# SYSTEM

OF

# MINERALOGY,

COMPREHENDING

ORYCTOGNOSIE,
GEOGNOSIE,
MINERALOGICAL CHEMISTRY,

MINERALOGICAL GEOGRAPHY, AND
ŒCONOMICAL MINERALOGY.


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# SYSTEM

OF

# ORYCTOGNOSIE,

*ACCORDING TO THE METHOD OF THE ILLUSTRIOUS WERNER OF FREYBERG.*

Wenn ich ein mineralogiſches Lehrbuch, um daraus zer lernen, aufſchlage, ſo thue ich es; entweder, um überhaupt eine kenntniſs von dieſer wiſſenſchaft zu erlangen, oder, um inſbeſondere von einem foſſile, daſs ich bloſs dem namen nach kenne, den vollſtandigen begriff zu bekommen: oder von einem foſſile, welches ich gefunden und an dem ich ſeine äüſſerlichen kennzeichen aufgeſucht habe, zu erfahren, wie es heiſſe und welchen platz es in dem ſyſtem der foſſilien einnehme. Leiſtet mir hierinnen ein Lehrbuch groſſen theils genuge, ſo nenne ich es gut, und wenn es mich völlig befriediget, denn nenne ich es volkommen.

*Werner's Auſſerlichen Kennzeichen*, ſ. 13.

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TO

COLONEL ALEXANDER DIROM,

OF MOUNT ANNAN,

QUARTERMASTER-GENERAL FOR SCOTLAND,

FELLOW OF THE ROYAL SOCIETY OF EDINBURGH, &c.

THIS SYSTEM OF ORYCTOGNOSIE

IS INSCRIBED,

IN TESTIMONY OF THE RESPECT AND GRATITUDE

OF HIS OBEDIENT, HUMBLE SERVANT,

ROBERT JAMESON.

COLLEGE OF EDINBURGH,
APRIL 30, 1804.

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# INTRODUCTION.

MINERALOGY is that branch of natural hiſtory * which makes us acquainted with all the properties and relations of minerals. As theſe properties and relations are very different from each other, we cannot

Definition of mineralogy.



* If it be true "that deſcription, when employed about "events, conſtitutes hiſtory," then certainly the uſual acceptation of the appellation, Natural Hiſtory, is erroneous. That relation which aſpires to the dignity of hiſtory, muſt embrace not only an exact and full deſcription of the object or thing treated of, but alſo aſcertain the relative time as well as manner of its production, and the change and alteration, if any, it has undergone in arriving at its preſent ſtate. Natural hiſtory therefore comprehends two diſtinct branches, the one making us acquainted with natural objects as they are preſented by nature, furniſhing us with ſufficient data and eaſily applicable criteria to diſtinguiſh them from each other, and this is *Natural Deſcription*. The other branch, Natural Hiſtory properly ſo called, conſiſts in the inveſtigation of the ancient and original ſtate of natural objects, and the ſucceſſive changes and alterations they have undergone till the preſent time. Thus in botany and zoology the queſtions, Were all animals and plants originally created as we at

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cannot arrange them together without producing much confuſion. On this account Werner found it neceſſary to conſider them under five different heads, or what he terms mineralogical doctrines: theſe are, *Oryctognoſie*, *Geognoſie*, *Mineralogical Geography*, *Mineralogical Chemiſtry*, and *Oeconomical Mineralogy*.

Oryctognoſie. *Oryctognoſie.*—Or what has been hitherto in Britain and France denominated mineralogy, is that branch of mineralogy which makes us acquainted with minerals in a natural order, under fixed denominations, and by well aſcertained characters.

Geognoſie. *Geognoſie**—teaches us the ſtructure, relative poſition and mode of formation of the mineral maſſes of which the cruſt of the earth is compoſed†.

*Mineralogical*

at preſent find them, or have they by degrees aſſumed the ſpecific forms they now poſſeſs? Are certain ſpecies become extinct? In what order and whither have they migrated? What change has climate produced? In mineralogy, at what period, during the formation of our earth, and under what circumſtances has a peculiar ſpecies of mineral been produced? Has it remained unaltered, or has it undergone changes? All theſe queſtions are of hiſtorical import, and belong to this department. In ſuch inveſtigation conſiſts the ſcientific proſecution of Natural Hiſtory; the mere art of diſtinguiſhing natural objects from one another can ſcarcely be entitled to that appellation.

* By Geology, Werner underſtands idle and imaginary ſpeculation reſpecting the formation of the earth.

† At firſt ſight the ſolid maſs of the earth appears to be a confuſed aſſemblage of rocky maſſes, piled on each other without order or regularity: to the ſuperficial obſerver nature appears in the rude matter of the unorganic kingdom, to preſent us only with

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*Mineralogical Geography*—deſcribes, in geographic order, the particular rocks that occur in the earth's ſurface in different countries, and makes us acquainted with the different ſpecies of foſſils that are contained in them, and the manner of their occurrence. It gives us Mineralogical geography.

with a picture of chaos, where none of thoſe admirable diſplays of ſkill and contrivance, which in the ſtructure of animals and vegetables ſo powerfully excite our attention, and claim our admiration, are to be obſerved. It is not ſurpriſing that this unfavourable opinion ſhould have long continued to be prevalent, when we conſider the ſkill, judgment, and experience which are neceſſary for enabling us to combine all that variety of apparently unconnected relations which are obſervable in the internal ſtructure of the earth. In ancient writers we find nothing on this important ſubject. The ſtriking phenomena of volcanoes appear frequently to have excited wonder and aſtoniſhment, which they always ſubſtituted for inveſtigation. After the revival of letters, when ſcience had aſſumed a more favourable aſpect, and mines came to be worked by freed men, the objects of the mineral kingdom excited a conſiderable ſhare of attention, the numerous intereſting phenomena, which daily preſented themſelves to the miner, were carefully remembered, and at length recorded by the celebrated miner Agricola. From that period until the time of Werner, mineralogiſts brought to light many individual, and a few general facts reſpecting the ſtructure of the earth. Lehman firſt pointed out the great natural diviſion of mountains into primitive and ſecondary; Cronſtedt aſcertained the age of ſeveral mineral repoſitories; Hamilton deſcribed the phenomena of volcanoes; Dolomieu made us acquainted with the ſtructure of volcanic hills; Sauſſure enlarged our knowledge of the variety of primitive rocks, and an excellent obſerver, our countryman Williams, made many excellent obſervations on the independent coal formation.

Notwithſtanding

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us a picture of the ſtructure and compoſition of particular tracts, geognoſie that of the whole globe.

Mineralogical chemiſtry. *Mineralogical Chemiſtry*—makes us acquainted with the quantity and quality of the conſtituent parts of minerals.

Oeconomical mineralogy. *Oeconomical Mineralogy*—teaches us the different uſes of minerals.

This excellent ſubdiviſion of the ſcience, firſt marked its true limits, and its vaſt extent, and pointed out a clear path for future mineralogiſts.

Notwithſtanding the labours of theſe induſtrious obſervers, our knowledge of the internal ſtructure of the earth was ſtill very limited and confuſed. Although obſervations had been made in very diſtant countries, and ſimilar rocks diſcovered in a variety of the moſt widely diſtant ſituations, yet no ſucceſsful attempt had been made to generalize theſe appearances, ſo as to diſcover the general ſtructure of the earth, and the mode of its formation. Sauſſure made the attempt, but neither his information nor ability ſeem to have been equal to this great taſk. He was alſo unacquainted with many facts which would have aſſiſted him, and his attention was too much occupied with particular and local appearances to effect what has been ſince ſo fully accompliſhed by the comprehenſive mind of Werner.

This great geognoſt, after many years of the moſt arduous inveſtigations, conducted with an accuracy and acuteneſs of which we have few examples, diſcovered the manner in which the cruſt of the earth is conſtructed. Having made this great diſcovery, he, after deep reflection, and in conformity with the ſtricteſt rules of induction, drew moſt intereſting concluſions, as to the manner in which the ſolid maſs of the earth may have been formed. It is that ſplendid ſpecimen of inveſtigation, the moſt perfect in its kind ever preſented to the world, which I ſhall give an account of in the volume of this work which treats of Geognoſie.

2. As

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2. As oryctognoſie is the ground-work of mineralogy, a knowledge of it muſt neceſſarily precede that of the other doctrines. This is the reaſon why it is to occupy the early part of this work. I muſt remark, however, that it is not purely oryctognoſtic, for I have added to the deſcription of each mineral, its chemical characters, conſtituent parts, geognoſtic and geographic ſituations, and a few notices reſpecting its uſes. Oryctognoſie the baſis of mineralogy.

3. An arrangement to be correct ſhould have but one object for its baſis; for when ſeveral are aſſumed it fails completely in accompliſhing its purpoſe: it is alſo indiſpenſably neceſſary in arranging natural bodies, that none which fall within the bounds of the ſyſtem be omitted. Many mineralogiſts, by aſſuming as the baſis of their ſyſtems not only the natural alliances, but alſo the chemical compoſition, geographic ſituation, and œconomical uſes of minerals, and by ſeparating the volcanic from other oryctognoſtic products, have rendered their ſyſtems unſtable and incomplete. The Wernerian oryctognoſtic ſyſtem is framed in conformity with the ſtricteſt rules of claſſification; it is founded ſolely on the *natural alliances and differences obſervable among minerals.* But on what do theſe depend? Werner anſwers on the quality, quantity, and mode of combination of the conſtituent parts. General rules of arrangement. Baſis of the Wernerian oryctognoſie.

Karſten, Hauy, Brochant, and other mineralogiſts have objected to the Wernerian ſyſtem, that it arranges minerals together which are completely different Objections to it.

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ferent in their internal compoſition; thus they remark ſapphire is placed in the flint genus, although it has been found to contain ninety-eight per cent. of alumina; and opal in the clay genus, although ninety-eight parts of ſilica. This objection, however, is founded on a miſconception of Werner's opinion. He does not pretend that his arrangement ſhall always correſpond with the experiments of the chemiſt; for it is only when chemical reſults agree with the natural alliances of the mineral that he gives them a place in his ſyſtem. In inſtances where the affinities of the mineral with thoſe already in the ſyſtem have not been made out, and we are ſtill uncertain as to its true nature, it is a matter of indifference where we place it. If it has been analyſed we may arrange it chemically, not however from a conviction that its place will thus be fixed, which cannot be done until we have, by the examination of a complete ſuite, combined with a knowledge of its geognoſtic relations, diſcovered whether or not its characters authoriſe the arrangement made by the chemiſt. If we were to allow the arrangement to be made according to the moſt improved chemiſtry of the preſent day, we ſhould have very diſſimilar minerals grouped together, and thoſe which are nearly allied ſeparated. In ſuch a ſyſtem garnet and thumerſtone would be conſidered as the ſame ſpecies; chlorite would be arranged among the ores of iron, and we ſhould have a tranſition ſuite beginning with pumice, and proceeding through pearlſtone, pitchſtone, clinkſtone, felſpar, talc,

The objections anſwered.

Chemical arrangement of minerals.

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talc, lepidolite, to leuzite. It is evident, therefore, that a chemical oryctognoſie, in ſo far as it ſtands in oppoſition to the natural alliances obſervable among minerals, muſt be rejected.

Subdiviſion of the mineral ſyſtem.

4. Having now ſtated the principle on which the Wernerian ſyſtem is founded, I ſhall next detail the method which is followed in dividing the whole maſs of ſimple minerals into *claſſes*, *genera*, *ſpecies*, *ſubſpecies*, and *kinds*.

Linnæan diviſions not ſufficient.

The Linnæan diviſion of claſs, order, genus, and ſpecies, having been found inſufficient for the arrangement of minerals, Werner, to remedy this inconvenience, formed two inferior ſubdiviſions, which he denominated ſubſpecies and kind.

Claſs.

The higheſt diviſion is the *kingdom*. The ſecond, or *Claſs*, is founded on what Werner terms the fundamental conſtituent parts. Of theſe there are four, *viz.* 1. Earthy, 2. Saline, 3. Inflammable, and 4. Metallic; and theſe form four great natural claſſes.

Genus.

The *Order* does not form one of the diviſions of this ſyſtem; therefore the next is the *Genus*, which is characteriſed by the predominating or characteriſing earthy, ſaline, inflammable or metallic matter.

Characters of the genus to be taken from its external aſpect.

There are many inſtances, however, where this definition does not apply. We may mention opal, diamond, and ſapphire. It would therefore be better to reſt ſatisfied with a deſcription, ſuch as we ſhall afterwards give, of the external aſpect of the genus, and only aſſume the idea of a predominating ingredient, as intimating what we are intitled to expect will after-



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wards be the caſe when analyſis becomes more perfect *.

The next diviſion is the *ſpecies*, which although the moſt important of the whole, has been ill underſtood by mineralogiſts.

It would be inconſiſtent with the brevity of this Introduction to mention all the variety of opinions that have been propoſed reſpecting mineral Species; it is ſufficient to mention that Werner conſiders all thoſe minerals that agree in external characters and internal compoſition as belonging to the ſame ſpecies †.

Species.

The next ſubdiviſions are ſubſpecies, kind, and variety. *Varieties* are thoſe differences which we obſerve in the individual external characters, as luſtre, fracture, hardneſs, &c.

Variety.

* In place of doubting of the accuracy of chemical analyſis, or of examining whether or not the chemiſt was entitled to believe that the ſubſtances which his analyſis gave him pre-exiſted in minerals, mineralogiſts called in queſtion a truth which appears inſeparable from the exiſtence of natural hiſtory, *viz. that the external aſpect is an expreſſion of the internal compoſition, and is a criterion of it.* In ſhort we may believe that every analyſis, (not confirmed by ſyntheſis), which does not agree with the natural alliances of minerals, is falſe.

† In the animal and vegetable kingdoms each plant and animal conſtitutes a whole, poſſeſſes a determinate form, each individual exhibits an eſſential difference, and is capable of definition. In the mineral kingdom each foſſil cannot be conſidered as an individual, but merely as a part of that immenſe individual, the globe; hence it is evident that, accurately conſidered, there exiſts but one mineral ſpecies or individual, which is the *globe*.

A *ſpecies*

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*A ſpecies* is compoſed of a greater or leſſer number of varieties. Species.

If in a ſpecies we meet with groups of varieties that can be well diſtinguiſhed from each other, we muſt give them a particular appellation; Werner denominates them *ſubſpecies*. Subſpecies.

To illuſtrate the manner of forming ſubſpecies, we ſhall take an example from the claſs of metals; it is lead glance which contains two ſubſpecies, *a*. Common lead glance. *b*. Compact lead glance. Mode of forming ſubſpecies illuſtrated.

The eſſential character of the ſpecies is as follows: Colour lead grey. Luſtre metallic. Streak unchanged. Mild. Soft. Very heavy.

*Firſt Subſpecies.* Common lead glance

Has ſometimes particular external ſhapes as reticulated, cellular, tubular, &c. It is often cryſtalliſed. Luſtre almoſt always ſhining, ſometimes ſplendent. Fracture more or leſs perfectly foliated, generally ſtraight, often curved foliated, with a threefold cleavage; ſeldom radiated and uſually ſhort, broad, and ſcopiformly diverging radiated. Very eaſily frangible.

*Second Subſpecies.* Compact lead glance.

Colour is lighter than the preceding ſubſpecies. Occurs only maſſive and ſpecular; has no particular external ſhape. Luſtre only glimmering. Fracture even. Fragments indeterminately angular. Does not occur in diſtinct concretions. Has more tenacity than the preceding ſubſpecies.

When an extenſive ſpecies is undivided, it is not only difficult to fix the picture of it in the mind, but



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the determination of the individuals of which it is compoſed requires a degree of ſkill and experience that few can hope to poſſeſs. It is therefore of the greateſt importance, when ſuch a ſpecies occurs, to endeavour to ſeparate the groups of characters from each other, and place them in the ſyſtem as ſubſpecies. It muſt not be concealed, however, that ſuch an operation requires much acuteneſs, and a moſt complete practical acquaintance with oryctognoſie. In the writings of ſeveral German mineralogiſts we meet with many new ſubſpecies; theſe are, however, vague indefinite things, that ſhew how little the framers of them have underſtood the Wernerian method.

Neceſſity and utility of forming ſubſpecies.

Difficulty of forming ſubſpecies.

Family. The term Family, uſed in this work, intimates that all the minerals included under it belong to a natural family.

4. All the differences mentioned in the preceding ſection muſt be arranged in a determinate order, and in ſuch a one as ſhall correſpond with the natural alliances of minerals. However eaſy this may at firſt ſight appear, we muſt confeſs that the greater number of attempts have proved inefficient. The idea of a chain of nature, which was employed by zoologiſts and botaniſts, was here adopted as the baſis of many arrangements, but no ſuch chain exiſts; for, if it did, every ſpecies could only paſs into the one preceding and following it, but this is not the caſe, for one ſpecies often paſſes into ſeveral, and others not into any, but ſtand iſolated.

No chain of nature.

The ſcheme in plate II. ſhews the incompatibility of a natural chain, where every link fits correctly into each

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each other, with the tranſitions of minerals. It repreſents the alliances of ſilver with gold, antimony, arſenic, ſilver, copper, iron, tin, lead, ſylvan, and mercury.

In the following ſection I ſhall detail the method which is followed in the arrangement of theſe differences, or claſſes, genera, ſpecies, ſubſpecies, and kinds.

Rules to be followed in the arrangement of the members of the ſyſtem.

5. In the arrangement of the members of the ſyſtem, we firſt begin with the moſt general, and proceed to the more ſpecial. Secondly arrange them as much as poſſible in a natural order; and thirdly, in the higher diviſion, as in the genera and ſpecies, we place the characteriſtic ones firſt, and allow the other leſs characteriſtic to follow in the order of their affinity; but when ſuites occur that do not poſſeſs ſuch affinities, we place the characteriſtic member in the middle, and arrange the others on both ſides according as they approach more or leſs to it. We ſhall now illuſtrate this method by giving an account of the arrangement of the different members of the ſyſtem.

Characters of claſs of earthy minerals.

6. The claſs of *earthy minerals* is diſtinguiſhed from the others by its being in general not remarkably heavy, brittle, poſſeſſing uſually white or light colours; being much diſpoſed to cryſtallize, uninflammable in a low temperature, and inſipid and inodourous. It is placed firſt in the ſyſtem by reaſon of its ſimplicity, its conſtituting the greater part of the cruſt of the earth, and its being the repoſitory of the minerals of the other claſſes.

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Characters of saline minerals.

The class of *saline minerals* is characterised by being moderately heavy, soft, possessing some degree of transparency, being chiefly white and sapid. It is placed immediately after the preceding class, by reason of its resemblance to it in several properties.

Character of inflammable class.

The *inflammable class*, which occupies the third place, is light, brittle, mostly opaque, always yellow, brown, or black, scarcely ever crystallized, does not feel cold, and as far as our present experience extends, it appears to be more nearly allied to the metallic than the earthy class.

Character of the metallic class.

The *metallic class* is heavy, chiefly opaque; in general possesses a peculiar lustre, is tough, often possesses some degree of malleability, exhibits a great variety of colours; is cold, and not easily inflamed. It is placed at the extremity of the system, because it is furthest removed, in properties, from the earthy class, and is nearly allied to the inflammable class.

Arrangement of the genera.

7. In a natural arrangement, as we have already mentioned, that genus, which possesses the characters of the class the most distinctly and completely, should be placed first, and the others should follow according to their greater or less affinity with it. In the class of earthy minerals or stones, the flint genus* possesses

* In the class of earthy minerals, there are six genera to which I have ventured to give the following denominations, 1. Flint genus. 2. Clay genus. 3. Talc genus. 4. Calc genus. 5. Baryte genus, and 6. Strontiane genus. The usual names, Siliceous genus, Argillaceous genus, &c. intimate, that the

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poſſeſſes thoſe properties and characters that entitle it to the firſt place. To the flint ſucceeds the clay genus, becauſe of its greater affinity to the flint genus than any other, and it paſſes by a natural gradation into the next, following the talc genus. The tranſition of theſe genera into each other is very complete, but the following genera, calc, baryte and ſtrontiane, do not afford ſo beautiful a continuance of the ſeries. Arrangement of the earthy genera.

Beſides theſe genera there is another that cannot be placed between any of thoſe that are here mentioned without interrupting the natural order, it is the zircon. This genus in its external characters has much reſemblance to the flint genus, but as it cannot follow, it muſt precede it, hence it is placed immediately be- Why zircon is placed before flint genus.

the minerals comprehended under them contain a preponderating quantity of the earth which gives name to the genus. This, however, is not the caſe with the ſpecies as arranged in this work, for ſome belong to the flint genus that contain no ſilica, and others to the clay genus that contain no alumina. I have therefore judged it more conſiſtent with the arrangement to adopt terms that expreſs, not any chemical compoſition, but have a reference to the moſt ſtriking and characteriſtic external characters of the genus, or to that ſpecies around which all the others belonging to the ſame genus, may by tranſition be arranged. Thus all the ſpecies belonging to the flint genus poſſeſs in an eminent degree the properties that in common life are termed flinty, and beſides can be arranged around quartz or flint as a central point. In a ſimilar manner all the foſſils arranged under the talc genus are connected with the ſpecies talc by external characters and tranſition. I have preferred the terms talc and calc to talcaceous and calcareous, to preſerve a uniformity in the nomenclature.

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fore the flint genus. But zircon is not the only example; there is ſtill another, which is the diamond; it muſt alſo have a place near the zircon, but on what pretence can an inflammable ſubſtance have a place here? The diamond was by the ancients placed among earthy minerals, but in latter times it has been diſcovered to be a combuſtible body, nearly pure carbon; hence chemiſts have very properly arranged it with inflammable bodies. Many oryctognoſts have adopted the ſame arrangement; but Werner, for the following reaſons, ſtill continues to conſider it as the moſt perfect of minerals, and as deſerving to hold its place at the head of the mineral kingdom. 1. It agrees in many of its external characters with zircon, therefore it muſt be placed near it, and not to interrupt the arrangement before it. 2. When compared with other inflammable minerals it preſents many ſtriking differences; thus inflammable minerals are light, ſoft, generally dark coloured, eaſily inflamed, and not cryſtallized; on the contrary, the colours of the diamond are very numerous, it is almoſt always regularly cryſtallized, has conſiderable ſpecific gravity, and of all minerals poſſeſſes the greateſt degree of hardneſs.

Why diamond is placed at the head of the mineral ſyſtem.

The ſaline claſs contains but one genus, Werner, however, has divided it into four, viz. 1. Carbona 2. Muriats. 3. Nitrats, and 4. Sulphats*.

Sailne genera.

* This method is probably objectionable, and therefore is not followed in this work.

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The genera of the inflammable class are, 1. Sulphur. 2. Coal, and 3. Graphite; and require no particular arrangement. Inflammable genera.

The metallic class, which is the next in importance after the earthy, contains a number of genera, which are arranged after the same method as the earthy genera, viz. those which possess the properties of the class in the highest degree are placed first. Metallic genera.

As platina possesses the metallic qualities in the highest degree, it is placed at the head of the class of metals. Next is gold, which agrees with platina in oryctognostic and geognostic characters. Mercury follows gold on account of its great specific gravity and strong lustre. Silver is the next genus; from it we have a natural transition to the next genus, copper. To copper succeeds iron, lead, tin, bismuth, zinc, antimony, cobalt, nickel, manganese, molybdœna, arsenic, scheele, menacane, uran, sylvan.

8. Having finished what was necessary to be said respecting the arrangement of the genera, I shall now illustrate, by an example drawn from the system, the mode of arranging the species. The example is from the flint genus. If the method which was employed in the arrangement of the genera be followed here, quartz, as the most characteristic species, should occupy the first place in the genus. Here, however, we find a whole series of species that cannot together be placed before or after quartz; the series must therefore be divided, quartz placed in the middle, and the other species so arranged that the first division shall precede, and the other follow quartz. By Arrangement of species.



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this method we are enabled to place all the ſpecies in a natural order, and obtain on the one hand a tranſition into the zircon genus, and on the other into the clay genus.

In the metallic genera, thoſe ſpecies which are in the metallic ſtate are placed firſt, next the different oxyds and combinations. Great attention muſt, however, be paid to the tranſitions, and their arrangements.

Arrangement of ſubſpecies.

9. As the ſubſpecies are few, their arrangement is comparatively eaſier; we muſt here attend, chiefly, to the rules of tranſition, ſo that the arrangement may be natural.

Characters of minerals.

10. The characters which are employed in the deſcription of minerals are, by Werner, divided into five claſſes, 1. External. 2. Chemical. 3. Phyſical. 4. Geognoſtic, and 5. Geographic.

1. *External Characters*—are thoſe which are diſcoverable by the external ſenſes, without inducing any conſiderable alteration in the aggregation of the mineral; thus colour, ſhape, luſtre, fracture, hardneſs, weight, &c. are of this kind.

2. *Chemical Characters*—are thoſe which are afforded by the complete analyſis of the mineral; by trials with acids, with the blow pipe, and Wedgewood's pyrometer.

3. *Phyſical Characters*—are thoſe phyſical properties of minerals which are diſcovered by trials with the magnet, or by rubbing or heating.

4. *Geognostic Characters*—The determinate occurrence of one mineral with another affords, what Werner

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ner terms the geognoſtic character. I ſhall mention a few inſtances. Glance cobalt has ſo ſtriking a reſemblance to arſenical pyrites that it is often confounded with it; it however occurs along with copper-nickel, which is never the caſe with arſenical pyrites; this then is the geognoſtic character which aſcertains it to be glance cobalt. Native arſenic frequently occurs along with red orpiment, but it never acompanies red lead ore; this, therefore, ſerves as an excellent character for diſtinguiſhing theſe two minerals, in doubtful caſes.

5. *Geographic Character*—is determined from the birth place or local ſituation of a mineral. Thus if we are preſented with a cochineal red coloured mineral from Joangeorgenſtadt, its birth place or geographic character announces it to be red ſilver ore: if the mineral be from Landſberg or Idria, we would conſider it as cinnabar; was it from the Hungarian mines, or thoſe among the Uralian mountains, we would reckon it red copper ore.

The geographic character muſt, however, be confined within very narrow limits, as we know that the occurrence of minerals is ſeldom confined to particular ſpots or countries, and we are often uncertain if the ſpecimens we have are from the places mentioned.

The geognoſtic character, on the contrary, is highly characteriſtic, and it is to be regretted that it has been hitherto ſo little attended to.

External characters ſufficient for the arrangement and deſcription of minerals.

It has been much diſputed which of the preceding kinds of character are beſt ſuited for the deſcription and diſcrimination of minerals. It was long the pre-



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vailing opinion, that external characters alone were ſufficient; the increaſing taſte for chemiſtry introduced the chemical characters, and theſe in their turn have been adopted by ſeveral mineralogiſts, to nearly the excluſion of all the others. Werner teaches, that all the different kinds of characters are to be employed, but of theſe, he conſiders the external characters as by far the moſt certain and generally applicable. Theſe characters are not only ſufficient for the deſcription, but alſo for the arrangement of minerals. That they are ſufficient for the diſcrimination of minerals is certain, from the obſervation of Werner, who declares, that no mineral has ever been diſcovered which could not be diſtinguiſhed by its external characters, and that they are ſufficient for its arrangement is equally evident from the greater number of ſpecies in the mineral ſyſtem being arranged ſolely by agreements and differences in the external characters.

As a knowledge of theſe external characters is abſolutely required of every one who ſhall venture on the ſtudy of oryctognoſie, I ſhould now proceed to give an account of them, I muſt, however, from the great extent of the ſubject defer this for the preſent; but ſhall give a full explanation of them in the following volume.

11. In writing the deſcription of a mineral, according to its external characters, Werner recommends

Method of deſcribing a mineral.

*a. That it ſhould contain all the external characters.* The external characters are not of equal importance; hence ſeveral mineralogiſts have judged it neceſſary, in their deſcriptions, to employ only the more characteriſtic

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teriſtic or eſſential ones. In ſome inſtances this may be done, but in the greater number of caſes, the omiſſion of any of the characters would lead to error. We muſt, therefore, in our deſcriptions, not only mention all the characters, but every branch of them, as far as they are characteriſtic of the ſpecies.

*b. That we ſhould place all the characters together.*—The older, and many of the modern writers in mineralogy, by endeavouring to follow the methods of the zoologiſt and botaniſt, have rendered their deſcriptions of minerals unintelligible. To obtain an acquaintance with the external aſpect of a mineral from ſuch a deſcription, or rather ſeries of definitions, we muſt combine the characters of the claſs, order, genus and ſpecies, and after this labour, what do we obtain but a deluſive and imperfect picture?

*c. That theſe characters ſhould not have any of the others intermixed.*—As the deſcription of a mineral according to its external characters is principally intended to give us a diſtinct picture of its aſpect, and of certain phyſical properties it poſſeſſes, we muſt be careful that it contains nothing foreign to that object; it muſt, therefore, contain no chemical, geognoſtic, or geographic characters.

*d. That they ſhould be arranged in a determinate order.*—When the characters are arranged in a determinate order, we are not ſo liable to omit any of them, and are enabled more eaſily to recollect the picture of the mineral. Werner arranges them in that order in which they naturally preſent themſelves to our ſenſes; thus beginning with colour, as that which

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which firſt attracts our notice, and placing the others in their correſponding places, viz. figure, luſtre, fracture, fragments, diſtinct concretions, frangibility, brittleneſs and weight.

*e. That they ſhould be ſufficiently accurately determined.*—Many minerals are completely alike, excepting in certain ſhades of character, which muſt alſo be mentioned if we do not wiſh to be deprived of the diſtinctions they afford. Thus it is not enough in deſcribing white ſilver ore, to ſay that is has a grey colour, nor even that it poſſeſſes a lead grey colour; accurate determination requires that the colour of white ſilver ore ſhould be given—fallow lead grey.

*f. That it ſhould contain only ſuch expreſſions as have met with univerſal approbation.*

*g. That the degree of the frequency of the occurrence of any one of theſe characters ſhould be expreſſed*, as by the following terms, abundantly, commonly, ſometimes, partly, ſeldom, rarely, very rarely.

*h. That the deſcription ſhould be written ſo as to afford a ſynoptical view, and that the characters may eaſily attract the eye* This is beſt done by beginning each character by a new line, and diſtinguiſhing the moſt important ones by capital letters, or, by printing in italics. My knowledge of oryctognoſie is too limited to permit me the uſe of italics.

Werner's method of deſcribing a mineral.

In deſcribing a mineral, according to the method of Werner, we do not employ a few iſolated characters, as is done in zoology and botany, but, as I have already mentioned, a ſeries or ſuite, which being peculiar to the ſpecies, conſequently characteriſes it.

But

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But ſuch a picture or deſcription is to be drawn up from the examination, not of one or a few, but from many ſpecimens, hence the neceſſity of having an extenſive mineral ſuite, before we pretend to know the ſpecies already in the ſyſtem, or to deſcribe new ones.

12. The only ſources from which the denominations of minerals ought to be taken, are the following: Sources from whence the names of minerals ſhould be taken.

α. *From ſome characteriſtic external character.* Thus the mineral which chemiſts term ſulphat of ſtrontian is, on account of its characteriſtic blue colour, denominated by Werner Celeſtine. Actynolite derives its name from its radiated fracture; Schalſtone, from its lamellar diſtinct concretions.

β *From reſemblance to other bodies.* Thus that remarkable mineral which was firſt found in Hungary and deſcribed by Fichtel as a ſpecies of zeolite, was, by Werner, denominated pearlſtone, on account of its ſtriking reſemblance in colour, ſhape, and ſtructure to pearl.

γ. *From their uſe.* As procelain earth from its uſe in the manufacture of procelain.

δ. *From the place where firſt found.* Thus Lydian ſtone derives its name from Lydia in Aſia, where it was firſt found.

ε. *From the name of the diſcoverer.* Thus the mineral denominated by chemiſts carbonate of barytes, is named by Werner Witherite, in honour of its firſt diſcoverer, Dr Withering.

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We muſt be very careful that the name conveys no falſe meaning, as is the caſe with black lead and others.

Minerals have often been named from their peculiar chemical properties or their conſtituent parts; but this is in general not to be recommended, as it renders the ſyſtem of names fluctuating by reaſon of the daily alteration in preceding chemical analyſes.

Chemical nomenclature not to be admitted.

Werner has, except in a few inſtances, very properly baniſhed the chemical nomenclature from oryctognoſie. In oryctognoſie, as in zoology and botany, the nomenclature ſhould be founded on ſome ſtriking external character, or when that does not readily occur, the name ſhould be arbitrary, derived from the name of the country where firſt found, that of the diſcoverer, &c.

13. From the great confuſion which reigned in mineralogy before the time of Werner, the aſcertaining the ſynonymes of preceding authors is often attended with much difficulty, and indeed in few inſtances can be completely ſatisfactory. I have therefore been ſparing of ſuch ſynonymes. In later writers they are more eaſily and ſatisfactorily aſcertained, and thoſe I have frequently noticed and have arranged in chronologic order*.

Synonymes.

Uſes of oryctognoſie.

As Oryctognoſie is the rudiments of Geognoſie, a knowledge of it is abſolutely required of the *geognoſt*. It makes him acquainted with the individual

* The ſynonymes I have quoted only refer to authors who have given deſcriptions of minerals.

minerals

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minerals of which the great mafs of the earth is compofed, with their various relations to each other, and thus paves the way for the inveftigation of the ftructure and numerous relations of thofe greater maffes of which the cruft of the globe is conftructed. To the geognoft.

To the *metallurgift* it affords the fure means of feparating the different ores, and thus prevents the numerous errors in the proceffes of fmelting, which are fo often committed by mixing with the pure ore different foreign and pernicious ores and foffils. To the metallurgift.

The *miner*, by an acquaintance with oryctognofie, is enabled to diftinguifh the various minerals he meets with in his fubterraneous workings from one another, and to regulate œconomically the labours of the feparating houfe, and the various operations of ftamping and waffhing. To the miner.

The *mineralogical chemift* cannot make us acquainted with the minerals which he has analyfed, or know thofe he is about to fubject to his operations, without a thorough knowledge of this branch of mineralogy. Its language will alfo enable him to defcribe his products and educts according to their colour, form, confiftence, texture, &c. which, although but little attended to, is unqueftionably of the greateft importance. We have only to read the defcriptions of chemical products that are ufually given to be convinced of the loofenefs of the language employed, and the neceffity of introducing into chemiftry the defcriptive language of oryctognofie. To the mineralogical chemift.

To thofe who occupy themfelves with the determination, value, and ufes of gems, ores, limeftones, To the œconomift



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coals, building ſtones, ſaline ſubſtances, &c. oryctognoſtic knowledge is abſolutely neceſſary; without it they will be expoſed to perpetual loſſes and diſappointments.

To the man of liberal education.

*To the man of liberal education* it will afford much inſtruction and pleaſure. It will give him a very great degree of accuracy in the determination of the external aſpects of bodies, whether natural or artificial, and this preciſion he will carry into the other objects of his enquiries. Beſides this, by becoming acquainted with the materials of which the earth is compoſed, he will naturally be led to continue his reſearches in order to become acquainted with thoſe more extenſive relations of minerals which are made known to us by that ſublime branch of mineralogy *Geognoſie*.

Qualifications required of an oryctognoſt.

15. To be entitled, however, to the character of an oryctognoſt, that empyrical knowledge which we ſo often meet with will not ſuffice. To merit ſuch a name we muſt be fully acquainted with all the external characters, with the manner of employing them; we muſt have a readineſs in knowing and a preciſion in diſcriminating minerals; we muſt be able eaſily to refer known minerals to their place in the ſyſtem, and when new ſpecies or ſubſpecies occur, we muſt be able to give them their proper place in a natural arrangement, and to arrange the tranſitions in ſuch a manner that the mineral ſpecies or ſubſpecies may participate of the characters of the preceding and the following members of the ſyſtem. We muſt from well choſen ſpecimens be able to determine the nature

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ture of their repoſitories, and among the mountains muſt be able to do the ſame. We muſt know the chemical properties and compoſition of minerals, and all their variety of œconomical uſes, and muſt know how to make, arrange, and deſcribe collections, and muſt be well acquainted with the hiſtory of the individual ſpecies, and with that of oryctognoſie in general.

In ſome countries mineralogy viewed as an inſignificant and eaſily acquired branch of knowledge,

Notwithſtanding the long experience and minute attention which are required to form an accompliſhed oryctogoniſt, in ſome countries mineralogy has been hitherto conſidered as merely a trifling branch of the ſcience of medicine, or of political œconomy, or claſſed perhaps with the art of mending a dull fire, which every perſon conceives he underſtands, whether he has given himſelf the trouble of learning it or not. The time, however, we truſt, is not far diſtant, when ſuch pretences to ſcience, the banes of true knowledge, will ſink into merited contempt, and when mineralogy will be eſteemed worthy of being regularly ſtudied as one of the moſt uſeful and intereſting branches of human knowledge.



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