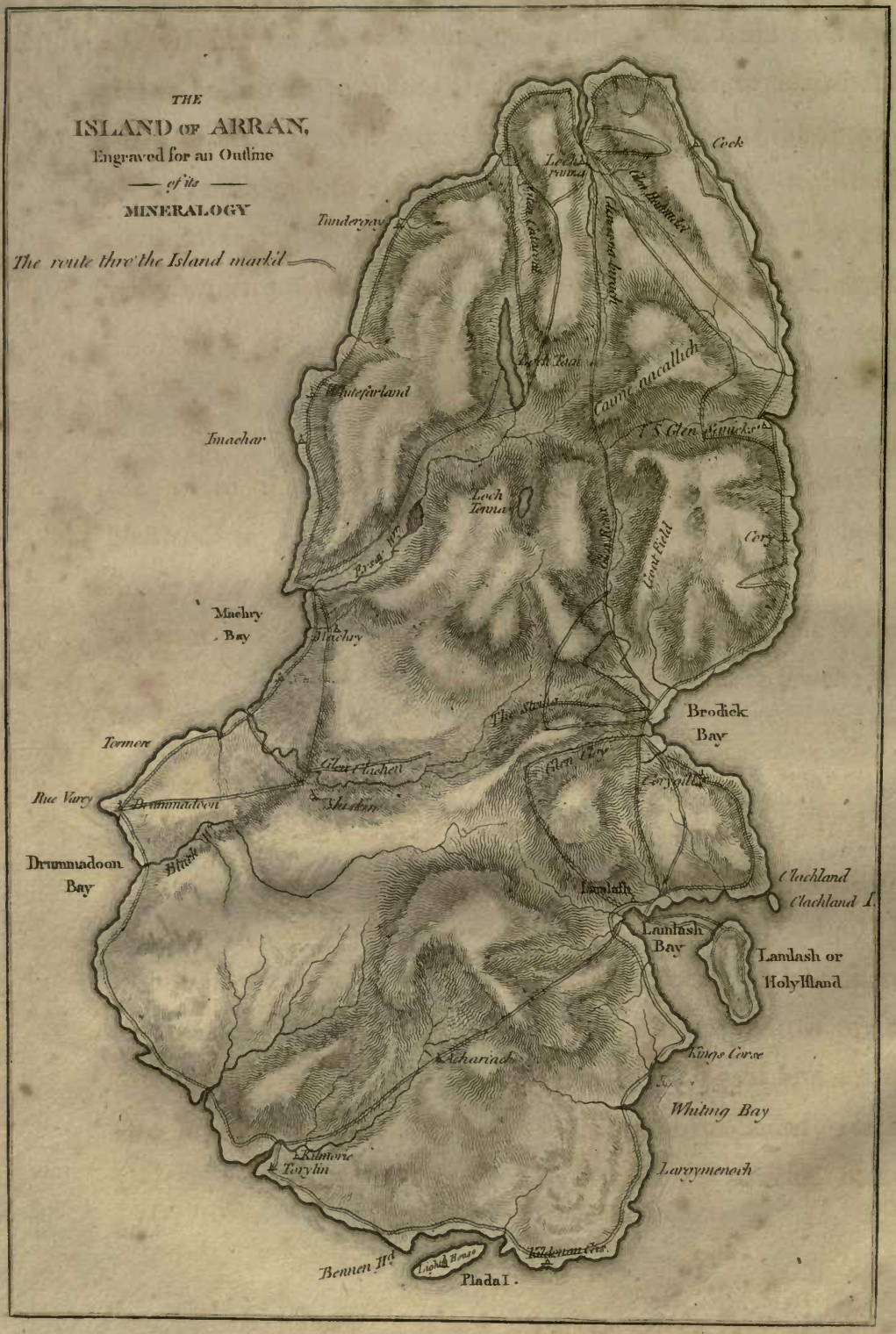
ARRAN.

CHAP. 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.

THIS 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


THE
ISLAND OF ARRAN,
Engraved for an Outline
— of its —
MINERALOGY
The route thro' the Island marked
Cock
Tunderagay
Imachar
Machry Bay
Machry
Brodick Bay
Glen Cloy
Corrygill
Drumadoon
Drumadoon Bay
Clachland
Clachland I.
Lamlash
Lamlash Bay
Lamlash or Holy Island
Kings Corse
Whiting Bay
Kilmore
Torrylin
Largymenoch
Bennen Hd
Pladal.

tervening 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 Glenſhirreg, 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-

 ſtone

* M. de C. Laſſone 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° to 15°. 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 "petrifaction, 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 Lamlaſh 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 Lamlaſh 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 appearence 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 accummulated 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-porphyry. 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 all

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

all around, I am inclined to believe that it reſts on the ſand-ſtone. In deſcending from this porphyry hill towards Lamlaſh, 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 Lamlaſh 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 ſand-ſtone, 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 bowlder 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.

Reuſs, 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 Reuſs. 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

intermediate between wacken-clay and wacken; laſtly, the middle of the vein is baſalt. The other vein has argillaceous iron-ſtone 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 Reuſs, vol. 2.

a clay-porphyry is to be obſerved; and upon the brow of the hill, where the rains, &c. have broken down the porphyry, ſeveral curious phenomena appear. In the firſt place, I obſerved the porphyry 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-porphyry; 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 porphyry, 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°. 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 Shiſkin, 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, *cæteris 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 determine

† 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 Glenroſa. 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-porphyry, 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 ſhiſtus 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 Glenroſa, it is extremely ſteep, which is owing in a great meaſure to the want of micaceous ſhiſtus 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 ſhiſtus, 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 ſhiſtus 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

aptheſs 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 meritent d'etre 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

 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 Iſla, 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°. 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 ſhiſtus 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 ſhiſtus. Amongſt the debris of the micaceous ſhiſtus 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 Sauſſure. 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 pretendu de ſa- " vans naturaliſtes. J'ai parcouru une grande quantité de ter- " reins primitifs, et je n'y ai jamais vu de couches. Quelque- " fois on appercoit des maſſes aſſez conſiderables de granites, " ayant une figure preſque rhomboidale, ſuperposés les uns " ſur les autres. Mais on ne ſauroit regarder ces ſuperpoſi- " tions pour des couches, puiſqu'elles n'ont rien de regulier, " et que ces maſſes, preſque rhomboidales, ne ſe rencontrent " que très rarement. Le plus ſouvent ces granites ſont fen- " dues, en differens ſens. Ces fiſſures ſe correſpondent

" quelque-

" quelquefois; ce qu'on prendroit, au prémier coup-d'œil, " pour des éſpèces de couches; mais un éxamèn plus appro- " fondi en fait bientôt reconnoitre la difference †." 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 celebrated 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 intereſting and elegant volumes. Reuſs, in his mineralogical geography of Bohemia, has detailed minutely many ſimilar appearances; and my learned friend Dr. Mitchell informs me, that the Reiſenbergs, a chain of mountains which ſeparate Sileſia 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 ſo ſunk 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 Sauſſure, in a late communication to the Bibliotheque 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,

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 pierre graphic 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 Bibliotheque Britannique, (vol. 8. p. 78.) it proved alſo to be a production of Corſica.

reſembling the veined granite of M. Sauſſure; 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 Sauſſure, 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 gneiſs *; Mr. Roſter found between Ellbogen and Schlackenwalde, in Bohemia, a great-grained granite †; and Mr. Sauſſure obſerved a maſs of granite which contained an oval piece of gneiſs ‡. Mr. Werner reckons his ſpecimen a proof that the gneiſs is of earlier formation than the granite; in other words, that the pieces of gneiſs have been broken off a ſtratum which was depoſited before the granite. Mr. Sauſſure, however, is of an oppoſite opinion: he is inclined to believe that theſe pieces of granite or gneiſs 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

* Werner, Kurze Klaſſification 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 *. Sauſſure, ſpeaking of this kind of decompoſition, remarks:

* Granite decompoſes in concentric layers.——Charpentier Mineralogiſche Geographie der Churſachſichen 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 ſuperieure.
" 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 exterieur, et qu'elles acquierent à l'air un degré de
" dureté ſenſible. Il ſuit de-là, que la partie exterieure, 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'interieur
" de la meme aſſiſe conſerve un certain degré de molleſſe. Et
" tant que les aſſiſes inferieures demeurent un peu molles, le
" poids enorme de toutes celles qui repoſent ſur elles doit à la
" longue les comprimer. Mais les parties exterieures, durcies
" par le contact de l'air, ne ſont pas ſuſceptibles de la meme
" compreſſion. Elles doivent donc s'en ſeparer, et former ainſi
" les exfoliations que l'on obſerve *."

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

CHAP. IV.

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

PITCHSTONE.

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

PITCHSTONE *from Lamlaſh 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° of Wedgewood's ſcale, it becomes black, is much rent, and internally a little porous; at 55° it had formed a porous enamel; and at 70° 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 ſlaty.

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° it intumeſced a little; its colour was ſlightly altered; the ſurface glazed, and, internally, porous. At 31°, intumeſced conſiderably, and ſoftened. It had then, externally, a browniſh glazed covering; internally, colour is grey, and very porous. At 65° it had intumeſced very much; forming an externally cavernous, yellowiſh-brown coloured maſs. At 100° 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, ſlaty; and the ſlates 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.

OBSER-

* Mr. Kirwan has found ſeveral pitchſtones to contain inflammable matter. *Kirwan's Mineralogy.*

OBSERVATIONS.

When pitchſtone was firſt diſcovered, it was believed by mineralogiſts to be the lapis obſidianus of Pliny *: its reſiny 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

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

† Newes 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.

† Bermanniſches 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 Wedgewood's ſcale *. Mr. Kirwan, who has made many experiments on their fuſibility, found that the moſt fuſible formed an enamel at 130° of Wedgewood; but in general were far more refractory, ſome remaining unchanged at 160° †. 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

* Journal Polytechnic.

† Elements of Mineralogy. Vol. 1. 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.

BASALT.

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. 1. § 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°.

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°. This fuſibility diſtinguiſhes it from the ſpecies of baſalt examined by Mr. Kirwan. He found them fuſible from 120° to 130°; and the figurate trap, or columnar trap, melted at 100°.

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-porphyry and greenſtone, and theſe he finds to contain a ſmall portion of ſoda

ſoda 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.

SIENITE.

Sienites, Marmor. *Pyropoecilus*, Plin. et Al. *Syenites*, Dr. Walker's Claſſ. Foſſil. *Granites Sienites*, Gmelin. Syſt. 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. Felſpar; reddiſh.
   Hornblende; green, and ſometimes black.
   Quartz; white, and ſometimes brown.

This ſpecies is more or leſs compact, and is ſometimes ſhiſtoſe.

2. Hornblende; green.
   Quartz.
   Felſpar.

This aggregate, which is almoſt entirely compoſed of hornblende, has the following characters:—

Colour. Dark leek-gren.

Luſtre. A number of ſhining points diſperſed through the the maſs, owing to the hornblende.

Tranſparency. None.

Hardneſs. Gives fire with ſteel, but not very plentifully. —Leaves a grey trace. It is difficultly diſtinguiſhable from many ſpecies of baſalt, and is often intermixed with patches of the firſt ſpecies.

3. Quartz.
   Felſpar.
   Hornblende.

This ſpecies, owing to the great proportion of quartz, has much the appearance of a ſandſtone.

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.

OBSERVATIONS.

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

Quartz—Is of various colours, white, yellow, or ſmoke; 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-porphyry; 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.

Fracture. In the gross, slaty; 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. *Grani es durus*, Cronſted. *Saxum quartzo, ſpato ſcintillante et mica in diverſa proportione mixtis, compoſitum;* Waller, Syſt. Miner. vol. i. p. 407.

The granite of this iſland is, in general, pretty compact; of a whitiſh-brown colour, owing to the ſlight-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 hexahædral 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° 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 ſeamed 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-

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 *.

BRECCIA.

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

 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 paliopetre. 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.

ARRAN.

CHAP. V.

Cory; Cock of Arran; and Loch-Ranza.

HAVING 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 criſtæ. 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°, 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 ſtratulæ, 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 bowlder 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 ſhiſtus, 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 in other countries; thus in Bergm. Erde-Beſch. 182, we are told that in the mountains of Quediliæ and Portfiællet 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 Caime-na-caillich; 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 ſteril and tremendous ſcene.

In

——— 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 ſhiſtus 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 ſhiſtus in immediate contact with the granite. The ſhiſtus 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 cloathed 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 †.

* 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.

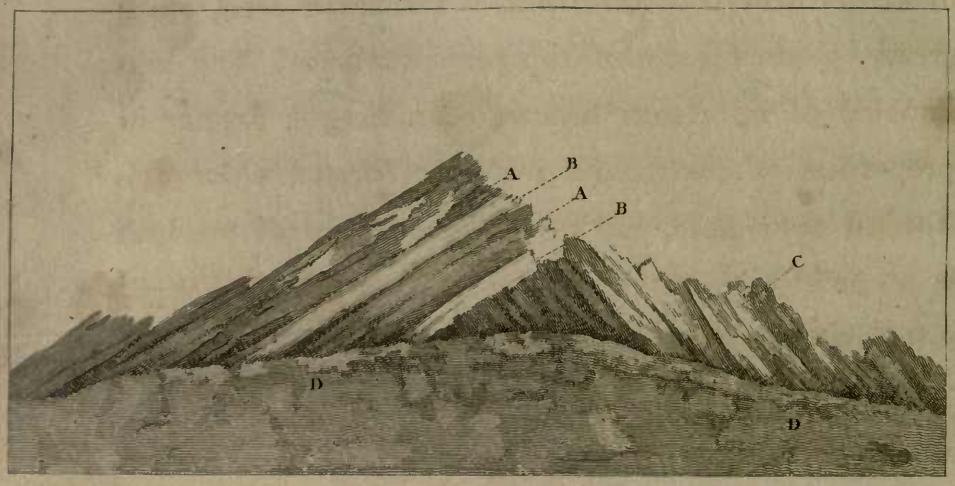
From this ſtratum to the Cock, which is the moſt northern point of the iſland, the ſhore is covered with immenſe maſſes of ſandſtone and breccia, which have tumbled from the neighbouring hills by the action of the weather. Ironſtone is found ſcattered upon the ſhore, and is probably connected with the 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 ſhistus, upon which it rests. Here, however, the ſandstone diſappears, and the micaceous ſhistus 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 ſhistus. 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 ſhistus. 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° and dips to the S. E.; the ſecondary ſtrata, are inclined at an angle of 45°, 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. Sauſſure 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.

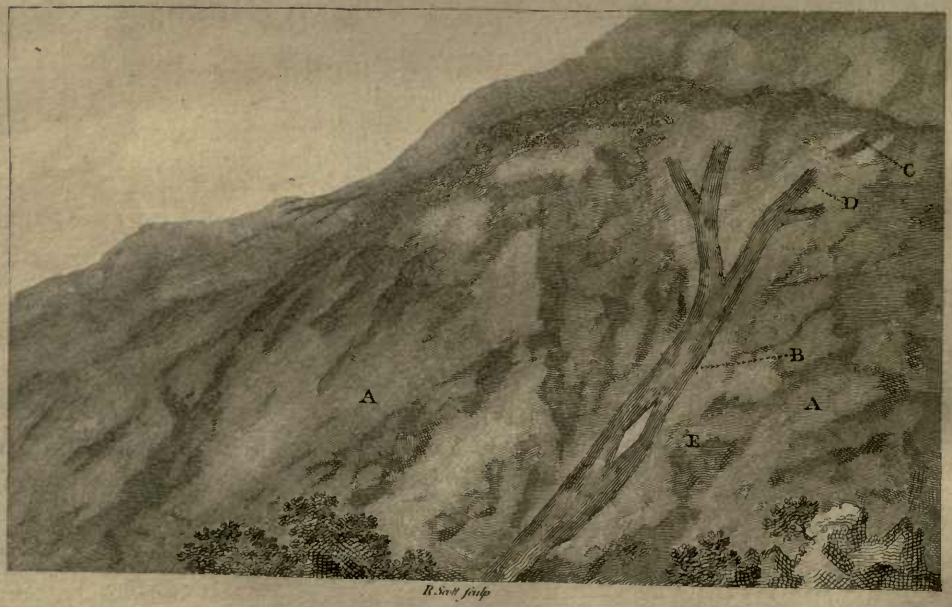
Glen-Ranza. This glen is about two miles long, and half a mile broad, running nearly north and ſouth, bounded on both ſides by lofty round-backed mountains, that riſe at a very conſiderable angle, and are nearly of the ſame height on both ſides of the glen. The inclination of the oppoſite mountains is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



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 ſhiſtus, 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 ſhiſtus, bounded by the ſtrata of micaceous ſhiſtus.

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 ſhiſtus, which lie upon the granite. The granite and ſhiſtus are often intermixed at their junction, and ſometimes ſmall granite veins are to be obſerved iſſuing from the maſſive granite, and traverſing the ſhiſtus. 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 ſhiſtus 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

 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-na-callich, 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 *. Sauſſure, at ſec-

* 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°; and the bottom alſo riſes, forming a conſiderable angle with the ſides. It is compoſed of various ſpecies of micaceous ſhiſtus and quartz. In ſeveral places baſalt veins may be obſerved traverſing the micaceous ſhiſtus, many hundred feet above the level of the ſea: even in the bottom of the glen, where the burn has expoſed the micaceous ſhiſtus, 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.

ARRAN.

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CHAP. 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 Brodick 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 ſlow-

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.

ARDESIA.

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, ſlaty.

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 ardeſia.

Use, &c. Several kinds of this rock, particularly the quartzy, 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 ſhiſtus.

ARRAN.

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CHAP. VII.

Glen-Catacol, Glen-Erſay, Glen-Clachan, Shiſkin, Tory-Lin, Benin-Head, Whiting Bay, Lamlaſh Bay, Lamlaſh 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 ſhiſtus, 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-Erſay, 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:

——————— A joyleſs coaſt
Around a ſtormy lake.

Yet here the grandeur and ſublimity of the ſurrounding granite mountains, envoloped 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-Erſay, and, in my way, obſerved large blocks of a beautiful dark leek-green coloured pitchſtone-porphyry, 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-

* Sauſſure 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-Erſay, 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-Erſay, when ſtrata of micaceous and talcaceous ſhiſtus 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.

† Charpentier Mineralogiſche von Churſachſen, § 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-Erſay, 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 ſhiſtus, 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 ſhiſtus. The micaceous ſhiſtus 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 ſhiſtus approaching to breccia; and here alſo the baſalt and micaceous ſhiſtus are much jumbled together, and ſome pieces of the vein are apparently inſulated in the micaceous ſhiſtus. Here, then, we have two facts; the former, the apparent tranſition from micaceous ſhiſtus to ardeſia; the other, maſſes of baſalt immerſed in the micaceous ſhiſtus, in a ſimilar manner to the baſalt I obſerved embedded in the granite upon the eaſt ſide of Glen-Roſa. 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 ſhiſtus 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-Irſa. Upon one ſide of this ſtream I obſerved primitive ſhiſtus, 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 Shiſkin; 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-porphyry 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 diſtinct 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°, dips in the ſame direction with the pitchſtone D, and has a ſimilar curve. It is not untike 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

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 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, aud 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-porphyry, 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-porphyry. 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 caves, or had been ſeparated from other veins or ſtrata. Upon the top of the cliffs, at the ſame place, I obſerved

ſerved a variegated pitchſtone, which was decompoſed, in ſome ſpecimens, almoſt to a browniſh-white earthy powder, cropping through the graſs; 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-porphyry, 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-porphyry, in others is evidently clay-porphyry. This fact is a preſumptive proof that the conjecture I have

made, with regard to the ſituation of the porphyry of Glencloy 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 Shiſkin, conſiderable cliffs now riſe before us, which are formed of clay-porphyry 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-porphyry, 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 Shiſkin 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 bowlder ſtones which cover its bottom, fragments of a light blackiſh green-coloured pitch-ſtone 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-porphyry,) 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 Lamlaſh 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 traveſed 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 ſouthern part of the iſland, is principally compoſed of ſandſtone, traverſed 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 pictureſque feature, which we have ſeldom an opportunity of obſerving 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 traverſed by baſalt veins, which are often of a great ſize.

From this to Whiting Bay, the cliffs are low, formed of ſandſtone, and traverſed 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 Lamlaſh 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 ſilex. *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

* 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 Bo-ſhe-la.

† 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 boulaſtein, found in Iceland, is a ſandſtone.—Eggert Olafsen Reiſe durch Iceland.

ſa. 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.

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

CHAP. 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.

N° II.

PITCHSTONE *paſſing to Horniſtone.*

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°, and at 118° 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° 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°

N° 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.

OBSERVATIONS.

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° 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. Reuſs informs us, that he obſerved pitchſtone paſſing, by various ſtages, to hornſtone, at Garſeback, near Meiſſen *. 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 Aufsatze, &c. von Franz. Ambros Reuſs, § 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 Drumodoon, the ſpecimens often cannot be diſtinguiſhed from what is called trap-porphyry.

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

Colour. Yellowiſh.

Luſtre. None.

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.

VEINS.

I. To 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 ſhiſtus, porphyry, ſienite, or ſandſtone.

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

STRATA.

STRATA.

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 ſhiſtus.

VIII. In examining the great glens, as Glen-Roſa, 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 horn-blende and paliopetre which is obſerved in blocks at the entrance of Glen-Roſa.

XI. In traverſing the hills of micaceous ſhiſtus, 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 ſhiſtus and ardeſia, in different parts of the iſland. In this inveſtigation it will be neceſſary to obſerve, 1. If the ſhiſtus, 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 ſhiſtus. 3. If the granite veins have the ſame grain with that of the granite of the neighbouring mountains. 4. If the granite and ſhiſtus be irregularly intermixed at their junction. 5. If the granite and ſhiſtus ever alternate

alternate with each other. This Werner conſiders as a rare appearance. I have not obſerved it in Arran. 6. If the micaceous ſhiſtus, 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 ſhiſtus being formed nearly at the ſame time.

BUTE.

BUTE.

CHAP. 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.

THIS 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 Kilmichael 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 again

gain appears at a little diſtance, and ſtill in its former direction. Maſſes of micaceous ſhiſtus are alſo to be obſerved in the midſt of the quartz vein. The appearance of a maſs of micaceous ſhiſtus, 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 ſhiſtus for the roofing of houſes;

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

and it is preferred to ſome kinds of ardeſia, from its great durability. Probably ſome ſpecies of micaceous ſhiſtus, 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-Chattan 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

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the ſouthern extremity is compoſed of the ſame rock with the Cumbray iſlands, and theſe are of the ſame rock with that of the Largs, which is on the ſouth bank of the river. Theſe facts would ſeem to indicate, that the oppoſite banks of the Clyde were at one time joined together, forming a very conſiderable extent of ſolid land. If this be admitted, (and there ſeems little doubt of its truth,) we muſt now endeavour to diſcover what means were employed to break down the land.

Philoſophers in their ſpeculations on this ſubject, have generally mentioned two agents, which they imagine have produced theſe ſtriking and awful phenomena; theſe are the waves of the ocean, and earthquakes. The firſt opinion has been ſtrenuouſly contended for by the late Dr. Hutton, who affirms, that all bays, peninſulas, iſlands, &c. have been formed by the long continued action of the waves of the ocean. This ſpeculation at firſt ſight ſeems very plauſible, but a more attentive conſideration diſcovers 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 ſame to day, as in the time of the Romans. The iſthmus of Corinth has not been viſibly altered for upwards of 2000 years. Scylla, of which Homer has given a correct deſcription, is now nearly in the

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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 travells through Sicily, vol. 4. p. 172.

‡ Maundrell's travells 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 inſtances; 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 reaſoning, 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 mountanious 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 tremenduous earthquake. In 1678, there

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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. 221.—Kirwan's Geological Eſſays, p. 500.

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 ſhiſtus, 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 Iſla 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 ſhiſtus 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 ſhiſtus, in ſome places alternating with conſiderable ſtrata of hornblende rock, and traverſed by baſaltic veins: and

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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-Kiliſled. The rocks are, all the way, of micaceous ſhiſtus, 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

‡ Journal des Mines, No. 3. p. 119.

mica might be found. At the head of Loch-Kiliſled 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 tedioufneſs 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, ſteril mountains of the mainland, riſing into various rugged forms, and intermixed with lochs, thus preſenting a wild and defolate 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 Kiliſled to this place, ſeem to be principally micaceous ſhiſtus, frequently paſſing to talcaceous ſhiſtus.

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 Iſla, 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 Iſla, and then of Jura.

ISLA AND JURA.

CHAP. X.

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

ISLA.

THIS iſland is thirty-two miles long, and, in ſome places, nearly as broad. It is the moſt ſouthern of the Ębudæ, 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

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 ſteril 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 moſs 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 Garthsneſs, 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 Loſſit 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 Gange.

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 Garthsneſs. 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

† 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 Marsala, 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 ſound of Iſla. Here the cliffs are low, and compoſed of compact micaceous ſhiſtus; 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 ſhiſtus 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 ſhiſtus, 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 conſider

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

† Obſervations ſur les Montagnes, 4to. Peterſburgh.

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 ſhiſtus, &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°; 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 ſtates 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 ſhiſtus appear; and here the hills riſe to a conſiderable height, being compoſed of micaceous ſhiſtus 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 ſhiſtus; 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 ſhiſtus, we have now ſtrata of ardeſia, chlorite-ſlate, hornblende rock *; and theſe

* Theſe Mr Mill includes under the name of Hornſtone.

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 Loch-laggan, 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

* 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 ſhiſtus, 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 ſhiſtus, 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,

* 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,

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 Sauſſure 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 ſhiſtus appears.

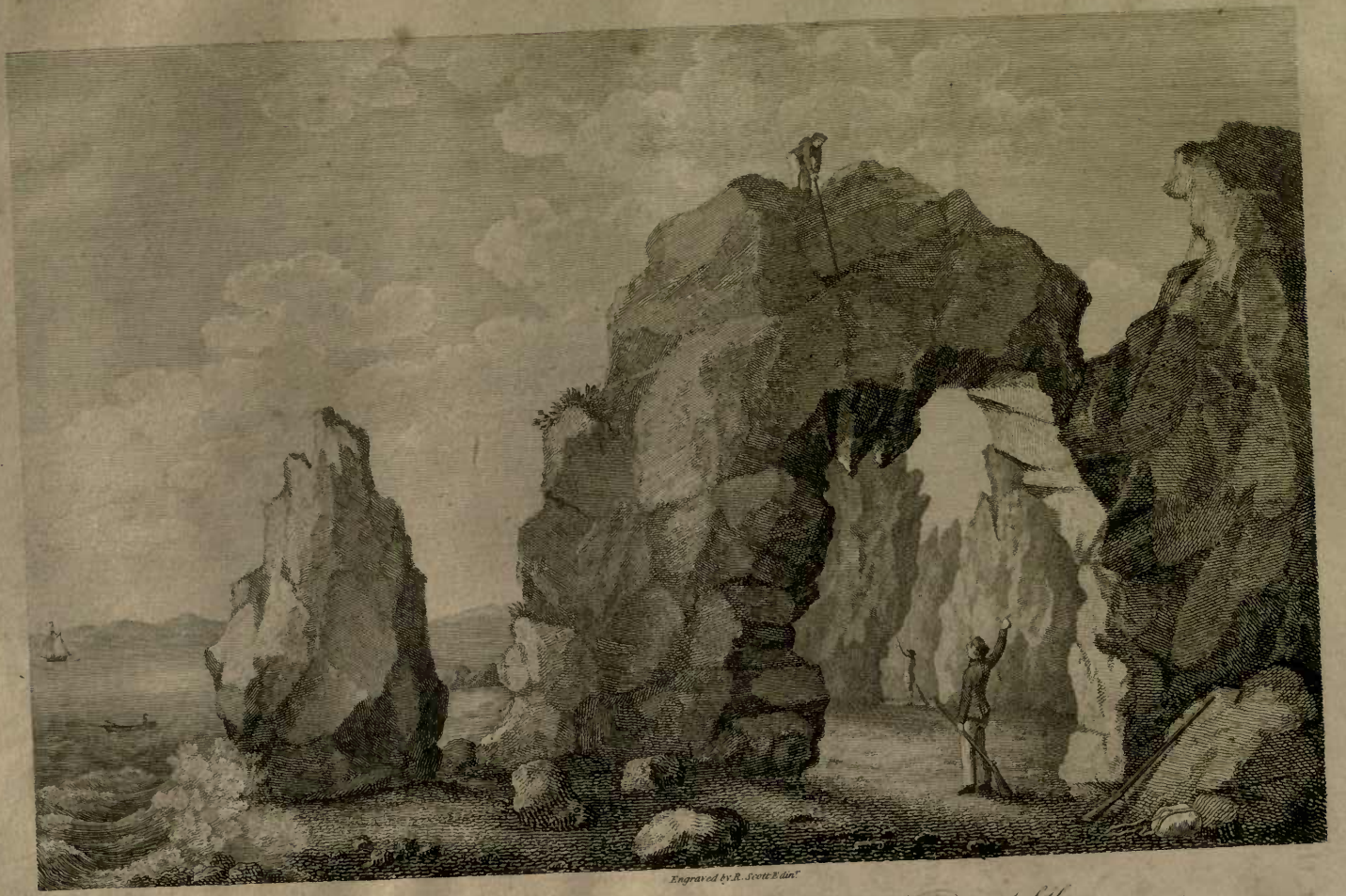
JURA.

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.r

CAVES *on the* WEST COAST *of the* ISLAND *of* JURA.



Engraved by R. Scott Edin.r

View of a PERFORATED BASALTIC VEIN *N.W.r coast of the* ISLAND OF JURA.

ſhelter to the deer and goats that browze 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°; 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 quartzy 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 ſmalt, and different kinds of porcelain, in the place of powdered quartz, or flint.

Many baſaltic veins are to be ſeen traverſing theſe quartzy 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

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-chaolois, 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 Oranſay 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°, 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 cotemperaneous formation with ardeſia *, micaceous ſhiſtus †, and gneiſs ‡; 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-

* Reuſs Mineralogiſche Geographie von Bohmen, B. 2. 186.

† Journal de Phyſique. New ſeries, vol. 1.

‡ Emmerling's Mineralogie, B. 3.

nite had been precipitated, ſtill a ſmall portion remained in ſolution; and was afterwards depoſited along with the gneiſs, 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 Sauſſure, 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 Palaſſo, La Peyrouſe, and Carbonieres in the Pyrenees; by Reuſs 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 ſhiſtus, alternating with rocks intermediate between talcaceous ſhiſtus 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 cryſtalized 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 ſhiſtus; and between the ſtrata we obſerved layers of beautiful hornſtone.

at length find the granular quartz rising from under the micaceous shistus, at an angle of 45°, 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 shistus; this is only true in part, as we sometimes observe the micaceous shistus 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 Rossshire*: 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 Brainsdorf, in Saxony, granular quartz has been observed passing into micaceous shistus. 2 Crell. Beytr. 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 Reuſs.—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 ardeſia, 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 ardeſia tegularis. At one place the ardeſia 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.

ISLA AND JURA.

CHAP. 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. COM-

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 ſhiſtoſe in the groſs.

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 quartzy 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, ſlaty; 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, Eſthner'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 ſhiſtus, 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 Scheifer*, *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 petrifactions; 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 ſiliceous matter, tranſmits a little light at the edges.

Fracture. Fine ſplintery.

Hardneſs. Yields with difficulty to the knife; and, when penetrated with ſiliceous 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 ſlaty; 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 Reuſs,

Reuſs †, 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.

SEIB.

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

SEIL, EASDALE AND OBAN.

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 ſhiſtus 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 ſhiſtoſe 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

SEIL.

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

* 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 ſhiſtus 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 (uebergangsgeburge) and flotz rocks (flotzgeburge). 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

* Emmerling, Band. 3. § 105.

iſland oppoſite to Eaſdale, we have an appearance of flotz ſtrata. Immediately upon the ſhore, I obſerved red-coloured argillaceous ſandſtone, ſtratified with ſandſtone breccia and baſalt, and the whole traverſed with baſaltic veins. There are alſo quarries of ardeſia tegularis in ſome parts of the iſland. But the principal attention of the proprietors is turned to the iſland of Eaſdale, where the ſlate has hitherto been found in great quantity.

EASDALE.

THIS iſland is about half a mile long, and of the ſame breadth, and is celebrated for its having afforded the beſt and greateſt quantity of ardeſia tegularis, of any part, of equal extent, in Great Britain. A very conſiderable portion of the iſland is compoſed of ardeſia tegularis, and this is traverſed by baſalt veins. The ardeſia, where in contact with the baſalt, is uſeleſs, being ſhivery, and breaking into ſmall pieces, unfit for the making of ſlates: it is alſo equally bad, where veins of quartz or limeſtone occur.

The

The iſland is now cut very low, excepting a ſmall portion at the ſouth end; and levels have been made out to the ſea, to carry off the rain water. As the greater part of the iſland is now upon a level with the ſea, it is plain that the raiſing of ſlates muſt be abandoned, or continue to be worked at a conſiderable expence by means of machinery; which would probably be a bad plan, when we conſider the extent and excellence of the rival quarries at Ballyhuliſh ‡. The moſt judicious arrangement would certainly be, to open more extenſive quarries in the neighbouring iſles of Luing and Seil, where, in all probability, after the ground is properly cleared, good ſlates may be found.

The ardeſia in this iſland was firſt quarried about one hundred years ago; but was for a long time of little importance, as ſandſtone flag and tiles were generally uſed for roofing houſes. As the uſe of ſlates became more prevalent, the quarries were enlarged; and the preſent managers having obtained a very favourable leaſe, theſe quarries have been wrought to ſo great an extent, that 5,000,000 ſlates are annually ſhipped from this iſland. The number of workmen is at preſent about 300; and

‡ The quarries at Ballyhuliſh employ about 200 men; and the ſlates are ſent to Leith, Clyde, England, Ireland, and America.

they are divided into quarriers and day labourers. The quarriers are paid annually at a certain rate for every thouſand ſlates: 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.

OBAN.

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. Caddell.

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 erruptions "in which water heated to the higheſt degree of ebullition, enters into concourſe 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 cur-
" rents. 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 ſhiſtus of a whitiſh colour, and others which
" were greeniſh, with a porous texture. Theſe ſhiſtus, or
" gneiſs, are compoſed of quartz, ſteatites, and ſmall ſcales of
" mica.

" Near the rock of micaceous ſhiſtus, there is found com-
" mon ſlate of a deep grey colour, approaching to black; the
" beds of which are almoſt even with the ground; quar-
" ries might eaſily be opened here with great advantage to
" the country. They would even become an object of com-
" merce. 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 (uebergangsgeburge). From the greater part of the iſland 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.

M U L L.

CHAP. XIII.

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

THIS 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 Roſs.

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 Skriddan, 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 occurence 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 va-

rioufly

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 reverſing 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°.

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 ſound 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 Achnacroſh, 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

baſaltic hills,) I obſerved numerous blocks of granite, ſimilar to thoſe upon the hill near Achnacraig. Theſe blocks ſeem to be derived from a baſalt tuff ſimilar to that obſerved near Achnacraig; and it is probable that ſuch a rock may be diſcovered in the neighbouring hills. It will be an object worthy the attention of future travellers, to aſcertain, whether this baſalt tuff merely covers the baſalt, as has been obſerved by Reuſs in the mountains of Bohemia, or alternates, as is the caſe with the baſalt tuff in the iſle of Canna, and in other parts of Scotland. It matters not in which of theſe ſituations it be found: it is ſtill to be conſidered as a ſecondary rock, and, like theſe, to have been depoſited from an aqueous fluid. Probably ſome may think that theſe maſſes have been ſeparated from the decompoſing baſalt itſelf, as it ſometimes contains pieces of granite. This, however, is an appearance ſo rarely to be obſerved in this iſland, that I can hardly imagine the granite blocks to be derived from that ſource.

Profeſſor St. Fond has ſpeculated upon this ſubject, as he obſerved ſimilar appearances in different parts of the iſland. For the information of my readers, I will extract the following paſſage from his Travels. "Theſe lumps of granite (ſays he) may have been "ejected from granite quarries, which perhaps exiſted 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, ſituated

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 ſhiſtus, 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 blaes (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 ſand-ſtone 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 Reuſs, coals inlaid in baſalt are worked †; in the Faroe iſlands, coal is found in ſtrata among baſalt ‡: at Meiſſen, in Heſſia, 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 in- " durated marle 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 gra- " nite; 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 Buneſan 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 occurence in baſalt. Emmerling. B 3. § 187.

We now left Artown, and walked on to Buneſan; 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 ſhiſtus. I endeavoured, as far as my ſhort time would allow me, to diſcocover 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 ſhiſtus. 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 ſhiſtus, 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

The micaceous ſhiſtus extends quite acroſs this part of the iſland; and continues for about a mile after we leave Buneſan, 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 ſhiſtus 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 Roſs, 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 Reuſs, 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 ſouth ſide of Roſs continues to be formed of granite and micaceous ſhiſtus, until we come upon a line with Buneſan, 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 centrical 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 chalcedony. 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.

M U L L.

CHAP. 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.

Fracture. Perfectly ſlaty.

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?—*Achnacroſh.*

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 tegmen 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 Petroſilex. La Metherie, who ſeems of the ſame opinion, denominates the true hornſtone of the Germans Keratite, and agrees with Dolomieu in applying the term Petroſilex to this foſſil ‡. I am, however, ſtill inclined to think, that it will be more correct to uſe the terms hornſtone and petroſilex in the ſignification as adopted by Werner; and that the petroſilex 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 Reuſs † 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.

† Reuſs, Aufzatze, § 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 Deriabin 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.

‡ 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.

ON COAL.

CHAP. XV.

Method of diſcovering COAL.

AFTER 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 iron-ſtone 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 ſoot-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 ſooty 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

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;

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.

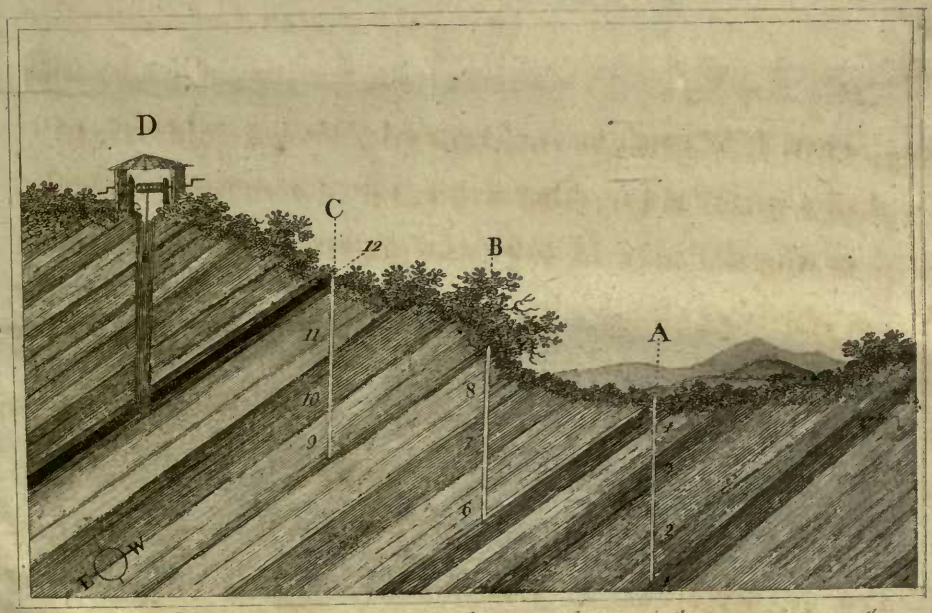
The quality of the coal is aſcertained from the following circumſtances:

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 nd aſhes.



Plan illustrating the method of boring for Coal

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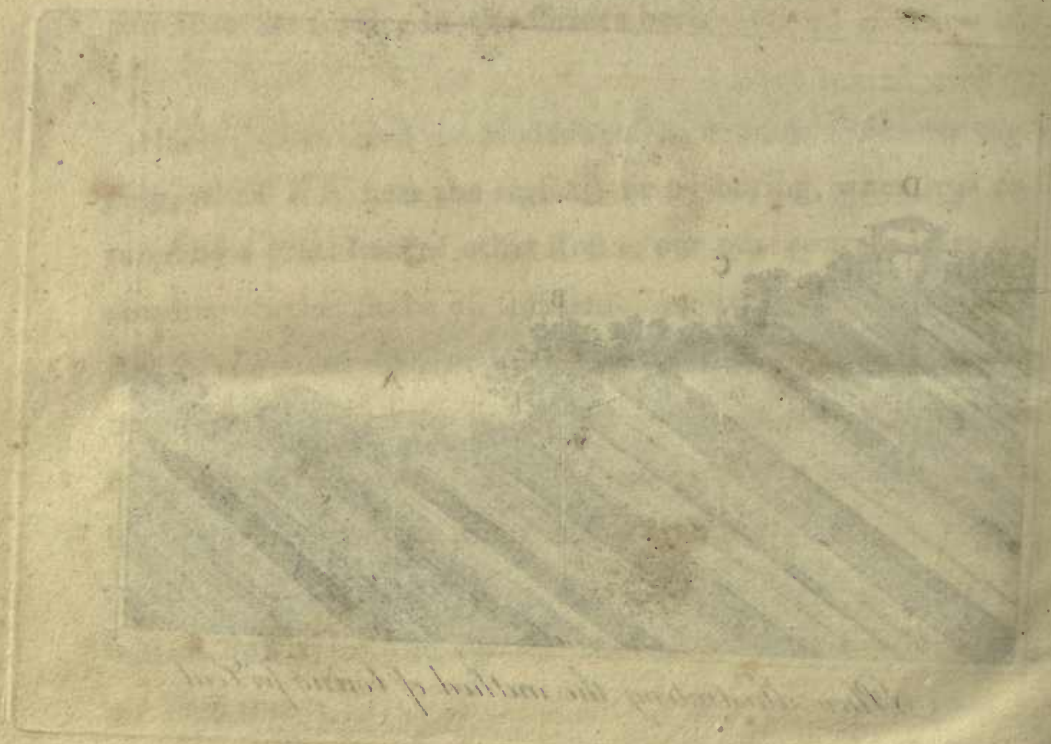

Storage