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OUTLINES

OF

MINERALOGY.

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VOL. I.

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TO THE REVEREND

THE DEAN

OF

WESTMINSTER.

My Dear Sir,

I may well feel desirous of expressing my obligations to One, from whom under Providence I ultimately derive most of the comforts of my present life.

To your kindness, joined with that of a relation now no more, I owe the inestimable blessing of a liberal education. To your favourable testimony I also owe my connexion with the University to which I have the happiness of belonging; and by which I have been honoured with the appointment that has led to the present publication.

To you therefore, yet not unmindful of what I owe to others, I have desired to dedicate this offering, however unworthy in itself; satisfied that you will measure my gratitude by a fairer standard than its merits.

I am,

My dear Sir,

With the sincerest respect,

Your most obliged and affectionate Friend,

J. KIDD.

Oxford,

Jan. 16, 1809.

PRÉFACE.

It has been my object in the following publication to give as concise yet comprehensive a view as possible of the general history of Mineralogy. Others must judge whether the plan which I have adopted is calculated to attain that end: but I trust that the end itself is desirable.

From the nature of the subject but little original information can be expected in an elementary treatise: and therefore, although I have purposely avoided making many immediate references, it would be easily understood that much has been borrowed from other works. The authors from whom I have derived the most general assistance are the Abbé Haüy and M. Brongniart: the first of whom gives the most systematic and clear account of minerals I have yet met with; the last, the most comprehensive: particular sources of information I have acknowledged as the opportunity afforded.

The division of the subject is comprehended under four general heads, which treat respectively of Earthy, Saline, Inflammable, and Metallic Substances; in the order observed by Mr. Kirwan in his Elements of Mineralogy. To these is added an Appendix, containing an account of several compound rocks &c.; which, though they are properly classed under the head of earthy substances, seem to admit of a separate consideration.

In the arrangement of individual minerals I have occasionally deviated from the plan adopted by Mr. Kirwan; either in consequence of subsequent improvements in the science, or because I have thought the order of the subject required it.

Thus, in consequence of the discovery that the jargon together with the hyacinth, and the emerald together with the beryll, contain respectively a new earth; those minerals have been removed from the siliceous genus of Mr. Kirwan, and classed under the head of that earth to which they properly belong: the two first, under zircone; the two last under glucine: and these earths, for a reason to be mentioned presently, have been placed between magnesia and alumine.

The sapphire and its varieties, the spinell ruby, and the topaz, have also been removed from the siliceous genus and placed under the head of alumine, or the argillaceous genus of Mr. Kirwan; because that earth is now known to be the principal constituent part of those minerals.

For a similar reason the chrysolite has been transferred from the siliceous to the magnesian genus.

The garnet ought perhaps to have remained among the siliceous compounds: but, as it will be seen by the foregoing alterations that all those substances which are ranked among the precious stones are thus brought together, I have taken the liberty of subjoining the garnet as being the only precious stone that remained.

Felspar, which has also been removed from the siliceous compounds, has been placed under the argillaceous; because it appears certain that many natural varieties of clay are derived from the disintegration of that mineral.

In the arrangement of saline and metallic substances no alteration of any importance has been made: but many of the former have been omitted.

In the third division, which treats of inflammables, all but the four first substances seem to be connected with each other by a natural series, and may be subdivided into three classes; the first comprehending the various forms of imperfectly mineralized vegetable matter; the second, the different varieties of coal; the third, bituminous substances: they are arranged in nearly an opposite order to that adopted by

Mr. Kirwan; because this arrangement seemed best calculated to elucidate the natural connexion above alluded to. Plumbago, which is by some classed with the diamond; by others, with coal; in the present instance is placed with the last of those substances: with which, of the two, it seems naturally the nearest allied.

One of the newly discovered earths, and some of the newly discovered metals, I have thought myself justified in altogether omitting; because they at present are of such very rare occurrence.

In the description of individual minerals I have first set down their more remarkable synonyms, together with an explanation of the origin or meaning of these; next, an enumeration of their most striking characters; after that, the results of their chemical analysis; and lastly their general history, together with the means of distinguishing them from other minerals resembling them in appearance.

The description both of the appropriate and distinctive characters has been principally collected from the Abbé Haüy: the chemical analyses have been collected from various sources.

The comparative statement from some of the earlier natural historians are a very small proportion of those which might have been produced: for I soon found that the attempt to reconcile their accounts with those of the moderns was, in by far the greater number of instances, an undertaking which no labour was likely to accomplish: and indeed from the fluctuation of terms I think it is hardly possible to be accomplished.

The introduction consists of two parts: in the first of which I have given a short account of that branch of the subject called geology; in the second, a general description of the more remarkable characters and properties of minerals.

For the imperfect manner in which some of the references are made I beg leave to apologize, by saying that the notes from whence they are taken were originally collected without the intention of publishing.

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TUNGSTEN.

THE literal meaning of this word is "heavy "stone." The metal was so called from the great specific gravity of this mineral, in which it was first discovered. It is also called "sheelium;" in honour of Scheele, who first ascertained the real nature of this mineral.

It exists in two natural forms; in one of which it is combined with lime; in the other, with iron and manganese: the first is usually called "tungsten;" the last, "wolfram."

Tungsten.

It may be scratched easily by the point of a knife.

It is commonly of a white or brownish white colour; if powdered and thrown into nitric acid it becomes yellow.

Specific gravity 6,06.

Primitive form, the cube: it is also reducible to an octohedron.

	Tungsten of Sweden.	*Tungsten of Cornwall.*
Yellow Oxyd of Tungsten	65	75,25
Lime	31	18,70
Silex	4	1,50
	100 *Scheele.*	95,50 *Klapr.*

The Cornish variety contained a small proportion of oxyd of iron, and of manganese.

Many of the specimens of tungsten met with in cabinets come from Zinnwalde in Bohemia; and are accompanied with mica crystallized in hexagonal plates, and with smoky quartz. Numerous minute crystals of tungsten sometimes incrust the surface of the latter substance.

Tungsten is also met with in Cornwall; and in Sweden. It usually accompanies tin ore and wolfram.

It was at first mistaken for a white variety of native oxyd of tin; from which it may be distinguished by the change of colour it undergoes when thrown into nitric acid. It is distinguished from carbonate of lead by not effervescing with an acid; and in not being blackened by an alkaline sulphuret: from sulphate of baryt, by its greater specific gravity; and by the yellow colour it assumes when thrown into nitric acid.

Wolfram.

Spuma lupi; of Wallerius: this is a literal translation of wolfram.

It easily yields to the file.

Colour, brownish black; with a degree of metallic splendour that is more apparent in some directions than in others.

Structure laminated.

Specific gravity 7,33.

Primitive form, a right angled parallelepiped.

Acid of Tungsten	. . .	67
Oxyd of Iron	. . . .	18
——— Manganese	. .	6,25
Silex	. . . .	1,50
		92,75 *Vauq.*

This substance was originally mistaken for antimony, which by the alchemists was called the wolf; probably because it acted violently upon, and as it were devoured the base metals, in the process of refining gold: hence arose the term spuma lupi, the word *ram*, which signifies "spuma," being applied commonly by the Germans to substances of a laminated structure.

Wolfram usually occurs in tin-mines.

It has been mistaken for native oxyd of tin, and for specular iron: but its splendour is more decidedly metallic than the former; and less so, than the latter. When pulverized it is of a blackish violet colour; oxyd of tin is of a greyish white.

It is specifically heavier than specular iron in the proportion of seven to five.

APPENDIX.

INTRODUCTION.

INTRODUCTION.

PART I.

THE soil or superficial covering of the earth consists principally of decayed vegetable matter, which has grown and withered on the spot through successive ages.

Beneath this are generally found loose heaps consisting of mould, with fragments and particles of stone, imbedded in the surrounding substance without any regularity or regard to the laws of gravitation: so that very frequently the heaviest masses are found nearest to the surface.

Some of these fragments are angular and irregularly shaped; others, of a rounded form and smooth surface: and in general the angular fragments are of the same nature with the varieties of stone met with in the neighbouring country, while the rounded fragments are entirely different.

This accumulation of earth and stones extends to different depths in different instances: but, in continuing to penetrate downwards, you at last constantly meet with what is usually called the solid rock: this differs from the superincumbent mass; not only in being more consolidated in its substance, but also in the nature of its constituent parts: and there is this further and remarkable difference; that the arrangement of its particles is perfectly regular, considered at least with respest to itself, and its texture is nearly the same throughout its whole substance.

In continuing to penetrate downwards, you find after a time that the nature of the rock alters; and by continuing to penetrate further and further you find similar changes occurring at stated distances; each successive rock differing from all those which preceded.

The same circumstances are met with in different parts of the same district; and the regularity of this succession has given rise to the idea, that the different rocks have been formed by successive deposition of the particles of which they are composed: and hence the technical terms *beds* or *courses;* which in philosophical language are usually called *strata.*

Many strata abound with organic animal and vegetable remains; while others, as some suppose, are entirely free from them: hence the idea that these latter were deposited previously to the existence of animals and vegetables; and hence, also, as adapted to this idea, the terms *primitive* and *secondary* strata. The probability of the truth of this idea is strengthened by the relative situation of these strata; the secondary constantly lying upon, and being never covered by the primitive.

Many strata, as in the instance of Bath and Portland stone, and also of the strata of Sandstone in the north easterly counties of England, bear evident marks of having once been in a minutely divided state: and their present arrangement so fully justifies the supposition of their particles having been accumulated by quiet deposition from water, that most, if not all, of those who reason on such natural appearances, entertain the same opinion as to this point of their history, however they may differ as to others.

And although the internal regularity of these several strata is strongly contrasted by the confused appearance of the loose earth and stones which cover them; yet the accumulation of these loose and confused heaps is with equal consent allowed to be owing to the operation of water also.

The effect produced by the continued agitation of water, on the form of substances exposed to its action, must have been very generally remarked. If, for instance, among the shingles of the sea-shore you were to throw variously shaped fragments of glass, stone, brick, or coal &c., you might by observation perceive that their projecting angles would be gradually worn off; and each fragment would in time become of a surface as perfectly smooth as the nature of its substance would allow; and its form would resemble that of a common pebble. This effect is so obviously the result of such an operation, that, in whatever situation pebbles occur, their rounded form is universally attributed to the mutual attrition produced by the agitation of water.

The pebbles that occur in those irregular heaps which lie above the strata are consequently allowed to have acquired their present form from the operation of water; and there are many arguments tending to shew that the mutual attrition which has occasioned this form did not take place on the spot where they now are; and that they have been transported hither from a distance: hence the heaps in which they occur are very commonly called *alluvial*; and the term *alluvion* is often used to express an accumulation of this kind.

There could not perhaps be a better illustration of the statement just made, than that which may be drawn from a spot in the neighbourhood of Oxford.

The alluvion, met with in digging near the angle made by the junction of the two London roads, consists of a species of gravel that is very irregular as to the appearance and size of its constituent parts; many of which are of the same nature with the masses of compact sandstone scattered over the vale of Berkshire; others are imperfectly formed pebbles of the flints of the neighbouring range of chalk hills: with these are found incomplete shells of the large fossile oysters met with in the limestone strata near Thame; and fragments of the quarries of Stones-field, which lie in nearly an opposite direction. Of all these, the perfectly formed pebbles are by far the hardest; and it is therefore clear that the attrition of these did not take place on the spot: and, in comparing the degrees of attrition of the different fragments, it is found that those are least worn, which, judging by their nature, may fairly be supposed to have been transported from the nearest points of distance.

All then are agreed in referring the origin, not only of the strata already described, but also of these irregular superficial heaps, to the action of water: but, in comparing the confused appearance of the one with the regularity of the other, we must be convinced, while we attribute these effects to the operation of the same agent, that the mode of that operation was very different in the different instances: and it seems evident that in the former, this operation has been gentle and gradual; in the latter, comparatively simultaneous and violent: and that the deposition of the strata must have been completed, before the accumulation of those alluvial heaps began to take place.

With respect to the time when these heaps were accumulated, there is no internal evidence to be collected from the nature of the heaps themselves: but it seems reasonable to conclude from the universality of their existence, that the operation of the cause which gave rise to them was itself universal. It seems also clear, that, as these appearances occur so constantly nearest the surface of the earth, they must be owing to the most recent of all those revolutions which have been supposed at different periods to have happened to our globe.

These characters are so easily referable to the operation of a universal deluge, that one should think its existence might be deduced from them alone; independently of the arguments arising from the concurrent testimony of all ages and nations, and a well grounded assurance of the truth of Scripture. Some however are disposed to argue that they are owing to the gradual operation of rivers carrying down with them the detritus of the land over which they have flowed; an opinion which will be again referred to, and against the probability of which there seem to be the strongest arguments.

It has been already said, that, after having penetrated these loose heaps, you constantly arrive at the solid strata placed beneath. These are remarkable for the general parallelism which they preserve one with another; though their direction frequently alters, and varies from a line making the smallest angle, to a line making nearly a right angle, with the horizon: and it commonly happens that in flat districts the strata are nearest the line of parallelism with the horizon; and in mountainous, the most remote from it. Saussure describes some of the central strata of the Alps as nearly vertical.

There is another and a remarkable observation respecting the various position of the strata, as connected with a level or a mountainous country: those strata, which in the level tract form the base of all the others, are generally found to constitute the highest ridges of the mountainous parts. So that if you suppose the uppermost stratum in any plain to be limestone, the next slate, &c. and the lowest granite, and were to travel towards the summit of the mountains rising from the plain; you would find, after ascending some way, that the limestone failed, and the slate appeared at the surface; and so on, till, reaching the summit, that stratum would be seen to occupy the highest situation, which in the plain was lowest.

And, often, if preserving the same line of direction you descended on the other side of the range, the same appearances would occur in an inverted order; of all the strata those nearest the centre having the highest degree of inclination, and being sometimes nearly vertical.

As the similarity of the strata is preserved, though their direction is altered; and as there is often the same internal evidence from their structure that they must have been once horizontal, it appears not improbable from considering their relative position in these instances, that at some period a power acting from beneath has elevated the lowest stratum; and by so doing has forced it through, and separated the disunited parts of, the superincumbent strata.

Many of those who argue in support of the above opinion suppose, that when this elevating force was applied the lowermost stratum was in a fluid or at least a soft state, from the application of subterraneous heat.

It frequently happens that in penetrating a stratum in a direction parallel to the contiguous strata, the miner is suddenly interrupted by a substance totally differing from that in which he was just before working: this interruption rarely lasts long, and by continuing to work in the same line he recovers the original stratum. By observation it has been found that this obstructing substance not only cuts transversely the stratum in which it may happen to be first noticed, but also many of those adjoining on either side; generally proceeding in an oblique direction, and being of inconsiderable thickness compared with the strata which it intersects. These interruptions are called *veins*, or cross courses; and, in Cornwall, lodes.

These veins are allowed on all hands to be of subsequent formation to the strata which they traverse; and to occupy the place of numerous rents and fissures, which are supposed to have been caused either simply by the desiccation, or by the violent separation, of the strata: but it is a subject of great dispute in what manner these veins were formed; some arguing that the substances of which they are composed were introduced gradually from above; others, that they were introduced violently and suddenly from beneath.

In general the strata are of very little value to the miner, compared with the veins that intersect them; it is in the latter that are contained those substances which are the object of his labour: and here also are found those mineral specimens which are principally sought for on account of the beauty of their appearance.

But sometimes, after having penetrated a vein, the miner finds himself in a different stratum from that which he has just left: and in such a case he may commonly regain the original stratum, by boring through one or more, sometimes of the inferior, sometimes of the superior contiguous strata.

Such a disposition of the strata is called by various expressive terms; as a fault, or slip, or trouble: and, in like manner, the strata are said to have been heaved or shifted: and by reasoning on the circumstances it appears probable, that in the formation of the cleft now filled by the vein, the divided portion of the strata on one side or other has been elevated or depressed.

For the sake of illustrating this appearance, let any one suppose a long range of perfectly uniform buildings, consisting of three separate stories, each twelve feet high: then, if you suppose that one half of the range should by any chance sink twelve feet, it is clear that the middle story of this would be exactly on a level with the lowermost story of the other half: and supposing the several stories to represent strata, it is clear that if you were mining in the middle stratum of that half which had sunk, and attempted to penetrate beyond the point of subsidence, you would advance into the lowermost stratum of the half which had not sunk, and would recover the middle stratum by quarrying upwards: or, if you were mining in the middle stratum of the half that had not subsided, you would penetrate into the upper stratum of the half that had subsided, and consequently would regain the middle stratum by quarrying downwards.

In some instances it appears that the superior strata have been separated by the elevation of the inferior, and that the divided parts have been removed to a great distance from each other; or else the portions which originally filled the interval have been broken up, and subsequently carried away. And this may explain the reason why, while in some parts of Derbyshire they find coal very near the surface, in others they cannot expect ever to find it; at least at any of the depths to which their mines have yet been carried: namely on the supposition that in these parts the coal strata have been either removed, or disjoined by a long interval.

The several phenomena which I have been attempting to describe occur so frequently, and are so much connected with the operations of mining, as to render the knowledge of them important in a practical point of view. They are at the same time so striking in themselves, that even the most simple and uninformed minds are naturally led to the consideration of their cause. It is not wonderful therefore that men of cultivated genius have attempted to explain what all are so forcibly led to contemplate: and hence those numerous Theories of the earth, or systems of Geology, which have been published within the last two centuries. And it is still less wonderful, considering that the fabrication of a world cannot be expected to come within the scope of human conception even, that these systems should be inconsistent, not only with each other, but in themselves. On this account it would scarcely be necessary to dwell longer upon them: but as the subject of geology was originally discussed in consequence of its connexion with particular passages of the Bible; and as arguments have sometimes been drawn from it, the tendency of which was to invalidate the authority of Scripture, it will not perhaps be useless to give a short outline of some of these theories. For, from the contradictory opinions contained in them we may be taught, with how much caution we ought to speculate on a subject in which there seems to be so little reason for the expectation, not only of proof, but even of probable conjecture: and may derive this satisfaction, that though we cannot always reconcile particular appearances to the literal interpretation of Scripture, we need not fear any representations that may be made from such grounds against its authenticity. Nor need our inability to reconcile those appearances at all weaken our belief in Scripture: for happily its credibility rests on higher grounds than our explanation of natural phenomena; and therefore it is as consonant with philosophy as religion to suppose that the task is beyond rather than contrary to reason.

One of the earliest systematic theories of the earth was the work of Burnet, who was master of the Charter House. He published it about the year 1680. It was his object to reconcile philosophy with religion: wherefore having first shewn from an examination of the progress of the arts that the human race has not existed longer than is stated in the Scriptures, he proceeds to the history of creation: and supposes that chaos being a fluid mass, the earth which as it were rose out of it, must have been uniformly smooth and without any of its present inequalities. The antediluvian world then, according to this idea, was without hill or valley; presenting an uninterruptedly even and spherical surface, which he compares to the outer covering of an egg, and calls the crust or shell of the earth. Within this shell he supposes a vast central abyss of water was contained; and this he makes the means by which the deluge was produced; in order to elucidate the expression made use of in Scripture, that, at the deluge, the fountains of the great deep were broken up: for, he says, the sun's heat penetrating the crust or shell of the earth, gradually acted on the water contained within it; which being thus expanded, or converted into vapour, broke through the crust by which it had hitherto been confined; and rushing out with great violence formed our present oceans. In the mean time the broken shell, falling in different parts into the abyss below, produced all that confusion of hill and vale, of rock and mountain, and the cavities contained within these, that is now every where apparent on the earth's surface. Descartes entertained the same idea with respect to the original form and subsequent rupture of this crust of the globe: and the idea may be traced to a much earlier date than the age of these writers. As this system is in a great measure the production of fancy, it is not necessary to make any observations on the probability of its truth: but, as I believe there is no reason for concluding from any part of the Bible that the antediluvian world was without mountains, it may be worth while to observe in this instance how difficult it is, even with the best intentions, to avoid running into an absurdity; when we attempt to explain the hidden nature of those operations which the Creator has thought fit to reveal in part only to our understandings. For let us consider but one obvious use of those ranges of mountains which are extended in every direction over the globe; and we shall see that without the aid of these its whole surface must soon become a barren desert: since all the rivers of the world are ultimately derived from the rain that has been precipitated from the clouds against their summits.

Burnet, in order to obviate this difficulty, accounts for the existence of rivers in the antediluvian earth by a condensation of aqueous vapour towards the polar regions; and supposes that the water resulting from this condensation produced rivers, which flowing from hence towards the equator grew gradually narrower; and were divided into more branches as they proceeded further from their source: but he ought to have added the reason why this condensation only took place at the polar regions; why not in the tropical regions then, as it does now? The possibility indeed of any order of things, where a creative power is concerned, is not to be disputed: but, to allow this possibility, and to attempt to explain the manner in which its effect is to be produced, are very different questions.

The theory of Whiston, who was mathematical professor in the university of Cambridge at the beginning of the last century, corresponds very much with that of Burnet: but he ventures in particular points to alter the literal interpretation of the Bible; asserting that the Scripture every where accommodates itself to the vulgar apprehensions of men with respect to such parts of natural philosophy as they were incapable of comprehending: and that therefore it is lawful to forsake the plain and obvious sense of any passage, where the nature of the thing itself, parallel places, or evident reason, afford a solid and sufficient ground for so doing. And such a licence indeed the most scrupulous have been ready to afford, when reason required and doctrinal points have not been affected by it.

Dr. Woodward, who was professor of physic in Gresham college, wrote a treatise on the theory of the earth about the same time with Whiston: he agrees with Burnet in supposing that there is an abyss of water on which the crust of the earth rests; but he differs from him as to the equality of surface of the antediluvian earth; drawing his authority for so doing, from an examination of those animal remains which are so constantly met with on and near the earth's surface; of which he says some are the exuviæ of river shells: and arguing that if there were rivers in the antediluvian world, there must have been mountains also.

M. de Buffon's theory of the earth, which is perhaps more generally known than the foregoing, affords a striking instance of those extravagances which even men of the greatest observation in the works of nature are liable to fall into: but I mean not to speak disrespectfully of his genius when I observe, that although in the construction of his theory he appears to have followed no other guide, except his own imagination; yet in almost the only instance where his ideas are divested of their usual extravagance, he confirms by his observations the authority of the Bible. For after having given it as his opinion that, at a period as far back as 75,000 years, a portion of the sun was violently detached by the shock of a comet, and carried to a great distance; he goes on to suppose that this, being in a red-hot and liquid state, separated into numerous portions which formed the several planets: and that these immediately began to revolve round their own axes, and round the sun, in the same manner as they do now. The earth, one of these newly created planets, very gradually cooled; so that, at the end of 25,000 years, the condensation of water began to take place; but was not completed till the end of 35,000. At this time the whole earth was covered with sea; and shell fish were produced; and the various strata of the earth formed in the bosom of the waters. At the end of 50,000 years, the waters began to retire; the currents of the sea fashioned out vallies; and subterraneous fires began to ravage the earth by their explosions. After this he supposes that elephants and the larger animals were produced in those parts of the earth that were sufficiently cooled, namely near the poles; and these gradually advanced towards the equator as the poles became colder and colder. At last man was produced; at a period of time, as may be deduced from his calculations, distant not much more than 6000 years from the present; which nearly agrees with the calculations drawn from the Mosaical account. With respect to the production of animals he conceives, that there is a vast quantity of organic living atoms (molécules organiques vivantes) constantly floating about: that these are capable of producing new species of animals where none already exist; and serve to perpetuate the species of those that do already exist.

Mr. Kirwan supposes that to a certain depth the globe was originally liquid; and there are many probable arguments in favour of this opinion: one of which is stated by Mr. Whitehurst in his Mineralogical History of Derbyshire in the following manner: that, as all fluid bodies while at rest assume a spherical form, and if set in motion revolve round their axis, and become oblately spherical or spheroid; it appears that the earth, this being its form, must have once been liquid; and in motion at the same time. Mr. Kirwan also supposes that "the eight generic "earths, all the metallic substances, the whole tribe "of simple saline and of inflammable bodies, were "held in solution by the aqueous menstruum which "was the cause of the liquidity of the globe: and "that this aqueous menstruum was of a more com-"plex nature than any that has since existed; and "consequently endued with properties very different "from any with which we have been since acquaint-"ed *." It is curious to compare this hypothesis with an observation which Mr. Kirwan makes in the course of the very same work; where he calls the supposition "absurd and gratuitous, which attri-"butes the ancient solution of stones, of the sili-"ceous genus only, to some imaginary menstruum; "which those who entertain the supposition say "has long since been destroyed or saturated *.' This chaotic fluid gradually evaporating, its solid contents were precipitated from their state of solution; various combinations of the dissolved substances taking place, so as to form that variety of appearance &c. which we observe in the different strata and rocks and mountains of our earth; till at length the higher regions being brought to view, by means of the total evaporation of the water which covered them, a distinction of land and sea was made. As in Mr. Kirwan's theory the operation of water alone is acknowledged in the consolidation of the strata, the system is often called Neptunian.

Dr. Hutton, in his theory of the earth, supposes that rivers are constantly washing away the soil through which they run; which is thence carried on, and deposited by them in the bosom of the ocean: that in this manner vallies are formed by the washing

* Kirw. Geol. Essays, p. 11. † Ibid. 119.

away of the soil, which originally was level with the existing hills and mountains: that all this soil, gradually deposited in the ocean, is there accumulated until by the force of subterraneous fire the deposited or stratified mass is melted, or at least consolidated; and then elevated through the waters: and thus new continents are formed. In this way, he asserts, our present continents originated from the detritus of former continents; and in the same manner, he says, the detritus of our continents will ultimately produce others. This system is sometimes called Plutonian, from the introduction of the agency of heat.

It must be allowed that in the foregoing theory there is great ingenuity, and a simplicity analogous to that which is observed in the operations in general of nature, in the idea of providing for the production of another earth by the very wasting and decay of this: and there is no doubt that with respect to internal consistency, Dr. Hutton's theory of the earth is much more philosophical than any other.

Strong objections however have been made on account of the length of time necessary to complete the operations involved in this hypothesis: much stronger I think may be made on account of the improbability that such a complete detritus of the land could be effected by the operations to which it is attributed: but the strongest of all is that the theory excludes the supposition of a general deluge.

In saying this I am far from meaning to insinuate that Dr. Hutton disregarded the authority of the Bible; and if in any instance he has advanced an opinion which is seriously at variance with the Scripture account, I should rather attribute this to a too great partiality to his own system than to any other motive. But as the theory itself certainly does not admit the supposition of a general deluge, it will not I trust be superfluous to point out the sources from whence proofs of such a catastrophe may be deduced as well from natural phenomena, as from the higher authority of universal tradition and the Bible.

With respect to the length of time involved in the hypothesis, it has been answered, that the Mosaic account has chiefly a reference to man; and that though he may not have been created above 6000 years, yet these operations may have been going on for any definite length of time previous to his creation. But is it consistent with reason to suppose that the ordinary processes of nature should have been going on for thousands, according to such a calculation one might say millions of years, while man, for whose support all these processes were instituted, himself did not exist? Cicero at least thought otherwise, when he says, " Sin quærat quispiam cujusnam causa tantarum re-

"rum molitio facta sit: arborumne et herbarum? "quæ quanquam sine sensu sunt, tamen a natura "sustinentur: at id quidem absurdum est. An be-"stiarum? nihilo probabilius, Deos mutarum et nihil "intelligentium causa tantum laborasse. Quorum "igitur causa quis dixerit effectum esse mundum? "eorum scilicet animantium quæ ratione utuntur*." And it cannot here be urged that Dr. Hutton excluded the idea of that final cause on which this argument rests; for he himself says, "This globe of the earth "is a habitable world; and on its fitness for this pur-"pose our sense of wisdom in its formation must de-"pend †." And, lest there should be any ambiguity as to the nature of those beings for whom it was framed, he afterwards adds, "The globe of this earth "is evidently made for man. He alone, of all the "beings which have life upon this body, enjoys the "whole and every part ‡." But I am ready to confess that judging from appearances alone, there are traces of many successive revolutions in our earth, of which no notice is taken in Scripture: and perhaps, as I think Mr. Kirwan has suggested, these appearances may be reconciled, by supposing that the Mosaic chaos was the ruin of a former world: an idea which is I trust not at all incompatible with our belief in Scripture, and which in itself seems highly reasonable.

* Cic. de Nat. Deor. lib. ii. cap. 54.

† Dr. Hutton's Theory of the Earth, vol. i. p. 4.

‡ Ibid. vol. i. p. 18.

With respect to the wearing away of the land, and its deposition in the sea, which Dr. Hutton supposes; it may be asked, why has not the sea, in proportion as it has been filled up, overflowed its borders and advanced on every side upon the land? As for partial encroachments they are not worth mentioning: for if the sea has encroached on the land in some instances, the land has equally encroached on the sea in others.

Dr. Hutton indeed allows that the geographical outline of the globe is the same now that it was two thousand years ago, or more; and argues that the detritus cannot therefore be measured by observation or history: but if this be admitted as an answer, and if it be granted, as Anaxagoras supposed, ὅτι τὰ ἐν Λαμψάκῳ ὄρη θάλαττα ἔσται, ἐάν γε ὁ χρόνος μὴ ἐπιλίπῃ*; yet this only removes one objection to make way for a stronger: for if mountains are in time to be levelled, from whence are to be derived those constant sources of water so necessary to life and vegetation; the existence of the one having already been shewn to have a necessary connexion with the existence of the other †: unless we shall say that there is a natural sympathy between the cessation of this detritus, and the renewal of those subterraneous convulsions which are to elevate the strata that then cease to be deposited.

* Diog. Laert. in vit. Anaxag. † Vid. p. 14.

But the fact is, that though undoubtedly every river is constantly wearing away particles of the soil through which it runs; yet it either deposits these during its course and thereby raises the level of its own bed; or, what rivers do not deposit in their course they deposit at their mouth. This has happened to a very remarkable extent in the lower part of the Delta of the Nile; and at the mouths of the Ganges; and of the great American rivers: and not only in these but in the instances of many smaller rivers: and Major Rennel shews very satisfactorily, in his geography of Herodotus, how this necessarily happens in the case of the Nile; and that what is said of the Nile is more or less applicable to every river.

An illustration of this fact is often presented to our eye: and every one must have had an opportunity of observing by the common road side, how during a storm of rain, the sand and small pebbles which are brought down by the rain torrents, soon accumulate and form a barrier against the descending current: and how, when the accumulated water has overtopped this barrier, it cuts out a fresh channel on the bed which itself has raised: and in the same manner as it raised this bed, it would by a repetition of the same cause raise another and another.

It may be said indeed that in some instances the sea is discoloured for many miles by the earthy particles poured into it from the mouths of large rivers: but no one supposes that with those earthy particles are also conveyed large fragments of stone, or even common pebbles: and without such a provision it does not seem clear, according to this theory, how the formation of brecciated strata is to be explained.

Another argument against this part of the theory may be collected apparently from the different direction of the course of rivers: for if all rivers excavate their own bed, why is not the direction of their course the same in all instances; and, as a serpentine course is the result of the natural action of water, why is it not observable as well in a rocky as in an alluvial district? or, again, since in a flat tract, the materials of which easily yield to the force of the current, the level of the river is generally but little below its banks, how does it happen that in rocky districts the river should often run greatly below the level of abrupt and high clifts, formed of the hardest stone? The serpentine appearance of the Forth while it winds through the alluvial tract between Stirling and the Domyatt hill, contrasted with the irregular course of the Esk among the romantic rocks of Roslin, will, to those who have seen the scenery alluded to, fully illustrate the reasoning here made use of.

With respect to the opinion that strong proofs of a general deluge may be deduced from existing appearances, I shall beg leave to refer the reader to what has been said in the six first pages of this Introduction: and, as the formation of the pebbles and alluvial heaps, there mentioned, is attributed by all to the operation of water, and the only point in dispute is, whether the effect has been produced by the constant action of rivers, or the violent operation of a deluge; if the first of these suppositions is inadmissible, this will be sufficient, in the present state of the question, to establish the truth of the last.

Since then among the imperfectly rounded fragments of stone, contained in the alluvion described in the fifth page, some have evidently been brought from a point nearer the source, others from a point nearer the mouth of the river that runs near it, it is clear that the deposition has not in this instance been the effect of the river itself: and, as similar appearances occur in very different parts of the world, the argument equally holds in those instances: but if these appearances cannot be referred to the action of rivers, they must be referred to the operation of a deluge; and it follows from the universality of the appearance that that deluge must have been itself universal.

I shall beg leave also to refer the reader to the description of an appearance mentioned under the head of siliceous pebbles, in the appendix at the end of the second volume. It is there stated that the gravel round about Windsor, though it consists in a great measure of the flint of the neighbouring chalk hills, contains several pebbles of a different size and character: and that these are found nearest the surface: and that they are more completely rounded than the flint, and have therefore been probably transported from a greater distance: and lastly that similar pebbles occur in every part of England.

If then this gravel has been deposited in consequence of the detritus occasioned by the gradual action of rivers, those pebbles which are nearest the surface must necessarily have been last deposited; and the strata from whence they have originated must be presumed to have been situated beneath the strata from whence the inferior parts of the bed of gravel originated; for it is evident that rivers must first act upon the highest strata, and that the detritus of these being the first deposited must occupy the lowest situation. How then has it happened, that no trace remains, at least within ninety miles, of the stratum from whence those superficially seated pebbles could have originated; whereas the whole country abounds with those strata of chalk, from whence the flint or most deeply situated part of the gravel has evidently originated?

Another argument in favour of a general deluge may be deduced from an appearance, which, if not as general as the preceding, leads to a conclusion full as convincing.

In several instances I have observed, that where a hill, or range of hills, rises somewhat suddenly from the surrounding tract of country; the flat tract is covered with pebbles of all kinds: but soon after the ascent of the hill has begun, the appearance of these pebbles ceases; and the loose stones which occur are of the same nature with the stratum of the hill itself. But, if Dr. Hutton's theory be true, surely the pebbles at the bottom of the hill ought to be of the same nature as those on the sides; for it would be absurd to say that at some former period rivers, which have run over the country situated round about the foot of the rising ground, have deposited these pebbles; since, from the natural slope of the ground in all these situations, those rivers must either have run up an inclined plane; or, if they have been formed by torrents descending from the adjoining high ground, it may be asked, why the pebbles brought down by them are not of the same nature with the rock, from which they must in that case have been derived?

Unless I have been very much deceived in the course of those observations which I have had an opportunity of making, the appearance which has just been described is very common, at least in this island : I observed it more particularly in the country round Broadway hill, which separates Oxfordshire from Worcestershire ; and in the country round that range of hills from which you descend into the vale of York in travelling northwards from Ferry bridge. I have mentioned this observation partly with the hope that others, whose travels are likely to be more extensive, and whose eye is more experienced, may have an opportunity of ascertaining whether or not it is correct. As far as my knowledge extends, the observation, or at least the present application of it, is new ; and if it is correct it seems to be of importance.

There are many phenomena connected with this part of the subject which would lead to discussions too minute for the confined nature of the present publication.

PART II.

Having attempted, in the foregoing part of this introduction, to explain certain general phenomena connected with the history of mineralogy; it remains to speak of the characters by which mineral substances may be individually distinguished.

In looking at even a small collection of minerals, with a view to the description of them, it is obvious that the varieties in any one of their external characters are very numerous: various shades of colour for instance, and various modifications of form, are continually presenting themselves; and consequently the variety in the descriptive language, where accuracy is aimed at, must be proportionally great: and it is on this account that, in mineralogical treatises, we meet with those numerous combinations of descriptive epithets which are suggested by the endless variety of colour, texture, consistence, and in short of every separate character of a mineral. On many occasions these discriminations have been carried to a tedious and nearly useless length; and principally in the description of colour, which, of all the characters of a mineral, is perhaps the least important; a difference in this respect often depending on causes too trifling to interfere with the real nature of the substances in which it occurs. Thus in the sapphire and the ruby the colour is widely different though the chemical analysis is nearly the same.

The characters which have been principally attended to in the following description of minerals are, their degree of fusibility, their hardness, phosphorescence, electricity, their refractive power with respect to the rays of light, their specific gravity, and their crystalline form : to which have been added, as often as it was possible, the results of their chemical analysis.

The most ready way of ascertaining the fusibility of a mineral substance is, by exposing a small particle of it to the flame of a candle or lamp concentrated by the instrument called a blowpipe : and if the heat thus excited is sufficient to liquefy the mineral, it is said to be fused. It must be observed however that the effect of fusion does not entirely depend, in all instances, on simple heat: for many earthy substances resist a very considerable degree of heat if placed in contact with charcoal, or a metallic substance ; which, if exposed to the same heat in contact with other earthy substances, would be melted ; the earths being disposed to vitrify when in contact with each other, at a much lower degree of heat than is requisite to fuse them separately. If a mineral is capable of resisting a great degree of heat without fusion, it is said to be "refractory."

The hardness of minerals has been expressed either by a comparison with each other, or their power of scratching glass; or by the effect of the file upon them: those which resist the file being the hardest.

By the phosphorescence of minerals is implied that faint light which they emit either by exposure to simple heat, or in consequence of friction.

The electricity of a mineral is that property which being excited, either by simple heat or by friction, shews itself in the attraction or repulsion of other substances, with which the mineral is brought nearly into contact.

It has been observed that some minerals acquire that kind of electricity which is called *vitreous*, as being peculiar to glass and other polished earthy substances: this is also called their positive electricity. Others acquire that kind which is called *resinous*, as being peculiar to resin and other inflammable substances: this is also called their negative electricity. Those which are in a metallic or nearly a metallic state acquire neither the vitreous, nor the resinous electricity; but altogether transmit the electric fluid. Some minerals are capable of acquiring both kinds of electricity: these are generally crystallized: and it is observed of them, that the parts which exhibit the different states of electricity differ from each other with respect to their form, although they are similarly situated; while in those crystals that are not electric the similarly situated parts correspond also in form. If a crystal for instance consist of a prism terminated at each extremity by a pyramid, and these pyramids differ as to the kind of electricity they are capable of acquiring; it will be found that they also differ in their form; one consisting of a greater number of surfaces than the other: and the part which has the greater number of faces acquires the vitreous; the other, the resinous electricity.

It is very generally known that a ray of light in passing from one medium into another, as from air into water, or glass, or any transparent substance, is turned more or less out of its original direction; and this alteration of course is called the refraction of the ray. Some transparent substances seem to have the power of also splitting the rays of light: this alteration of the course of the rays is called their double refraction; and minerals possessing this power have the property of presenting a double image of an object viewed through them.

By the specific gravity of a mineral is understood the amount of its weight, when compared with the weight of a quantity of water of the same bulk with itself. Thus if a cubic inch of limestone were found to be double the weight of a cubic inch of water, the limestone would be specifically heavier than the water in the proportion of two to one ; and its specific gravity would be set down thus, 2. If its weight were found to be equal to the weight of two cubical inches and a half of water, it would be specifically heavier than the water, in the proportion of two and a half to one ; and its specific gravity would be set down thus 2,5 ; the fractional parts being expressed by decimals.

The crystalline forms under which individual minerals occur are various, and may be considered as one of their most important characters.

Every mineral substance, perhaps, if placed under particular circumstances is capable by a peculiar arrangement of its particles of assuming a regular and appropriate form ; and as this effect was first observed in the substance known by the name of rock crystal, the term crystal was extended to every other substance possessing an analogous regularity in its form ; even though it wanted that icy appearance and transparency which belong to the rock crystal, and which gave rise to the term itself.

If minerals could always be made to crystallize under precisely the same circumstances, there is good ground for supposing that those of the same nature would always assume the same form; for it is possible in a great many instances by carefully placing different solutions of the same substance in as similar circumstances as possible, to obtain from all proportionally similar crystals; and as the same similarity continues, in repeating the process whatever number of times, it is clear that there is in those substances a disposition to assume one particular form in preference to all others. But as the least variation in the circumstances will produce a corresponding variation in the form, it is also clear that the variation in the form of crystals may be infinite.

Hence there must necessarily be a difficulty, where the same substance presents itself under a great variety of forms, of determining the particular form which the substance would assume when placed under the most favourable circumstances for arranging its particles according to the laws of its nature.

This form may generally be discovered by mechanical division; and in many crystallized substances the eye is capable of perceiving that a division may be effected in some directions much more easily than in others. Supposing therefore you were to take any one of the varieties of a crystallized substance, and forcing the edge of a knife in those directions where there was least resistance, were to continue to make fresh and parallel sections, a solid figure would at last be extracted of a different shape from the original or any of the intermediate forms; and this figure would remain unaltered, except with respect to its size, though the division were carried to the furthest point. In cutting off for instance the solid angles of a cubic crystal of fluor spar, you first obtain eight new triangular surfaces: and if you continue the division in the parallel of these planes you ultimately obtain an octohedron; which is the primitive form of fluor spar. A similar nucleus may be extracted from every crystallized variety of the same substance; and hence this is called its primitive form.

By the means which have just been described all the varieties of all kinds of crystals, with a few exceptions, have been resolved into six primitive forms, which are

The parallelepiped, either cubic or rhomboidal.
The octohedron.
The tetrahedron.
The regular hexhedral prism.
The dodecahedron, having twelve equal and similar rhomboidal surfaces.
The dodecahedron, consisting of two regular six-sided pyramids applied base to base; or having twelve triangular surfaces.

As the primitive form is the same in all the varieties of crystals of the same substance, the corresponding angles must be similar in every instance: and the identity of the form may often be better established by measuring the angle than from an inspection of the whole substance. Thus two rhomboids may differ so little from each other, that the perception of the difference may be lost to the eye under common circumstances; but may readily be detected by actual measurement: for which purpose an instrument, called from the circumstance a goniometer, has been invented.

Having arrived at the primitive form of any crystal, in most instances the division may be continued in the parallels of the same planes to any extent; but in no other direction: this division consequently does not alter the form. But some primitive forms are divisible in planes that are not parallel to their surfaces; and, when this is the case, a solid figure is extracted which differs from the primitive form of the crystal to which it belongs. M. Haüy calls this the "integrant "molecule."

The forms of the integrant molecule are three: the tetrahedron, the triangular prism, and the parallelepiped: and it seems probable that every crystal is made up of a vast number of these integrant molecules: and that the different varieties of crystals have been produced by a variation in the arrangement of these.

This supposition may be illustrated by taking a great number of small cubes for instance, and so arranging them as to form a larger cube, or an octohedron, or any other form; which may be easily effected. Such a process may be traced by the eye in many crystals; particularly in those of fluor spar. All those crystals which are variations of the primitive form are called *secondary;* but this with reference to form merely: for in their chemical composition they are exactly the same.

The term secondary has however been applied to certain crystallizations possessing a form not belonging to the nature of their substance. These are also called, and with more propriety, pseudo-morphic crystals; and appear to have been formed by a deposition of the particles of the pseudo-crystal, either immediately on the surface, or in the mould of the crystal of some other substance. Suppose for instance a quantity of any plastic substance were to be moulded on a natural crystal; and, the crystal being removed, a quantity of wax were to be poured into the mould, it is evident that the wax would thus acquire the form of a substance differing very much from itself in quality.

Sometimes the confusion produced in the process of crystallization is so great that the crystallized form is to the senses entirely lost: as when crystals become lenticular, and lose the character so distinctive of their nature, namely their termination in straight lines bounding plane surfaces; or when they are so closely and intricately aggregated as to give rather a regularity and peculiarity of internal structure, than of external form.

Of the preceding characters of mineral substances their hardness, phosphorescence, electricity, and their refractive power with respect to the rays of light, are called physical.

The "matrix" of a mineral is the substance in which it is immediately imbedded; or through which it is disseminated.

EARTHY SUBSTANCES.

LIME.

Native Lime.

THOUGH lime is a principal constituent part of many mountainous and level tracts of the earth, its natural existence in an uncombined state is yet very questionable. Mr. Kirwan indeed observes that " its existence is not naturally improbable, since " several stones contain uncombined calx, as appears " by various analyses * :" but in these instances the proportion of the lime to the whole mass of the compound is so small, as probably to preserve it from the action of substances that would otherwise unite with it: in the same manner as silver, which is very readily soluble in aqua fortis, may be protected from its action by a superabundant alloy of gold, which is insoluble in that acid. There is also reason to suppose that in most of, if not all, the instances alluded to by Mr. Kirwan, the lime is chemically combined with the other constituent parts of the mineral in which it is found.

* Kirw. vol. i. p. 74.

The common forms of lime are chemical combinations of that earth with some particular acid: they will be spoken of according to the order in which the compound is found to prevail in nature, beginning with that which occurs in greatest abundance.

Carbonate of Lime.

Almost all the varieties of marble and common limestone, together with those earthy concretions that take place in many natural springs and caverns, as also the numerous class of substances, called Calcareous Spars, consist, almost entirely, of lime in chemical combination with carbonic acid, or fixed air; the former constituting somewhat less than three fifths, the latter somewhat more than two fifths of their whole weight: hence in scientific language they are called Carbonates of Lime. The carbonic acid, or fixed air, may be expelled by heat, or by the addition of any other acid: in the latter case an effervescence takes place; and this effervescence is a very distinctive character of calcareous carbonates.

The proportion of water in carbonate of lime is very small, scarcely amounting to one part in a hundred; and of this Wallerius was aware: "Probe hic "observandum, omne liquidum quod expelli potest "fortissimo igne a lapide calcareo vix centesimam "partem, sæpe minus, lapidis calcarei destillati con-

"stituere*." And though since his time the proportion has been stated as much greater, yet by the latest experiments it appears that the proportion of water does not exceed the above statement of one part in a hundred.

The specific gravity of carbonate of lime varies from 2,3 to 2,8.

Marbles and Limestones.

The term Marble was originally applied to any mineral substance capable of receiving a polish, and used, in consequence of the beauty of its appearance, for ornamental purposes: in the present instance it is applied to such mineral substances only, as from the nature and proportions of their constituent parts are justly denominated Carbonates of Lime.

The term Limestone also, which strictly speaking is applicable to any natural compound containing a large proportion of that earth, is here used to express those natural compounds only, in which lime combined with carbonic acid is the principal constituent part.

In this sense then, marbles and limestones are with respect to their chemical analysis the same: they differ only in their uses and external characters.

Almost all of them contain some portion of iron: many contain clay also; and where the proportion of clay is considerable, the substance possesses those properties which constitute a Marl.

* *Waller*. vol. i. p. 152.

Marbles.

Parian Marble.

Lychnites of Pliny; so called because, according to Varro, the quarries were sometimes worked by torch-light. These quarries were in the island of Paros; from whence the term *Parian Marble.*

Marbre Statuaire; from its use.

Marbre Grec; probably from the remains of Grecian sculpture executed in this marble.

Chaux Carbonatée saccaroïde, and *Marbre salin;* from its resemblance to a granular mass of white sugar or salt.

Specific gravity 2,7.

Lime	52
Carbonic Acid . . .	45
Alumine, with minute quartz crystals	3
	100 *Kirw.*

Marbles of this kind are relatively the lowermost of calcareous strata; from which circumstance, as arguing priority of deposition, and because they rarely if ever contain animal or vegetable remains, and are supposed therefore by some to have been formed previously to the existence of organic matter, they are called Primitive Marbles. In many of them the structure is completely sparry; but even in those which are granular, the particles have a distinctly crystalline character: this is by some supposed to have been the result of consolidation from previous solution in water; by others, from a state of liquefaction by heat: the improbability of the latter opinion was for a time successfully maintained by the supporters of the former, on the supposition that marble is necessarily calcined instead of liquefied by heat: but Sir James Hall has lately shewn by experiment that all forms of carbonate of lime may be melted by heat acting upon them under strong compression; and that in becoming solid they assume an appearance closely resembling that of natural specimens.

Parian marble containing no iron does not lose its colour by exposure to air and moisture; whereas white calcareous carbonates in general become yellow under the same circumstances, in consequence of the alteration produced on the iron contained in them: on this account, and from the uniform delicacy of its colour, Parian marble is particularly applicable to the purposes of statuary. The Venus de Medicis and that of the Capitol are of this marble.

Carrara Marble.

Marmor Lunense: this and the foregoing name are derived from places situated on the eastern coast of the gulf of Genoa, near which this marble is quarried.

Specific gravity 2,8.

Its general history corresponds very closely with that of Parian marble; but it is even whiter and of a finer grain than that, and appears to have been ultimately preferred by statuaries on this account. The Antinous of the Capitol and, according to Dolomieu, the

Apollo Belvidere are of Carrara marble. Some parts of the beds of this marble contain a considerable proportion of siliceous particles : a small proportion is found in the analysis of every part; in which it corresponds with the analysis of Parian marble as given above. Wallerius says of this marble that when it is *semipellucidum* it is called Phengites or Tassus; but, from a passage in Suetonius, Phengites seems applicable not so much to a transparent marble, as to one that is opaque and capable of reflecting the rays of light like a mirror: the passage alluded to is in the life of Domitian: " Parietes Phengite lapide " distinxit; e cujus splendore per imagines quicquid " a tergo fieret provideret."

Cipolino.

The accounts of this marble are somewhat confused : it appears upon the whole to be a variety of the Parian and Carrara, stratified or veined with greenish mica: and from the supposed resemblance of these veins or bands to the laminæ of an onion (*cipolla* in Italian) it has received the name of Cipolino. Saussure describes it as sometimes entirely white, sometimes partly bluish; and of a granular texture.

Pentelic Marble.

This is a variety of the Parian and Carrara. Its name is derived from mount Pentelicus, in the neighbourhood of Athens, where it was first quarried.

White granular Marble with black Veins.

This marble, which is met with at Carrara, is very commonly used in this country for chimney-pieces and hearths. The veins are often too irregularly distributed to afford any probable ground of conjecture in themselves respecting their origin: but in many instances a transient view is sufficient to shew that they are a connecting medium between numerous and irregularly disposed fragments of white marble: and, keeping this observation in remembrance, the nature of the distribution of the veins may often be traced by a nearer inspection, where at first sight every thing seemed irregular and confused.

It is worthy of remark that the fragments of this marble are often mutually so indented as to give the vein a serrated appearance; compared, not unaptly, by Mr. Playfair, to the sutures of the human cranium. It has been argued from this appearance, that the mass in which it occurs must at some time or other have been in a soft state, in order to have admitted such a mutual indentation of the fragments: but in many instances the correspondence of the outline of the connected fragments is so exact, and the direction of the outline is at the same time so irregular, as to render it improbable that the fragments were ever separated from each other; since it is difficult to suppose they could have met again so exactly in the same points of contact. In this case we are left to imagine that some force simply divided the mass in various directions without separating the fragments from each other, further at least than to admit the matter of which the vein is composed : yet this conclusion, considering the exceedingly confused appearance of the whole, seems equally difficult of admission. It appears indeed to be one of those phenomena that admit not of satisfactory explanation.

Dolomite.

Many primitive marbles effervesce slowly with acids, especially if not previously pulverized; and are phosphorescent when scraped in the dark : the phosphorescence sometimes accompanied with a smell exactly resembling that of putrid animal matter. A fragment of this kind of marble in the Oxford collection contains numerous minute particles of magnetic iron. In some I have observed that if thrown into liquid nitre at a red heat, they give out a phosphorescent appearance; which commencing at the edges of the fragment submitted to the experiment proceeds to the centre: this phosphorescence is little more than momentary, and is not produced by heat; nor indeed by ignited nitre, upon a fragment that has previously been exposed to a red heat. Many of those primitive marbles which are of a granular structure, if sawn into thin laminæ and heated, become elastic: the effect is said to be produced in consequence of the evaporation of the moisture previously contained in them. Some are so loosely compacted as readily to crumble between the fingers.

Primitive marbles possessing the foregoing characters are called Dolomites, from M. Dolomieu; who first observed them among the remains of ancient sculpture at Rome; and afterwards in the mountains of the Tyrol, and in the Alps: but this class of marbles has not yet been accurately defined. Of the four following analyses of Dolomite, the three first are taken from Brogniart; the fourth from the Ph. Tr. for 1799.

Carbonate of Lime	52	53	52
Carbonate of Magnesia	45	42,5	46,50
Iron and Manganese	3	3	0,75
	100	98,5	99,25

Dolomite of Rome.

Lime	30,92
Magnesia	21,48
Carbonic acid	43,60
Alumine and Iron	4
	100,00 *Mr. Tennant.*

Many statues of Grecian workmanship are made of Dolomite; of which there are no known quarries in Italy: many of the relics of ancient statuary at Rome are however of Dolomite, and hence these are supposed to have been brought from Greece.

Brecciated Marble, or Breccia.

The origin of the term Breccia, according to Winkelman, is not known, but is said by Menagius to be derived from the German word *brechen*, signifying to break; and the term is certainly applied to marbles composed of fragments of various forms: these are in general variegated in their colour.

A marble much used in this country at the beginning of the last century, for the purposes of ornamental masonry, is a Breccia, the fragments of which are of the general character of primitive marble, but varying in their colours; being partly white, and partly brown and red: the connecting medium is for the most part a calcareous carbonate of a brownish red colour. The fragments are sometimes angular, sometimes more or less rounded; often very distinct from the substance by which they are cemented, but sometimes so confused with it as to occasion a difficulty in ascertaining the brecciated character of the marble.

The saloon at Blenheim, some of the halls and altar pieces in Oxford, and also many of the churches in London, are ornamented with a Breccia of this kind.

Brocatello.

This marble is met with in Spain and in Italy: the Spanish Brocatello, the most valuable, is found at Tortosa in Catalonia: it is a Breccia of small fragments closely cemented together; the predominating colour a golden yellow. The name of this marble is derived from its resemblance to Brocade. "Si albis, flavis, et rubris, maculis insignitum fuerit

"[sc^t. marmor] in modum *panni aurei,* appellatur Bro-
"catello *."

Vert Antique.

The epithet *Antique* is applied to those marbles which are known only from their remains in ancient sculpture; their quarries no longer existing.

We may collect from the writings of the ancients, that the simple agreement in colour often determined the application of the same name to substances in other respects very different: hence the difficulty of ascertaining the distinctive characters of the present marble.

Pliny mentions the custom of covering ornamental buildings with thin slabs of such marbles as were scarce; and traces of this custom still remain in Italy, and in many of the ancient buildings of Constantinople. That the vert antique was rare, and held in great esteem, and that the quarries were soon exhausted, may be collected from various authorities: we may therefore suppose that its characters are different from the characters of those substances, which, though called vert antique, are of common occurrence; such as green porphyry, serpentine marble, and serpentine; and that the remains of it will not only be seldom met with, but will bear marks of the original rarity of the substance. These characters agree with some small slabs of marble which I have received from

* *Waller*. i. 137.

professional architects as specimens of the vert antique: and to this kind of marble therefore I would apply the term. The specimens alluded to are very thin slabs, one side only of which is polished; which seems to shew that the marble was used for the purpose of giving a superficial covering to a less valuable material, and was not therefore itself common. Saussure says, that at a little distance from the city of Aoste, the great road to Italy passes under a triumphal arch, which is built of a coarse stone, and was anciently faced with marble.

The specimens above mentioned differ entirely in their characters from those other substances which are occasionally called vert antique; and they are of much rarer occurrence in cabinets. They appear to be parts of an irregular Breccia, consisting of fragments of dark grey compact limestone, black argillaceous schistus, and white granular marble, imbedded in a species of serpentine; which here and there is of a uniformly green colour, and a considerable degree of transparency, very closely resembling Jade, or compact Talc.

The fragments of white marble are very singularly fringed as it were with a green substance, which, proceeding in the form of close parallel fibres from every part of the edge, penetrates into each fragment to the extent of about the tenth of an inch.

This appearance is of difficult explanation; because it seems that the penetration, being so regular and accommodated to the outline of the fragment, must have taken place subsequently to the formation of the Breccia.

The situation of the quarries of genuine vert antique is not well ascertained: perhaps Pliny may allude to it in the following observation: "pretiosissimi quædam generis [sc[t]. marmora] sicuti Lacedæmonium viride *." Winkelman says, but without giving his authority, that it was quarried in the promontory of Tænarium.

Pieces of columns, cornices, &c. of vert antique are dug up in various parts of Italy; and many of the mosques of Constantinople are ornamented with it; these mosques being the remains of ancient temples: but no statue made of this marble has yet been met with.

Rouge Antique.

In the Oxford collection there is a small pillar of red marble, called Rouge Antique, of a very fine polish and close earthy texture: the colouring matter is nearly destroyed by the application of a red heat, but is deposited during solution in muriatic acid: the substance of this marble does not burn to a good lime.

In the same collection is an unpolished fragment, called also Rouge Antique, in texture resembling a fine grained sandstone: this burns to a better lime than the preceding: the colouring matter of this also is nearly destroyed by heat, and deposited during solution in muriatic acid; the deposition consisting of

* Nat. Hist. lib. xx.

gritty particles. I have seen a small bust of red marble exactly corresponding in its characters with the last mentioned specimen: it was brought into England some years since from Aleppo; and as the workmanship is old it may perhaps be a genuine specimen of rouge antique.

Of this marble there is no known quarry: pieces of it are dug up in Italy, though very rarely.

Black Marble.

Thoroughly black marbles are very uncommon. They are of a uniform compact earthy texture: their colouring matter is in a great measure volatile, or capable of being volatilized by the process of calcination; and hence, especially as they contain little or no iron, they give a very white lime.

The substance known to artists by the name of *Nero Antico* is a black marble.

Black and White Marble.

The term is here intended to express, not the common black-veined marble, but that variety of marble which to artists is known by the name of *Nero è Bianco Antico.* This consists of fragments, partly of perfectly white, and partly of perfectly black marble; the beauty depending on the intensity and uniformity of the separate colours.

A specimen of this marble in the Oxford collection is curious in a geological point of view: it consists of very irregular fragments, the shivered state of which appears to have been the effect of a great degree of violence; while the fineness of their edges seems to shew, that they have scarcely been moved from the situation where that force was applied: and yet from the difference of their colour, the fragments must, probably, have belonged to different strata.

Serpentine Marble.

Brochant observes that the green marbles of Italy, which are in such request, are for the most part serpentines, containing small veins of calcareous carbonate. In other instances the proportions of these constituent parts are very various.

A marble of this kind has lately been discovered in Anglesea; the calcareous part of which is of the nature of Parian marble.

Tiree Marble.

So called from the Scottish Island of the same name.

This is a primitive marble, of an unequally deep flesh colour; which by calcination becomes of a dirty white. It contains numerous particles of a dark green substance of a sparry structure; the nature of which has not yet been accurately ascertained.

Stalagmitical Marble.

*Alabaster** of the ancients; and sometimes *oriental alabaster* of the moderns: but the term *oriental*

* For the etymology of this term see the article *granular gypsum*.

is applied by jewellers and statuaries to express merely the beauty or hardness, not the native situation of any substance.

This when polished may be known by the distinct appearance of a stratified structure. The colour and direction of the strata or bands are various, and have been determined by local circumstances and the accidental admixture of vegetable or metallic matter that has been deposited together with the calcareous.

Some of the remains of ancient sculpture are of this marble. Where the strata were all of the same colour, and white, it seems to have been called simply, alabaster; where of different colours, alabaster onyx.

The alabaster of the present day is a gypsum or sulphate of lime.

Shell Marble.

Some marbles consist in appearance almost entirely of shells; but the body of each shell is in general filled with compact earthy calcareous carbonate; sometimes with reddish brown calcareous spar: this observation holds particularly with respect to Purbeck marble, which is made up of numerous shells of the variety called Cornu Ammonis.

Lumachella.

This marble, which forms the roof of a lead mine at Bleyberg in Carinthia, is a compact earthy calcareous carbonate of a brown colour, containing a great proportion of clay, and numerous fragments of small shells; many of them turbinated. The surfaces of these fragments when polished reflect the rays of light in such a manner as to present a kind of iridescent appearance, which is very vivid, and seems to proceed from their interior: the predominating colour in this iridescence is a deep orange red, and has given rise to the terms Lumachella and Fire-marble.

Florentine Marble.

This is a remarkably compact carbonate of lime, containing a great proportion of clay: its polished surface exhibits the appearance of rocks or ruined buildings, of a reddish brown colour: the ground of the marble is a light drab colour. The colour of the figured part is owing to Manganese*.

Cottam Marble.

The base of this marble is of the same nature with the Florentine; but the figured part presents a different appearance both in colour and distribution; the colouring matter is nearly black, and disposed in an irregularly arborescent form. It is met with near Bristol.

* Vid. the article *Calcareous Flagstone.*

Limestones.

Chalk.

Creta cohærens, solida, of Wallerius.
Specific gravity 2,3.

Lime	53
Carbonic Acid . .	42
Silex and Alumine .	2
Water	3
	100 *Kirw.*

The word creta, though applied by Wallerius and others to chalk, is generally used by the early naturalists to express clay: " proderit sabulosis locis " *cretam* ingerere; cretosis ac nimium densis, *sabu-* " *lum* *:" where, as sabulum certainly means sand, it is nearly evident, from the reciprocal use of the substances mentioned compared with the opposite properties of sand and clay, that creta signifies the latter. " Lateres non sunt e sabuloso, neque arenoso, mul- " toque minus calculoso ducendi solo; sed e *cretoso* †."

Again, it may be observed with respect to the following line,

" Hinc humilem Myconen, *cretosaque* rura *Cimoli* ‡,"

that the Cimolian earth is described in various passages of Pliny &c. under characters peculiar to clay.

There are two passages in which creta seems to be applicable to chalk: one in Horace;

* Columell. p. 73.

† Plin. Nat. Hist. Ed. Brot. vol. vi. p. 174.

‡ Ovid. Metam. lib. vii.

—"*cretâ* an carbone notandi *."

the other in Pliny; "Alia *creta* argentaria appellatur, "nitorem argento reddens †:" this being a common use of chalk at the present day.

Chalk differs not materially in its analysis from common limestone and marble. In the mass it is distinctly and regularly stratified; and it seems worthy of observation, that although the declivity of chalk hills is often very considerable, the direction of the strata, in England at least, is almost if not always nearly parallel with the horizon. The strata of most other substances are met with of various degrees of inclination; which many suppose to have been effected by an elevating or depressing force, that acted subsequently to their deposition; the tenacity of the strata having been sufficient to preserve their relative situations to each other. From the want of such tenacity, were the chalk strata completely broken up and shivered, wherever the supposed force was applied? and does this account for the original parallelism of those portions of the strata that remain ‡?

Chalk contains no metallic ore of any value; none indeed of any kind with the exception of occasional nodules of iron pyrites and ochre: but it contains in great abundance thin beds or seams of flint, lying in a direction parallel with the strata, and at various distances from each other.

* Horat. Sat. iii. lib. 2.

† Plin. Nat. Hist. Ed. Brot. vol. vi. p. 184.

‡ Vid. the article *Flint*.

The organic remains of chalk, which are not numerous, are principally of testaceous animals: the substance of them is almost always siliceous. Varieties of the Echinus are most common.

Chalk when well burnt makes as good lime, according to Smeaton, as the hardest marble. The harder kinds of chalk are used in building. In the preparation of whiting, chalk is pounded and diffused through water; and the finer part of the sediment is then dried: by this means the siliceous particles are separated; which, by their hardness, would scratch the surface of metallic and other substances, in the polishing of which whiting is employed.

Chalk strata are very frequent in the south eastern parts of England, and are continued in the same direction through great part of France; though, according to Delametherie, the strata of Dover and Calais are not precisely of the same nature. They occur also in Gallicia; in some of the islands of the Baltic; and in Poland.

Bath Stone.

Specific gravity 2,5.

This stone is composed of very minute and nearly spherical shells, either simply aggregated or not very firmly cemented together. It is much used in masonry on account of the ease with which it yields to the chisel; and from this circumstance it is technically denominated a free-stone: for the sake of greater accuracy it is sometimes called a calcareous free-stone;

for many siliceous stones, from the same property of being easily worked, are also called free-stones.

This stone effervesces very rapidly when thrown into muriatic acid; giving out a faint smell like spermaceti, and leaving scarcely any residuum: upon the addition of prussiate of potash a bluish white precipitate is deposited. A similar smell and precipitate may be observed in many limestones that are principally made up of shells.

Portland Stone.

This stone very much resembles Bath stone; but, as far as I have had an opportunity of observing, it contains many flattened portions of shells, whereas the particles of Bath stone are all nearly spherical.

Westminster bridge is built of Portland stone, and the King's docks in Plymouth were originally coated with it. Mr. Smeaton having observed that in the latter instance the stone, although the construction had been recently made, was perforated in numerous places by small shell-fish of the tribe of the Pholas, which easily make their way through this stone on account of its softness, was induced to use a harder kind of stone in constructing the foundation of the Edystone lighthouse.

Stone of this nature is very common in every part of the world. The base of the plains to the south of Paris is of this kind: there are abundant quarries of it in the neighbourhood of Caën in Normandy; and it was frequently imported from thence into England in the first centuries after the conquest. Westminster abbey is built partly of Caën, partly of Portland stone. According to Horneman the building at Siwah, the Oasis of Ammon, is a calcareous free-stone standing on a rock of the same nature, and containing petrifactions of shells and small marine animals. Browne describes the same stone as being full of marine remains: as also the stone of which the great Pyramids of Giza are built; and the rock on which they stand. Pallas speaks of the hills in the neighbourhood of the Volga as being in general calcareous with marine remains. Forster describes the stone of the country near Benares as very like Portland stone; but closer grained, and deeper coloured.

As this stone is so generally met with, and is so easily worked, it is no matter of surprise that it has been in all ages and countries so commonly employed for the purposes of masonry and coarse statuary: and hence the similarity of character in the stone of most of the remains of ancient buildings, &c.

Limestones of this kind are often comparatively soft when first taken out of the quarry; and harden by exposure to air; probably in consequence of the evaporation of the moisture contained in them. Stone of this kind is, though often very indistinctly, of a laminated structure; and when used in building ought to be placed so, that the laminæ may have the same parallelism with the horizon which they had in the quarry: otherwise it crumbles and peels off; of which there are many instances in the public buildings of Oxford. The effect is perhaps to be explained in the following manner: in general the laminæ of this stone, in its natural position, are parallel or nearly so with the horizon; and press therefore perpendicularly on each other: but if in building they are placed so as to be vertical to the horizon, their mutual support is in a great measure destroyed; and the moisture of the atmosphere &c. then penetrating, swells the substance of the exterior laminæ, which give way in the direction where there is least resistance; namely, towards the surface exposed to the air: and thus the beauty and strength of the building are impaired. If that moisture congeals, as in frosty weather it sometimes will, the expansion is greater, and the effect consequently more remarkable. It must however be added, that cylindrical columns of this stone sometimes undergo concentric disintegration, which cannot well be explained on the above principle.

Magnesian Limestone.

This is a variety of calcareous free-stone, remarkable for containing a considerable proportion of magnesia. Limestones of this kind, if used after calcination as manures, are very injurious to the process of vegetation: and this property has been ascertained to depend on the presence of the magnesia contained in them.

The limestone of parts of Derbyshire, Nottinghamshire, and Yorkshire is of this kind. At Matlock the limestone of the rocks on the side of the river where the houses are built, is calcareo-magnesian; on the other, simply calcareous.

York minster and Westminster hall are built of magnesian lime-stone; of which the following analyses were made by Mr. Tennant.

Stone of York Minster.		*Stone of Westminster Hall.*	
Carbonic acid . .	47,00	Carbonic acid . .	47,16
Lime	33,24	Lime	33,48
Magnesia . . .	19,36	Magnesia . . .	17,76
Iron and clay . .	0,40	Iron and clay . .	1,60
	100,00		100,00

Mr. Tennant considers this variety of limestone as an impure and coarse Dolomite; to which it bears the same relation that Portland stone does to Parian marble.

The proportions of lime and magnesia, contained in this stone after it has been calcined, are three fifths of the former and two fifths of the latter.

Magnesian limestones seldom contain many shells.

Calcareous Tufa.

Tophus Calcareus. The terms tufa and tophus, apparently derived from the verb τύφω, in their original application are appropriate to volcanic productions; especially to such as are of a spongy or porous texture.

Calcareous tufa appears to be a porous limestone, bearing the impression of reeds, and grass or moss;

and containing sand and shells, and various extraneous substances.

Dolomieu applies the term tufa to a coarse breccia that has been formed under water, by a mixture of the slime and mud of rivers with fragments ejected from volcanoes.

Travertino or Tevertino.

These terms are probably derived from the word *Tiburtinus*: for Vitruvius speaks of Saxa Tiburtina; and that the Lapis Tiburtinus was a calcareous carbonate appears from a passage of Palladius, in which it is described as capable of being burnt to quick-lime *.

Winkelman calls Travertino a stony concretion of a spongy nature; and says that it is particularly formed in the waters of the Anio (called now the Teverone), which have a petrifying quality: and hence these quarries are occasionally replaced by fresh stone, in blocks of which tools have occasionally been met with †.

St. Peter's is built of Travertino. The ruins of Pæstum are of the same kind of stone, which is asserted by some to have been originally deposited from the rivers that flow in that neighbourhood.

Limestone of this kind hardens in a remarkable degree by exposure to air; and it is not

* Rei Rust. Auctor. p. 409.

† Winkel. tom. iii. p. 20.

improbable that the great solidity of Roman masonry has arisen from the joint use of Travertino and Puzzolana, which are both met with in the same neighbourhood.

Piperino.

Dolomieu applies this term to a stone of an *argillaceous* base, which is formed by an eruption of muddy matter that is common in Italy.

According to Winkelman, Piperino is a stone of a hardness intermediate between that of Travertino and Tufa; employed very early in the buildings of Rome; and called by the ancients *Saxum Albanum*, from the place where it was quarried: from this account we may infer that Piperino is a *calcareous* stone, somewhat of the nature of the two preceding.

The foundations of the Capitol (built U.C. 367.), some of which are still to be seen, are of Piperino: the principal sewer also (built U. C. 358.), near Albano, is of the same stone: as also a bust discovered in the tomb of Scipio in the year 1780 *.

Roe-Stone.

Cenchrites; Meconites; Hammites, ovis piscium similis; of Pliny: so called, respectively, from its resemblance to an accumulation of millet seeds, poppy seeds, and grains of sand.

Oolithus; from its resemblance to the roe of a fish.

* Winkel. tom. i. p. 30.

Specific gravity 2,45.

Carbonate of Lime	90
Alumine, with a little Iron . .	10
	100 *Kirw.*

Roe-stone is not common.

According to Brochant, it is sometimes used, for the purpose of dressing land, instead of marl. It is met with in considerable quantity in the province of Thuringia in Saxony.

Pisolithus or Pea-stone.

This, like the last mentioned, is made up of distinct spherical concretions; not of so uniform a size, but upon the whole much larger: many of them are nearly as large as, and do not differ much in external appearance from, a dried pea; whence indeed the name of the stone. A concentric formation may easily be traced by mechanical division in some of the larger particles; and is evident in observing the appearance of a transverse section of most of them: in which case the nucleus also, round which the deposition has taken place, may often be distinctly seen. Some of the concretions are as large as a walnut, and contain a considerable proportion of ochry clay, which gives them a reddish brown colour. It occurs in the neighbourhood of the hot springs of Carlsbad in Bohemia; and, according to Mr. Jameson, Werner's hypothesis of its formation is this: "Parti-
"cles of sand appear to be raised in the water by means

"of air-bubbles, and become covered with calcareous "earth, which is deposited around them in lamellar "concretions; at length the globular concretions thus "formed acquire so much specific gravity, that they "fall down, and being agglutinated give rise to "Pea-stone *:" but it may be observed that according to this explanation the spherical concretions ought all to be of the same size, which is very far from being the case; or if they increased in size after their subsidence, their form would become hemispherical, since the deposition of earthy matter would continue to take place only on their upper surface. Besides which, as air bubbles usually burst upon coming to the surface of the water through which they have risen, it is not easy to understand why the particles of sand should not sink, immediately upon being disengaged from the bubbles that elevated them.

Calcareous Concretions of Tivoli.

Confetti di Tivoli; Bellaria Tiburtina; Stalagmites confectionarius; Bellaria lapidea; of Wallerius.

The appearance of these concretions fully justifies the application of the foregoing names: for, in shape and whiteness, they remarkably resemble those small sweetmeats that are formed by enveloping carroway seeds, &c. in a paste of sugar; and like them also they contain an extraneous nucleus, round which they have probably been formed by concentric depositions.

* Jameson, vol. i. p. 504.

The incrusting substance of these concretions is not entirely carbonate of lime: a proportion amounting to about one fifth of the whole, which is very light, of a white colour, and insoluble in diluted muriatic acid, appears to be sulphate of lime. A number of these cemented together would form a Pisolithus; but the particles are not so smooth or regular in their form as those of the Carlsbad Pisolithus, nor is the concentric formation so evident.

Limestone of a greyish black Colour.

Many of the darker coloured varieties emit a fetid smell when scraped, and hence are called Swinestones. Mr. Kirwan says of these that they are "generally presumed to contain some bituminous "substance, and with good reason; though he could "procure none from a specimen which he tried by "distillation, nor any air distinct from fixed air *."

Their colour is dissipated during calcination: and as many of them burn to nearly a white lime, generally indeed in proportion to their original darkness of colour, it seems that they contain only a small quantity of iron.

Bergman says that in the mountains of West Gothland dark coloured fetidly smelling limestone occurs in great plenty, and is there burned to lime; the expense of fuel being much diminished, from the aliment the stone itself affords when heated to

* Kirw. vol. i. p. 90.

redness. Mr. Kirwan, from whom the foregoing statement is taken, adds, that this quality is known in many parts of the county of Galway, where this stone abounds, but fuel is scarce; and hence it is often employed to heat rooms, as it remains hot many hours*.

Limestones of a light blue or grey Colour.

In many instances the colour depends on the presence of clay which contains iron in a low state of oxydation; the proportion of the clay amounting to a little more than one tenth. Limestones of this kind burn to a buff-coloured lime; and Mr. Smeaton observed that lime of this colour formed a harder mortar under water than any other: this property he attributed to the presence of iron, and made successful experiments in support of his opinion. He found that scales of iron from the forge, and lime, mixed in equal proportions, made a good succedaneum for Puzzolana; this being a substance commonly employed for giving to common mortar the property of hardening under water.

This variety of limestone is common in Somersetshire; and occurs, in the form of shingles or large pebbles, at Aberthaw on the coast of Glarmorganshire.

Bergman observed that lime made from some limestones of Upland, which became blackish by calcination, possessed the same property of hardening

* Kirw. vol. i. p. 90.

under water; and that this property depended on the presence of manganese.

Bluish grey limestone often passes into marl.

Calcareous Slate or Flagstone.

Specific gravity 2,6.

There is a very extensive quarry at Stonesfield, near Woodstock, the limestone of which has the property of being easily separated into laminæ by mechanical means; or even by the action of the atmosphere. The manner in which the effect is produced in the latter instance may be understood, by a reference to what was said respecting that superficial disintegration which takes place occasionally in calcareous free-stone *.

This variety of limestone is employed very generally for the purpose of covering the roofs of houses; whence it has been called Lapis tegularis. The property of being thus easily separated into laminæ depends partly upon the proportion of clay contained in it (for this property is in general more remarkable in proportion to the quantity of clay contained); and partly upon the nature of its original deposition: for the stone of some parts of the quarry contains a considerable quantity of minute shells resembling millet seeds; and it seems worth observation, as connected with the schistose property of the stone, that

* Vid. p. 23.

the deposition of shells is more abundant on the surface than in the substance of the laminæ.

In some instances, a singular arborescent appearance is observable on the contiguous surfaces of adjoining laminæ: the colour of this is for the most part black; and, from some experiments that were made for the purpose of ascertaining its nature, appeared to be principally manganese. The same appearance is observable in some varieties of Florentine marble. Sometimes the colour is only superficial; at others it penetrates far into the substance of the stone. The explanation of the appearance is not obvious; but perhaps some liquid, holding the colouring matter in solution, originally insinuated itself into the clefts by which the laminæ are separated from each other, and deposited this, particle by particle; by something like that continuous attraction, if the term is allowable, which takes place in the freezing of moisture on a pane of glass.

Marls.

Specific gravity varies from 1,6 to 2,4.

If calcareous carbonates contain a sufficient proportion of clay to crumble by exposure to air, and fall into a powder in water, they are then called Marls. The proportion of calcareous carbonate in marls varies from about two thirds to four fifths; all which part may be separated by most of the acids; being readily soluble in them: the residuum is clay; which itself consists, as all clays do, of alumine and silex. The several constituent parts of marl are in such a minute state of division as to be invisible to the naked eye.

According to the proportion of the calcareous and argillaceous parts, different marls, as used in agriculture, are applicable to different soils: where the calcareous part is comparatively abundant, the marl is proportionably applicable to a clayey soil; where the argillaceous part is more considerable than usual, to a sandy soil.

Marls have frequently a fissile structure; and in this case may, by the eye, be confounded with the softer varieties of argillite or slate, called Shale: but, as the former effervesce with acids, which the latter do not, it is very easy to ascertain the real nature of each.

There is a variety of schistose marl impregnated with bitumen, remarkable for commonly containing the impression of fish or marine plants: and it is further remarkable in this marl, that the positions of the fish are often very much contorted; as if they had died by a violent death. Emmerling indeed goes so far as to suppose that the copper pyrites, often found in marl of this kind, was the occasion of their death, their substance itself being impregnated with the pyritical matter.

Saussure mentions a curious fact respecting the impressions of fish met with on a hard schistose marl in Monte Bolca, near Verona; namely, that the impressions of one hundred and five different species have been there recognized, of which

Twenty-seven belong to	European seas.
Thirty-nine	Asiatic seas.
Three	African seas.
Eighteen	south American seas.
Eleven	north American seas.
Seven	fresh water lakes and rivers of different parts of the world *.

From the fissile structure of marls, the frequent presence of organic remains in them, and the equable mixture of their component parts, Wallerius supposes that they originated from the detritus of other substances; and that they were once in a liquid state. This is now very generally allowed to have been their origin: especially as they only occur among secondary strata.

It appears from Pliny, and the Rei Rusticæ Scriptores, that marls were very anciently used as manures. The principle of their use is not yet clearly understood: but seems to depend partly on the minute state of division in which the calcareous part exists; for Wallerius relates, that in some countries, finely divided calcareous carbonates are used simply as a substitute for marl. A similar practice prevails in some parts of England; and the substance employed is a kind of fine sand, consisting almost entirely of minute and minutely comminuted shells,

* Sauss. Voyag. tom. vi. p. 52.

met with in the Scilly islands, and some parts of the coast of Cornwall.

Ludus Helmontii.

Septarium.

Tophus in segmenta divisus; of Wallerius.

This substance is an indurated marl, containing numerous veins of carbonate of lime, which divide it into distinct partitions; and hence the term *septarium:* sometimes the transverse sections of these partitions are nearly of a square form; and as they then resemble the surfaces of dice, the substance has been called in consequence *Ludus Helmontii;* Van-helmont having particularly described it.

This variety of marl sometimes occurs in distinct and flattened spheroidal nodules; sometimes in larger and irregularly shaped masses, or even strata.

In the former instance the veins of calcareous carbonate are opaque and of a white colour; and so distributed as to be of the greatest dimensions at the centre, from whence they gradually diminish towards the circumference of the nodule, but terminate within it. From this distribution Mr. Playfair draws a very strong argument in support of Dr. Hutton's theory; since, as in this case, "the "matter with which the veins are filled could not "have been introduced by infiltration from without, "or in any other way; the only supposition left for "explaining the singular structure of the fossil is,

" that the whole mass was originally fluid; and that " in cooling the calcareous part separated from the " rest, and afterwards crystallized *."

The argument is, I think, incontrovertible in the particular instance; but in many instances of the massive and irregularly shaped Ludus, the veins are neither disposed in the same manner, nor are they of the same colour and opacity: on the contrary they possess that kind and degree of transparency and colour, which is characteristic of those varieties of carbonate of lime, that have unquestionably been deposited from water, as in stalagmites, &c.: and besides this, there are internal marks of a periodical formation of the vein, both from its stratified character, and the difference of colour in the different corresponding strata.

It may be further observed, that the veins met with in marls of this kind, as also in dark coloured common limestones, are themselves either without colour; or are coloured by matter that is soluble in water: while the colouring particles of the substance containing them are insoluble in water.

Marl sometimes occurs in the form of distinct nodules, which, in their natural position, resemble pebbles imbedded in the surrounding soil. These nodules are usually met with in beds of marly clay; and are often arranged with much regularity; as in some

* Playf. Illust. pp. 30, 31.

of the quarries of Shotover hill, in the neighbourhood of Oxford. Pliny seems to describe a nodular marl of this kind under the name of Creta Columbina: "*Glebis* excitatur *lapidum modo*: sole et "gelatione ita *solvitur* ut tenuissimas bracteas faciat. "Hæc ex æquo fertilis *." He alludes to a variety of marl of which he has been speaking. The large nodules in Shotover hill undergo nearly the same disintegration, by exposure to the changes of the atmosphere.

Stalactitic Carbonate of Lime.

Water, in penetrating through marble or limestone strata, very commonly becomes impregnated in its passage with particles of the calcareous carbonate; which it subsequently deposits, either by simple exposure to air, or upon the surface of extraneous bodies with which it comes into contact: in the first instance giving rise to those formations called Stalactites, &c.; in the last, those earthy incrustations commonly called Petrifactions.

The most familiar instance of the deposition of calcareous matter from water is that, which takes place on the inner surface of vessels employed for the purpose of boiling water impregnated with calcareous carbonate: it is called by Wallerius, Tophus Calcareus lebetum; the term tophus arising from its

* Nat. Hist. lib. xvii.

resemblance, in lightness of texture, to real tophi or volcanic productions. A similar deposition takes place at a common temperature, upon the surface of tubes and reservoirs conducting and holding the same kind of water. The incrustation separated from the sides of Carfax conduit, in Oxford, (at the time of its removal, about twenty-five years since) was nearly an inch in thickness; and of a distinctly sparry structure. There is, in the Oxford collection, part of a wooden duct that served to convey the water from this conduit: the transverse section of it is of a square form, and it is worthy of observation that the calcareous incrustation, which is of a stratified appearance, is of equal thickness on every one of the four surfaces: by which it appears, that a deposition of this kind is not merely mechanical; nor does it necessarily follow, as some have argued, that such depositions accumulate according to the law of gravity: and hence there is no difficulty in supposing, that vertically situated veins may have been sometimes formed by lateral and successive depositions *.

Agaric Mineral.

Creta farinacea, spongiosa; of Wallerius.

Lait de Montagne; from its white appearance, while oozing from the clefts of mountains.

Lac Lunæ; from a similar appearance with the

* Vid. the article *Ludus Helmontii.*

foregoing, which occurs in a particular cave in Phrygia: this cave, according to the tradition of the neighbourhood, having been formerly frequented by Diana.

This is a stalactitic deposition of carbonate of lime, frequently met with in the clefts of calcareous strata, particularly such as are of a porous texture; in some instances it adheres to the sides of the cleft with the resemblance of a fungus (*agaricum*): and hence its name.

The appearance that gave rise to the term Lac Lunæ is often observable in that bed of gravel which is situated on the north side of Oxford, between the Isis and the Cherwell: and is explained by the nature of the gravel which contains a considerable proportion of broken shells: whence also the *petrifying* nature of the brooks that issue from this stratum *.

Agaric mineral is sometimes confounded with a variety of clay; but may be easily distinguished by means of its ready solubility in diluted nitric or muriatic acid, which scarcely acts on the latter substance.

It is very common in Switzerland, where it is much used for the purpose of whitening the fronts of houses.

The limestone of that part of Oxfordshire round Chipping-Norton, and the adjacent towns, very commonly undergoes an alteration which converts it into the state of Agaric Mineral. In some notes of ex-

* Vid. the article *Osteocolla*.

periments, made about four or five years since, I find that a piece of limestone of this nature, but as yet unaltered, lost less of its weight by calcination than common limestones lose. The experiment was not repeated, and therefore I should not rest much on this result; but that it corresponds with the results of other experiments, made with the view of ascertaining the proportion of carbonic acid contained in limestone of this kind. By these, in which the carbonic acid was expelled by means of muriatic acid, it appeared that equal weights of Parian marble, of Portland stone, and of calcareous spar, yielded very nearly equal quantities of carbonic acid gas, or fixed air: that the limestone in question, when unaltered, yielded a considerably less proportion of carbonic acid than the foregoing calcareous carbonates; but that when converted into agaric mineral it yielded the same proportion. The experiments were repeated two or three times with different weights of the various substances, and, if accurate, lead to the following inference; that agaric mineral is probably produced from a calcareous carbonate, containing a less proportion than usual of carbonic acid, by the absorption of the additional quantity requisite for its chemical saturation.

A variety of agaric mineral is met with in the form of slime or mud at the bottom of fresh water lakes. This is the case at Langors pool, near Brecon, where it is perhaps brought by torrents from adjoining calcareous hills.

Stalactitic Incrustations.

If water impregnated with calcareous matter remains long in contact with extraneous substances, an earthy incrustation takes place, that soon excludes the incrusted substance from view; which thus, in common language, is said to be petrified: the shape, that is, remaining the same; but the substance in appearance converted into stone. In this manner are formed the well known *petrifactions* of birds' nests, moss, leaves, &c. If the process be carried on for a sufficient length of time, and the incrusted body be of a perishable nature, as in the case of vegetable matter, the whole of this is removed by gradual decay, and the remaining mass is entirely earthy: but its form, and the circumstances of its situation, will generally serve to shew its origin.

The warm springs of St. Philippe in Tuscany contain a great proportion of calcareous matter, which they deposit so compactly round substances immersed in them as to be employed for the purpose of obtaining casts, and models &c. With this view hollow moulds being suspended in the water, the earthy particles are deposited in them; and the deposition, when removed from the mould, preserves the exact impression of it. These incrustations are very delicately, but very firmly compacted; and of a whiteness equal to that of Carrara marble. It is said that there are springs of the same kind near Guanca-Velica in Peru; and that many vases and statues &c. are placed in the

Church of Lima, which have been formed from such depositions as those of St. Philippe. In a similar manner (as Kircher relates in his Mundus Subterraneus *), the inhabitants of the neighbourhood of Tolfa incrust wooden models of crucifixes and candlesticks with crystals of alum, by keeping them immersed for some time in a solution of that salt; and with these adorn their altars.

Osteocolla.

The substance so called by the earlier mineralogical writers, from its resemblance to a mass of agglutinated bones, is nothing more than a calcareous deposition that has taken place round small branches and twigs of trees. In many instances the vegetable substance has been removed, and its place supplied by the deposition of fresh earthy matter: seldom however entirely; for in making a transverse section of any of the branches of such a mass, there may be generally observed the trace of a longitudinal cylindrical cavity; which shews that the deposition originally took place on something that has been subsequently removed.

The incipient stage of the process just described may be seen in some of the springs of Shotover hill, near Oxford: and in many of the small brooks which run into the Cherwell on the north side of that city. The dead leaves &c. found in the bottom of these

* Vol. i. p. 336.

brooks being generally covered with a thin earthy incrustation, which readily peels off.

Stalactite.

The term stalactite is applied particularly, to those calcareous concretions which are formed on the roofs of natural caverns; and which resemble in their shape the common icicle.

The matter of the stalactite, as has been already stated, is conveyed by water that has penetrated the contiguous strata; and in its deposition assumes various appearances according to accidental circumstances.

If the water oozes through very slowly, some time elapses before a drop is formed of sufficient size to fall by its own weight; and, in this interval, some of the calcareous particles are separated from the water, and adhere to the roof. In this manner successive particles are separated and attached to each other, until a stalactite is formed.

When the formation is rapid, the texture is comparatively loose, and of an earthy appearance; and this is particularly the case with those stalactites that are formed from recently constructed arched buildings, as bridges, or cellars; where the stalactite is made up of thin concentric cylinders, like a roll of fine cinnamon. In other instances the substance is completely sparry: and, often, very closely resembles the transparent part of the quill of a bird's wing; and not unfrequently terminates in a spherical assemblage of small pointed crystals.

Flos Ferri.

The form of this is irregularly coralloïd. It is met with at Schemnitz in Stiria in the clefts of sparry iron ore; from which circumstance, and the delicacy of its general appearance, it has received the above appellation: but it contains no iron. Some suppose it to be a stalactitic carbonate of lime. Count Bournon has conjectured that its form is the effect of sublimation; the direction of the coralloïd branches being too wavy and uncertain to have proceeded from stalactitic deposition. A tranverse section of this substance shews a delicate instance of a fibrous radiated texture: the branches are often of a silky lustre externally, owing to an aggregation of very minute crystals, superficially investing them.

Stalagmite.

If the percolation of water containing calcareous particles is too rapid to allow time for the formation of a stalactite, the earthy matter is deposited from it after it has fallen from the roof upon the floor of the cavern; and in this case the deposition is called a stalagmite: a verbal distinction adopted merely for the convenience of description.

Stalagmites are commonly, at least in the early stage of their formation, of a mamillary shape: by gradual accumulation they become conical.

In some instances the separation of the calcareous matter takes place both at the roof and on the floor of the cavern; and, in the course of time the substance of each deposition increasing, they both meet; and form an irregular but continued pillar. Local circumstances, and the degree of celerity with which the deposition takes place, vary the appearance of the effect produced; and hence those grotesque accumulations which have been described as representing the forms of various animate and inanimate substances: as the fancied figures of lions &c., in some of the caverns near Buxton, and in other parts of Derbyshire. In the quarries of the island of Antiparos these depositions have been carried to a great extent: an account of the fantastic shapes of which is given in extravagant terms in a letter written to Kircher, inserted in his Mundus Subterraneus *. A passage in Pliny is applicable to this part of the subject: "Inter plurima alia Italiæ miracula, ipsa marmora in lapicidinis crescere auctor est Papirius Fabianus, naturæ rerum peritissimus: exemptores quoque affirmant compleri sponte illa montium ulcera †." The latter circumstance is often affirmed of the quarries of Antiparos.

* Vol. i. p. 122—130.

† Nat. Hist. lib. xxxvi.

It has been already said * that stalagmitical depositions constituted the alabaster of the ancients.

Greenish white Stalagmite of Derbyshire.

Specific gravity 3,1.

In making some experiments to ascertain the nature of the colouring matter of this stalagmite, I found that it contained a considerable proportion of oxyd of zinc: and I have reason to think that not only the perfectly white, but also the green part owes its colour purely to this oxyd. I did not ascertain the exact proportion of the metallic oxyd; but it appeared to be considerable; as might indeed be supposed from the specific gravity of the mineral: this being much greater than in the case of calcareous stalagmites in general.

Observations on Stalactites, &c.

In the generality of instances these depositions are of a light brown colour, and opaque; or of a dirty straw colour, with some degree of transparency: the colour is probably owing to the presence of vegetable matter dissolved by the water in its passage through the soil. In other respects stalactitic carbonate of lime is purer than that of the strata from whence it is derived; the water not readily dissolving other earthy or any of the metallic matter contained in them.

* Vid. p. 15.

Mr. Coxe, during his travels through Europe, never failed to observe that calcareous depositions abounded in all those districts where the disease called Goitres was prevalent. Pallas mentions the coincidence of this disease, and of springs impregnated with calcareous carbonate on the banks of the Volga: the same coincidence is well known in Derbyshire; and is met with frequently in Oxfordshire. It has often been observed in Sumatra; in which last place at least the origin of the disease cannot be referred, as it often is, to the custom of drinking snow water. A paper however, written by Dr. Reeve, in the Philosophical Transactions for 1808, controverts the truth of the supposition, that this disease arises from the use of water impregnated with calcareous carbonate.

General observations on Calcareous Strata.

Saussure says it is a general observation, though subject to some exceptions, that in the great chains of mountains the exterior ridges are calcareous: and that secondary limestones, containing or made up of shells, are almost always covered with sandstone, and breccias of various kinds. It has been already said, that of calcareous strata in general, those which are called Primitive have the lowest relative situation. Calcareous free-stones and marls on the other hand are placed nearest the surface; and are supposed in consequence to have been the last deposited.

With respect to the organic remains met with in secondary carbonate of lime, it has been observed, that their form appears in general to have been well preserved : and this not only in the case of hard, but of soft and perishable substances ; whereas those organic remains that occur in clay are in general more or less flattened. This circumstance is curious, because in reasoning from the different characters of the strata, one should have supposed that the pressure of the latter would have been much less than of the former ; and the form of the contained substances consequently less altered.

Calcareous strata are often remarkably contorted, and in some instances appear even to have been elevated, and thrown back upon themselves. In all these contortions, however, they preserve their mutual parallelism.

The hardest and most compact carbonates produce the best lime : and in all instances the lime is better, if the stone has been calcined soon after its removal from the quarry : this effect seems to depend on the moisture remaining in it ; for when limestone that is to be calcined is very dry, it is customary to sprinkle it with water just before it is put into the kiln.

Many compact limestones contain some proportion of carbon, derived probably from animal or vegetable decomposition : in some the carbon is combined with bitumen. The bituminous particles, being volatile, may be driven off by heat simply: the carbon can only be driven off by the joint action of heat and air; and hence limestones containing it, when calcined in close vessels, never give a perfectly white lime.

Satin Spar.

Lime	50,8	
Carbonic Acid .	47,6	
	98,4	*Mr. Pepys.*

This substance when polished has that kind of lustre which belongs particularly to satin: and seems to derive this from its fibrous structure, joined with a certain degree of transparency in the separate fibres. The structure of it is remarkable from an appearance of stratification in a direction at right angles to that of the fibres: but, according to Mr. Gregory Watt, this is common to substances in general of a fibrous and radiated structure.

There is a specimen in the Oxford collection consisting of several tabular pieces of fibrous carbonate of lime applied irregularly to each other: the fibrous appearance is nearly as delicate as that of the satin spar, but the structure is not so compact, and the substance is completely opaque.

There is another specimen in the same collection, said to have been found in the neighbourhood of Bath, of a dirty brown colour; the structure of which is so loose that each fibre may be readily detached from the mass, and then easily crumbles between the fingers in a transverse direction to its length. The same transverse separation takes place also in the mass, giving the appearance of steps. These observations are merely made with a reference to the apparently similar, though more compact structure, in the satin spar; under the idea that with respect to their original formation the two last mentioned varieties may be connected with that substance.

The satin spar of Cumberland occurs in a rock of argillaceous schistus: the substance of the spar is intersected, at right angles to the fibres, by yellowish green veins of iron pyrites.

Satin spar occurs also in Derbyshire, according to Mr. Jameson.

Crystallized Carbonate of Lime.

Calcareous Spar; as commonly denominated in this country.

The primitive form of crystallized carbonate of lime is a rhombic parallelepiped: and if any of its varieties be broken, by a force applied however indiscriminately as to its direction, the fragments will always be rhomboidal: and although the dimensions of the corresponding sides may differ in different instances, the angles will invariably be the same.

All the transparent varieties of calcareous spar have a double refracting power.

Many calcareous spars are partially transparent: the opaque parts are often milk white; and I have found in several instances, that these parts contain oxyd of zinc: in which they resemble the greenish white stalagmite of Derbyshire *.

The specific gravity of calcareous spars is about 2,7. They do not effervesce with acids so violently as other forms of carbonate of lime; probably on account of their greater density. If they are transparent, there is scarcely any deposition during their solution.

Primitive Calcareous Spar.

The form of this, is a parallelepiped; the sides of which are similar and equal rhombs, with angles of $101^d\ 30'$, and $78^d\ 30$.

Primitive crystals of carbonate of lime are not often met with; but rhomboidal fragments of secondary crystals are frequently mistaken for them. The surfaces of the primitive crystal are sometimes convex.

Secondary rhomboidal crystals occur; which are more or less obtuse than the primitive: one variety is nearly cubic.

* Vid. p. 46.

Iceland Spar.

Iceland Crystal; from the place whence it comes.
Double refracting Spar; from the property described above *.

Specimens of this, which is not a natural variety of calcareous spar, are transparent, of a rhomboidal form, and shew very dintinctly the effect of the double refracting power: they are commonly said to be fragments of double six-sided pyramidal crystals, which are met with on the western coast of Iceland.

The iridescent appearance frequently observable in the interior of Iceland spar arises merely from the refraction of rays of light, occasioned by the splitting of the laminæ of this substance. The same effect may arise from a similar cause in any fragment of a transparent variety of calcareous spar.

Dog-tooth Calcareous Spar.

Chaux Carbonatée Métastatique; of Haüy.

This variety, which is very common in Derbyshire, has a dodecahedral form; the outline of each surface being a scalene triangle. Its appearance, upon the whole, represents a double six-sided pyramid: but insulated crystals are not often met with; and, in general, when the crystals are grouped, one only

* Vid. p. 51.

of the pyramids is seen. The form of this, the apex being very acute, has given rise to the epithet *Dog-tooth*. Bergman obtained the primitive form from this variety by mechanical division.

In this crystal there is a correspondence of particular angles, and the degree of inclination of particular faces, with the primitive crystal: and hence the epithet *métastatique*. "Ces deux propriétés produisent une espèce de *métastase*, ou de transport des angles du noyau sur le cristal secondaire, ce qui a donné naissance au mot *métastatique* *."

In the Ecton copper mine, situated on the borders of Derbyshire and Staffordshire, very remarkable specimens of a variety of the dog-tooth crystallization occurred some years since: they are transparent, and of a greenish brown colour; and contain within them numerous minute crystals of copper pyrites, sometimes of a bright yellow colour, sometimes beautifully iridescent. These specimens occur very commonly in mineralogical cabinets.

Many specimens of the stalactitical iron ore of Gloucestershire are studded with small dog-tooth crystals of calcareous spar, of a reddish brown colour: the apex only of each crystal is perceptible, projecting from one of the solid angles of a rhombic crystal that has been formed round each of the dog-tooth crystals. The appearance is very remarkable.

* Haüy, tom. ii. p. 135.

Prismatic Calcareous Spar.

Chaux Carbonatée prismatique; of Haüy.

The form of this crystal is a regular six-sided prism: it was from this variety that M. Haüy conceived the possibility of extracting the primitive form of crystals in general. A specimen of hexhedral carbonate of lime was given him, which was incomplete only in one part: the surface of the incomplete part had adhered to the mass from which the crystal was detached. This circumstance suggested the idea of dividing the crystal in different directions; and by persevering in the manner already explained *, M. Haüy extracted a rhombic parallelepiped.

Crystals of this variety, met with in the Hartz and in Bohemia, are often partially of a milk white colour; owing to the presence of oxyd of zinc.

Nail-headed Calcareous Spar.

Crystals of this form are a variety of the six-sided prism, terminated at each extremity by a flat three-sided pyramid, resembling the head of a common nail: this resemblance has given rise to the epithet by which the variety is distinguished.

There is a curious specimen, from Cumberland, in the Oxford collection, compounded of rhomboidal and nail-headed crystals; in which, two of the diago-

* Vid. Introduction.

nal solid angles of the former are surmounted by an imperfect crystal of the latter.

Arragon Spar, and Arragonite.

Harder than Calcareous Spars in general.
Slightly phosphorescent, when thrown in powder on burning coals.
Specific gravity 2,9.

This variety of calcareous spar occurs in the form of short regular six-sided prisms, commonly of a dull brownish green colour, singularly blended with a shade of violet; and slightly transparent at the edges. The surfaces of the sides of the prism are comparatively smooth: those of the base are channelled, by lines radiating from the centre: and, often, six of these channelled lines are stronger than the rest, so that the crystal appears as if it might be easily divided into six triangular prisms.

Crystals of Arragon spar often contain smaller crystals of the same imbedded in them; as also several small crystals of quartz, coloured by red oxyd of iron.

According to the analysis of Klaproth, this substance differs not from common carbonate of lime as to its constituent parts; but as it is irreducible by the usual means to the form of the primitive crystal, M. Haüy thinks that it must be a distinct species. Werner conjectures that it may contain phosphoric acid, from its resemblance to apatite, a variety of phosphate of lime.

It was first met with in the province of Arragon; and since, in France and Germany.

The matrix is sometimes a red clay, sometimes a gypsum.

There is a substance usually placed among calcareous spars, of a closely radiated prismatic structure; colourless, and nearly as limpid as rock crystal; and, like Arragonite, harder than calcareous spars in general: this, according to Count Bournon, may be considered as a variety of Arragonite.

Pearl Spar.

Sidero Calcite; of Kirwan: from its component parts, calcareous earth and iron.

Brown Spar; from its change of colour by exposure to air or heat.

Specific gravity 2,8.

Carbonate of Lime	96
Oxyd of Iron and Manganese .	4
	100 *Berthollet.*

This substance is called Pearl-spar from its colour and peculiar lustre. Where the proportion of iron and manganese is sufficient to raise the specific gravity above 3, the pearly lustre is not present: and where the proportion of the same substances is sufficient to raise the specific gravity to 3,6, it is to be considered as the ore of iron called *Spathose*, or *Sparry*.

Pearl-spar is harder than common carbonate of lime; and effervesces slowly with acids: but it is reducible to the primitive crystal. It becomes magnetic by the blowpipe, in consequence of the iron contained in it: and blackens by the same process, or by exposure to air, in consequence of the manganese contained in it.

It is commonly met with in the form of veins, or a crystalline incrustation investing other minerals: the latter arrangement appearing to be the result of small flattened rhombs applied to each other in a curved direction, so as to give a foliated appearance. It is said by Mr. Jameson to be one of the principal vein stones in the mining district of Freyberg, and to be considered as indicating the neighbourhood of rich silver ore.

Rhomb-Spar.

Bitter Spar; from the magnesia contained in it; which was originally denominated the earth of *bitter* salt, because obtained readily from sulphate of magnesia *(Epsom salt).*

Muri-calcite, of Kirwan; from the magnesia and lime contained in it: magnesia having been called muriatic earth, as being the base of one of the saline substances contained in sea-water.

Blackens and becomes magnetic by the blowpipe.

Specific gravity 2,5.

	Rhomb-spar from the Tyrol	*from Sweden.*
Carbonate of Lime	52	73
Carbonate of Magnesia	45	25
Oxyd of Iron and Manganese	3	2
	100 *Klapr.*	100 *Klapr.*

A specimen in the Oxford collection consists of several rhombic crystals grouped together, some of them nearly an inch in diameter: they have externally a brown ochry incrustation; internally they are of a pearly lustre, yellowish colour, and nearly transparent. They blacken and become magnetic by the blow-pipe; and in their chemical characters in general answer to rhomb-spar.

Rhomb-spar is considered by some, and properly, as it appears from the description just given, to be a variety of pearl-spar.

It is found at Königsberg, in Norway; in Saxony; in the Tyrol; in Cornwall; and on the banks of Loch Lomond.

Veins &c. of Calcareous Spar.

Under this head may be comprehended those veins &c. which occur in calcareous strata in general: as the white sparry veins observable in black limestones; and those crystallized incrustations that take place in the cavities of coarse calcareous free-stone, which are very common in the limestone of Oxfordshire, and in that of Yorkshire. The cavities in which this crystalline incrustation has taken place are often irregular, and the explanation of their origin not obvious; but sometimes they are nothing more than the hollow of shells contained in the limestone where they occur. These veins and incrustations have perhaps been formed by the infiltration of the matter of which they are composed.

In some instances these calcareous veins are of a red colour; and occur in red marl or clay: the colour in these instances is probably owing to particles of red clay, or oxyd of iron, that have been deposited during the formation of the calcareous carbonate. In the library of the Botanical Garden in Oxford there is a mass of irregularly crystallized carbonate of lime, of a red colour; which, according to a note preserved with it, was detached from the Acropolis of Athens.

Sulphate of Lime.

The hardness of sulphate of lime is inferior to that of carbonate of lime. At a low red heat the cohesion of its particles is in a great measure destroyed, and it crumbles into a white farinaceous powder. Its specific gravity varies from 1,87 to 2,32; that of the crystallized varieties being the greatest.

The principal constituent parts of the natural forms of this substance are lime, sulphuric acid, and water.

The amorphous varieties are called gypsum; the crystallized, selenite: the gradations between the two are very delicate; for often, in the same specimen, a texture completely earthy passes, almost imperceptibly, into a structure completely crystalline. Those varieties which are least crystalline contain the least proportion of water, as appears by the following experiments.

	Grs.
1010 grains of earthy or uncrystallized sulphate of lime, after having been exposed to a white heat for a quarter of an hour, lost of its weight	275
1417 grains of fibrous or imperfectly crystallized sulphate of lime, &c. lost	442
1597 grains of selenite or perfectly crystallized sulphate of lime, &c. lost	711

The proportions in the loss of weight in the several substances, compared with the original weights, are respectively as 27, 30, and 40, to 100; or nearly so.

If no coaly matter be in contact with sulphate of lime when exposed to a white heat, it is not further decomposed than by the loss of the water originally contained in it: the proportion of which in the different varieties may be judged of by the results of the experiments just stated, supposing them to have been accurately conducted; which, according to my notes, I believe they were. I am not, however, so well satisfied on this point as I should otherwise be, because Bergman states the proportion of water in sulphate of lime as not more than 22 to 100*.

Whatever be the proportion of the water of composition in sulphate of lime, the proportions of the two other constituent parts are as follow:

Lime	43
Sulphuric acid .	57
	100 *Mr. Chenevix.*

Sulphate of lime occurs generally in the neighbourhood of rock salt, and greyish black bituminous limestone. It is rarely, if ever, metalliferous.

It may be distinguished from carbonate of lime by its inferior degree of hardness; by the ready alteration it undergoes in a low red heat; and by not effervescing with acids.

Gypsum of Montmartre.

In the Oxford collection are some selenites from the quarries of Montmartre near Paris; which are here and there incrusted with, and also contain in their interior, a soft earthy substance of a cream colour. By an extemporaneous analysis of this earthy matter it appeared to consist of a mixture of

* Vid. the article *Selenite.*

sulphate of lime and carbonate of lime : it is probably therefore the gypsum from which the real plaster of Paris is made; for Haüy says of the gypsum of Montmartre that it naturally contains the quantity of calcareous carbonate requisite to make a good plaster; which, in the case of most other gypsums employed for the same purpose, is supplied artificially.

Plaster of Paris, taken in its extended sense as applied to all other analogous compositions, is prepared from gypsum by calcination: which process drives off the water of the sulphate of lime, and the carbonic acid or fixed air of the carbonate of lime, contained originally in the gypsum. The gypsum in this state has a strong disposition to absorb a certain proportion of water; and during this absorption the mass is consolidated: in which process it is supposed that the particles of the calcined carbonate of lime act as a connecting medium round which the sulphate of lime, in re-combining with the water that had been driven off during the calcination, undergoes a hasty and imperfect crystallization.

Granular Gypsum.

The colour of this when pure is delicately white.
Specific gravity varies from 2,27 to 2,310.

Gypsum of a granular texture is much used in statuary &c.; and is often called Alabaster: but it has been already said that the same term is applied to stalactitic carbonate of lime of a stratified ap-

appearance; and it is also applied to white marble.

With respect to the term alabaster, the following passages appear to me to afford the most satisfactory explanation of its origin;

'Αλάβαστρος, παρὰ τὸ λήβω μετὰ τοῦ στερητικοῦ ἄλφα· λαμβάνει δὲ τὸ ρ̄ 'Αλάβαστος οὖσα. "οὐ λαβεῖ-"σθαι διὰ λειότητα ἀδύνατον *."

'Αλάβαστρος. ἐστὶ λήκυθος ἡ ὦτα μὴ ἔχουσα· ἧς οὐκ ἐστὶ λάβεσθαι †.

If either etymology is to be rested on, the last is perhaps preferable; because alabaster seems to have been employed in the construction of unguent boxes, and other vessels, which, from their small size, did not require handles by which to lift them.

Granular gypsum has often a slight degree of transparency; and is employed in consequence, when formed into vessels of the proper shape, as an ornamental lamp-holder. It is soft enough to be turned with ease in a common lathe.

In the Oxford collection is a specimen of granular gypsum from near the falls of Niagara in America, which is literally as white as snow. It is further

* Vid. Etymolog. Magn.

† Dan. Scott Append. ad H. Steph. Thesaur.

remarkable on account of several well defined and perfectly transparent small rhomboidal crystals of selenite, which are irregularly disseminated through its substance.

Compact earthy Gypsum.

Compact earthy gypsum, if of a uniform texture, and of a colour sufficiently delicate, is employed often in ornamental masonry: if of a coarse and irregular texture, it is applied to agricultural purposes and the processes of the arts and manufactures. It is frequently marked with irregular veins and patches of a reddish brown colour; the colour owing to the presence of a clay coloured by red oxyd of iron. In many instances the iron is apparently derived from beds of blue clay or marl, contiguous to the gypsum: and it seems worthy of observation, that the clay, which is of a blue colour while simply contiguous to the gypsum, is of a red colour when intimately mixed with it. The same circumstance is observable, in some instances, in rock salt: the clay, which in a detached situation is blue, when contained in the salt is red; and hence that reddish brown colour of some of the varieties of rock salt.

It might be worth while to moisten an intimate mixture of colourless gypsum and blue clay; and also of colourless rock salt and blue clay; in order to see whether, in process of time, the colour of the clay would become red.

Farinaceous Gypsum.

Specific gravity 1,872?

According to Brochant farinaceous gypsum occurs very rarely; and is to common gypsum what stalagmitic carbonate of lime is to common limestone.

The calcareous concretions of Tivoli apparently consist, in part, of farinaceous or stalagmitic sulphate of lime *.

Fibrous Gypsum.

Specific gravity 2,3.

This variety occurs only in small masses or veins in the neighbourhood of strata of compact or granular gypsum: to which perhaps it holds the same relation that satin spar holds to white marble. The fibres of gypsum of this kind are often curved in various directions, at the same time that their parallelism is still preserved. Sometimes they are so loosely aggregated as to be separable by the least force; sometimes so compactly, as to be capable of resisting a violent blow of the hammer. In the latter case the lustre is occasionally very delicate, and attended with a pecu-

* Vid. p. 29.

liar reflexion of light from the surface, like that of the stone called the cat's eye: specimens of gypsum indeed of this kind, when artificially cut and polished, have been sold as that stone. Fibrous gypsum may be also mistaken for varieties of asbestus: but it is easily distinguishable from both the abovementioned substances, by its inferior degree of hardness, and by the alteration it undergoes in a low red heat.

In the neighbourhood of Matlock a variety of gypsum occurs of a broad arborescent or foliated form, not very unlike the leaves of endive.

Selenite.

Vitrum Ruthenicum, and *Moscoviticum;* but these terms have been considered by many as properly applicable to Mica. Pallas however mentions some crystallized masses of selenite, met with on the banks of the Volga, which were of several pounds weight, and were used instead of glass.

Gypsum speculare, and *glaciale;* from its obvious resemblance to glass and ice: so the common labourers in the pits, where it occurs near Oxford, call it *quarry glass.*

Glacies Mariæ; from its supposed application to the ornamental process of *frosting* the images of the Virgin Mary, which custom is common in Roman Catholic countries: but the substance generally employed for this purpose is probably Mica.

It has a double refracting power, but not easily discoverable.

Specific gravity 2,32.

Primitive form a four-sided prism at right angles with its base; which is a parallelogram with angles of $113^d\ 8'$ and $66^d\ 52'$.

Lime	32
Sulphuric Acid . . .	46
Water	22
	100 *Bergm**.

The term selenite, literally signifying moon-stone, is derived from the colour and soft lustre of this substance.

Selenites occur in considerable abundance, in a blue marl lying above a stratum of calcareous freestone, in some of the quarries of Shotover hill, near Oxford. The crystals there met with have commonly ten rhomboidal surfaces; two of which, opposite to each other, are very considerably larger than the other eight; the latter being produced, as it were, by the bevilling of the several edges of the former. These crystals are very easily separable into thin laminæ, in a direction parallel to the larger surfaces; and the laminæ, in being separated, often split transversely into rhomboidal plates, with angles of $113^d\ 8'$ and $66^d\ 52'$; which are the angles of the base of the primitive crystal.

* Vid. p. 61.

In some instances the crystals are remarkably elongated in the direction of the larger surfaces: in others they assume a lenticular shape. Sometimes they are aggregated in groups, and radiate from a common centre.

The most singular variety of selenite is formed like the barbed head of an arrow. This form may be artificially obtained by dividing one of the crystals above described, or, more conveniently, a card cut into a similar shape, in the direction of its greater diagonal: and then transposing the separated parts in such a manner, that two of the alternate angles, produced by the diagonal division, shall make the point; the other two, the barbs of the arrow-head.

The marl, in which these lenites of Shotover are found, contains numerous particles of pyrites; a compound consisting of sulphur and iron: and it appears that the sulphur, becoming acidified by some natural process, combines in this state with the lime of the calcareous carbonate contained in the marl, and thus promotes the formation of the selenite. That sulphuric acid is there formed, appears from an examination of the fossile oyster shells found in the same marl; part of the substance of which, originally a carbonate of lime, has in many instances been converted into a sulphate of lime: in consequence of which alteration, these parts of the shell do not effervesce upon the application of an acid to their surface: while the unaltered parts effervesce very readily.

The iridescent appearance sometimes observable in the interior of selenites depends merely on the refraction of light, occasioned by a partial separation of some of the laminæ of the crystal.

By exposure to weather selenites lose much of their glassy lustre and smoothness; and acquire a corroded appearance. These effects are probably owing to the removal of particles by the rain and moisture of the atmosphere; sulphate of lime being to a certain extent soluble in water.

Selenite may be easily distinguished from calcareous spar, by its inferior degree of hardness; and by not effervescing with acids: from mica, by its want of elasticity; and by becoming instantly opaque and friable upon the application even of the flame of a candle: from transparent zeolites, by not swelling into a spongy mass when submitted to the action of the blowpipe.

Observations on Gypsum.

The following explanation of the term Γύψος, in Latin *Gypsum*, shews that it was applied by the ancients to an earthy substance that had been exposed to the action of fire: Γύψος· *οἱονεὶ γήεψος τὶς οὖσα· ἡ ἑψηθεῖσα γῆ* *: in which it corresponds with the gypsum of the moderns.

The gypsum of the ancients corresponded also with

* Vid. Etymolog. Magn.

that of the moderns in whiteness; as appears from the following passage: γύψου ἢ χιόνος λευκοτέραν *.

And it was, by the general description of it, an earthy compound of lime: but the ancient naturalists sometimes seem to apply it to sulphate of lime, the gypsum of the present day; and sometimes to a calcined carbonate of lime, or quick-lime, which they called Calx.

In the following passages the term is applied to a sulphate of lime: "Cognata calci res gypsum est. Qui "coquitur lapis non dissimilis alabastritæ esse debet: "omnium autem optimum fieri compertum est e *lapide* "*speculari*, squamamve talem habente †:" the term *lapis specularis* applying very closely to our selenite, which is a sulphate of lime. "Gypsoma dido statim uten-"dum est, quoniam *celerrime* coit ‡:" the word *celerrime* being much more applicable to the comparatively rapid consolidation of calcined gypsum when moistened, than to that of common mortar.

In other instances gypsum is rather applicable to quick lime: "Vinorum medicaminis tanta cura est ut "*cinere* apud quosdam, ceu gypso alibi, &c. instau-"rentur §," where ashes being employed, probably on account of their alkaline properties, for the purpose of neutralizing the acid of the wine; we may suppose the substance called Gypsum was employed on

* Platon. Phæd. † Plin. Nat. Hib. lib. xxxvi.
‡ Plin. Nat. Hist. lib. xxxvi. § Ibid. lib. xiv.

account of its possessing the same properties: and this is the case with respect to quick lime; but not with respect to the substance now called gypsum. It may be said indeed that as many gypsums naturally contain calcareous carbonate, which during calcination is converted into quicklime, this may explain the difficulty: but from the above passage it may be inferred that gypsum was in common use for thus medicating wines; and, if its use depended upon the presence of the qualities belonging to the quicklime, it would have been much more economical to use quicklime itself, as being so much more easily obtained. There is a passage in Theophrastus in which a ship is said to have been set on fire in consequence of the moistening of its cargo, which consisted of gypsum and wearing apparel: in this case there can be little doubt that the substance called gypsum could not have been of the same nature with the gypsum of the present day; which in no instance perhaps contains such a proportion of carbonate of lime as when calcined would be sufficient to produce this effect.

Besides its use in statuary &c. gypsum is employed in agriculture, and some chemical processes of the arts. In agriculture it is of most use in soils that are naturally too moist. In the preparation of muriate of ammonia, commonly called sal ammoniac, its use depends on the sulphuric acid contained in it; which in one part of the process combines with the ammonia.

Most gypsums contain about a fiftieth part their weight of iron; several, more than this: and a small proportion of silex and alumine.

Anhydrous Sulphate of Lime.

Cube Spar; from its disposition to separate into cubic fragments.

Muriacite; this name arose in consequence of an analysis of Klaproth, by which it appeared that this substance contained fifteen parts of a hundred of common salt.

Hardness, much greater than that of sulphate of lime in general.

Does not become white by heat, like common sulphates of lime.

Separable into cubic fragments by the application of the least force.

Specific gravity 2,964.

Lime	40
Sulphuric Acid	60
	100 *Vauq.*

As Vauquelin's analysis differs so much from Klaproth's, it seems evident that their experiments were not made upon the same substance; for the results obtained by such able chemists would hardly have differed so much in the analysis of the same mineral.

In consequence of its containing no water, it has received the above epithet *anhydrous:* to the absence of water is perhaps owing to the readiness with which this substance may be separated into fragments.

Fluate of Lime.

Fluor, or Fluor Spar. This name is derived from its occasional use as a flux for metallic ores.

Derbyshire Spar; the Fluor of Derbyshire being most known in this country.

Hardness, greater than that of Carbonate of Lime.

Phosphorescent by friction, and still more so when exposed to a red heat: the property however, and with it the colour, is destroyed by such a heat.

Specific gravity 3,1.

Primitive form, a regular octahedron.

Lime	57
Fluoric Acid . .	16
Water	27
	100 *Scheele.*

Fluate of lime is rarely of an earthy texture: it is most frequently crystallized in cubes: and is remarkable for the natural beauty, and variety of its colours; whence fluors have been occasionally called mock gems.

The primitive form of fluate of lime is easily obtained by mechanical division; but does not often occur in nature.

Fluate of lime may easily be distinguished from carbonate of lime by not effervescing with a weak acid. If reduced to powder, and made hot, it effervesces slowly with sulphuric acid; and may thus be distinguished from phosphate of lime: the effervescence is occasioned by the separation of the fluoric acid, which when in a disengaged state is aëriform.

Vestiges of phosphoric acid are said to have been discovered in most fluors; with which perhaps their phosphorescent property may be connected. It does not exist in the colourless varieties of fluor, nor in artificial fluate of lime.

Fluor occurs principally in veins, either simple or mixed; and accompanies various metallic ores.

There is a specimen in the Oxford collection, the form of which is that of a bivalve shell; to the inner surface of which are attached imperfect crystals of nearly colourless fluor. This specimen had been classed as a carbonote of lime, from which substance it is scarcely distinguishable by the naked eye: accident led me to examine it chemically, and I found that both the shell itself, and the fragments of imbedded crystals, were fluate of lime. This is the only instance in which I have seen or heard of organic remains, the matter of which consisted of lime in combination with fluoric acid.

Colourless Fluor.

Many of the crystals of Derbyshire fluor are colourless, and have their surfaces sprinkled over with minute particles of pyrites. In some instances it appears, that after these pyritical particles have been deposited, an augmentation of the crystal of fluor has taken place: so that the spangled surface of the inner crystal may be viewed through the superincumbent laminæ of the outer. In a few instances this process has been repeated several times; and, by means of the interposed particles of pyrites, numerous parallel planes may be seen within the body of the crystal.

Purple Fluor.

The intensity of the colour of purple fluor varies from the palest to the deepest amethystine shade; and, if a crystal of this colour be held between the eye and a strong light, a shade of green is often observable.

A variety of cubic purple fluor occurs in Cornwall, in which each face of the cubic is so modified as to have the appearance of a very flat pyramid; so flat, that the difference of the planes of the four sides is not easily perceptible.

There is a dull violet coloured fluate of lime from Siberia; which, without splitting upon the application of a red heat, as is the case with fluors in general, becomes of a beautifully green colour: from which property it has been denominated chlorophane.

Cumberland abounds in crystals of purple fluor;

many of them remarkably large. The colour of them often inclines to red: sometimes they are clouded with opaque white specks.

In the fluors of Cumberland the structure of a large crystal, arising from the aggregation of smaller of the same form, is frequently very evident.

Blue Fluor.

Blue Iohn; of the Derbyshire Miners.

The colour of this, like that of the foregoing, varies from the palest to the deepest shade: sometimes it is so intense as to appear black; but even the most dark coloured, when reduced to powder, become, like black flint under similar circumstances, comparatively pale.

The blue fluor of Derbyshire is found in a mine near Castleton. The mine is in a hill of limestone, the substance of which is broken into irregular cavities. Some of these cavities contain large stalactitic concretions of carbonate of lime: many are partially occupied by masses of brown clay, in which irregularly shaped nodules of blue fluor are met with. A transverse section of these nodules exhibits a concentrically crystalline structure.

This is the variety that is most commonly employed in the fabrication of ornamental vases &c. The natural colours may be modified or destroyed by heat; passing from blue to reddish purple, brown, and different shades of yellow; in the last change having often a honey-coombed appearance: but the colours thus artificially obtained never equal the natural colours in beauty.

Green Fluor.

Green Fluor is comparatively of rare occurrence: and is not often distinctly crystallized: yet it is more disposed to separate into fragments of the primitive form than any other variety.

The phosphorescence of green fluor is particularly beautiful.

A variety occurs in Cornwall consisting of laminæ that are partly green and transparent; and partly perfectly opaque and white. From specimens of this variety, primitive crystals may be easily extracted by mechanical means: these crystals are sometimes superficially incrusted with pyrites.

The chemical difference between the green and the white part has not, I believe, been ascertained: perhaps the latter has partially or entirely lost its water of crystallization; for it is very friable.

Yellow Fluor.

More rare, at least when the colour is clear and deep, than any other variety. It has been said that the fracture of fluor always exhibits a laminated structure; yet I have seen a specimen of yellow fluor, the fracture of which is in part completely vitreous.

Corroded Cubic Crystals of Fluor.

Chaux Fluatée Aluminifère; of Haüy.

The surface of these crystals, which are usually met with in cabinets in small detached cubes, has a spongy appearance; as if they had been partially corroded: their texture is also porous throughout. Those parts which have not been corroded are colourless and transparent. When boiled in diluted nitric acid they leave a mass consisting of numerous grains of white fluor; and the acid deposits a deep blue precipitate on the addition of prussiate of potash. They are said to contain ferruginous clay, the presence of which would explain the precipitate occasioned by the addition of prussiate of potash. May not their corroded appearance have been produced by some form of zinc?

Earthy Fluor.

Specimens of this variety are rarely met with.

In some instances its appearance is stratified, as if it had been deposited in a minute state of division.

PHOSPHATE OF LIME.

Phospholite; of Kirwan.

The principal constituent parts of this mineral are lime and phosphoric acid. It is rarely met with either amorphous or crystallized; yet in the latter state more frequently than in the former.

Compact Phosphate of Lime.

Specific gravity 3.

Phosphorescent, according to M. Haüy, when thrown on burning coals.

Lime	59
Phosphoric Acid . .	34
Silex	2
Fluoric Acid	2,5
Oxyd of Iron . . .	2,5
	100,0 *Pelletier.*

This variety is in appearance very like close grained gypsum, or white marble.

It is met with in great abundance, forming entire hills, in the province of Estramadura; and is employed in building. It scarcely occurs elsewhere. It may be distinguished from gypsum, by its greater degree of hardness and specific gravity; and by its solubility in nitric acid: from white granular marble, by scarcely effervescing during its solution in the acid above mentioned. Sulphuric acid decomposes it easily at first; but, combining with the lime contained in it, soon envelopes it with a crust that in a great measure interrupts the further action of the acid.

Crystallized Phosphate of Lime.

Apatite: so called in consequence of the errors mineralogists were led into respecting its real nature, from its resemblance to the Emerald, Chrysolite, Hyacinth, and other gems.

Spargel-stein, or *Asparagus-stone;* from the particular shade of green of some of its varieties.

In hardness inferior to Fluor Spar.

Some of its varieties are phosphorescent, when thrown in powder on burning coals.

Specific gravity 3,2.

Primitive form, a regular hexhedral prism.

Lime	55 . . .	54,28
Phosphoric Acid .	45 . . .	45,72
	100 *Klapr.*	100,00 *Vauq.*

Crystallized phosphate of lime is met with in the tin mines of Saxony, Bohemia, and Cornwall. The primitive form occurs very rarely. The prism is frequently so compressed as to become tabular; and its sides are generally longitudinally striated.

Crystallized phosphate of lime may be distinguished from those precious stones with which it is likely to be confounded, by its phosphorescence and inferior degree of hardness.

Arseniate of Lime.

Pharmacolite; so called in consequence of the poisonous nature of one of its constituent parts.

Specific gravity 2,64.

Acid of Arsenic . .	50,54
Lime	25
Water	24,46
	100,00 *Klapr.*

This mineral has been found in France; and in the territory of Fürstenberg in Germany. It occurs in small acicular crystals of a silky lustre, grouped on granite. Those of France are perfectly white. The surface of those of Germany is of a violet colour, supposed to be owing to the presence of cobalt: their interior is white.

STRONTIAN.

This earth is so denominated from Strontian, in Argyleshire; where one of its natural compounds occurs in great abundance. It has hitherto only been found in combination with carbonic or sulphuric acid.

Carbonate of Strontian.

Hardness intermediate between that of carbonate and fluate of lime.
Specific gravity 3,66.
Primitive form not ascertained.

Strontian	61,21	69,5
Carbonic Acid	30,20	30,0
Water	8,50	00,5
	99,91 *Dr. Hope.*	100,0 *Klapr.*

Carbonates of strontian are frequently of a pea-green colour; from which they pass through numerous shades till they become nearly white. They are generally met with in radiating fasciculi, which consist of slender prismatic crystals: these crystals when loosely compacted present a silky lustre; and their shade of green is in that case fainter: when closely compacted they are of a deeper green: and where the colour is most intense the texture is nearly as close as that of flint. Carbonate of strontian is sometimes of various shades of an ochry brown colour.

In the Oxford collection is a very large mamillated mass of this substance, that has apparently been formed stalagmitically round an irregularly shaped nucleus consisting of sulphate of baryt with galena.

According to Mr. Jameson, this variety has hitherto been met with only at Strontian in Argyleshire.

Carbonate of strontian is more readily soluble in nitric acid than carbonate of baryt; and without that white deposition which takes place during the solution of the latter substance. When exposed to the action of the blowpipe it communicates a beautiful purplish red colour to the flame: paper also, dipped in a solution of nitrate of strontian, or crystals of this salt, communicate the same colour to flame. The foregoing characters distinguish it from carbonate of baryt. It is easily distinguishable from carbonate of lime by its greater degree of hardness and specific gravity.

Sulphate of Strontian.

Celestine; from the blue colour of some of its varieties.

Hardness very nearly the same as that of carbonate of strontian.

Specific gravity varies from 3,58 to 3,95.

Primitive form, a four-sided prism at right angles with its base; which is a parallelogram with angles of 104^d 48′, and 75^d 12′.

Fibrous Sulphate of Strontian from Pensylvania.		*Sulphate of Strontian from Sicily.*	
Strontian . . .	58	Strontian . . .	54
Sulphuric Acid .	42	Sulphuric Acid. .	46
	100 *Klapr.*		100 *Vauq.*

Sulphate of strontian has often a shade of blue: when colourless and amorphous, many of its varieties very closely resemble sulphate of lime.

It is common in the neighbourhood of Bristol, and in the islands of the Bristol channel; particularly in Barry island on the coast of Glamorganshire. In the last mentioned place, numerous indurated earthy nodules are met with of a reddish ochry colour; some of which when broken are found to be partially hollow, and contain tabular crystals of sulphate of strontian of a delicate pale blue. The body of each nodule consists in a great measure of a loose spongy aggregation of granular crystals of reddish carbonate of lime.

This variety may be distinguished from sulphate of baryt by its inferior specific gravity, and by giving a slightly red colour to the flame of the blowpipe: from carbonate of strontian and of baryt, by its insolubility in nitric acid.

BARYT.

The natural history of baryt corresponds very closely with that of strontian. Its name is derived from its great specific gravity.

Carbonate of Baryt.

Witherite; from the name of Dr. Withering, who first discovered it.

Hardness nearly the same as that of carbonate of strontian.

Specific gravity 4,3.

Primitive form not ascertained.

Baryt	74,5
Carbonic Acid .	25,5
	100,0 *Vauq.*

Carbonate of baryt has a violent emetic property, and sometimes acts as a direct poison. In Cumberland it is often employed for the purpose of destroying rats. It is met with in a lead mine at Anglesark in Lancashire, accompanied by sulphate of baryt. Specimens frequently occur containing both substances:

the sulphate is the whiter and more transparent of the two.

The distinctive marks between carbonate of baryt and carbonate of strontian have been described under the head of the latter substance.

M. Haüy says that fifteen grains of the carbonate of baryt of Anglesark killed a dog, on which the experiment was made, a few hours after it had been received into the stomach: but that the same dose of an artificial carbonate, prepared from a natural sulphate of baryt, in another dog only produced vomiting.

Sulphate of Baryt.

This substance occurs both in an earthy and a crystallized form. It is sometimes used as a flux for metallic ores.

Earthy Sulphate of Baryt.

Cawk; of the Derbyshire Miners.

Earthy sulphate of baryt is not met with in many places. In Derbyshire it is very common, and is the matrix of many of the minerals of that district.

Crystallized Sulphate of Baryt.

Heavy Spar, and *Baroselenite;* from its great specific gravity and occasional resemblance to Selenite.

Hardness nearly the same as that of sulphate of strontian.

Has a double refracting power.

Specific gravity varies from 4,29 to 4,47.

Primitive form, a four-sided prism at right angles with its base; which is a parallelogram with angles of $101^{d}\ 32'$, and $78^{d}\ 28'$. These angles almost correspond with those of the primitive crystal of carbonate of lime.

Baryt	67,2
Sulphuric Acid . . .	32,8
	100,0 *Dr. Withering.*

A very common form of crystallized sulphate of baryt is tabular, with bevilled edges. The crystals radiate from the matrix containing them, but in planes nearly parallel: where they unite, they often become opaque; and sometimes, the rest of the crystal being transparent, the edges alone are opaque.

Sulphate of baryt is sometimes found investing galena, and fluor spar, in hemispherical groups, consisting of delicate lenticular crystals closely aggregated.

There is a variety of sulphate of baryt met with near Freyberg, called *stangen-spath* (bar-stone). It consists of fasciculi of small bars or prisms, which are linked together by smaller prisms running between them nearly at right angles.

The distinctive marks between sulphate of baryt and carbonate of baryt, and also carbonate and sulphate of strontian, have been already given*. Many of the varieties resemble carbonate of lead, but the latter is very easily reduced to a metallic state by the blowpipe.

Bologna Stone.

Met with in a grey argillaceous marl in Monte Paterno, near Bologna.

Sulphate of Baryt . .	62
Silex	16
Alumine	14,15
Sulphate of Lime . .	6
	98,15 *Ann. de Chem.* 1788.

The form of this substance is sometimes irregularly rounded; sometimes lenticular. The structure is laminated, yet has at the same time a fibrous and radiated appearance: its lustre much resembles that of the common corundum.

This mineral, if calcined, pulverized, and made

* Vid. pp. 84—86.

into cakes, acquires a phosphorescent property by exposure to light: the phosphorescence is visible upon simply taking it into a dark place. This is the preparation known in chemistry by the name of phosphorus of Bologna.

MAGNESIA.

MAGNESIA.

THEOPHRASTUS, in speaking of the different ways in which stones are capable of being worked, makes the following observation: οἱ δὲ (sc^t. λίθοι) τορνευτοὶ τυγχάνουσι, καθάπερ καὶ ἡ Μαγνῆτις αὕτη λίθος*. where the stone called Μαγνῆτις is described as capable of being turned on a lathe; a character by no means applicable to the mineral now called the *magnet*, but very appropriate to some of the natural compounds of magnesia: those for instance that are called Pot-stones.

Theophrastus adds with respect to the same substance, ἣ καὶ ὄψει περιττὸν ἔχουσα· καὶ ὥς γε δή τινες θαυμάζουσι τὴν ὁμοίωσιν, τῷ ἀργύρῳ μηδαμῶς οὖσαν συγγενῆ †; and the resemblance to silver here described is strongly characteristic of one of the varieties of the natural magnesian compound called Talc; which is indeed at the present day often called Silvery Talc. Pliny, enumerating the varieties of the loadstone, says, " deterrimus reperitur in Magnesiâ

* Theophr. p. 397. † Ibid. p. 397.

"Asiæ; candidus, neque attrahens ferrum, similisque "pumici*." This description is much more applicable to some of the varieties of talc, than to the magnet of the present day.

From the foregoing passages I should conclude, that the term Μαγνῆτις was applied occasionally by ancient authors to some natural compound of the earth under consideration; and that in this way the etymology of its present name may be explained. Hill, indeed, in his notes on Theophrastus, says, that the ancient Greeks called the loadstone Λίθος Ἡράκλεια; the later Greeks, Μαγνῆτις λίθος: but that the latter term was properly applied to a species of lapis ollaris (*Pot-stone*).

Magnesia has not yet been met with in a native state. Its natural compounds are principally mixtures, or chemical combinations, of different earths with oxyd of iron; and, generally speaking, are remarkable for an almost unctuous softness, perceptible upon touching them; and for their disposition to a fibrous texture, and green colour. But though these characters evidently depend upon the presence of magnesia, the proportion of this earth rarely amounts to so much as one half of the weight of the mineral in which it is contained. Of the other component parts silex is the most abundant, and frequently amounts to as much as all the rest.

* Nat. Hist. lib. xxxvi.

Serpentine.

Infusible in the heat of the Berlin Porcelain furnace.
In hardness, superior to carbonate of lime: but it may in general be scratched by the knife.
Specific gravity varies from 2,26 to 3.

Magnesia, silex, and oxyd of iron seem to be the essentially constituent parts of serpentine; but their proportions are very different in different instances: that of the magnesia varying from 23 to 38 parts in 100.

The serpentine of modern mineralogy has acquired its name from the same natural resemblance, which gave rise to the term among the ancients; its general colour resembling that of a snake's skin: but the serpentine of the moderns is very different from that which the ancients frequently distinguished by this name. The latter is a green porphyry, and belongs to the argillaceous or perhaps the siliceous genus: the modern serpentine is always strongly marked by characters peculiar to magnesian compounds.

The Lizard point, in Cornwall, is a mass of serpentine, in which the predominating colour is a dark green; inclining sometimes to black, sometimes to brown; with occasionally a very obscure shade of red. If this promontory derived its name, as is usually the case in such instances, from the outline of its shape when seen at sea; and not from the colour of its substance; the coincidence of its name and colour is remarkable. Irregularly shaped patches of semitransparent colourless calcareous spar are met with here and there in these rocks; together with layers of partly white and partly red indurated steatite.

Serpentine is often traversed by veins of soft fibrous amianthus, which run in various directions through its substance: the fibres of the veins are placed in general at right angles to their course; and their diameter frequently does not exceed the tenth of an inch.

Serpentine, when intersected by veins and specks of white granular carbonate of lime, is called serpentine marble*.

Serpentine rocks are rarely metalliferous. Those which contain iron in a low state of oxydation are magnetic: and sometimes distinct particles of the iron may be seen by the naked eye.

Noble Serpentine.

This variety of serpentine is of a uniformly green colour, with a slight degree of transparency. In Italy, where it is used for ornamental purposes, it is known by the names of *Verde di Prato* and *Verde di Susa*.

Noble serpentine occasionally contains garnets,

* Vid. p. 15.

which in polished ornaments add greatly to its beauty.

It sometimes has a broad and flat foliated structure; and, in colour and lustre, is very like dark green semitransparent jade.

Lapis Ollaris.

Pot-stone; so called from the custom of turning it on the lathe into vessels of various shapes.
Lapis Siphnius, and *Lapis Comensis;* from the names of places where it is met with.
Specific gravity 2,75.

Pot-stone of Chiavenna.

Magnesia	38,54
Silex	38,12
Alumine	6,66
Oxyd of Iron	15
	98,32 *Wiegleb.*

This stone in its external characters is intermediate between serpentine and coarse steatite.

Mr. Jameson says that at Zöblitz, in Upper Saxony, several hundred people are employed in quarrying, cutting, turning, and polishing the serpentine met with in that neighbourhood; and that the various vessels &c. into which it is formed, are distributed through all parts of Germany. This serpentine may therefore be considered as a variety of pot-stone. Pliny mentions a similar custom: "In *Siphno* lapis est

" qui cavatur tornaturque in vasa, coquendis cibis
" utilia: quod in *Comensi* Italiæ lapide *viridi* acci-
" dere scimus *."

This substance is useful in the construction of furnaces; being very refractory in the fire.

Pot-stone is very common in the upper part of Italy; and occurs always in the neighbourhood of serpentine.

The Duke of Argyle's house at Inverary is built of Pot-stone, said to be met with in that neighbourhood.

Steatite.

Soap-stone: both these names are expressive of the leading external characters of the substance; which are a consistence and softness to the touch, resembling suet or soap.

Specific gravity 2,6.

Infusible.

	Steatite of Cornwall.	*of Bareuth.*	*Red Steatite.*
Silex	48,0	59,5	64
Magnesia	20,5	30,5	22
Alumine	14,0	0,0	3
Oxyd of Iron	1,0	2,5	5
Water	15,5	5,5	6
	99,0 *Klapr.*	98,0 *Klapr.*	100 *Vauq.*

Vauquelin also analysed a variety of steatite brought from New Caledonia, which the inhabitants of that

* Nat. Hist. lib. xxxvi.

place are said to mix with their food; but he found nothing nutritive in its composition. The existence of the custom among many savage tribes is authentically established.

In the rocks of serpentine forming the Lizard point in Cornwall, there are several veins of steatite, which, as far as I recollect, have upon the whole a vertical direction. The same vein wears very different appearances in different parts; being sometimes white; sometimes in a white ground containing specks of a reddish yellow, or brown, or purple; or a mixture of all these. In some parts the proportion of the coloured part considerably predominates; and in some parts the white is entirely wanting. In proportion as the colouring matter abounds, and especially if the colour is not uniform, the steatite loses its distinctive unctuous character; being neither so soft to the eye nor to the touch, nor yielding to the knife so easily, as the finer kinds.

The steatite of Cornwall, which is remarkable for containing a more than usually great proportion of alumine, is extensively used in the china manufactory at Worcester. The infusibility of this substance, on which its value in a great measure depends, arises from the total absence of lime in its composition. The equally valuable property of preserving its colour in the heat of the furnace, to which it is exposed in the process of baking the porcelain, is accounted for by the very small proportion of metallic matter contained in it.

Steatite is met with in very different states of induration; being sometimes hard enough to resist any impression of the knife, to which it often yields with the greatest ease.

Coarse steatite closely resembles the finer varieties of pot-stone.

There is a semi-indurated variety met with in Corsica, principally of a dull light green colour, with black specks of an irregúlar shape: it is remarkable for containing numerous very minute grains of magnetic iron.

Wallerius describes a variety of steatite, of a dark colour and close earthy texture; which is called Creta Hispanica, and is used as a fuller's earth. A similar use of steatite is attributed to the Arabs, who are said to employ it in their baths instead of soap.

Steatite occurs principally in the form of veins, in serpentine; and in irregularly shaped nodules imbedded in varieties of basaltic rocks.

It is sometimes met with in a crystallized form; but the crystals are pseudomorphous.

Myrsen.

Corruptly called *Meerschaum* by the Germans, according to Mr. Kirwan. Mr. Jameson says it is so called in consequence of its being found near the sea, the foam of which it resembles in lightness. Mr. Kirwan does not explain the term Myrsen.

Keffekil; a Tartar name, modified by the Turks.

Specific gravity nearly the same as that of water.

Infusible.

Silex	50,50
Magnesia . . .	17,25
Lime	0,50
Carbonic Acid .	5
Water . . .	25
	98,25 *Klapr.*

There are three or four specimens of this substance in the library of the botanical garden, at Oxford; which were brought over from Asia Minor by Dr. Sibthorpe and Mr. Hawkins: in their appearance they differ little from a mass of prepared magnesia, and perhaps therefore have undergone some artificial process.

According to Mr. Kirwan this mineral is found near Burza in Lower Asia; and is the substance of which the large Turkish tobacco-pipes are made, being first boiled with grease: the pipes are formed from the mixed mass, and then hardened by exposure to air. The exudation and alteration in colour of this grease, produced by the heated tobacco, gradually give the pipes a brown tinge. Some scrapings from these pipes, analysed by M. Wiegleb, were found to consist of very nearly equal quantities of silex and magnesia.

This substance is said to be used as a fuller's earth by the Turks.

Fabroni met with a substance, very like this in external characters and chemical analysis, near Sienna in Italy; of which he made bricks that were light enough to swim in water. Pliny speaks of such bricks.

Asbestus and Amianthus.

The literal signification of the first of these terms is, *unextinguishable;* but, as the verb ἀποσβέννυμι is metaphorically used in the sense of *aboleo*, or *perdo*, it may be rendered, *imperishable:* this explanation being much more appropriate than the former to the peculiar character of the substance. The literal signification of the last term is *unstained* or *unsoiled.* The etymology of these terms, the first of which directly, the last indirectly, expresses the incombustible nature of the substance to which it is applied, shews that they were originally synonymous: and so indeed they may be considered still; for they are applied to substances, which do not differ more in their chemical analysis than many varieties of minerals confessedly of the same species.

The term *amianthus* is now generally used to express those varieties of the present species which have the softest, most flexible, and most easily separable fibres: *asbestus* is applied to those, the fibres of which are comparatively brittle, harsh to the touch, and closely compacted. The gradations in the shades of difference are too delicate to admit of description; though the substances in which the extreme characters reside differ at least as widely from each other, as the finest unspun silk from the most compactly fibrous wood.

Loosely fibrous and flexible Amianthus.

Specific gravity 0,9.

Fusible by the blowpipe to a blackish glass. Its separate fibres contract into a minute vitreous globule when exposed to the flame of a candle; but a number taken together are only made red-hot.

Silex	. . .	59
Magnesia	. .	25
Lime	. . .	9
Alumine	. .	3
		96 *Mr. Chenevix.*

This probably is the substance from which were woven those incombustible cloths, in which the ancients sometimes burned the bodies of their dead.

The appearance of cloth of amianthus differs not much from that of coarse common cloth; but in consequence of the comparative brittleness of the mineral substance employed in the former instance, the continuation of each fibre is frequently interrupted; which gives a ragged appearance to the cloth made from it. In order to facilitate the process of weaving amianthus, its fibres may be mixed with flax; and the last may afterwards be separated by exposing the cloth to a heat sufficient to consume the flax without altering the amianthus.

The fibres of amianthus have sometimes all the softness and lustre of silk; they are generally white in proportion to their fineness.

Amianthus is met with, principally in serpentine, in various parts of Europe. A coarse silky variety occurs in such abundance in Corsica, that Dolomieu used it for the purpose of enveloping the minerals which he collected in the neighbourhood.

Sometimes a mass of soft fibrous amianthus abruptly adheres to a mass of semitransparent calcareous spar; sometimes distinct fibres of the former are seen passing between the laminæ of the latter, in parallel directions; and there is an insensible transition of the one substance into the other. In these cases the calcareous spar possesses a faint shade of green, which is perhaps derived from its connexion with the magnesian compound.

Compactly fibrous and flexible Amianthus.

Mountain leather; from its texture, and the toughness depending on this.

The appearance of this variety of amianthus is not very unlike the tendinous part of veal when boiled. By mechanical means its fibres may be separated from each other, and in that state differ not much from those of the preceding variety, but have not the same degree of softness and silky lustre.

Compact spongy Amianthus.

Mountain Cork; from its texture and lightness. Specific gravity 0,8.

This substance differs from the foregoing variety, principally perhaps in its texture; which is not in the least degree fibrous. It differs from the varieties of amianthus in general, by being found chiefly in mineral veins; while they are met with in serpentine at large.

Fibrous Asbestus.

Specific gravity 2,6.

Magnesia . . .	48,45
Silex	46,66
Oxyd of Iron . . .	4,79
	99,90 *Wiegleb.*

The fibres of this are always closely aggregated, and are harsh to the touch and friable; by which characters the substance is distinguishable from fibrous amianthus. Different specimens possess different shades of green: few perhaps are entirely devoid of colour; and differ in this respect from fibrous amianthus, which is often delicately white.

When the fibres are larger than usual, and of a flat prismatic rather than a fibrous form, the substance resembles actinolite: but when pulverized it is unctuous to the touch, and may thus be distinguished from it.

Sometimes the fibres have a slightly curved direction, at the same time preserving a mutual parallelism; and the mass in which they occur is disposed to separate, upon the application of a sufficient degree of force, into fragments of an oblong and curved conical form. I have seen fragments of this kind, detached from a mass of serpentine containing grey iron ore, in which one half of the fibrous mass was of the nature of asbestus, from which it rapidly graduated into the appearance of grey iron ore; the fibrous form remaining, with a colour and lustre completely metallic.

The fibres of asbestus sometimes appear to be rhomboidal prisms. From this circumstance perhaps, and from its general connexion with serpentine, Saussure considers asbestus as a crystalline form of the latter substance.

The various forms of asbestus and amianthus may easily be distinguished from other minerals resembling them in appearance: from plumose sulphate of alumine, or of iron, or of zinc; by the ready solubility and styptic taste of the latter substances: from fibrous gypsum; by the change this undergoes in a low red-heat: from actinolite, thallite, and hornblende; by the unctuous feel of the powder of asbestus &c. compared with that of actinolite, &c.

Ligniform Asbestus.

Infusible in the heat of the Berlin porcelain furnace.

This often occurs in cabinets in flat wedge-shaped masses converging to a point: the structure of these is apparently fibrous; and sometimes in the same fragment fasciculi of fibres radiate from different centres, producing a very singular appearance by their mutual intersection.

The colour of these masses is sometimes nearly white, sometimes brown; and they frequently resemble splintery fragments of wood; from whence arose the application of the epithet by which this variety of asbestus is distinguished. In many instances the fibrous appearance is only superficial; and a transverse division of them shews that they are internally of a compact earthy texture.

Some varieties of ligniform asbestus are of a distinctly green colour; and a remarkably compact texture: the fibres, which though visible to the eye are scarcely separable by mechanical means, are parallel to each other; and the mass in which they occur is divided by numerous dark coloured lines crossing the fibres at right angles. It is observable that these masses are disposed to break into separate pieces in the direction of these lines. Sometimes the lines are very irregular in their direction, and at the same time curved, presenting a reticulated appearance: in which case it is often difficult to ascertain whether the substance should be called serpentine or asbestus. Asbestus of this kind, when polished, has often a silky lustre.

Talc.

It is easily cut by the knife.

It was hardened, and became paler, in the heat of the Berlin porcelain furnace.

Specific gravity varies from 2,58 to 2,87.

Primitive form, a prism at right angles with its base; which is a rhomboid with angles of 120[d] and 60[d].

Silex . . .	50
Magnesia .	44
Alumine . .	6
	100 *Hœpfner.*

Talc rarely if ever occurs distinctly crystallized: it is most commonly met with in thin broad laminæ easily separable from each other: sometimes in soft masses made up of minute scaly particles more or less closely aggregated; which give it a silvery appearance: and lastly, in a completely indurated earthy form; as in the case of the substance called French Chalk.

Laminated Talc.

The laminæ are either flexible and inelastic; or, if not sufficiently firm to admit of being bent, they crumble between the fingers into small scales, or into a soft powder which adheres to the skin with somewhat of a pearly or silvery lustre.

The softness perceptible upon touching laminated talc, and its want of elasticity, sufficiently distinguish it from mica; with which it may be confounded by the eye. It may be distinguished from selenite by remaining unaltered in a low red heat; which converts the latter substance into a white friable powder.

When the substance of the laminæ is separable into small scales, it has been sometimes employed, like mica, for the purpose of frosting images of the Virgin; a custom already spoken of under the head of Selenite *.

When laminated talc, or indeed any form of this substance, is capable of being triturated into an impalpable powder, it is sometimes mixed with red

* Vid. p. 66.

colouring matter, and used as a cosmetic. This practice may perhaps elucidate a passage in Pliny's Natural History, describing the preparation of a pigment which he calls *purpurissum*. From this passage, which is in the thirty-fifth book, it appears that *purpurissum* was prepared by pulverizing a white earthy substance; which was afterwards impregnated with a purple colour, by steeping it in a fluid charged with the particular dye.

Venetian Talc.

This term has a reference rather to the commercial than to the natural source of the substance so called. It is a talc of a laminated structure; but this structure is often not observable in large masses of it: though they may be easily separated by mechanical means into very thin flexible and inelastic laminæ, which are nearly colourless, and of a glassy transparency. The mass, before separation of the laminæ, is in proportion to its thickness opaque, and of a light but lively green colour. Talc of this kind is common in the Tyrol; in Saxony; and in Silesia. It occurs always in serpentine rocks.

Indurated Talc.

***Craie de Briançon**;* from the place where it is met with.

French Chalk; called chalk perhaps from the white powder into which it may be reduced by mechanical means.

Silex	62
Magnesia . . .	27
Alumine	1,5
Oxyd of Iron . .	3,5
Water	5
	99,0 *Vauq.*

This substance is much employed when reduced to powder for the purpose of removing stains, occasioned by grease, from silk.

If lines be traced on glass by means of a piece of indurated talc, they remain invisible; or are scarcely perceptible by the naked eye, till breathed on. I have not met with an explanation of the effect produced in this instance; but it may perhaps in part depend on the comparative softness of the substance with which the impression is made; the condensation of the breath taking place more readily on the glass, than on the talc covering the glass; and the impression of the talc becoming apparent by the simple contrast.

This variety of talc when very highly indurated closely resembles, and perhaps does not much differ in any of its characters from, the light coloured jade commonly employed in Turkey for making handles of scymitars, &c.

Jade.

Pierre des Amazons: this term is applied to a dark green variety of jade, which is so called from the river of that name in America; among the pebbles of which it is said to be found: but M. Humboldt observes that it is brought to that part of America from the interior.

Beilstein, in Germ.; in Engl., *Axe-stone;* many specimens of the above-mentioned variety of this substance having been originally met with by Europeans in the form of axes, and wedges, &c.; this being the use to which it is frequently applied by the natives of the places where it is met with.

Igida: according to Mr. Jameson this is its Indian name; from which the Abbé Estner conjectures the French derived the word *Jade.*

Specific gravity varies from 2,95 to 3,38.

Fusible by the blowpipe.

Analysis of Jade by M. Hæpfner.		*Analysis of Jade by M. Theod. de Saussure.*	
Silex	47	Silex	53,75
Carbonate of Magnesia	38	Lime	12,75
Carbonate of Lime . .	2	Alumine	1,5
Alumine	4	Oxyd of Iron . .	5,0
Oxyd of Iron . . .	9	Oxyd of Manganese	2,0
	100	Potash	8,5
		Soda	10,75
		Water	2,25
			96,50

It appears from a comparison of the analyses just stated, that the results obtained by M. Hæpfner differ very remarkably from those of M. de Saussure. The latter gentleman has also analysed a substance, closely resembling the green American jade or axe-stone, which he first met with in the form of a pebble on the shore of the lake of Geneva; and afterwards in a serpentine rock near Turin. The analysis gave the following results:

Silex . . .	44
Lime . . .	4
Alumine . .	30
Oxyd of Iron .	12,5
Soda . . .	6
	96,5

Very beautiful specimens of this substance, with respect to their size and colour, have been brought from America, and some of the islands of the Pacific; in the form of axes &c. artificially cut and polished. They are of a deep but bright green colour, with a waxy transparency at the edges: their hardness is very considerable, as appears from the use for which they were evidently intended; but this is at the same time accompanied with a remarkable toughness: their texture is very compact in general, but here and there it is partly schistose, partly fibrous or splintery; with which probably their toughness is connected. To the touch they are remarkably smooth; and their lustre is almost as though the surface had been oiled.

Some mineralogists have supposed that a substance so hard could not have received such an accurate delicacy of form, from people so uncivilized as the native Americans; and have therefore conjectured that when first met with it is soft, and that it afterwards hardens by exposure: but the variety which M. de Saussure analysed was completely hard when first separated from its native rock: and, besides this, Robertson describes the perseverance of the Americans, in the very instance of the formation of their tools, as most remarkable.

There is a variety of jade, which comes from China, of a greyish white colour with an obscure shade of green: it is used in Turkey for handles of scymitars, and other instruments. It it much harder than the American green jade.

Jade is sometimes of a delicate lemon colour; and disseminated in specks through the substance of white primitive carbonate of lime. I have seen a specimen of this kind from one of the western islands of Scotland.

Nephrite.

Lapis Nephriticus: the term is particularly applied to pebbles consisting either wholly or in part of jade; and arose either from their kidney form, or from the superstitious application of them to the cure of diseases of the kidney: their form perhaps having originally led to such an application. So, almost within the last hundred years, our Pharmaçopæia had a preparation of dried fox's lungs, which was given in cases of pulmonary consumption.

Pebbles of this kind occur in great abundance in one of the islands on the western coast of Scotland. They are frequent also on the shores of the lake of Geneva.

Chlorite.

When pulverized it is soft to the touch.

Fusible into a black slag, and afterwards magnetic.

Chlorite is so called from its colour; which is a dark dull green. This depends on the oxyd of iron contained in it; and is very nearly of the same shade in all the varieties of this substance: more nearly perhaps than in the case of any other mineral.

Its fusibility depends on the great proportion of oxyd of iron contained in it.

Small Foliated, or Scaly Chlorite.

The foliated or scaly particles of this variety are closely compacted; and in the mass have an obscurely schistose structure. The foliated chlorite of Corsica contains octahedral crystals of magnetic iron ore; and sometimes adheres so closely to the surfaces of the crystallized iron, as not to be easily separable.

Earthy Chlorite.

Peach; of the Cornish Miners.

Talc Chlorite Zographique; of Haüy: from its use in painting.

Green Earth of Verona; being met with in that neighbourhood: perhaps also the *Appianum viride* of Pliny, which he says was prepared from a green clay; to a substance of which kind the earth of Verona bears a strong resemblance.

Silex	26	Silex	53
Alumine	18,50	Alumine	12
Magnesia	8	Magnesia	3,5
Oxyd of Iron	43	Lime	2,5
Muriate of Soda or of Potash	2	Oxyd of Iron	17
Water	2	Water	11
	99,50 *Vauq.*		99,0 *Klapr.*

Earthy chlorite very commonly accompanies the tin-ore of Cornwall, and is disseminated through the same matrix in the form of small earthy grains or specks. It is easily recognized by its green colour.

The cavities, and irregularly spherical particles of calcareous spar, agate, &c. met with in basaltic rocks, are often superficially covered with earthy chlorite. Specimens of the Bohemian garnet are also frequently covered with an earthy form of chlorite; but in many instances the incrustation of the garnet is of a distinctly small foliated texture.

The substance known in the arts by the name of the green earth of Verona is met with, in irregular nodules, in the north of Italy: in its appearance it resembles green clay, and according to the analysis of Meyer contains no magnesia. Dolomieu, however, who has visited the spot, considers it as a variety of chlorite. It is used in oil-painting and stucco. It is perhaps derived from the detritus of disintegrated basaltic rocks *.

* Vid. sup.

Actinolite.

Shorlaceous Actinolite; of Kirwan.

Strahlstein, in Germ.; in Engl. *Arrow-stone:* met with in "long slender prisms, or rather pyramids, being thicker at one end than the other, "and hence called Strahl, or Arrow-stones*."

Asbestinite: when the prisms are acicular, actinolite may be mistaken for asbestus: and hence the foregoing name.

Sufficiently hard to scratch glass.

Specific gravity 3,33.

Fusible in the heat of the Berlin porcelain furnace into a fibrous slag.

Primitive form a rhomboidal prism; the sides inclining to each other under an angle of 124^{d} 30′, or 55^{d} 30′.

Silex . .	64
Magnesia .	20
Lime . .	9,3
Alumine .	2,7
Oxyd of Iron	4
	100,0 *Bergm.*

Silex . . .	50
Magnesia .	19
Lime . . .	10
Alumine . .	1
Oxyd of Iron	11
—— of Chrome	3
	94 *Laugier.*

This substance is called actinolite from the occasional radiated distribution of its crystals. Its most striking natural form is that, in which it occurs

* Kirw. vol. i. p. 168.

in distinct rhomboidal prisms, of a bright dark green colour, irregularly imbedded in compact silvery talc. Owing to the softness of the matrix, these prisms may very easily be detached from it by mechanical means: but it is difficult to obtain them of any considerable length, as they are remarkably disposed to separate transversely by the application of even a slight force. In consequence of this, it is very common to see the extremities of them, thus broken, slightly projecting from the mass of talc containing them.

In some instances the number of the crystals, compared with the volume of the mass containing them, is very few: in others, the proportions of the contained and the containing substances are nearly equal: and in some, the proportion of the crystals so far predominates that the talc may be rather said to cement them together, than to contain them. If the talc is entirely wanting, which occasionally happens, the appearance of the mass is not very unlike coarse fibrous asbestus.

Sometimes the crystals of actinolite are nearly of a black colour; and the talc containing them is of a dirty white, here and there stained of a brownish ochry yellow.

Actinolite sometimes occurs in compact masses, consisting of small flat prisms not easily separable from each other; parts of the specimen being of a green, and other parts of a distinctly red or greenish red colour: the difference of colour is perhaps owing to the difference in the degree of oxydation of the iron contained in them.

Dolomieu and Haüy seem inclined to consider actinolite as a variety of Hornblende.

Boracite.

Cubic Quartz; from the joint consideration of its form and hardness.

It was fused in the heat of the Berlin porcelain furnace, into a yellowish clear glass.

Sufficiently hard to scratch glass.

Electric, by heat, at the eight points formed by the solid angles of the cube: four of them having the vitreous; the others, the resinous electricity*.

Specific gravity 2,56.

Primitive form, a cube.

Boracic Acid . .	68,00
Magnesia . . .	13,50
Lime	11,00
Silex	2,00
Alumine	1,00
Oxyd of Iron . .	0,75
	96,25 *Westrumb.*

Boracite, which is so called from its containing boracic acid, is the only mineral of the magnesian

* This property is explained in the introduction, under the head of *Electricity* of Mineral Substances.

genus in which the earth is found combined with an acid, and at the same time crystallized.

The common form of crystals of boracite is a modification of the primitive form; and is an incomplete cube, having each edge singly or doubly bevilled.

The colour of the crystals is commonly a whitish drab: but sometimes they are colourless, and nearly as transparent as glass; in which case they are said to contain no lime.

Boracite is always met with in a crystallized state; and hitherto has only been found in the neighbourhood of Luneburg, in the duchy of Brunswick. The crystals are separately and sparingly distributed through a mass of gypsum, by which they are accurately enveloped. The gypsum is of a compact stony texture, and nearly of the same colour with the crystals.

Chrysolite.

Peridot; of commerce.

Topaz of the ancients, probably; for Pliny describes the topaz under characters very appropriate to the chrysolite of the moderns: and evidently the chrysolite of the moderns, being green, must differ from the chrysolite of the ancients: as the latter from its name was doubtless of a golden yellow colour.

Infusible by the blowpipe.

Sufficiently hard to scratch glass.

It has the double refracting power in a very remarkable degree.

Specific gravity 3,4.

Primitive form, a four-sided prism, at right angles with its base; which is a parallelogram.

Chrysolite from the Levant.

Magnesia . . .	50,5 . . .	43,5
Silex	38 . . .	39
Oxyd of Iron . .	9,5 . . .	19
	98,0 *Vauq.*	101,5* *Klapr.*

The chrysolite of the moderns, the least hard of those stones called gems, is commonly of some shade of green; often of an olive or even bottle green: it

* The increase of weight in this analysis depended on the difficulty of accurately drying the precipitates obtained during the process of the analysis.

differs therefore, judging by its name, from the chrysolite of the ancients. That probably was either a deep coloured variety of the Oriental topaz; or the gem which we call the hyacinth. The Brasilian topaz is out of the question at such an early period of history, and the Saxon and Siberian are too light coloured to justify the application of the name; supposing even that they were known at that time.

The native situation of the chrysolite is not ascertained. The chrysolites of commerce are principally imported from the Levant. They appear generally in the form of irregularly worn fragments, with occasional traces of a quadrangular prismatic crystallization.

Bruce mentions an emerald island in the red sea; but says that the green substance he there met with was scarcely harder than glass. May not this have been a chrysolite, and this island the topaz island mentioned by Pliny * ?

Minute crystals of this substance are said to have been met with in serpentine; and the analysis of chrysolite seems to justify the supposition of a natural alliance between the two substances.

Jewellers have created much confusion with respect to the identity of the chrysolite; having applied the term to many different substances, from a mere resemblance in colour.

* Vid. the article *Topaz*.

Olivin.

Basaltic or *Volcanic Chrysolite;* partly from its resemblance to chrysolite, and partly from its being met with in basältic rocks, and in lavas.

The olivin of Unkel was fused in the heat of the Berlin porcelain furnace into a glossy porous mass.

Specific gravity 3,26.

Olivin from the Basalt of Unkel.

Silex	50
Magnesia . .	38,50
Lime	0,25
Oxyd of Iron .	12
	100,75 * *Klapr.*

It is evident from a comparison of their analyses, that olivin is allied to chrysolite. The term olivin is derived from its usual shade of colour.

Olivin occurs in grains or irregularly spherical particles, in basaltic rocks: according to some, in no other situation.

It is very liable to decomposition, first losing its lustre and then its consistence; crumbling at length into a loose earthy powder of a yellowish brown ochry colour. From a knowledge of this circumstance

* Vid. the preceding note, p. 120.

the porous appearance of some varieties of basalt may perhaps be accounted for; the particles of olivin originally contained in them having been separated by gradual decomposition.

Those spherical particles of a yellow colour and vitreous appearance, met with in the native iron of Siberia, are supposed to be a variety of olivin.

The following description of the substance found in the native iron of Siberia is taken from a paper in the Philosophical Transactions, written by Mr. Howard.

It cuts glass, but not quartz.

Electric by friction.

Extremely refractory in the fire; not, even in the least degree, losing its transparency.

Specific gravity 3,28.

It presents no trace of a determined crystalline form.

Silex	54
Magnesia	27
Oxyd of Iron	17
Oxyd of Nickel	1
	99 *Mr. Howard.*

In its analysis it corresponds with the chrysolite and olivin; and, like the latter substance, is liable to decomposition; ultimately crumbling into a gritty dry powder.

ZIRCONE.

This earth is so named from one of its natural compounds, the zircon or jargon of Ceylon; the only substance, with the exception of the gem called the hyacinth, in which it has yet been discovered.

The minerals of this genus are transparent, and variously coloured.
In hardness they scarcely exceed quartz.
Infusible, but lose their colour by fire.
Have a remarkably strong double refracting power.
Specific gravity about 4,4.
Primitive form, an octohedron; each face of which is an isosceles triangle. The ordinary form of the crystals is a quadrangular prism terminated by a four-sided pyramid.

They may be distinguished from other gems by their inferior degree of hardness; and by their strong double refracting power.

Zircon of Ceylon.

Jargon, or *Mock Diamond*. The term jargon has been given to such colourless gems as, when cut and polished, are liable, from their lustre, to be mistaken for the diamond: it has usually been applied more particularly to the substance in question.

Zircone . . .	69	
Silex	26,50	
Oxyd of Iron .	0,50	
	96,00	*Klapr.*

The zircon of Ceylon is found, together with crystals of the ruby, spinell, tourmaline, &c., in the sand of the rivers which have their source in the high mountains, situated towards the centre of the island.

It occurs in the form of small flat colourless particles, not unlike pieces of thin glass with the angles and edges slightly rounded. It is much used for the purpose of jewelling watches.

Next to the spinell it is the gem most frequently met with in the rivers of Ceylon.

Hyacinth.

	Hyacinth of Ceylon	*of Norway*	*of Expailly.*
Zircone	70,0	66	65
Silex	25,0	31	33
Oxyd of Iron	0,5	2	1
	95,5 *Klapr.*	99 *Vauq.*	99 *Klapr.*

The hyacinth of modern mineralogy is commonly of a deep golden or amber colour; and may perhaps be the chrysolite of the ancients: for its colour is much more appropriate to a substance so denominated, than that of the modern chrysolite; and is equally far removed from the colour of a gem which we may suppose the ancients to have denominated a hyacinth. By the above analyses it appears that the hyacinth and the jargon belong to the same genus, and differ from all other minerals in containing an earthy substance peculiar to themselves.

Many substances however are called hyacinths by the jewellers, from a mere resemblance in colour: thus the Oriental hyacinth, so called from its great degree of hardness, is a variety of the ruby: the hyacinths of Compostella are crystals of quartz, coloured by red oxyd of iron.

The Norway hyacinth is met with, very distinctly crystallized, in a rock composed of reddish coloured felspar and hornblende.

The hyacinth of Expailly is found in the sands of a rivulet, which runs among volcanic rocks, near Puy in Velay: small sapphires are found in the same situation *.

* Vid. the article *Sapphire.*

GLUCINE.

This earth, which is called Glucine from the sweet taste of many of its saline forms, has hitherto been met with only in the beryll, the emerald, and another mineral lately found in Peru. It was first discovered in the beryll.

Beryll.

Aquamarine ; from the sea-green colour of some of its varieties.

Chrysoberyll; appropriate to those varieties which incline to a golden or yellow colour.

Sufficiently hard to scratch glass easily: it scratches quartz with difficulty.

Scarcely altered in the heat of the Berlin porcelain furnace.

Has a slight double refracting power.

Electric by friction.

Primitive form, a regular hexhedral prism.

Specific gravity 2,7.

Analysis of the Beryll.

Silex . . .	68	Silex . .	66,45
Alumine . .	15	Alumine .	16,25
Glucine . .	14	Glucine .	15,50
Lime . . .	2	Oxyd of Iron	0,60
Oxyd of Iron .	1		98,80 *Klapr.*
	100 *Vauq.*		

The beryllus and smaragdus of the ancients were similar to each other, if not the same substance; for Pliny, after having just spoken of the smaragdus, says, " eandem multis naturam aut certe similem habere berylli videntur *:" and from what follows it appears that those berylls were most esteemed which resembled the colour of clear sea-water: which preference holds with respect to the aquamarines of the present day. The chrysoberyll, which was less vivid, and of a golden yellow tinge, was held next in estimation: when paler than usual it was called a Chrysoprase.

Berylls usually occur in their primitive form, a regular six-sided prism: which is commonly striated longitudinally. The crystals, which are formed by the connection of several prisms at their terminal faces, are easily separable at the points of union: and, like the tourmaline and basalt, present upon separation a convex and a concave surface.

Berylls are brought from India; and also from

* Nat. Hist. lib. xxxvii.

Brasil. The most beautiful are said to come from Daouria on the borders of China.

Aquamarines of very large dimensions have lately been discovered in France.

The beryll may be distinguished from tourmaline, in being electric by friction; but not by heat: from apatite, by its superior degree of hardness.

Emerald.

Smaragdus of the ancients? it is uncertain what this substance was; though it certainly in some degree corresponded, in the beauty of its colour, with the emerald of the moderns.

Easily scratches glass, but quartz with difficulty.

In the heat of the Berlin porcelain furnace it became opaque, but was otherwise unaltered.

Specific gravity 2,7.

It is one of the lightest and softest of the precious stones.

Has a moderate double refracting power.

Primitive form, a regular six-sided prism.

Analysis of the Emerald of Peru.

Silex	64,60		68,50
Alumine	14,00		15,75
Glucine	13,00		12,50
Lime	2,56		0,25
Oxyd of Chrome	3,50		0,30
Water	2,00	Oxyd of Iron	1
	99,66	*Vauq.*	98,30 *Klapr.*

From the preceding analyses it appears, that the emerald of Peru only differs essentially from the beryll, by containing an oxyd of the metallic substance called Chrome. It is supposed that the more lively hue of the emerald is owing to the peculiar nature of the metallic substance by which it is coloured.

Emeralds are said to have been found in Asia, particularly in Ceylon; and in Egypt: but it is doubtful whether a stone of the same species with the Peruvian emerald, that is, containing at the same time glucine and oxyd of chrome, was known before the discovery of America. Tavernier says that the emerald is an occidental gem, imported from America to the Philippine islands, and from thence into Europe.

That which is called the Oriental emerald, and which differs from the Peruvian not less in its superior degree of hardness than in the nature of its constituent parts, is a green variety of the sapphire; and of this nature probably is the gem of the late Archbishop of York, mentioned by the Dean of Westminster in his History of the Commerce and Navigation of the Ancients. This gem, engraved with a Medusa's head of Grecian sculpture, was brought from Benares *.

The table in the abbey of Reichenau near Con-

* Vol. ii. p. 759.

stance, said to be of emerald, was ascertained by Mr. Coxe to be green fluate of lime.

The famous cup long preserved at Genoa under the name of *Sacro Catino*, and now in possession of the French, is upon good grounds considered as nothing more than green glass.

Baccius in a treatise on gems, written in the seventeenth century, mentions this cup; not without a doubt of its being an emerald: "Genuæ vas amplum "habetur ex Smaragdo, *si* ex Smaragdo fit *."

It is not easy to conjecture what was the nature of the smaragdus of the ancients: Pliny says that it possessed the most vivid of all green colours; and this probably might be said at his time of the Oriental emerald: but it may be inferred from the following passage that the smaragdus was too commonly used, and its dimensions too large, to justify the supposition of its being that substance. Speaking of the smaragdus he says, "Scalpentibus gemmas non "alia gratior oculorum refectio est: ita viri dilenitate "lassitudinem mulcent †."

The emerald is rarely of any considerable magnitude, and at the same time perfectly clear and free from spots.

The emerald possesses the same distinctive marks of character as the beryll. The resemblance between

* Bacc. de Gemmis, p. 55.
† Nat. Hist. lib. xxxvii.

them induced Wallerius to class them under the same head before the correspondence in their physical and chemical characters had been ascertained. Werner however still considers them as distinct species.

The emerald is found in considerable abundance in Peru, between the mountains of New Grenada and of Popayan, in the clefts and cavities of schistose and granitic rocks.

Count Bournon met with crystals of emerald in France, in a part of the same rock where he found sapphires *.

Brochant says that Dolomieu found a transparent and colourless emerald, in granite, in the isle of Elba.

Euclase.

This substance has been so denominated by M. Haüy, in consequence of its remarkable fragility.

It has the double refracting power to a very great degree.

By the blowpipe it loses its transparency; and is afterwards fused into a white enamel.

Specific gravity 3,06.

Primitive form, a prism at right angles with its base; which is a parallelogram.

* Vid. the article *Sapphire*.

Silex	35 to 36	
Alumine . . .	18 to 19	
Glucine . . .	14 to 15	
Oxyd of Iron .	2 to 3	
	69 to 73	
Loss	31 to 27	
	100 100	*Vauq.*

The loss taken notice of in the account of its analysis depended, in part, on the volatilization of water contained in it: and hence probably its transparency is destroyed under the action of the blowpipe.

Of all minerals this is most easily divisible into laminæ.

There is only one known variety in the form of the crystal of this substance: and this is very remarkable on account of the number of its sides; which, when the variety is perfect, amount to seventy-eight. It consists of a prism having fourteen sides, terminated at each extremity by a summit or pyramid of thirty-two sides.

ALUMINE.

THIS earth is a constituent part of the salt called *Alum;* from a solution of which it may be conveniently obtained, nearly in a state of purity: and hence its present name. It is sometimes called *Argill,* as being a principal constituent part of clays, or natural argillaceous compounds.

Native Alumine.

The existence of native alumine is nearly as questionable as of native lime. An earthy substance said to be native alumine, and often met with in cabinets in small kidney-formed nodules of a very white colour, was some years since discovered near Halle in Saxony; but as it was found, according to common report, in a piece of ground attached to a chemical laboratory, many mineralogists doubted its natural origin; and supposed it to be an artificial preparation, which had been thrown aside after the completion of the experiments that had given rise to its production. Mr. Jameson however says, that from its form, and the situation where it is found, it appears to have had a natural origin: and that no laboratory is nearer the spot than a quarter of a league. He subjoins the following analysis :

Alumine	45
Sulphate of Lime . .	24
Water	27
Lime, Silex, and some muriatic Salt . .	4
	100 *Fourcroy.*

From the analysis it might be inferred that this substance is not a natural production; and certainly it is not entitled to be considered as a specimen of native alumine.

Wavellite.

Hydrargillite; from its constituent parts, water and pure argillaceous earth.
Sufficiently hard to scratch agate.
Infusible.
Specific gravity 2,7.

Alumine . . .	70
Water	30
	100 *Mr. Davy.*

This substance has been denominated Wavellite, in compliment to Dr. Wavel; who discovered it in the clefts of a soft argillaceous schistus, near Barnstaple in Devonshire.

It occurs in hemispherical tubercles, rarely larger than a pea, adhering firmly to the surface of the schistus on which it is found. From its internal as well as its external appearance it was at first supposed to be a variety of zeolite; being very white, with a pearly or silky lustre; and of a delicately radiated structure.

A variety of the same substance, from one of the mines in Cornwall, has been analysed with nearly similar results by the Rev. W. Gregor.

If any mineral may be considered as a pure natural form of alumine, it is this: as water is the only foreign substance contained in it.

Sapphire.

Perfect Corundum; of Count Bournon.

Télésie; of Haüy.

Asteria; of the ancients? Saussure supposes that the asteria is an oriental sapphire; because some of the varieties of the latter, when cut in particular directions and exposed to the sun, exhibit the appearance of a star of six rays. The method of cutting them so as to produce the effect cannot always be accomplished by design: the effect depends upon a reflexion of the light in the interval of the laminæ of the stone.

The sapphire, after the diamond, is the hardest substance in nature.

In the heat of the Berlin porcelain furnace it was unaltered, excepting that in some pieces the colour became a little paler.

Primitive form, a regular six-sided prism, according to Haüy; but, according to Count Bournon, a slightly acute rhomb, the plane angles of which are 94^d and 86^d. M. Haüy's mistake in this instance arose from the great difficulty of obtaining the primitive form by mechanical division.

Specific gravity 4,016; the mean specific gravity of sixteen different specimens of sapphire, taken by Count Bournon.

Alumine	98,5	Alumine	92
Lime	0,5	Silex	5,25
Oxyd of Iron	1	Oxyd of Iron	1
	100,0 *Klapr.*		98,25 *Chenevix.*

According to the analysis of M. Klaproth, who considers the lime as casual, the sapphire appears to be nearly a pure native form of alumine, coloured by oxyd of iron: its great degree of hardness and specific gravity depends perhaps on the state of aggregation of its particles.

The sapphire varies from a deep clear blue to the lightest shade of the same colour: it is occasionally entirely colourless, and is then called white sapphire.

Sometimes there is a considerable shade of black mixed with the blue. Sapphires have frequently a striated cloudy appearance internally. Their laminated structure is often rendered visible by accidental fractures.

Sapphires are principally found in the rivers of Ceylon; and in Pegu, and the adjacent country. Their matrix is not known; but is supposed by M. Werner, from an examination of the sand in which they are found, to be a species of trap or basalt.

Sapphires have also been met with in Bohemia, at the foot of basaltic rocks; where, as in Ceylon, they are accompanied by hyacinths: and in France, in the stream of Expailly*; where also they are accompanied by hyacinths.

Ruby.

Perfect *red* Corundum; of Count Bournon.
Télésie *rouge;* of Haüy.
Oriental Ruby; of commerce.

The physical characters of the ruby, saving the difference in colour, correspond almost exactly with those of the preceding variety. It generally has a mixture of blue, which gives it a tinge slightly inclining to purple.

In hardness it is a little inferior to the sapphire.

* Vid. p. 127.

Unaltered by the heat of the Berlin porcelain furnace, excepting that its colour became more vivid.

Specific gravity 3,977; which was the mean specific gravity of twenty different specimens of ruby, taken by Count Bournon.

Alumine	. . .	90
Silex	. . . .	7
Oxyd of Iron	.	1,2
		98,2 *Mr. Chenevix.*

From the similarity in their chemical analysis as well as their physical characters, the ruby and sapphire are now very generally admitted to be varieties of the same species.

A perfectly transparent ruby is comparatively of much rarer occurrence than a perfectly transparent sapphire; and hence the superior value of a ruby, when of a certain size and without defect, compared with an equally perfect sapphire of the same size.

Oriental Topaz, Amethyst, Emerald, and Chrysolite.

Yellow, purple, green, and yellowish green perfect Corundum; of Count Bournon.

Télésie, *jaune, violette, and verte*; of Haüy.

These are varieties of the sapphire; and are respectively called *Oriental* topaz, amethyst, emerald, and chrysolite: to distinguish them from the Brasilian, Saxon, and Siberian topaz; and from the common amethyst, which is a coloured variety of transparent quartz, or rock crystal; from the emerald of Peru; and from the chrysolite of the Levant.

In some specimens, traces of all the different colours are observable.

The oriental topaz has usually a reddish tint.

The oriental amethyst may be considered as resulting from an intimate union of the colours of the ruby and sapphire.

The oriental emerald is derived perhaps from the union of the sapphire with the oriental topaz: but a small proportion of the red colour of the ruby is also, commonly, present; which gives to the green a brown and dull tinge.

The oriental chrysolite may be considered as a variety of the oriental emerald; in which the sapphire and the oriental topaz being united, the yellow colour of the latter predominates.

Lapidaries call all precious stones *oriental,* the hardness of which is inferior only to the diamond: they adopted this custom in consequence of having observed that the hardest precious stones came from the East. The epithet is particularly applicable in the present instance: because the above varieties are not only harder than any other substances resembling them in colour and transparency, except the diamond; but are only, or principally, found in India.

All these different varieties, together with the sapphire and the ruby, are essentially the same as to their chemical composition; the proportions of the constituent parts only slightly differing: they equally correspond in their physical characters. Hence they are now very generally referred to the same species; at the head of which the sapphire is placed as being the hardest, and specifically the heaviest: and as they also correspond in their chemical composition and physical characters with the different varieties of the substance called corundum, but are superior to these in colour and lustre &c., Count Bournon has denominated the former *perfect* corundum; the latter *imperfect* corundum: a division that might be very readily adopted on his authority, but that it would be difficult to supersede the use of such names as the sapphire &c.; the substances so called being very constant articles of commerce.

Count Bournon observes that the hardness and specific gravity of these gems are in proportion to their transparency: that though so much harder than flint they do not, when struck by steel, produce so numerous or such bright sparks: that they are phosphorescent by friction; but not so easily, or with so vivid a light as quartz, and without the peculiar smell that accompanies the phosphorescence of the latter substance: that their structure is laminated; and that those which are the least perfect are most easily divisible by mechanical means: and, lastly, that he is yet doubtful whether these substances are found in any part of the world except certain districts of India: though he thinks he met with sapphires in France, in the mountainous parts of the province of Forez, near Montbrison *.

Tavernier says that Pegu produces rubies; espinels, or mother of rubies; yellow topazes; blue and white sapphires; hyacinths; and amethysts: but that the natives of the country, who are employed in collecting them, call all precious stones *rubies*; specifying them by their colour: thus sapphires are *blue* rubies; topazes are *yellow* rubies; &c. The coincidence between this local classification, which arose merely from the substances being found in the same place, and the classification of the present day, which depends on the identity of their chemical composition &c., is singular.

Spinell Ruby.

Balass Ruby; so called from the word *Balacchan*, the Persian name of Pegu.

In the heat of the Berlin porcelain furnace, part of it melted imperfectly into a scoria.

In hardness it is inferior to the oriental ruby.

Specific gravity 3,66.

Primitive form, a regular octohedron: this is also the form in which it is commonly met with.

* Phil. Trans. 1802.

Alumine	82,47
Magnesia	8,78
Acid of Chrome . .	6,18
	97,43 *Vauq.*

Crystals and fragments of the spinell ruby constitute more than nine-tenths of what is known in commerce by the name of *sand of Ceylon*. This sand is a collection of various precious stones separated from the sediment of the rivers of that island, by which they have been conveyed from the interior : but as a selection of the most valuable has already been made in India, where they receive their first polish, crystals of the spinell of any remarkable size or beauty are rarely met with in the sand when it is imported into Europe.

The spinell is met with in the same situation with the oriental ruby, and principally in Pegu and Ceylon. The matrix is not known : but it is supposed by M. Werner to be a species of basaltic rock.

In the Hon. Mr. Greville's collection there is a specimen containing spinell imbedded in calcareous spar, and accompanied with crystals of mica and magnetic pyrites.

The spinell is sometimes of a yellow, and sometimes of a bluish colour : sometimes entirely colourless.

Topaz.

This name is derived, according to Pliny, from an island in the red sea where the topaz of the ancients was found. It has already been said that the topaz of the ancients was probably the chrysolite of the moderns *.

There are three principal varieties of the topaz; the Brasilian, the Siberian, and the Saxon. All these have the property of changing the colour of syrup of violets to a green; but in order to produce the effect they must be first reduced to powder, and suffered to remain in contact with the syrup for a few hours.

The existence of fluoric acid in the topaz has been only recently ascertained. The discovery was made by MM. Klaproth and Vauquelin.

Many other mineral substances are sometimes distinguished by the name of topaz; as the hyacinth, the chrysoberyll, yellow transparent quartz, and even yellow fluor spar. The oriental topaz is a variety of the sapphire, already described under the head of that substance.

The topaz may be distinguished from the chrysoberyll, by its greater specific gravity; and, generally, by its difference in form; the crystal of the latter substance being commonly an hexhedral prism: from yellow fluor and quartz, by its greater degree of hard-

* Vid. p. 120.

ness: from the hyacinth, by its inferior specific gravity.

Brasilian Topaz.

In hardness it is intermediate between spinell and quartz; yielding a little to the file.

Has a double refracting power.

Electric by heat; positively at one extremity, negatively at the other.

In the heat of the Berlin porcelain furnace it became white and opaque.

Specific gravity 3,5.

Primitive form, a prism at right angles with its base; the angles of which are 124^d 22$'$ and 55^d 38$'$. The common form is an oblique angled four-sided prism; terminated at one extremity by a short quadrilateral pyramid, the faces of which are generally unequal.

Alumine	47 to 50
Silex	28 to 30
Fluoric Acid . .	17 to 20
Oxyd of Iron . .	0 to 4

The colour of the Brasilian topaz is commonly a deep golden yellow; sometimes it is of a saffron or reddish hue.

The yellow varieties become of a pink colour by exposure to a red heat; and are then called Brasilian rubies.

Siberian Topaz.

The Siberian topaz is commonly transparent, and colourless; or of a very pale bluish green shade, too faint to be easily perceptible. It is accompanied by crystals of the beryll and aquamarine. Like the Brasilian topaz it is electric by heat; positively at one extremity, and negatively at the other.

Saxon Topaz.

The Saxon topaz corresponds very closely with the Brasilian, excepting that it is electric by friction instead of heat. The electricity is excited very easily, and continues for half an hour or more.

The colour of the Saxon topaz is a pale wine-yellow.

Garnet.

Granatus, of Wallerius; from the resemblance of some of its varieties to the colour of the fruit and flower of the pomegranate.

Carbunculus, and *Pyropus*; of Pliny, &c.?

Ἄνθραξ of Theophrastus? this and the two foregoing names are derived from the fire-red colour of the substances to which they were applied: and are particularly applicable in that sense to some varieties of the garnet.

The colour most esteemed in the garnet is red: but it is met with of various other colours; yellow, green, brown, and black.

It is sufficiently hard to scratch quartz.

Fusible by the blowpipe.

Specific gravity varies from 3,55 to 4,18.

Primitive form, a dodecahedron with rhomboidal faces, all of which are similar and equal. This form, which corresponds with that of the cells in a bee-hive, comprehends the greatest capacity under the smallest extent of surface.

The essentially constituent parts of garnet are silex, alumine, lime, and oxyd of iron; but the proportions of these vary considerably.

Silex	34 to 52	in 100 parts.
Alumine . . .	6 to 28	
Lime	0 to 33	
Oxyd of Iron .	10 to 36	

*Oriental or Sirianic Garnet**.
Sp. gr. 4,085.

Silex . .	35,75
Alumine .	27,25
Oxyd of Iron	36,
Oxyd of Manganese.	0,25
	99,25 *Klapr.*

Bohemian Garnet.
Sp. gr. 3,718.

Silex . .	40
Alumine .	28,50
Magnesia .	10
Lime . .	3,50
Oxyd of Iron	16,50
Oxyd of Mang.	0,25
	98,75 *Klapr.*

* So called from Sirian, a town in Pegu, now destroyed. Vid. Klaproth's Essays, Engl. Transl. vol. i. p. 334.

	Transparent, Bohemian Garnet.	*Red Garnet, from the Alps.*
	Sp. gr. 4,15.	
Silex	36	52
Alumine	22	20
Lime	3	7,7
Oxyd of Iron	41	17
	102* *Vauq.*	96,7 *Vauq.*

Yellow amorphous Garnet of Corsica.
Sp. gr. 3,55.

Silex	38
Lime	31
Alumine	20
Oxyd of Iron	10
	99 *Vauq.*

	Black Garnet, from the Alps.	*Black Garnet, found near Frescati.*
		Sp. gr. 3,79.
Silex	43	34
Lime	20	33
Alumine	16	6,4
Oxyd of Iron	16	25,5
	95 *Vauq.*	98,9 *Klapr.*

By the preceding analyses it appears, that the Sirianic and Bohemian garnet, which are most valuable on account of their transparency and colour, contain a greater proportion of iron than any of the other va-

* Vid. the preceding note, p. 120.

rieties: the yellow and black garnet, a greater proportion of lime, and a less proportion of alumine. It appears also, as indeed might be expected, that the specific gravity of garnets is heightened in proportion to the quantity of iron contained in them. The difference however in these analyses renders it doubtful, whether these several substances can be considered as of the same species.

The oriental or noble garnet, as it is also called, is said to be of a crimson colour; the Bohemian, rather of a blood red: but more than one opportunity has occurred, in the preceding pages, of observing that the term oriental has a reference rather to beauty and hardness, than to local situation. The Bohemian garnet would indeed by jewellers be called oriental in preference to any other; being of a greater degree of transparency: hence indeed it is most frequently used in jewellery. In some instances the colour is so intense, that, to facilitate the display of this, it is cut into a form somewhat resembling the cup of an acorn; but more flattened.

The Bohemian garnet is found, together with hyacinths and sapphires, in alluvial districts, which appear to have been formed by the detritus of basaltic and serpentine mountains.

Small Bohemian garnets, when pulverized, are sometimes used as emery.

Garnets are met with in most parts of the world; principally in gneiss, and rocks of the magnesian genus. They are very common in the highlands of Scotland, and are disseminated in crystals through the substance of varieties of gneiss and granite. I have seen specimens from that quarter consisting of small dodecahedral crystals, of a blackish red colour, and about the size of a pea, loosely cemented together by a dark coloured substance bearing no proportion in quantity to the garnets themselves, which constitute more than nine tenths of the whole mass.

Some remarkably large crystals of garnet are met with in the mountains that separate Stiria from Carinthia : they are incrusted with green talc. Equally large crystals are found in the Tyrol; but without this incrustation of talc. Some of these large crystals are of a dark reddish black colour, and capable of receiving a polish sufficiently fine to reflect the images of objects from their surface.

In some parts of Germany, and Bohemia, common garnets are employed as a flux in the reduction of iron ore; a purpose to which they are particularly adapted, as they themselves contain a considerable proportion of iron.

It is a remarkable fact that in some instances the most perfectly transparent garnets affect the magnetic needle.

The garnet when of a dodecahedral form may be distinguished from the hyacinth of the same form, by the angle under which its faces mutually incline to each other, which is in every instance 120^d; while in the hyacinth it is sometimes greater, and sometimes less. On the same principle it may also be distinguished from dodecahedral hornblende, and some of the varieties of staurolite. It may be distinguished from leucite, by its fusibility and greater specific gravity: from the ruby and spinell by its inferiority in colour and hardness, and by its fusibility.

There is a curious passage in Pliny, in which it appears that in his time imitations of the precious stones were commonly made in glass; with foil, or something analogous, placed under it: but that they might be detected by their want of hardness, and inferior specific gravity. He makes the observation in speaking of the difficulty of distinguishing real from artificial carbuncles, or garnets. "Nec est aliud difficilius quam discernere hæc genera: tanta est in "eis occasio artis, subditis per quæ translucere cogantur: adulterantur *vitro*, simillime; sed cote deprehenduntur, sicut aliæ gemmæ factitiæ, *mollior* "enim natura: deprehenduntur et *pondere*, quod "minus est *vitreis* *."

* Nat. Hist. lib. xxxvii.

Corundum.

Adamantine Spar: when pulverized it is used by the Chinese and Indian lapidaries instead of diamond powder, for cutting and polishing gems; &c. and hence the preceding name.

Its hardness is very considerable; as appears from the use to which it is applied, described above.

It has a double refracting power.

Primitive form is the same as that of the sapphire: it is commonly of a distinctly laminated structure, and is easily divisible into rhombic fragments.

Specific gravity 3,931: which was the mean specific gravity of thirty-three different specimens of corundum, taken by Count Bournon.

Corundum of China.

Alumine	84,0	86,50
Silex	6,5	5,25
Oxyd of Iron	7,5	6,50
	98,0 *Klapr.*	98,25 *Vauq.*

Corundum of Bengal.

Alumine	89,50
Silex	5,50
Oxyd of Iron	1,25
	96,25 *Klapr.*

Corundum of Malabar		*of Ava*	*of the Carnatic.*
Alumine	86,5	87	91
Silex	7	6,5	5
Oxyd of Iron	4	4,5	1,5
	97,5	98,0	97,5 *Mr. Chenevix,*

Corundum is an Indian term, an explanation of which I have not met with. The Chinese corundum contains a little more than one tenth of its weight of magnetic iron ore, mechanically disseminated through its substance in particles of various sizes; sometimes as large as a hazel nut: their form is indeterminate. In the foregoing analysis these particles were previously separated by applying a magnet to the pulverized stone.

The Bengal corundum contains no magnetic iron: a few grains are occasionally found adhering to its surface.

The Chinese corundum is of a deep brownish green colour; that of Bengal is of a light yellowish colour; of Malabar, a reddish brown; of the Carnatic, a greyish or greenish white. The last mentioned variety is most commonly met with in cabinets; and generally in fragments that more or less approach to a cubic form.

The above varieties of corundum are met with in granitic rocks, of which they form a distinct component part after the manner of felspar: and their general appearance is indeed not unlike that of felspar.

Emery.

Smiris cinerea, solida; of Wallerius.

It is sufficiently hard to scratch flint; and scarcely yields to the file.

Specific gravity 4.

Alumine	80	65,6	50	
Silex	3	3,2	8	
Oxyd of Iron	4	8,	32	
Undissolved residuum		18		
	87	94,8	90	*Mr. Tennant.*

Emery of Jersey.

Alumine	70	
Oxyd of Iron	30	
	100	*Vauq.*

Mr. Tennant once saw in London as much as fifty tons of emery, consisting of angular blocks incrusted with iron ore, pyrites, and mica; the last mentioned substance frequently penetrating the whole mass, and giving it when broken a silvery appearance. It is remarkable, he observes, that the above substances which have no chemical relation to the emery itself accompany also the corundum of China; with which emery agrees in hardness, specific gravity, and analysis. Mr. Tennant did not find any pieces of a crystallized form.

In consequence of the iron contained in it being at a low state of oxydation, it is sometimes magnetic; and particular varieties of emery are in their appearance not unlike grey iron ore; octahedral crystals of which are contained in the emery of Jersey and Naxos: hence emery has often been classed as an ore of iron. It is now considered as an impure variety of corundum.

The emery of Smyrna, called so because imported from thence, is found in scattered fragments and pebbles at the foot of primitive mountains in the isle of Naxos. This is the variety principally used in England.

Emery is found in Saxony; in Guernsey and Jersey; on the coasts of Normandy and Spain; and abundantly in the islands of the Egean.

It is separated from the substances accompanying it, by the operations of pounding and washing: the different sediments are then collected, and are valuable in proportion to the fineness of the particles.

It is used according to Winkelman in giving a polish to sculpture worked in porphyry.

In the working of gems, and it is even employed in cutting the hardest of them, as the sapphire and ruby, emery is mixed with water: in the working of metals, it is mixed with oil; probably to prevent their rusting.

Felspar.

Felspar signifies Rock-spar, from the German word *fels*, a rock. By some it is called Feldspar or Field-spar, from the German word *feld*, a field; crystals of it being often found dispersed over open tracts of country.

It is sufficiently hard to scratch glass, and strike fire with steel.

Phosphorescent, and electric (though not easily) by friction.

It has a double refracting power.

Specific gravity varies from 2,4 to 2,7.

Primitive form, an irregular obliquely angled parallelepiped.

It occurs both crystallized and amorphous. Sometimes uninterrupted masses of felspar are met with in the form of rocks or mountains: but most commonly it is a constituent part of other rocks, particularly granite and porphyry.

The principal constituent parts of felspar are silex and alumine; the proportion of the former greatly exceeding that of the latter. In some instances a considerable proportion of potash is present, which gives a fusibility to the compound; the varieties which do not contain potash being very refractory.

Adularia.

So called from the word *Adula*, an old name of one of the heights of St. Gothard; where it was discovered in the fissures of rocks of gneiss and micaceous schistus.

It is also called *Moon-stone*, from its colour and soft lustre.

In the heat of the Berlin porcelain furnace it was fused into a clear colourless glass.

It generally occurs in double crystals, which are sometimes eight or ten inches long, more or less perfectly transparent; and of a delicate cream colour, with a pearly lustre. Some of the surfaces are marked with broad shallow channels.

Specific gravity 2,55.

Silex	64
Alumine . . .	20
Lime	2
Potash	14
	100 *Vauq.*

The fusibility of adularia is owing to the potash contained in it.

The crystallized substance, formerly called white shorl of Dauphiny, is a variety of felspar; in transparency resembling adularia.

Argentine Felspar.

Oculus piscis.

This substance, the appearance of which is in part explained by its name, was discovered and analysed by a gentleman of the name of Dodun. He met with it, in the form of rounded fragments, in the black mountain of Languedoc.

Silex	46
Alumine . . .	36
Oxyd of Iron .	16
	98

In its external characters it is nearly allied to felspar; but by the quantity of oxyd of iron contained seems essentially to differ from it.

Green Felspar.

In the Berlin porcelain furnace it was fused into a milk-white glass.

Silex	62,83
Alumine	17,02
Lime	3
Potash	13
Oxyd of Iron . .	1
	96,85 *Vauq.*

This variety, which is met with at the eastern base of the Oural mountains, is remarkable on account of its colour, and the great proportion of potash contained in it.

Blue Felspar.

This variety has only yet been met with in Stiria. It differs from the generality of felspars, in being of a compact and earthy instead of a laminated texture. Thin and irregularly curved laminæ of silvery talc penetrate its substance in various directions, and add greatly to its beauty; the blue colour of the mineral being itself very delicate.

Opaline Felspar.

Labradore-stone; having been first found in rounded fragments, in an island on the Labradore coast.

Specific gravity varies from 2,67 to 2,69.

The general colour of this stone is an iron grey: it is called opaline from a remarkable play of colours, visible, as it were in its interior, when held in particular directions: the most conspicuous colours are blue, green, purple, and orange-red; the intensity of these altering according to the alteration of the direction in which the stone is held.

Compact laminated Felspar.

Felspar of this kind occurs most commonly in granite; it is generally opaque, and of some shade of a brownish red; or a pale flesh colour; or nearly colourless. Sometimes it is disseminated in tolerably distinct crystals through the mass of granite; the form of the crystals being for the most part an oblong rhomb. Their structure is frequently remarkable on account of the reversed situation of the laminæ in the two longitudinal halves of each crystal: in consequence of which the light is reflected much more vividly from one half than the other, when the crystal is held in certain directions.

Observations on Felspar.

Felspar is often remarkably disposed to undergo a spontaneous disintegration; which there is reason to suppose, in some instances at least, depends on a previous alteration in the nature or proportions of its component principles. This alteration is thought by Werner to have been effected by the loss, either partial or entire, of the potash naturally contained in it. And this opinion is supported by the observation that felspar is, often, less fusible in proportion to its state of disintegration; and that those felspars in which a considerable proportion of potash is present are very fusible.

Some have thought that the disintegration depends on exposure to the atmosphere: but Mr. Jameson observed, at great depths in the mines of Freyberg, beds of gneiss completely sheltered from the action of the weather, in which the felspar was entirely disintegrated. Perhaps this altered state of felspar may be referred, as Mr. Davy has suggested with respect to the spontaneous alteration of mineral substances in general, to the agency of electricity.

But this part of the history of felspar, perhaps the most important, has not yet been well elucidated; and it is safer therefore to confine ourselves to the description of its altered appearance, than to attempt an explanation of the cause of this.

There are in the Oxford collection some specimens of a coarse porphyry, the ground of which is of a brick-red colour: the crystals of felspar contained in it are not very numerous; but they are in general well defined; and in the unaltered parts perfectly transparent, and of a glassy appearance. From this state they pass through numerous stages of disintegration; until they become completely opaque, and differ not in texture and appearance from a loose white earth. In some of the crystals the alteration has taken place universally, in others partially only: so that sometimes the central part of a crystal is completely transparent, while the exterior is opaque and readily crumbles into powder; and *vice versâ*.

Earthy Felspar of Cornwall.

The felspar of the white granite in many parts of Cornwall occurs in a completely disintegrated state. Here and there indeed the process has not advanced sufficiently far to destroy the cohesion of the particles of the felspar, though its substance is so far softened as easily to yield to the knife like steatite: but upon the whole it is in a loose earthy state.

In the neighbourhood of St. Austle there is a tin mine, or rather quarry, in which the different stages of this process may be traced very satisfactorily. The altered state of the felspar renders the granite of this quarry so friable that it is very easily removed; and hence the veins of tin-ore by which it is intersected are not followed in the usual manner by means of shafts and levels; but the granite is quarried like free-stone, and the ore is separated by the process of stamping and washing.

In some parts of the quarry the disintegrated felspar occurs in distinct patches, and may be easily detached without any particles of the quartz; with which it is in general intimately mixed: but at all times it may be separated by simply stamping the granite, and diffusing it through water.

The particles of tin ore and of quartz very soon subside, in consequence of their greater bulk or specific gravity; and the supernatant water, together with the felspar suspended in it, is drawn off and conveyed to pits &c., excavated for the purpose. By degrees the felspar subsides; and, the water being again drawn off, a white sediment is left of the consistence of paste: if this be dried it contracts into a soft earthy mass of a very white colour, and in appearance and general characters closely resembles a very pure natural clay. This process is analogous to that by which whiting is prepared from chalk*. The felspar thus separated is extensively employed in the manufacture of porcelain.

Kaolin of China.

The kaolin of the Chinese very much resembles the earthy felspar of Cornwall: and is derived from the disintegration of granitic rocks.

Silex	71,15
Alumine . . .	15,86
Lime	1,92
Water	6,73
	95,66 *Vauq.*

Petuntzé of China.

It is doubtful whether this name is applicable to a modification of kaolin, or to the disintegrated rock from which the kaolin is obtained.

In a short but very interesting account of minerals, published by a gentleman of the name of Rozin, it is stated that the petuntzé of China is a felspar which has lost a portion of the potash naturally belonging to it; but, not having been reduced to a completely earthy state, still retains traces of a laminated structure: and that the kaolin of China differs from the

* Vid. p. 20.

petuntzé in having undergone decomposition to a greater extent; and having been in consequence almost entirely deprived of the potash originally contained in it: that in the composition of China these two ingredients are mixed; the proportion of potash present in the mixed mass giving that degree of fusibility which is just sufficient to cement the particles together, without vitrifying the porcelain: that the petuntzé by itself would be too fusible for the purpose intended; the kaolin too refractory to acquire a sufficient degree of cohesion between its particles.

Porcelain Clay.

Nearly infusible in the greatest heat of a porcelain furnace.

In whatever state of induration this is met with, it has probably been derived from felspar; and has been reduced to its present state by some natural process analogous to that which has been described in the account of the earthy felspar of Cornwall.

Porcelain Clay of Limoges.

Silex	55
Alumine	27
Lime	2
Oxyd of Iron . .	0,5
Water	14
	98,5 *Vauq.*

The clay, of which the Berlin porcelain is made, is found below Halle in the district of Magdeburg: that of which the Austrian porcelain is made, at Passau. The French porcelain clay is met with in the vicinity of Limoges.

If clay, which otherwise would be fit for making porcelain, contain one tenth part of lime, it is fusible in the heat to which the porcelain must necessarily be exposed, and consequently unfit for the purpose intended. It may contain as much as one twentieth part without occasioning the vitrifaction of the mass. Oxyd of iron is injurious in a double sense; for it not only promotes vitrifaction, but discolours the porcelain by the alteration it undergoes during the process of baking.

Mr. Kirwan observes that clays found under coal are in general the least fusible; because the coal obstructs the infiltration of water containing calcareous particles.

Clays in which the siliceous ingredient predominates, in the proportion of three or four to one, are best adapted for the composition of porcelain; because, when baked, they best resist sudden alterations of temperature.

An inferior kind of porcelain clay is found in that part of Bovey heath, in Devonshire, which is near the London road: it is met with not much below the surface of the earth; and, from a consideration of its situation and the attendant circumstances, appears evidently to be a natural deposition of earthy felspar. Whoever considers the swampy nature of that heath, the appearances observable on its surface, and its relative situation to the adjoining granite hills, may easily be convinced that it is derived from the detritus of these, washed down and deposited by water: for this heath is as it were a natural bason, which must necessarily receive whatever is brought down from the adjoining high ground; and its surface in a great measure consists of a white sandy quartz and occasional crystals and fragments of felspar, that evidently correspond with the quartz and unaltered felspar of the neighbouring granite.

But the strongest evidence of the nature of its formation is derived from an examination of those beds of clay, as they have been hitherto usually termed, which are interposed between the layers of the fossile wood, commonly called Bovey coal.

The substance of this clay appears to be of a much more compact and uniform appearance in some parts than in others. I collected specimens on the spot, some of which do not differ very much from the common white granite of Cornwall; but the felspar is not of so delicate a colour, nor are the particles of quartz so uniformly disseminated through it: an appearance which justifies the supposition that the granite has been disintegrated and its constituent parts subsequently reunited, though not with their original regularity. Other specimens, from the same spot, seem to be the result of a similar but still less regular deposition; the felspar being of a dirtier colour, and the particles of quartz neither so numerous nor so uniformly disseminated through their substance, as in the former instance. And, lastly, in some specimens the particles of quartz are rarely present: so that the mass very closely resembles a light coloured variety of potters' clay.

The gradations in these appearances, compared with the local circumstances, seem to leave very little doubt that these several varieties of clay, as well as the porcelain clay met with in a different part of the heath, are nothing more than depositions of disintegrated felspar, occasionally mixed with particles of quartz: nor is it surprising that the porcelain clay should be much whiter than the others, since the latter have evidently been deposited at the same time with those trunks and branches of trees which constitute the Bovey coal, the vegetable extractive matter of which has probably discoloured them.

Pipe Clay.

Leucargilla? of Pliny?
Terra Samia? of the ancients.

This clay is so called from its use in the fabrication of tobacco pipes. It scarcely differs in its composition from porcelain clay; but the siliceous particles are not sufficiently fine to render it applicable to the same purpose.

Potters' Clay.

Specific gravity varies from 1,8 to 2.

Potters' clay does not differ materially from pipe clay. It frequently contains a greater proportion of lime and of oxyd of iron; and hence is more liable to vitrify, and to be discoloured by the application of the higher degrees of heat: on which account it is employed in the composition of the inferior kinds of earthen ware or pottery; and is called in consequence, potters' clay.

M. Vauquelin analysed various specimens of earthen ware; and from an average of the results of his experiments it appeared, that the proportions of the constituent parts in a hundred were as follow:

Silex . . .	at least 66
Alumine . .	20 to 33
Lime . . .	5 to 20
Oxyd of Iron .	0 to 3

The situation in which potters' clay is found and its general appearance and character afford probable grounds for supposing that it has been formed, in the manner described in the preceding pages, by the deposition of the finer parts of disintegrated rocks of various kinds. Those which contain least iron have been probably derived from granite and its varieties: those which contain most, from basalt perhaps, and rocks of that genus.

Stourbridge Clay.

This is a natural clay containing very little lime or iron; and hence it is neither much coloured nor disposed to vitrify in the higher degrees of heat: on which account it is employed in the construction of furnaces; and in the fabrication of fire bricks, as they are called from being so refractory; and of those coarse vessels in which porcelain is usually baked, in order to preserve it from external injury during that process.

Those fire bricks which are made at Stourbridge very readily produce sparks when struck by steel; and their internal appearance is altogether not very unlike the soft white granite of Cornwall, excepting that they are of a yellow colour. The granite of Cornwall is sometimes indeed employed as a clay in the fabrication of crucibles, a manufactory of which kind is carried on at Truro. From an examination of the substance of these crucibles it appears, that the granite has been simply pounded; and tempered with just a sufficient proportion of clay to give it the requisite degree of tenacity: since the constituent parts of the granite may be easily recognized by the eye. These crucibles are nearly if not quite as refractory in the fire as the Hessian crucibles the substance of the latter were analysed by M. Vauquelin, and gave the following results.

Silex	69
Alumine . . .	21,5
Lime	1
Oxyd of Iron .	8
	99,5

The Truro crucibles probably do not contain so great a proportion of oxyd of iron.

Common Brick Clay.

The usual colour of this clay, which is met with in great abundance in various parts of England, is brown or slightly reddish brown; and depends upon the presence of oxyd of iron. The red colour peculiar to common bricks and tiles depends upon the alteration of the oxyd of iron during the process of burning; and this probably is effected by the decomposition of the water, with which the clay was tempered to give it the requisite degree of tenacity; its oxygen contributing to the further oxydation of the iron, and consequently producing the usual change of colour. If the proportion of oxyd of iron contained in brick clay be greater than ordinary, and especially if at the same time the proportion of lime is also considerable, the bricks are often superficially vitrified: and this affords an explanation* of an appearance very common in brick kilns, where the surfaces of some of the bricks are glazed, and of a green colour; the oxyd of iron being disposed to vitrify with earthy substances, particularly lime, and possessing the property of communicating a green colour to glass. A variation in the proportions of lime and oxyd of iron is thus seen to affect the chemical characters of bricks. Their mechanical characters are also affected by a variation in the proportions of the silex and alumine: if the silex predominates in too great a degree, the clay is not sufficiently ductile; if the alumine, the bricks made from it will be rifty. The best proportions are

Silex . . .	86
Alumine . .	14

These proportions are very nearly the same as in the clay of the neighbourhood of London: and where the proportion of alumine predominates to this extent the compound is called loam.

Loam.

This term is derived from the German word *leime* originally signifying a viscid earth.

Loam of the neighbourhood of London.

A reddish grey sand as fine as meal	87
Alumine . . .	13
	100 *Bergm.*

By this analysis loam appears to be a clay, in which the silex predominates remarkably and is in a very minute state of division.

In consequence of the great proportion of the silex, and the ease with which from its minutely divided state it may be made into a paste, loam is successfully employed in the composition of lutes to be used in very high degrees of heat. From a variation in the proportions of the constituent parts it is called either a sandy or a clayey loam.

General Observations on Porcelain and Potters' Clay.

Mr. Kirwan observes, that alumine, when not combined with carbonic acid, or fixed air, retains moisture with great obstinacy; and therefore is not fit for making porcelain: whence he supposes the practice is derived of exposing clays to the air for a long time before they are employed for that purpose.

A clay in which the proportion of silex is much smaller than usual, is unfit for pottery; as being disposed to separate into clefts: it is technically called a *fat* clay. If the proportion of silex be much greater than usual, the clay has scarcely sufficient tenacity: this is called a *meagre* clay. Fat clays are preferable to meagre clays in the construction of glass house crucibles, as being less acted on by alkalies.

Common clays when breathed on have that particular smell called earthy. This is by some supposed to depend on the alumine; by others, on the oxyd of iron and other foreign substances contained in them.

According to Wallerius almost all argillaceous earths give ammonia, or hartshorn, by distillation; and most of them contain some particles of inflammable matter. These two facts, joined to the consideration of their texture, and the situation where they are met with, which is in general near the surface, seem to prove that they have been formed from the detritus of other substances.

The occasional blue or bluish grey colour of clay in some instances depends on the oxyd of iron contained in it: in which case it is generally reddened by calcination. In some instances clay of this colour, or even completely black clay, becomes white by calcination: in which case the colour is owing to the presence of inflammable matter.

Fullers' Earth.

Creta Cimolia, of Pliny; from the island of Cimolus, now called Argentiera. "Est et *Cimoliæ* cretæ "usus in vestibus *. Primum abluitur vestis Sar- "dâ—dein sulphure suffitur: mox desquamatur "*Cimoliâ* †."

Smectis: from the verb σμήχω, *abstergo.*

The fullers' earth of Hampshire was fused in the heat of the Berlin porcelain furnace into a dense blackish green scoria.

Fullers' Earth from Hampshire...		*from the Island of Cimolus.*
Silex	51,8	63
Alumine	25,0	23
Magnesia	7,0	0
Carbonate of Lime	3,3	0
Oxyd of Iron	3,7	1,25
Water and other volatile matter	5,5	12
	96,3 *Bergm.*	99,25 *Klapr.*

Fullers' earth, which is commonly of a dark drab colour with an obscure shade of green, is not ductile like common clay, when mixed with water; but rather crumbles into a powder like marl. It is also nearly friable; and does not adhere to the tongue.

The fullers' earth of the island of Cimolus, analysed

* Plin. Nat. Hist. Ed. Brot. vol. vi. p. 183.

† Ibid. pp. 183, 184.

by M. Klaproth, was brought over from thence by Mr. Hawkins. Similar specimens were also brought from a neighbouring island: and in both instances numerous grains of quartz were disseminated through the mass. From this circumstance, joined with the results of the analysis and the primitive character, in a geological point of view, of the islands of the Archipelago, I should conclude that the fullers' earth of Cimolus was derived from the decomposed felspar of a disintegrated granite. Fullers' earth is met with in France, Saxony, and Sweden; and in very great abundance in different parts of England, as at Woburn, Ryegate, and Maidstone. A great proportion of the fullers' earth of commerce comes from Hampshire.

English fullers' earth is often met with between strata of sandstone.

The specific action of fullers' earth depends on the alumine contained in it: and it appears that the proportion of this should not be less than a fourth or fifth of the whole mass. It should not however be much more; for in that case the fullers' earth would be too tenacious to diffuse itself through water. The silex also should be in a very minute state of division; otherwise the particles, being too rough, would wear out the texture of the cloth to which it was applied.

M. Klaproth found that the earth from Cimolus possessed the fulling property in a superior degree to the English.

Lithomarga.

La moelle de pierre; of Brochant.

According to Wallerius the term lithomarga is applied to those argillaceous earths which are met with in the clefts and cavities of rocks. It would be very difficult therefore, if not impossible, to give a particular description of the substances so denominated.

Ochre and fullers' earth are sometimes classed under the head of lithomarga.

Ochres.

Specific gravity varies from 1,4 to 2.

The term ochre (Ὦχρα) in its original acceptation implied a yellow earth: for Theophrastus, having already called it an earth, says that it is used instead of arsenic; and Pliny says of arsenic, that it is most valuable when of a pure golden colour. Numerous passages might be produced, were it necessary, to prove this point.

The term is at present applicable to any coloured earth; but particularly to natural clays coloured by oxyd of iron. The principal varieties are yellow, red, and brown.

Where the proportion of iron is sufficient to be worth extraction, ochres may be considered as a variety of the argillaceous ores of that metal.

Yellow Ochre.

Ochra, and *Sil Atticum*; of Pliny.

This substance, which is a clay coloured by an oxyd, or perhaps a carbonated oxyd, of iron, is principally made use of as a coarse paint. A variety met with in Shotover hill near Oxford, is of a remarkably uniform colour and fine texture; it is preferred in commerce to all others.

Coarse yellow ochre is frequently converted into red ochre by calcination: in which process probably the carbonic acid or fixed air is driven off, and the iron at the same time is further oxydated by means of the decomposition of the moisture contained originally in the ochre.

Red Ochre.

Rothel, in Germ.; and *Ruddle* or *Reddle*, of many parts of England; from its colour. Hence probably the etymology of the name of the county of *Rutland*.

Terra Lemnia; from the island of Lemnos: whence it has been obtained in great abundance from time immemorial. This variety is also called *Terra sigillata*.

Rubrica, and *Sinopis*; of Pliny: the first name derived from its colour; the last from the name of the place whence it was anciently exported for commerce.

Bole ; and *Armenian Bole.*
Μίλτος, of Theophrastus.

Terra Lemnia.

Silex	47
Alumine	19
Carbonate of Lime .	5,4
Carbonate of Magnesia	6
Oxyd of Iron . . .	5,6
Air and Water . . .	17
	100,0 *Bergm.*

It has been already stated that red ochre is frequently obtained by calcining yellow ochre. Theophrastus says that the method of conducting the process was accidentally discovered by a person, who, in an inn which had been burnt down, saw a heap of ochre that had been partly changed to a red colour by the action of the fire.

Red ochre is used as a coarse paint in almost every part of the world.

The variety called terra Lemnia, which is not however always red, affords a considerable revenue to the Turkish government: the native ochre of Lemnos is washed, in order to separate the sand, &c., and is then formed into flat cylindrical pieces; which are stamped and sold under the name of terræ sigillatæ. These were formerly used, to a great extent, medicinally: their use is now principally confined to painting. In the heat of the Berlin porcelain furnace this variety melted into a compact greenish black glass.

Red ochre when of a very fine texture and sufficient degree of consistence is cut into pencils, and sold under the name of red crayon.

Brown Ochre.

Umber, or *Umbre;* so called from the part of Italy where one of its varieties is met with.

Brown Ochre of Cyprus.

Silex	13
Alumine . . .	5
Oxyd of Iron . .	48
Oxyd of Manganese	20
Water	14
	100 *Klapr.*

The history of this substance is very much confused. Wallerius says that there are two kinds; one, light and inflammable, and generally met with in strata of coal or fossile wood; the other, a true ochre or clay coloured by iron. The first is a variety of the substance called *terre de Cologne;* and is often confounded with umber, and brown ochres in general.

Agalmatolite.

Bildstein; signifying literally *Lard-stone:* so called from its resemblance to lard.

Specific gravity 2,8.

Silex	56
Alumine	29
Lime	2
Potash	7
Oxyd of Iron . .	1
Water	5
	100 *Vauq.*

Transparent Agalmatolite.

Silex . .	54
Alumine .	36
Oxyd of Iron	0,75
Water . . .	5,50
	96,25 *Klapr.*

Opaque flesh-red Agalmatolite.

Silex . .	62
Alumine .	24
Lime . .	1
Oxyd of Iron	0,5
Water . .	10
	98,5 *Klapr.*

This substance, from its unctuous feel and general external character, had been considered as a variety of steatite; but it appears from the preceding analyses that it does not contain the least particle of magnesia: it is now therefore classed as an argillaceous compound.

It comes principally from China, where it is worked into various figures: from which circumstance Klaproth was induced to call it agalmatolite. It must be remembered that the substance of some of those Chinese figures is a particular form of rice; and, from their close resemblance the two substances are liable to be mistaken for one another.

Cyanite.

Sappare; of Saussure.

Disthène; of Haüy: this name has a reference to the double electric power of the substance; some of its crystals being positively, others, negatively electrified by friction; even though placed under the same circumstances.

Its hardness is as nearly as possible equal to that of glass.

Infusible by the blowpipe. In the heat of the Berlin porcelain furnace it became white and friable.

Specific gravity 3,5.

Primitive form an oblique angled four-sided prism.

Alumine . . .	54
Silex	29
Lime	2
Magnesia . . .	2
Oxyd of Iron . .	6,65
Water &c. . .	5
	98,65 *Theod. de Saussure.*

Cyanite, so called from its blue colour, commonly occurs in the form of flat laminated prisms, which are often partly white and partly blue; the colours running in irregular streaks, and mutually graduating into each other. The blue part has generally some degree of transparency: and the colour is sometimes equal to that of the inferior varieties of the sapphire; for which substance cyanite, when cut and polished, has been sold.

Some varieties are yellowish or greenish.

In consequence of its infusibility Saussure employed the laminæ of this substance for the purpose of attaching to them particles of other minerals, during their exposure to the action of the blowpipe.

The matrix of cyanite is commonly talc, gneiss, or micaceous schistus: the most beautiful specimens are found in talc, in mount St. Gothard. It is also met with in Spain; in different parts of Germany; and in Scotland.

It may be distinguished from mica, by its infusibility, and want of elasticity: from actinolite, by its infusibility: from sapphire, or even blue quartz, by yielding to the impression of the file.

Mica.

Vitrum Moscoviticum; because used in Russia instead of glass.

Glacies Mariæ; because employed, when broken into small pieces or scales, in *frosting* images of the Virgin Mary *.

* Vid. p. 66.

It was superficially glazed in the heat of the Berlin porcelain furnace.

Specific gravity varies from 2,65 to 2,93.

Primitive form, a four-sided prism at right angles with its base; which is a parallelogram with angles of 120[d] and 60[d].

Silex	50
Alumine . . .	35
Magnesia . .	1,35
Lime	1,33
Oxyd of Iron .	7
	94,68 *Vauq.*

Mica is so called from its glittering appearance; by which it may in general be easily recognized in compound rocks, as granite, gneiss, &c.

When distinctly crystallized, which does not often happen, its form is usually an hexhedral plate; and, according to Saussure, these plates are almost always set on their edges. Sometimes a great number being closely applied to each other produce a six-sided prism.

In whatever form mica occurs, it has the peculiar property of being divisible into laminæ to any extent; which often, simply in consequence of their extreme tenacity, reflect the colours of the rain-bow. Haüy says that by calculation he found the thickness of some of these laminæ to be not more than the six hundred thousandth part of an inch. When the crystalline laminæ of mica are in complete contact with each other throughout the whole extent of their surface, they are usually transparent: otherwise they are not, unless divided into very thin plates.

Mica, when of sufficient size and transparency, is often used in Russia instead of glass; and when employed in the windows of ships of war, which till lately was a common custom, has the advantage of glass in not being liable to be shattered by the shock of cannon: but by exposure it loses its transparency. Not being easily injured by fire it makes a very good substitute for glass, in the construction of lanterns, &c.

Mica is a constituent part of almost all granite; and appears to have been originally crystallized in the body of that compound rock. It is also commonly met with in sand-stones and secondary schisti: in which case it is hardly to be considered as the result of crystallization; but as the detritus of crystallized mica, that has been subsequently deposited with the other component parts of the strata in which it occurs.

In some instances mica is of a delicate white, or a bright yellow colour; and from its lustre joined with its colour has occasionally been mistaken for silver or gold. Miners call this, cat gold or cat silver. There is a patch of mica of this kind on the ridge of Malvern, between the Well house and the town.

White or greenish mica may be distinguished from talc, by its elasticity; and by not possessing the unctuous feel of the latter substance: from selenite, by remaining unaltered in a low red heat: from sulphuret of molybdena, by its elasticity; and by not staining paper when rubbed upon it: from crystallized oxyd of uranium, by its elasticity; and by not passing into the state of a black scoria under the action of the blowpipe: from grey micaceous iron ore, by being less fragile, and by adhering less easily to the fingers when crumbled; also, by not being magnetic, as that often is.

Schistus or Slate.

Under this head may be ranged a numerous class of rocks, principally of an argillaceous base, remarkable for their schistose structure. In some of these, organic remains occur very frequently; in others, rarely, if ever: hence the latter are called *primitive* schisti; the former, *secondary* schisti.

Primitive schistus is met with, in general, contiguous to granite; from which its characters may be traced by almost insensible degrees; gneiss and its varieties being the first steps of the transition. Strata of primitive schistus are often nearly vertical; sometimes, incurvated in the most irregular manner. They are commonly intersected by small veins of quartz or calcareous spar which divide the whole mass into compartments of a rhomboidal form.

The softer kinds of primitive schistus are remarkably metalliferous. The matrix of the silver ore in the mines of Potosi is said to be of this nature.

Primitive schistus often contains cubic crystals of iron pyrites.

Secondary schistus may easily be distinguished from primitive; both by its relatively superficial situation, and by the organic remains or detritus of other substances contained in it.

Common or Roofing Slate.

Clay Slate; of Werner.

This is a variety of primitive schistus, the characters of which fall too generally under common observation to require much description. The occasional green colour of roofing slate is probably owing to chlorite: its blue or purple colour, to oxyd of iron.

Reddish Slate of Anglesea.

Silex	38
Alumine	26
Magnesia	8
Lime	4
Oxyd of Iron . .	14
	90

Slate of this kind occurs in great abundance in Caernarvonshire, on the estates of Lord Penrhyn:

and, at present, almost all the slate of commerce is derived from those quarries.

Roofing slate is also quarried in Devonshire, and in Cumberland.

This variety of slate is sometimes sufficiently hard to be used as a whetstone.

Killas.

This term is commonly applied to the primitive schistus of Cornwall, which is met with in very different states of induration; and of various shades of colour: sometimes scarcely differing from common slate; at others, soft enough to crumble between the fingers, and of a greyish white colour.

Shale.

Slate Clay; of Werner.

This term is commonly applied to a soft secondary schistus, which is almost constantly found in the neighbourhood of coal.

It frequently contains vegetable impressions; particularly of reeds and species of fern: and is disposed to separate in the planes of these impressions. The surface of the impression is concave on one of the divided parts; on the other, convex: but it is a singular circumstance that the two sides of the leaf are never represented in the same instance; and, in the case of ferns, it is the impression of the inferior surface only of the leaf, that is preserved.

Schistus of this kind is often strongly impregnated with bitumen; which is accounted for in some measure by its natural relative situation to coal. This variety is common in Derbyshire. It is called bituminous shale.

Bituminous shale sometimes contains impressions of fish.

Aluminous Shale.

Many varieties of shale contain pyritical matter in a minute state of division, disseminated very uniformly through their substance: and, either spontaneously, or in consequence of artificial processes, are capable of affording a considerable quantity of the saline substance called alum; whence they have been specified by the epithet *aluminous*. A specimen of this variety analysed by M. Klaproth gave the following results:

Silex	40
Alumine	16
Sulphate of Lime; ——— of Iron; ——— of Potash	4,5
Water	7
Black Oxyd of Iron .	6,4
Carbon	19,6
Sulphate	2,8
	96,3

M. Klaproth remarked that the sulphur of the foregoing analysis was not united to the iron, but to the carbon; and in a manner not yet understood.

If the spontaneous alteration in aluminous shale does not advance with sufficient rapidity, the production of the alum may be accelerated by moistening and artificially heating the shale: but this part of the subject will be spoken of under the head of *Alum*.

Aluminous shale is sometimes of a close earthy texture, as in the variety met with at Whitby in Yorkshire. The aluminous shale of the Hurlet mine near Glasgow, which will be more particularly described hereafter, scarcely shews its schistose structure till the formation of the alum has been carried to some extent.

Black Crayon.

Aluminous shale is often accompanied by another variety of shale, much used in drawing, &c.; and commonly called *black chalk*. The component parts of this substance are as follow:

Silex	64
Alumine . . .	11,25
Oxyd of Iron .	2,75
Carbon . . .	11,
Water	7,50
	96,50 *Wiegleb.*

This substance is a considerable object of traffic in Italy; and hence by artists is sometimes called *pierre d'Italie.*

SILEX.

The term silex, as applied to a simple earth, is derived probably from those hard pebbles, which are commonly met with in every part of the world; and which possess the leading characters of the natural compounds of this earth: these are, a degree of hardness sufficient to strike fire with steel; infusibility in the fire, when uncombined with other earths; and insolubility in acids. In Wallerius, and the earlier mineralogists, siliceous compounds are called *lapides vitrescentes*; either from their being sometimes employed instead of sand in the composition of glass; or because, when mixed with an alkali, they easily vitrify. Almost all the natural forms of silex contain more than nine tenths of the pure earth; the other constituent parts are in general alumine, and oxyd of iron, either separate or combined.

Quartz.

This term is applied to the several varieties of the substance called rock crystal, and sometimes also to other minerals resembling it: Wallerius, speaking of its derivation, says, "Conjecturæ locus est hunc la-"pidem a rimis plerumque transversis, scilicet Ger-"manorum *querr* et *ritz*, suum nomen contractum "*Quartz* obtinuisse *."

It is sufficiently hard to scratch glass, and strike fire with steel; but yields to the file.

Has a double refracting power.

Phosphorescent, by friction; with a peculiar empyreumatic smell.

Infusible in the heat of the Berlin porcelain furnace.

Specific gravity varies from 2,50 to 2,66.

Primitive form, a slightly obtuse rhomboid; the plane angles of which are $94^d\ 4'$ and $85^d\ 56'$: but this is rarely met with. It may sometimes be observed in the crystalline incrustation that occasionally invests bluish calcedony.

Quartz, whether distinctly crystallized or not, for the most part occurs in veins; though these are sometimes so large as to assume the appearance of mountainous masses. It has in general a vitreous appearance when broken; and this is sometimes joined with an unctuous lustre that has given rise to the terms *Quartzum pingue; Quartz gras*; &c.

The common form of quartz crystals is, when completed, a six-sided prism; terminated at each extremity by a six-sided pyramid: but as the crystals fre-

* Vol. i. p. 219.

quently project from the matrix containing them, so as only to exhibit a part of the prism with the pyramid attached to it, double pyramidal crystals with an intervening prism do not often occur. Where they do occur, they are either simply aggregated, as in some of the varieties of the mineral called Sinople; or entirely imbedded in the matrix containing them, as in decaying granite and other rocks. The surfaces of the prism are often transversely striated, while those of the pyramid are to the eye perfectly smooth. In general the length of the prism is greater considerably than that of the pyramid. In some instances the prism is so shortened, as to be scarcely perceptible; and then the form resembles that of two six-sided pyramids, joined base to base: but it very rarely happens that the prism is absolutely wanting, though the eye cannot discover it. Crystals approaching to this form, and of a very remarkable degree of transparency, occur in the iron stone found near Bristol: they are called Bristol diamonds.

Although the greater number of quartz crystals are varieties of the form above described, yet from the mutual disproportion of the different sides of the prism and pyramid, the resemblance is often so much obscured that the real form cannot easily be traced. Sometimes two opposite sides of the prism are so much broader than the other four, as to give the crystal a tabular form: sometimes the area of one of the sides of the pyramid is larger than that of the other five taken together; and the area of the side immediately adjoining is not only the smallest of all, but so small as to be scarcely perceptible. In some instances the faces of the pyramids are alternately large and small: in which case the large faces are pentagons; the small faces, triangles.

But in all these variations arising from a difference in the size and form of the surfaces, the mutual inclination of the sides of the prism constantly takes place under the same angle.

Crystallized quartz does not easily admit of mechanical division; but accidental fractures sometimes exhibit in a very distinct manner the direction of the crystalline laminæ.

Pseudomorphous crystals of quartz are not uncommon: they are principally of the following forms.
The cube, derived from fluor spar.
The regular octohedron, from the same.
An oblique six-sided table, from sulphate of baryt.
An acute six-sided pyramid, from calcareous spar.

The surfaces of these pseudomorphous crystals are in general rough.

Transparent Colourless Quartz.

Glassy Quartz; from its vitreous appearance when broken.

Crystal, and Rock Crystal; from its resemblance to ice; and from its common occurrence in the clefts of rocks.

Silex	93
Alumine . . .	6
Lime	1
	100 *Bergm.*

If the authority of Bergman may be questioned, the proportion of silex is probably greater than here stated: perhaps indeed colourless quartz is altogether of a siliceous nature; for even the common black flint contains ninety-eight parts in one hundred of silex : and it may reasonably be supposed from all its characters that colourless quartz is a purer natural form of silex than common flint. The analysis of amethystine quartz gives nearly ninety-eight parts in one hundred of silex.

Perfectly transparent and colourless quartz resembles glass very closely : but the bubbles and fissures, which often occur in both, afford an easy method of distinguishing them; the bubbles being irregularly diffused, and nearly of a spherical shape, in glass; but, in quartz, disposed on the same plane or on parallel planes : and, generally, in the form of clouded specks.

The iridescent appearance often visible in the interior of quartz depends on the refraction of light, in consequence of fissures either naturally or artificially formed. The Iris of Pliny is perhaps a variety of this kind ; for he says, in speaking of it, " *sexangulam* "esse ut *crystallum* constat *." The appearance may be artificially produced, by heating quartz nearly red-hot and then plunging it into cold water. By this means internal fractures are formed; and, if the quartz be dipped into a coloured liquid, which is sometimes done for the purpose of sale, the colouring matter is absorbed between the rifts. Quartz crystals are sometimes *superficially* iridescent; but this depends on a very thin incrustation of a metallic nature.

Colourless quartz occurs commonly in the cavities of primitive rocks, especially granite and micaceous schistus. It is sometimes met with in the cavities of granular marble.

Some of the most beautiful specimens come from Madagascar; from Mont Blanc; and from Dauphiny.

Crystals of colourless quartz occasionally contain cavities which are partially filled with water: the air bubble, or the space unoccupied by the water, is visible in moving the crystal in various directions.

If the opposite surface of that part of a crystal which adheres to the matrix be polished, an appearance may be sometimes observed in the interior, resembling scales of mica as it were interposed between the crystal and the base on which it rests: this appearance probably depends on small fissures of a flat conchoidal shape; and is analogous to the appearance observable in aventurine †.

* Nat. Hist. lib. xxxvii.

† Vid. the article *Aventurine*.

Transparent quartz sometimes contains in its interior a green substance very closely resembling moss; which is supposed to be chlorite: sometimes it contains prismatic crystals of tourmaline, or of thallite; and of red titanite, formerly called red shorl.

Transparent blackish brown Quartz.

Cairngorum; from a mountain of that name in Aberdeenshire.

Crystallus colorata fusca, of Wallerius; and *Quartz-hyalin enfumé*, of Haüy: the colour being often like that of smoke.

Morio and *Pramnion;* of Pliny? "Morio quæ nigerrimo colore translucet, in India vocatur Pramnion *."

This varies in colour from a deep black, to a shade of brown so slight as scarcely to be perceptible: in the last case the transparency and lustre are very beautiful; and of such specimens seals &c. are commonly made. A yellow tinge is sometimes mixed with the brown: and in a few instances the colour is a pure yellow.

Transparent brown quartz is met with abundantly in the Alps.

This variety of quartz is occasionally of so intense a colour as not to be transparent, except at the edges of its fragments. In those crystals that are of the darkest colour, the transverse striæ are often very

* Plin. Nat. Hist. lib. xxxvii.

strongly marked. The shape of the crystals is often also very irregular; the line of distinction between the pyramid and prism being very ill defined, and the sides of each varying so much in their dimensions in different parts, and having so little symmetry, as to give the appearance of an oblong and imperfectly rounded cone.

Transparent yellow Quartz.

Occidental Topaz; from its colour, and inferior degree of hardness, when compared with the oriental topaz, or yellow sapphire.

Mock Topaz; and *Topaz of Bohemia.*

The colour of yellow quartz, which is often of a very delicate tinge, resembles the Saxon rather than the Brasilian topaz.

The Cairngorum quartz passes into this variety.

Transparent rose red Quartz.

Bohemian and *Silesian Ruby.*

Independently of its inferior degree of hardness and specific gravity, the colour of this variety is too faint to admit of its being easily mistaken for the ruby: besides which, it in general occurs in amorphous masses of too great a size to lead to such an error. The colour is supposed to be owing to manganese.

Transparent blue Quartz.

Mock sapphire, and *occidental sapphire*; of some mineralogists.

Saphir d'eau; of de Lisle.

It may be easily distinguished from the oriental sapphire, by its inferior degree of hardness and specific gravity.

Crystallized Amethystine Quartz.

Infusible, but loses its colour by the blowpipe. Specific gravity 2,75.

Silex	97,50
Alumine . . .	0,25
Oxyd of Manganese and Iron	0,50
	98,25 *M. Rose.*

According to Pliny the amethysts of the ancients were "omnes violaceo colore et scalpturis faciles *:" the latter part of the description is more applicable to fluor spar than quartz.

The amethyst of commerce is in most instances amethystine quartz: when jewellers apply the term to the purple variety of the sapphire, they add the epithet *oriental*.

Amethystine quartz occurs in different parts of Europe; either in veins, or lining the interior of

* Nat. Hist. lib. xxxvii.

spherical and kidney shaped agate balls, which are met with in porphyry and amygdaloid. Sometimes it forms a crystallized incrustation round a nucleus of a different nature. In the generality of instances the pyramid is the only part of the crystal that is visible; and, upon making a transverse section of these crystallized masses, it appears that they have been formed by successive depositions of pyramidal crystals; some of which are of a very pale, others of a deep violet colour: the form of the pyramidal crystallization being easily traced by numerous acutely waving lines, or bands; the directions of which are parallel with each other, and with the outline of the exterior crystals.

There is no regular gradation in the colours of these bands; and, not unfrequently, those which are nearest in situation are most different in colour.

The surfaces of the exterior crystals are sometimes of a red, or a brownish red colour: sometimes they have a corroded appearance; and in particular instances the superficial cavities, from whence this corroded appearance proceeds, are filled with small micaceous tufts, or acicular particles of an imperfectly metallic lustre, of specular iron ore, and manganese. There is a series of specimens of this kind in the Oxford collection, brought from the north of Europe, which evidently seem to prove that all the foregoing appearances are connected with each other: and that the red or brownish red incrustation, observable on the surface of some of the crystals, is a more highly oxydated state of these metallic substances, which in a less oxydated state occupy the corroded cavities of other crystals.

The mountains of Murcia contain great abundance of amethystine quartz.

Opaque Crystallized Red Quartz.

Hyacinth of Compostella; from the colour and local situation of one of its varieties.

Crystallized Jasper; improperly so called.

The colour of this substance which is nearly a brick-red, is upon the whole very uniform: the substance itself is met with in very different states of aggregation. A mass of it sometimes consists of distinct prismatic crystals loosely adhering to each other; and the form of the crystals, which is a six-sided prism, terminated at each extremity by a six-sided pyramid, is very delicately defined. At other times the form is less distinct: and in some instances the mass appears to be made up of minute crystalline grains. In the last case it is called sinople. The texture becoming still more compact the granular character is lost, and it assumes the appearance of red jasper.

This variety of quartz is found near Compostella in a matrix of gypsum. It is coloured by oxyd of iron.

Those small red crystals imbedded in the variety of calcareous spar called arragonite are crystals of opaque red quartz.

Aventurine.

So called from its resemblance to the artificial substance of the same name. This variety of quartz is opaque, and of a light reddish brown colour; and appears to contain in its interior numerous minute particles of yellow mica. The appearance is sometimes owing to the actual presence of such particles: sometimes it arises from a great number of minute fissures that reflect the light so as to produce the appearance above described *. M. Haüy gives the following account of the origin of the term aventurine. "Un "ouvrier ayant laissé tomber, par hasard, ou, comme "l'on dit, *par aventure*, de la limaille de laiton dans "une matière vitreuse en fusion, donna le nom "d'*aventurine* à ce mélange, dont on a fait, depuis, des "vases et autres objets d'ornement. Les minéralogistes "ont appliqué le même nom aux substances naturelles "dont ce produit de l'art offroit une imitation appa-"rente *."

Aventurine is found in Bohemia and in Arragon.

Prase.

This variety of quartz is so denominated from its leek-green colour.

The colour of prase is very uniform; and, according to Brochant, is owing to the presence of

* Vid. p. 197. † Tom. ii. p. 422.

thallite. Others conjecture that it is owing to chlorite.

Chrysoprase.

So called from it yellowish green colour.
In hardness inferior to calcedony.
In the heat of the Berlin porcelain furnace it became of a light blackish grey colour.

Silex	96,16
Lime	0,83
Alumine	0,08
Oxyd of Nickel .	1,
——— Iron . .	0,08
	98,15 *Klapr.*

This substance has hitherto been only met with in the neighbourhood of Breslaw, in Silesia; where it occurs, in veins, in rocks of the magnesian genus.

It is of a much lighter green than the variety of quartz called prase, mixed with a faint tint of yellow. Its colour is owing to the oxyd of nickel contained in it.

Polished specimens of this substance are particularly beautiful on account of their colour; and sometimes they have a considerable degree of transparency: but it is difficult to obtain them of a large size without flaws or clouded specks.

Chrysoprase is said to lose much of its colour when kept in a warm and dry place.

Paper Quartz.

Quartz sometimes is met with divided by numerous fissures, which run in a variety of directions; from whence the whole mass appears like an irregular assemblage of thin laminæ resembling paper.

Masses of this kind are sometimes so porous as to be lighter than pumice stone, and to swim on the surface of water: whence the term *swimming stone.*

Plasma.

The colour of this substance is described as between grass and leek green; it is marked with ochre yellow and whitish spots; the latter very characteristic.

It is nearly as hard as calcedony.

Has a slight degree of transparency.

Specific gravity 2,5.

There are great doubts about the nature of this substance. By Werner and Emmerling it is ranked as a variety of calcedony coloured by chlorite. Its native situation is not known; having been hitherto found only among the ancient ruins of Rome.

Jasper.

Very little satisfaction is to be obtained from the writings of the early natural historians respecting the characters of this substance; some describing it as transparent and of a vitreous appearance; others, as opaque.

It is infusible by the blowpipe.

In hardness, nearly equal to quartz.

Specific gravity varies from 2,3 to 2,7.

Silex	75
Alumine . . .	20
Oxyd of Iron .	5
	100 *Klapr.*

The formation of jasper is supposed by some to have arisen from the infiltration of siliceous particles, in a very minute state of division, into the substance of a natural clay, coloured by oxyd of iron: and the appearance of jasper in many instances strongly justifies this opinion. In the Oxford collection there is a specimen, which, in looking at its polished surface and judging by the eye alone, might easily be imagined to be a mass of soft ochry clay separated into irregular clefts, and having the interstices filled with nearly limpid water. On examination the colourless part appears to be of a pure siliceous nature; and the coloured part, which to the eye alone is of a pulpy softness, is found to be as hard as jasper in general.

In the same collection are two specimens, one of them taken up from the bed of the Thames near Richmond, which in their general characters do not differ from coarse yellow ochre; but their form is nodular and they consist of concentric layers that may be very easily separated from each other: the lines observable upon the surface of a transverse section of one of these nodules so exactly resemble the character of that variety of jasper called the Egyptian pebble; that certainly any one would be inclined from this circumstance to refer both substances to a similar origin: and if in this case you suppose the soft and porous substance of the ochre to be penetrated by siliceous particles introduced by infiltration, it would become in every respect of the same nature with Egyptian jasper.

Ribband Jasper.

The colours of this are grey, green, yellow, and red: and it is called ribband jasper from the striped disposition of these.

The most remarkable variety is composed of parallel layers of a green and brownish red colour: it comes from the Oural mountains.

Ribband jasper is also found in Saxony, and in Sicily, sometimes in the mass, sometimes in rounded pebbles; Werner thinks that it is allied to a variety of hornstone.

Sinople.

Jaspis opaca, facie granulari, of Wallerius; who adds, "nomen huic a *sinopis* Græcorum, quo appellabant omnem ochram rubram martialem *."

This substance has been already spoken of under the head of opaque crystallized red quartz. When its texture becomes sufficiently compact it is usually classed as a jasper. In this state it is sometimes capable of a very fine polish. Its colour is a bright brick-red; which occasionally passes into yellow: both colours depending on the oxyd of iron contained.

Egyptian Jasper.

Infusible.

Specific gravity 2,58.

This variety of jasper is principally found, in the form of pebbles, in the sand of Egypt and the neighbouring deserts. A friend of M. Brochant saw them in the matrix, which is a breccia entirely composed of siliceous fragments, and forming the base of that part of Africa.

It has also been met with in Europe; principally in Lorraine.

The polished surface of a transverse section of Egyptian jasper presents a singular arrangement of dark coloured lines, which upon the whole have a concentric distribution. The colours of Egyptian

* Vol. i. p. 319.

jasper are chesnut and yellowish brown; and the colour is always the darkest towards the exterior part of the pebble.

Wood Jasper.

This variety is so called from its general appearance, which often very accurately resembles petrified wood. In some cases this appearance is the result of the original formation of the substance: in others it seems to have arisen from the actual deposition of siliceous in the place of vegetable matter. The following distinctive mark has been given by which to ascertain the real origin of this jasper. In petrified wood not only the concentric circles of the original vegetable are present; but also the vessels or fibres which extend from the centre towards the circumference.

The smooth Turkey hone-stone is made of this variety of jasper.

Wood jasper is found in Bohemia, Hungary, &c.; and in Siberia: but the matrix of it is not known. Masses closely resembling trunks and branches of trees occur in great abundance dispersed over the sandy districts of the northern part of Africa.

Blood-stone.

Heliotropium; of the ancients.

In the heat of the Berlin porcelain furnace, the colour became whitish grey; and the red spots disappeared, leaving cavities in the places which they occupied.

Specific gravity 2,66.

Pliny describes the appearance of this substance very accurately. He says it is "porracei coloris, et "sanguineis venis distinctum*." In another passage he speaks of a variety of prase marked "sanguin-"eis punctis."

The colour of this substance is a deep, but not entirely uniform, dark green; with occasional small specks or points of a blood-red colour. From the beauty of its polished surface it is much used for ornamental purposes; as in snuff boxes, the handles of knives, &c.

According to Brogniart it is believed to be a variety of calcedony coloured by chlorite. Mr. Kirwan considers it as evidently allied to jasper.

The blood-stone came originally from the East. It has been found in Iceland, and in Bohemia, in the form of a vein.

* Nat. Hist. lib. xxxvii.

Black Flint.

Infusible, but becomes perfectly white at a high degree of heat.

Specific gravity 2,58.

Silex	98		97
Lime	0,50		
Alumine	0,25		1
Oxyd of Iron	0,25		
Volatile matter	1	Loss	2
	100,00 *Klapr.*		100 *Vauq.*

The black flint, as appears by the foregoing analyses, is nearly a pure natural form of silex.

In this country it occurs either in thin strata disposed horizontally in chalk; or in loose beds of a coarse gravel. In the former instance it is in the mass of a dark grey or nearly black colour; when in thin fragments, of a light grey with a considerable degree of transparency: reduced to powder it is nearly white. Externally it has a superficial coating of an opaque white colour; but it does not seem clearly ascertained of what nature this substance is: whether a particular state of chalk in its passage into flint, or an altered state of the flint itself.

By exposure to the changes of the weather flint loses its black colour, and becomes ochry; probably in consequence of the further oxydation of the iron originally contained in it: and hence the colour of those beds of gravel met with in the vicinity of London, and all those districts where strata of chalk occur; these beds being principally made up of fragments of the common black flint, altered by exposure to the air &c.

Entrochi and varieties of the echinus occur in a fossile state imbedded in flint; the substance of those fossile bodies being at the same time of a flinty nature: sometimes the shell of the echinus is calcareous, but so far changed from the animal state as to be of a sparry structure; and in these cases the cavity is filled with flint.

Hollow nodules of flint occur occasionally, partly filled with a white crumbling substance, resembling chalk in its appearance; but not always effervescing with an acid. Sometimes the cavity of these nodules has a blistered surface; as if the flinty matter had been deposited stalactitically: in this case the appearance of the blistered part is very like calcedony.

Pear-shaped masses of flint are sometimes met with, bearing no mark of an organic origin with the exception of their shape: and in some intances these are penetrated in various directions by tubular cavities somewhat resembling the cavities formed in lime stone by the pholas *.

The flint of the chalk strata in the neighbourhood of Wantage has often a flattened form; and consists of two plates attached to each other imperfectly, much

* Vid. p. 21.

after the manner of the outer and inner plates of the thick bones of the human cranium. In some instances it has an irregularly stratified appearance; and is frequently of a light grey colour. I have specimens of this kind which resemble in their stratified appearance and colour some of the varieties of the siliceous stalagmite of Iceland: not that I would infer that this flint has been owing to a formation of that kind, but that flint may in some instances have been so formed. Mr. Kirwan indeed says that one hundred and twenty-six silver coins have been found inclosed in flint, in Denmark; as also an iron nail, at Potsdam.

Two very opposite opinions are entertained at the present day respecting the origin of flint as it occurs in strata of chalk: one, that it has been deposited there by aqueous infiltration of the siliceous particles; the other, that it has been forcibly injected while in an ignited and liquid state between the strata of the chalk.

Werner's idea is, that during the deposition of chalk, air was evolved; which, in endeavouring to escape, formed irregular cavities that were afterwards filled up, by infiltration, with flinty particles. Mr. Kirwan entertains the same idea respecting the infiltration of flint; and in support of his opinion observes that chalk is constantly found to contain more or less of minute siliceous particles. An objection to Werner's hypothesis seems to arise from the difficulty of accounting for the means of support of the strata of chalk during the infiltration into these cavities: for these cavities do not appear to have been distinct or insulated, but continuous throughout the whole extent of the strata of chalk; which is divided by them into immense tabular masses; and which without support must, obviously, have subsided on each other. The hypothesis of the forcible injection of the ignited and liquid flint is Dr. Hutton's: against the admission of which may be urged the difficulty of conceiving that a stream of liquid ignited matter would have been forced in lines so regularly parallel as the seams of flint evidently are. It may be said indeed that this may in some measure be accounted for by the regular stratification of the chalk: but why then is not the same appearance observable in the case of basalt or whin among the strata of sandstone, which are equally regular with the strata of chalk? Or, again, why did the stream of flint divide itself at all, and why was it not forced forward in one irregular mass or vein like basalt: and, if it did thus divide itself, where are we to look for the point from whence it began to diverge into different veins?

But this is a question, like many others in geology, that may exercise the ingenuity of those who speculate upon it; but does not seem likely to admit of any satisfactory solution on physical principles: and consequently does not deserve that warmth of argument which is often bestowed upon it.

Chert.

Petrosilex; of some authors.

Chert is a species of flint which occurs in irregular veins and patches in the substance of common limestone; and is often not sufficiently defined in its character to be recognized at once by the eye from the limestone containing it: from being incorporated with the substance of the *rock* containing it, and never occurring in distinct nodules like the common black *flint*, it has been called petrosilex or *rock-flint*. The chert met with in the limestone of Derbyshire is often of a light bluish grey colour: sometimes it is of a jet black.

Chert has been called a not yet matured agate, and its occasional appearance justifies the term: though perhaps it may with more propriety be classed as an imperfect calcedony.

Touch-stone.

Basanite; from its occasional use in assaying the purity of gold and silver.

Lapis Lydius: this term, applied originally by the ancients to a variety of the touch-stone, found in the bed of the Tmolus, has been subsequently extended to any stone capable of answering the same purpose.

Roche de corne naturelle; of Dolomieu.

This is a variety of primitive schistus, the structure of which is so compact that the schistose character is often not distinctly perceptible, except in great masses: its texture in particular parts is as close as flint: and hence the term siliceous schistus is applied to it.

Sometimes in the same specimen one part will be completely compact; another, distinctly schistose to the eye; though the laminæ are very compactly aggregated, and scarcely capable of separation. In siliceous schistus of this kind earthy chlorite frequently occurs.

The use of the touch-stone for the purpose of ascertaining the degree of purity of gold and silver is spoken of frequently in the writings of the ancients.

Λυδίῃ ἶσον ἔχειν πέτρῃ στόμα· χρυσὸν ὁποίῃ
Πεύθονται μὴ φαῦλον ἐτήτυμον ἀργυραμοιβοί *.

Χαλκὸν κατάχρυσον καὶ ἄργυρον γνωρίζει, καὶ πόσον εἰς τὸν στατῆρα μέμικται †. Theophrastus gives an accurate description of the use of the lapis Lydius; and describes an apparatus very analogous to the *touching needles* of the present day; by which, in employing various artificial alloys as a standard of comparison, the purity of gold was readily ascertained by the colour of the streak impressed on the touch-stone.

Black compact basalts, and even dark coloured limestones, are often used as touch-stones.

Novaculite, or Hone-stone.

Most of the finer kinds of hone-stone are a remarkably compact siliceous schistus. Those hone-stones

* Theocr. Id. ιβ. † Theophr. p. 397.

so commonly met with in commerce, which consist of two strata, one of which is yellow, the other blackish, come from the neighbourhood of Namur. The character arising from the double colour is often imitated artificially; hone-stones of this kind being in much esteem.

The Turkey hone-stone is so called from having been first brought from the Levant.

Coarser hone-stones are of a splintery schistose structure.

Calcedony.

This name is derived from Chalcedon in Bithynia, the place where it is said to have been originally found.

The fracture of calcedony has a waxy appearance, with a slight degree of transparency.

Infusible and unaltered in the heat of the Berlin porcelain furnace.

Rather harder than flint.

Specific gravity 2,6.

Calcedony of Ferröe.

Silex	84
Alumine	16
	100 *Bergm.*

Almost all the appearances of calcedony justify the idea that it has been formed by stalagmitic deposition; particularly the blistered or mamillated appearance so commonly observable on its surface.

A very singular stalactitic form of calcedony occurred some years since in one of the Cornish mines: it is nearly opaque and colourless; and from its close resemblance to an agglutinated mass of the cylindrical, bones of small birds it has been denominated *skeleton* calcedony.

But although calcedony appears to have been separated from water in as great a state of purity as any mineral; and often to have been placed under circumstances as favourable as possible to crystallization; it never shews the least tendency to an internal crystalline arrangement of its particles: its fracture is always perfectly compact. Crystals, indeed, the substance of which is calcedony are often met with; but they are always pseudomorphous; and very frequently they are not solid, which is a strong argument in favour of their stalagmitic origin. Their surface is rarely smooth. The derivation of calcedony from the common black flint may be traced by very delicate gradations, and sometimes in the same specimen: for upon breaking a nodule of the flint a cavity is not unfrequently discovered, the surface of which consists of irregularly blistered calcedony; the substance of the flint insensibly passing into that of calcedony.

Calcedony is frequently contained in rocks of the basaltic genus, in nodular masses. These masses, which are in general of a light bluish grey colour, are often hollow, and set with amethystine quartz crystals.

Onyx.

This term was originally applied to a substance resembling the human nail in colour: "exponenda est et "onychis natura. Sudines dicit in gemma esse cando- "rem *unguis humani* similitudine *." This substance was most probably a calcedony of a uniform light colour; such as is often met with in mineralogical cabinets. The term was sometimes applied to particular varieties of alabaster: for Pliny says that the onyx was first used for drinking vessels; afterwards for the feet of couches, &c: that when employed for boxes to hold unguents, it was by some called alabastrites: that when calcined it was employed in making plasters §. These several uses depend on characters, that are much more applicable to a calcareous stone, than to the onyx of the present day.

Sardonyx.

This term was originally applied to a stone, the colour of which was compounded of the onyx and sard. "Sardonyches olim, ut ex nomine ipso appa- "ret, intelligebantur candore in Sarda, hoc est velut "carnibus ungue hominis imposito, et utroque trans- "lucido ||." Carnelians are sometimes of that yellowish red colour which would result from an intimate mixture of the two. I have seen a specimen in which the colours were perfectly distinct; the central part of the nodule being red, the exterior part

* Plin. Nat. Hist. lib. xxxvii.

§ Nat. Hist. lib. xxxvi.

|| Ibid. lib. xxxvii.

yellow: the transverse section of this represented an irregularly oval surface of a red colour, surrounded by a band of yellow.

The sardonyx of modern jewellery is a variety of the onyx of the present day.

Stratified Onyx.

Onyx, *stratis diversimode coloratis* constans; of Wallerius.

Camehuia; of the same author, and others.

Camaieu or *Cameo*, and *Onyx;* of modern jewellers: particularly when the colours of the strata are white and black, or white and brown.

Ὀνύχιον of Theophrastus: who says, τὸ δὲ Ὀνύχιον, μικτὴ λευκῷ καὶ φαιῷ παράλληλα *. The word φαῖος is described in Constantine as expressive of a colour between white and black: and a stone consisting of parallel bands of this and of a white colour corresponds with the onyx of the present day.

Winkelman describing an antique Egyptian gem, consisting of a white stratum under a stratum of a deep colour, calls it *agat' onice* †: which description agrees with that of Theophrastus. Natural appearances would justify the classification of this substance either with calcedony or agate.

The value of this substance in jewellery depends particularly upon the difference in the colour of the

* P. 396. † Vol. i. p. 123.

strata: and in engraving heads or whole figures upon the onyx, in *relievo*, as it is technically called, the upper stratum is made use of for the representation of the intended figure; the lower, for the base on which this is to rest. In engraving in *intaglio* this order is reversed, and the figure is cut in the lower stratum. In the former instance the figure is convex, and projects from the inferior stratum; in the latter it is concave, and sinks in from the superior stratum.

In some varieties the strata are four or five, or even more, in number; and the colours, of very different shades: these, when cut into a spherical shape, closely resemble the eyes of various animals; the upper stratum being brought to a point answering to the pupil. "Zenothemis dicit Indicam onychem plures habere "varietates, nigram, igneam, corneam; cingentibus "candidis venis *oculi* modo intervenientibus, quarun-"dam et obliquis venis *."

From the resemblance of specimens of this kind to the eyes of different animals have arisen various terms expressive of the particular resemblance: as leucophthalmus, erythropthalmus: and, with a reference to the number of the zones, diopthalmus; and triophthalmus: again, from a resemblance to the eyes of particular animals, lycophthalmus, aigophthalmus, &c.

Wallerius specifies these varieties by the name of "onyx fasciis et zonis concentricis diversimode co-

* Plin. Nat. Hist. lib. xxxvii.

"Ioratis;" and adds that they are sometimes called by the Italians *occhi di gatti*, but that they are not the true cat's eye.

Agate.

Petrosilex, of some authors: being found in distinct nodules imbedded in rocks.
Achates, of Pliny; so called from the name of a river in Sicily *.
Specific gravity 2,6.

According to Werner agate is not to be considered as a distinct species of stone; but as made up of crystal, quartz, horn-stone, calcedony, jasper, &c. aggregated in binary, ternary, or more numerous combinations: even one of these, if it presents two or more colours and is susceptible of a good polish, is called an agate.

Agates in their native state exist in the form of irregularly shaped nodules, imbedded in rocks of the basaltic genus. Many rocks of this kind on the coast of Scotland are disintegrated by the long continued action of the weather and waves: and the agate nodules thus separated are accumulated on the shore. These are the substances known commonly by the name of Scotch pebbles. The surface of these nodules is in general very irregular and coarse, and by this they may be distinguished externally from the

* Vid. Theophr. p. 396.

common pebble; the surface of which is smooth in consequence of the attrition that gave it its form. Sometimes they are superficially incrusted with a green substance resembling earthy chlorite.

A transverse section of an agate generally presents an arrangement of numerous concentric lines, which upon the whole are parallel with the outline of the section: the colour of these lines is for the most part red, or an opaque white. The central part often consists of crystalline quartz, and sometimes the pyramidal form of the crystal is distinctly visible.

In the transverse section of many agates the concentric lines are incomplete, and a conically shaped interval is visible; from either side of which the several lines appear to issue, and, proceeding in a direction parallel to the circumference and to each other, terminate in the opposite. Those who support the opinion of the aqueous origin of these nodules argue, that the fluid containing the siliceous matter of which the agate is composed entered by this opening, and that a periodical concentric deposition of the earthy particles took place: and that the difference in colour of the several depositions depends upon the state of the fluid introduced, which was sometimes charged with metallic as well as earthy particles. Those who argue in support of the igneous origin of these substances ask, in what manner could the water have escaped from the cavities into which it had been introduced, after it had deposited the earthy particles before held in solution.

Wallerius says that solutions of silver and other metals are sometimes used for the purpose of giving artificial colours to agates; but that artificial may always be distinguished from natural colours by exposing them to the fire, which destroys the former.

In some agates the lines are so disposed as to form numerous radiating angles: these are commonly called varieties of *fortification agate;* a term which very aptly expresses the general appearance of their distribution as compared with the plan of the outworks of a fortified town.

In many agates the intervals of the concentric lines are partially or universally of an opaque reddish brown colour, owing to the presence of oxyd of iron in that part of the substance of the agate: these parts are of the nature of jasper; and from the mixed character of these varieties the term *jasp-agate* has originated.

In some instances there is an arborescent distribution of the lines; which is occasionally owing to the actual presence of leaves, and a substance resembling sea-weed or fine coral intangled as it were in the siliceous matter of the agate: from this appearance has arisen the term *dendrachates*.

These various appearances, which have given rise to appropriate terms, are taken notice of by Pliny;

who in speaking of the agate *(achates)* says, "multa et cognomina ejus. Vocatur enim Jaspa-"chates, Sardachates, Dendrachates &c *."

Mocoa Stone.

Achates Mochoënsis, of Wallerius; who adds, "ab "urbe Moka vel Moko in Arabia felici †."

This variety may be classed under the dendrachates of Pliny.

According to some it is called Mocoa stone from the place of its importation; for they say that it is only shipped at Mocoa, after having been brought there from a distance. According to others the term is derived from a word signifying moss; this variety of the agate sometimes appearing to contain that vegetable.

The ground of the Mocoa stone is generally semi-transparent, and of a light brownish honey colour; with representations of the form of leaves, moss, and vegetable fibres of a brown and black colour.

Cacholong.

This is an agate nearly of a milk white colour; and is commonly met with in cabinets in the form of artificial beads. It is said to be found in some of the

* Nat. Hist. lib. xxxvii.

† Vol. i. p. 299.

rivers of Tartary, and that the literal signification of its name is the "stone of the river." According to Wallerius the Kalmucs form their idols of this stone.

Agate of the same kind is met with in other parts of the world.

Carnelian.

Achates Carneolus; of Wallerius.

Quartz *Agathe Cornaline;* of Haüy.

Sardion; of Theophrastus; and *Sarda;* of Pliny. The term Sardion, or Sarda, is by some derived from a resemblance in colour to the flesh of the anchovy, or a similar fish, when salted: the expression in Pliny is "a *Sardis* sale conditis." Salmasius says it is from *Sardinia* or *Sardes.* The term Carnelian is perhaps expressive of the flesh-colour of this mineral.

In the heat of the Berlin porcelain furnace it became of a snow white colour, preserving its lustre.

Specific gravity 2,6.

Carnelian, often called Cornelian, is sometimes imported from India in the form of irregularly shaped nodules, very much resembling Scotch pebbles; and a transverse section of these nodules very often presents a similar arrangement of concentric lines with that of the common agate: of which it is now generally considered a variety. The nodules of carnelian have generally a reddish brown coloured crust.

The most striking colours of the carnelian are that deep flesh red peculiar to it; and a bluish white, very like the colour produced by the mixture of a little milk with a great deal of water. The flesh red is sometimes blended with a shade of yellow; and this variety seems to be the sard of the present day.

The white carnelian is sometimes streaked or spotted with red. I have heard of a variety of this kind which was cut as a *cameo:* the device was a head of Bacchus; and it was so contrived that the red spotted part represented the cheeks, the rest being entirely white.

Arabia and India produce the most beautiful Carnelians; but the greatest number come from Germany.

Opal.

Pæderos, of Pliny; according to some: but perhaps the pæderos of Pliny is our diamond.

Oriental or *Noble Opal:* applied to those varieties which are most remarkable for their beauty.

Infusible by the blowpipe; but becomes opaque and milk-white.

Specific gravity 1,7 to 2,1.

Opal of Cscherwenitza in Hungary.

Silex	90
Water	10
	100 *Klapr.*

Common *bluish white Opal of Kosemütz in Silesia.*		Common *greenish yellow or* Pitch Opal *of Telkobanya in Hungary.*	
Silex . . .	98,75	Silex . . .	93,50
Alumine	a slight trace	Oxyd of Iron	1
Oxyd of Iron	of each.	Water . . .	5
	98,75 *Klapr.*		99,50 *Klapr.*

According to Tavernier the opal is only found in Hungary: this observation is perhaps applicable to the variety called noble opal.

It occurs, in very irregularly shaped and imperfectly defined patches, in a kind of indurated coarse sandy clay, of a light reddish yellow colour; by Werner called clay porphyry. It is sometimes nearly transparent and colourless; sometimes slightly wheyish and opaque; the degree of this opacity and wheyish appearance varying so that it occasionally becomes completely opaque, and of a milk white colour. But in all the intermediate stages there is a disposition in the substance to refract the rays of light in a very remarkable manner: the colour most in esteem, as arising from this refraction, is green. The effect is produced in consequence of the presence of numerous small fractures or fissures in the interior of the opal, the intervals of which produce a varying refraction of the rays of light. All these colours disappear when the substance of the opal is reduced by mechanical means to very minute particles.

The most beautiful opals come from Cscherwenitza in Upper Hungary. Opals have also been met with in the neighbourhood of Freyberg, in Saxony; and in other places.

The noble opal on account of its softness and sometimes splitting from change of temperature is not so valuable as it would otherwise be in jewellery. The common opal, the analysis of two varieties of which has been given above, is of various colours: it is not so diaphanous as the noble opal. It is met with in amygdaloid and porphyry in various parts of Europe.

Cat's Eye.

Pseud-Opal.

In the heat of the Berlin porcelain furnace it became soft and opaque.

Specific gravity 2,6.

Silex	95
Alumine	1,75
Lime	1,50
Oxyd of Iron	0,25
	98,50 *Klapr.*

The name of this mineral is very expressive of the appearance arising from the reflection of light from its interior; which appears to be described in the following passage of Pliny: " inclusam lucem *pupillæ* modo " quandam continet, ac transfundit cum inclinatione, " velut intus ambulantem; ex alio atque alio loco

" reddens *." Pliny gives this description in speaking of the asteria: and Saussure thinks the asteria is a sapphire †.

The form of this mineral, as generally met with, is somewhat spherical like an eye : but this is the effect of artificial cutting and polishing. It has already been said that a similar varying reflexion of light may be obtained from the surface of a piece of fibrous semitransparent gypsum cut into a similar form ‡.

The cat's eye and the variety of felspar called adularia sometimes have a close resemblance; but the former is much less fusible than the latter, and has a compact or conchoidal fracture rather than a lamellated one.

The cat's eye is imported from Ceylon and the Malabar coast, but never in its natural state.

Hydrophanous Opal.

Achates unguium colore, in *aëre opacus* ; *aqua, perlucens;* of Wallerius.

Hydrophanous Opal, of Saxony.

Silex	93,12
Alumine . . .	1,62
Volatile matter .	5,26
	100,00 *Klapr.*

Some varieties of the opaque opal have the pro-

* Nat. Hist. lib. xxxvii. † Vid. p. 137. ‡ Vid. p. 66.

perty of becoming hydrophanous; that is, they acquire a considerable degree of transparency by immersion in water: by the absorption of which the effect is produced. M. Haüy mentions an opal of this kind which by immersion in water, during a few minutes, acquired one fifth of its original weight. The bubbles of air expelled by absorption of the water are visible soon after immersion.

Opals of this kind when dry adhere to the lips like baked clay; the reason of which is evident from what has been already said.

Semi-Opal.

Pitch-stone.
Quartz resinite commun; of Haüy.
Infusible.
Specific gravity 2,5 at most.

Silex	90
Water	8
The proportion of Iron contained in semi-opal is variable.	
	98

The lustre and fracture of this substance remarkably justify the application of the term pitch-stone, by which this variety is often distinguished.

Semi-opal varies in colour: the principal colours are milk-white, yellow, brown, and red. Some of the yellow varieties very closely resemble gamboge.

Semi-opal is met with in various parts of Europe; principally in granite and porphyry.

Some of the varieties closely resemble petrified wood; and are met with near Schemnitz in Hungary.

Some are very like transparent wax or jelly.

Menilite.

Silex	85,5
Water and coaly matter	11
	96,5 *Klapr.*

This variety of semi-opal occurs in small kidney-shaped masses, externally of a bluish brown colour: internally of a deep umber brown. The structure is thick laminated. In its natural situation it is disposed in interrupted layers in a white argillaceous earth, which separates the beds of gypsum at Ménil-le-Montant, near Paris.

Tourmaline.

Shorl, of Kirwan; as applied to those varieties which are black. The term shorl, or schorl, as it is sometimes written, is derived from the name of the village of Schorlaw in Saxony; where the substance first called shorl was found. It has been customary till lately to apply this term to a great variety of crystallized substances; particularly those of a prismatic form.

Tourmaline, of Kirwan; as applied to those varieties which are of a green colour.

Black shorl, and *Electric* shorl; of many mineralogists.

Cockle, of the Cornish miners; as applied to the varieties which are black.

In hardness it is inferior to quartz; but scratches glass.

According to Haüy it is fusible by the blow-pipe into a white or grey enamel, whatever the original colour may have been.

Electric, by heat; positively at one extremity, negatively at the other: when the electricity is excited by friction it is always positive. The transparent varieties are most electric.

Specific gravity varies from 3,08 to 3,36.

Primitive form, an obtuse rhomboid; the plane angles of which are $113^d\ 35'$ and $66^d\ 25'$, according to Haüy; according to Count Bournon $114^d\ 12'$ and $65^d\ 48'$.

	Tourmaline of Brasil	*of Ceylon.*
Silex	40	37
Alumine	39	39
Lime	3,84	15
Oxyd of Iron	12,50	9
—— of Manganese	2	
	97,34 *Vauq.*	100 *Bergm.*

Crystals of tourmaline are almost always of a prismatic form; the prism longitudinally striated or channelled, and terminating in a flat irregular pyramid at each extremity: the number of the faces is different in the two pyramids; and that which has the smallest number acquires by heat the negative or resinous electricity; the other, the positive or vitreous: hence the former repels, the latter attracts light bodies; and if two crystals of tourmaline suspended by a thread of silk be presented to each other in an electric state, the similar extremities will repel, the dissimilar will attract each other. The heat best adapted to shew the electricity of the tourmaline is from about 100^d to 212^t of Fahr. It may be rendered electric either by holding it near the fire, or plunging it in hot water for two or three minutes. If heated above a certain point it ceases to be electric: if heated still further, it recovers its electricity; but with this difference, that the poles which were before positively, become now negatively electrified: and *vice versâ*.

The electric property sometimes remains for several hours: and, if a crystal in a state of electricity be broken into the smallest pieces, each fragment will have a positive and a negative pole. Transparent crystals are most electric: those containing most iron are least electric.

Prismatic crystals of tourmaline are disposed to separate transversely, in the same manner as the beryll *: one surface of the divided part being concave, the other convex. The prism sometimes approaches to a cylindrical form, in consequence of the great number of the longitudinal striæ or channels above spoken of.

Tourmalines are met with of various colours: the commonest colour is black, or brownish black; and this is the variety which often is found, in compact radiating fasciculi, in the granite of the Land's End, in Cornwall; and in that compound rock, consisting of a mixture of this mineral and of white quartz, on which Roche castle stands, near Bodmin in Cornwall.

The green tourmaline of Ceylon is of a beautiful emerald colour; whence it has been erroneously supposed by some, that the Emerald was indigenous in that island: whereas no emerald has yet been found there. From a similar error the green tourmaline of Brasil is often called the Brasilian emeral: or, when of a sufficient shade of blue, the Brasilian sapphire.

* Vid. p. 129.

The transparency of the tourmaline is attended by this singular circumstance; that, generally speaking, it only takes place when the light is viewed in a direction perpendicular to the axis of the prism; even when, from the shortness of the prism, its thickness is greater than its length.

Crystallized tourmalines occur very commonly in the Tyrol; in rocks, the base of which is talc.

Fragments of crystallized tourmaline are frequently found in the sand of the Ceylon rivers; and the most beautiful specimens come from that island. Black tourmalines are met with in granite, gneiss, and other primitive rocks. Tourmaline is distinguished from hornblende, actinolite, thallite, the chrysolite, and the emerald, in being electric by heat; and by the singular nature of its transparency, abovementioned.

Rubellite.

Red Shorl of Siberia.

The physical characters of this mineral correspond very closely with those of tourmaline; of which it is supposed to be a variety by many mineralogists: it principally differs from the tourmaline in being infusible.

	Rubellite of Siberia, of a violet red colour.	*Rubellite of Siberia, of a blackish violet colour.*
Silex	42	45
Alumine	40	30
Manganese	7	13
Soda	10	10
	99 *Vauq.*	68 *Vauq.*

The rubellite is so called from its occasional bright red colour; this varies from a delicate rose-pink to a deep blackish purple; and all the different shades are sometimes visible in the same crystal. The transparency is very various.

The rubellite was first found in a granite mountain in the Oural chain; in a vein composed of felspar, quartz, mica, and black tourmaline. It has since been found crystallized in the *sand of Ceylon.*

The Hon. Mr. Greville possesses a mass of rubellite, as large as a moderately sized melon: it was originally presented by the King of Ava to Colonel Symes; and is valued at 1000l. sterling, supposing it to be used for the purposes of ornamental jewellery. It is entirely composed of crystals, placed side by side, and slightly diverging from each other: the colour of the mass is a pale purplish red, passing into black at the base.

The following quotation from Pliny, though perhaps not strictly applicable to rubellite, is very curious; as pointing out the electric property of a precious stone, evidently resembling the rubellite.

In speaking of gems of a red colour he says, "Ex "eodem genere ardentium Lychnis &c. præcipuæ "gratiæ—probatissima in Indis, quam quidam remis-"siorem Carbunculum esse dixierunt. Secunda bo-"nitate similis est Ionia, appellata a prælatis flori-"bus: et inter has invenio differentiam; unam, quæ "purpura radiat; alteram, quæ cocco; a sole *excale-"factas*, aut digitorum adtritu, *paleas* et chartarum "*folia ad se rapere* *."

Hornblende.

Basaltine, and *Basaltic Hornblende*; of Kirwan: so called from its frequent occurrence in basaltic rocks.

Opaque Rhomboidal Shorl; of de Lisle.

Amphibole; of Haüy: so called on account of its doubtful character; which arises from its resemblance in some points to other minerals.

Easily fusible into a greyish black glass.

Sufficiently hard to scratch glass; but scarcely strikes fire with steel.

Specific gravity 3,25.

Primitive form, a four-sided prism which makes an oblique angle with its base: the base is a rhomboid with angles of 122^d 56′ and 57^d 4′.

* Nat. Hist. lib. xxxvii. ed. Brot. vol. vi. p. 286.

Silex	. . . . .	58
Alumine	. . . .	27
Lime	. . . . .	4
Magnesia	. . . .	1
Oxyd of Iron	. .	9
		99 *Bergm.*

The term hornblende was originally applied to a compact or foliated variety of the present mineral; partly on account of its resemblance to the substances called *horn*-stones, and partly because, from its great specific gravity, miners mistook it for a metallic ore: in which case upon finding out their error they usually apply the term *blende* to the substance by which they were misled. Thus the ore of zinc, which closely resembles galena, is called *blende* or pseudo-galena. And on the same principle, Mr. Kirwan observes, the common people call those nuts *blind* which contain no kernel.

Large and distinct crystals of hornblende are not often met with. They are frequently found in the clay of disintegrated basalt; by which it appears that they resist the action of the weather, &c. longer than the basalt which contained them. In other respects they scarcely differ from basalt, except in form: for basalt may be traced by insensible gradations into a compact completely crystalline form of hornblende.

The first stage of the transition appears in the presence of minute acicular crystals of hornblende dispersed here and there through the basalt: in treating of which substance the history of hornblende will necessarily be resumed.

Hornblende is distinguished from tourmaline in not being electric; and by its conversion into a much darker coloured glass under the action of the blow-pipe: by the latter character it may also be distinguished from thallite: it may be distinguished from acicular asbestus by the rough feel of its powder, compared with the soft feel of the powder of asbestus.

It has already been said that some mineralogists are inclined to consider hornblende and actinolite as varieties of the same species *.

Axinite.

Thumerstone; from Thum in Saxony.

Violet shorl; and *glassy* shorl.

Sufficiently hard to scratch glass easily.

In the heat of the Berlin porcelain furnace it was fused into a dense glass of a deep brown colour.

Specific gravity varies from 3,21 to 3,29.

Primitive form, a prism at right angles with its base; which is a parallelogram with angles of 101^d $30'$ and 78^d $30'$.

* Vid. p. 118.

Silex	52,70	44
Alumine	25,79	18
Lime	9,39	19
Oxyd of Iron	8,63	14
—— of Manganese	1	4
	97,51 *Klapr.*	99 *Vauq.*

The common form of crystallized axinite is a very flat and oblique rhomboid, resembling the cutting edge of a hatchet; whence it has been called Axinite.

It is usually of a dull violet colour, and sometimes has a considerable degree of transparency: the colour is probably owing to the manganese contained in it. Sometimes it is green.

It was first found at Thum in Saxony: since, in Dauphiny; where it is accompanied by crystallized quartz, asbestus, thallite, and the variety of felspar, called formerly white shorl *. It has also been found in Cornwall, both crystallized and amorphous: and near Königsberg, in Norway. It occurs commonly in the clefts of serpentine rocks.

* Vid. p. 158.

Thallite.

Glassy Actinolite; of Kirwan.
Green Shorl; of *Dauphiny.*
Epidote; of Haüy: this name alludes to a peculiarity in its form, supposed to have been produced by a more than usual accretion, *(accroissement)* of the integrant molecules *.
Acanticon; from the canary bird: the plumage of which its powder resembles in colour.
Arendalite; from Arendal, in Norway.

Fusible by the blowpipe into a brown scoria.
It easily scratches glass, and gives fire with steel.
Becomes electric, though not readily, by friction only.
Specific gravity 3,45.
Primitive form, a prism at right angles with its base; which is a parallelogram with angles of 114^d 30′ and 65^d 30′.

	Thallite of Arendal, in Norway.	*Thallite of Dauphiny.*	*Thallite, met with in the matrix of Corundum.*
Silex	37	37	45
Alumine	21	27	28
Lime	15	14	15
Oxyd of Iron	24	17	11
—— of Manganese	1,5	1,5	
	98,5 *Vauq.*	96,5 *Descostils.*	99 *Chenevix.*

The common form of thallite is prismatic: the

* Vid. Haüy, tom. iii. p. 112.

prisms are very various in size; sometimes an inch or more in diameter, sometimes only acicular. It is in the latter state that thallite particularly resembles actinolite; from which however it differs both with respect to its primitive form and analysis *.

The crystals of thallite met with at Arendal in Norway are remarkably large. It is met with in great abundance in Dauphiny; in the same matrix with axinite: the form of its crystals in that place is commonly acicular; and the crystals are disposed to break transversely. In Cornwall it often accompanies crystallized quartz.

Thallite may be distinguished from tourmaline, in not being electric by heat: from acicular asbestus, by the dryness and harshness of its feel when reduced to powder.

Crystals of thallite are rarely if ever transparent, the only transparent crystals M. Haüy ever saw came from the valley of Chamouni: they were called *aqua-marine shorl;* but had neither the intensity nor delicacy of colour peculiar to the aquamarine.

* Vid. p. 116.

Lapis Lazuli.

Pierre d'Azur ; of Brochant and other mineralogists.
Zeolites, colore albo et caruleo, argentum continens ; of Wallerius.
In the heat of the Berlin porcelain furnace it was fused into a dense brownish black glass.
After calcination it forms a jelly when dissolved in acids; and hence it was formerly supposed to be a zeolite.
Sufficiently hard to scratch glass.
Specific gravity varies from 2,76 to 2,94.

Silex	46
Carbonate of Lime .	28
Sulphate of Lime . .	6,50
Alumine	14,50
Oxyd of Iron . . .	3
Water	2
	100,00 *Klapr.*

According to M. Haüy the Arabians call this mineral by the name of *azul;* and hence the term lapis *lazuli.*

The blue colour of lapis lazuli was formerly supposed by most mineralogists to be owing to the presence of copper; of which however not the least particle is contained, as appears by the foregoing analysis. Wallerius thought that it was coloured by silver: and hence the latter part of his description of it *.

* Vid. sup.

Lapis lazuli frequently contains iron pyrites, disseminated through its substance in specks and veins. It is also often mixed irregularly with white patches of carbonate of lime, or quartz. It has not yet been found crystallized.

In the mass this substance is used for ornamental purposes; when separated from the matrix in the state of powder, it is used as a pigment, and is called *ultramarine*. Baccius says it is probably so called because it exceeds the colour of the sea: but this etymology seems fanciful. Perhaps it was so called in consequence of its being imported into Europe from beyond sea; for according to Jameson it has not been met with in Europe except among the ruins of Rome. The colour is prepared by calcining the mineral, pounding, and washing it; and collecting the sediment.

Tavernier says that it is found near Thibet. According to Mr. Kirwan it is found only in the confines of Siberia and Tartary, or China; and lately, as is reported, in America.

Lapis lazuli is distinguished from blue copper ore by retaining its colour in an ordinary heat.

Lepidolite.

Lilalite; from its colour, which resembles the flower of the *lilac.*

In the heat of the Berlin porcelain furnace it was fused into a greyish white transparent glass. This glass by the addition of a little nitre became violet coloured.

It is easily cut by the knife.

Specific gravity 2,81.

Silex	54,50
Alumine	38,25
Oxyd of Iron and of Manganese . . .	0,75
Potash	4
	97,50 *Klapr.*

Silex	54
Alumine	20
Fluate of Lime . . .	4
Oxyd of Manganese .	3
——— Iron	1
Potash	18
	100 *Vauq.*

Lepidolite is made up of numerous flat shining particles, resembling the *scales* of very small fish; and hence its name.

It has not yet been met with crystallized, although a crystalline structure may be traced by mechanical division in the above mentioned scaly particles. It was first discovered in a granitic rock near Rozena in Moravia; and has since been met with in Sweden.

Zeolite.

Mesotype; of Haüy: so called because its primitive form is intermediate between the primitive forms of two other minerals, with which it is often confounded.

It is not much harder than carbonate of lime.

Electric by heat.

Has a double refracting power.

Specific gravity 2,08.

Primitive form, a prism at right angles with its base; which is a square.

Silex	50,24	50
Alumine	29,30	20
Lime	9,46	8
Water	10	22
	99,00 *Vauq.*	100 *Pelletier.*

Zeolite upon the first application of the blowpipe swells with a degree of effervescence, in consequence of the dissipation of the water contained in it: hence it has been called zeolite.

When reduced to a fine powder, and thrown into nitric acid, it is soon converted into a gelatinous mass.

The two foregoing characters taken together are very distinctive of this substance.

Zeolite occurs principally in rocks of the basaltic order, accompanied by calcareous spar and calcedony. These several substances, disseminated through the rock containing them in the form of irregularly shaped nodules, produce that appearance, which has given rise to the term amygdaloid; the white nodules appearing like almonds imbedded in the surrounding substance, and being particularly conspicuous in consequence of the darker colour of the matrix containing them.

These nodules sometimes moulder away, leaving the space vacant which they had occupied: and hence the origin of those cavities observable in some varieties of basalt. This effect is probably owing to a loss of the water of crystallization; and in proportion as the zeolite becomes of an earthy or farinaceous consistence, its electric property is weakened.

Zeolite is commonly crystallized in delicate prismatic fibres, which radiate from a common centre.

The *Stilbite* of Haüy, so called from its delicate pearly lustre, is considered by some as a variety of zeolite; and resembles it in many points: but it is neither electric by heat, nor does it resolve itself into a jelly in acid.

The *Chabasie* of Haüy, often called *cubic* zeolite, is also considered sometimes as a variety of zeolite; from which however it differs in the same manner as stilbite: its form besides, which is a rhomboid so obtuse as to appear to the eye like a cube, is a strong mark of distinction. The term, which however was not first adopted by M. Haüy, is apparently derived from the word χαβάζιος; which is made use of in the poem entitled Orpheus de lapidibus, and is probably a corruption of the word χαλαζίας which is applicable to a mineral substance resembling hail in its appearance.

The *Analcime* of Haüy, so called from its weak electric power, is another of those substances that are considered by many as zeolites: this differs from zeolite in the same manner as stilbite. Some of its crystals resemble those varieties of leucite and the garnet, which have twenty-four trapezoidal faces: but, from the whiteness of their colour, may be more easily mistaken for the former than the latter. Crystals of this form are met with in the basalt of Arthur's Seat near Edinburgh.

Prehnite.

Chrysolite of the Cape; from its yellowish green colour, and the situation where it was first found.

Greenish Zeolite; from its colour and radiated form.

In the heat of the Berlin porcelain furnace the prehnite of Scotland was converted into an opaque dense slag.

Scarcely scratches glass.

Electric by heat?

Specific gravity varies from 2,60 to 2,69.

Primitive form is supposed to be a prism at right angles with its base; which is a parallelogram: but this has not yet been ascertained.

Prehnite of the Cape.

Silex	44	50
Alumine	30	20,4
Lime	18	23,3
Oxyd of Iron	5	4,9
	97 *Klapr.*	98,6 *Hassenfratz.*

This mineral was named from Col. Prehn, who discovered it at the Cape of Good Hope; and was at first mistaken for several other substances, as chrysoprase, the chrysolite, &c. It was afterwards classed as a variety of zeolite: but is now considered as a distinct species.

Prehnite frequently occurs in irregularly crystalline masses of a white, or green, or yellowish colour: these when broken present numerous small radiated surfaces of a circular form.

Since its first discovery at the Cape of Good Hope it has been met with in the Tyrol; in Dauphiny; and in the basaltic rocks of Scotland.

It is distinguished from zeolite in not being converted into a jelly by nitric acid.

Staurolite.

White cruciform Hyacinth; of de Lisle.

Andreasbergolite; from St. Andreasberg in the Hartz, where it was first found.

Slightly scratches glass.

It gives a greenish yellow phosphorescent light when thrown in powder on burning coals.

Fusible by the blowpipe, with effervescence.

Specific gravity 2,33.

Primitive form, an octohedron; each surface of which is an isosceles triangle.

Silex	49	47,5
Baryt	18	16
Alumine	16	19,5
Water	15	13,5
	98 *Klapr.*	96,5 *Tassaërt.*

It is a singular coincidence that a substance, from its form called staurolite, or cross-stone, should have been first met with in the neighbourhood of a place called St. Andreasberg.

The cruciform crystals of this mineral consist of two compressed four-sided prisms, terminated at each extremity by four faces: these prisms cross each other at right angles.

Those of St. Andreasberg are often very delicately defined.

Staurolite has also been met with at Strontian in Scotland; but the crystals of this variety are either single, or very irregularly united.

It is distinguished from white varieties of the hyacinth, by its fusibility and inferior degree of specific gravity: from zeolite, in not being electric by heat.

Vesuvian.

Idocrase; of Haüy. Its crystalline forms partake of the nature of other minerals: and the term idocrase is meant to express their mixed character.

Brown Volcanic Hyacinth.

Vesuvian Chrysolite; of the lapidaries of Naples: this name is applied to the yellowish green varieties.

Sufficiently hard to scratch glass.

Has the double refracting power to a considerable degree: but this is not often perceptible; few crystals being sufficiently transparent.

In the heat of the Berlin porcelain furnace, it was fused into a compact and nearly colourless glass.

Specific gravity varies from 3,08 to 3,40.

Primitive form, a prism at right angles with its base; which is very nearly a square.

Vesuvian of Siberia		*of Mount Vesuvius.*
Silex	35,50	42
Lime	33	34
Alumine	22,25	16,25
Oxyd of Iron	7,50	5,50
	98,25	97,75 *Klapr.*

This mineral is met with near Mount Vesuvius, accompanied by hornblende, mica, garnet, and carbonate of lime: but it does not seem ascertained whether the specimens in which it occurs are parts of the mountain itself; or whether they have been ejected from the crater. It has also been found in a species of serpentine, in Siberia. One of the varieties of the primitive form of vesuvian consists of a prism, with sixteen sides, terminated at each extremity by thirty seven surfaces.

Vesuvian may be distinguished from the garnet, when they resemble each other in colour, by its inferior degree of specific gravity: from the hyacinth, by the same circumstance; and by the inferior degree of its double refracting power: from the Brasilian tourmaline, in not being electric by simple heat. It is most easily confounded with the chrysolite; but its colour is rarely so delicate.

Leucite.

Grenatite; so called in consequence of having been mistaken for a variety of the garnet.

White Garnet; from its colour and occasional resemblance in form to the garnet.

Amphigène; of Haüy: so called because its secondary crystals may be resolved either into a cube or into a dodecahedral rhomboid; thus having, as it were, a double origin.

It is influsible by the blowpipe.

Scarcely hard enough to scratch glass.

Specific gravity 2,46.

Primitive form, a cube.

Silex . .	53,50
Alumine .	24,25
Potash . .	20, 9
	97,84 *Klapr.*

Silex . . .	56
Alumine . .	20
Lime . . .	2
Potash . . .	20
	98 *Vauq.*

Leucite occurs, principally in distinct crystals, in varieties of lava; but is not met with in all volcanoes.

Its crystals are found in greatest abundance in the neighbourhood of Naples.

According to Brochant it resists decomposition more obstinately than the lavas containing it: hence it is often found in insulated situations; as in many places along the road that leads from Rome to Frescati. According to Mr. Jameson it sometimes undergoes disintegration like felspar, and passes into an earthy state.

Leucite has in a few instances been met with in natural rocks.

A common form of its crystals is a figure having twenty-four trapezoidal faces; which corresponds with one of the varieties of the garnet, but is usually better defined. This is the mineral substance in which the existence of potash was first discovered: and it is remarkable that though the proportion of potash is so great, the leucite is infusible.

Leucite may be distinguished from the garnet, of which it has been sometimes thought a variety, by its inferior degree of hardness and specific gravity; and by its infusibility: also by its nearly total want of colour; all the varieties of garnet that have yet been discovered having a considerable shade of colour.

END OF THE FIRST VOLUME.

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