IX. *Remarks concerning the Natural-Historical Determination of Diallage.* By W. HAIDINGER, Esq.

(Read November 3. 1823.)

THE following paper contains the results of a series of inquiries, which lead to the conclusion, that the mineral called *Smaragdite* by SAUSSURE, does not form a species of its own; but that this name has been given to a compound of certain varieties of two distinct species, *Augite* and *Hornblende*, the natural-historical species of *paratomous* and *hemiprismatic Augite-spar*.

Owing in part to the slight degree of resemblance prevailing among its varieties, the authors who have described them differ so essentially in opinion, that I am obliged to go into various details, both respecting the external appearance of the mineral itself, and of the opinions of mineralogists, in order to afford a correct view of the natural-historical species, to which these varieties belong, since this is the basis upon which every system, and, indeed, all accurate information in natural history, is founded, and the fixed point to which the one and the other must be referred.

The more particular objects of these examinations are the grass-green, and such other green and greenish-grey varieties as are found to be in immediate connexion with them in the same identical specimens. A connexion between the real *Smaragdite* and the foliated *Anthophyllite* of WERNER, or the *Schiller-spar* of the Hartz, does not exist, and has been gratuitously assumed by the Abbé HAÜY, and by other mineralogists.

There is scarcely any thing which tends more evidently to prove the homogeneity of individual bodies, than the transitions between them, if correctly ascertained; but we must not

take for granted as a genuine transition, whatever appears to be so to the unassisted senses, or, indeed, what is considered as such in many mineralogical works. A real transition should not be considered to take place, till the differences in each of the single characters, taken separately, have been collected into as many continuous series *; and before this has been accurately effected, it will in every respect be found more useful for natural history, to consider as particular, although doubtful, species, such varieties as are but imperfectly known, than to unite them with other species, respecting which our information is more complete: for the uncertain existence of a particular species, will always be more apt to induce naturalists to examine more closely the variety in question, than the admitted or supposed want of distinctness of some varieties of another species, which has already been correctly described.

Although HAÜY may have traced the connexion between his *Diallage verte* and some greenish-grey, and blackish varieties, yet a similar passage is entirely wanting among these, and the two subdivisions of his *Diallage métalloïde*, the natural-historical species of diatomous and hemiprismatic Schiller-spar. In the first of these, the Diatomous Schiller-spar, the regular forms are as yet unknown; but, besides the difference in the hardness of that substance and Green Diallage, it is impossible to join into one continuous series the degrees of their specific gravity. As to the second, or Hemiprismatic Schiller-spar, that identity in the series of crystallisation, which is requisite to establish a transition, is entirely wanting, at least in so far as we are yet acquainted with the forms which it presents.

The first naturalist who considered Smaragdite as a species of its own, was the elder SAUSSURE, by whom it was first accurately described, and provided with the above-mentioned

* MOHS' Grund-Riss der Mineralogie, Th. i. s. 408.

name*. Modern mineralogy itself can scarcely be said to go beyond that period. *Smaragdite* was joined to *Felspar* by ROME' DE L'ISLE, and to *Schörl* by DE BORN. On account of the difference in the perfection of its laminæ, HAÜY gave it the name of *Diallage*†, and thus introduced it into the mineralogical systems. When HAÜY was publishing the first edition of his *Traité*, he was not yet acquainted with those substances which in the second he calls *Diallage métalloïde*; but he exhibits among his *Diallage*, under the very same denomination, the varieties of *Hypersthene* (prismatoidal Schiller-spar), which he afterwards established as a particular species. WERNER‡ does not acknowledge *Diallage* as a particular species, but considers it as a variety of granular Actinolite. Very little, at that period, had yet been prepared for a more accurate examination of the natural properties of minerals, and in determining new varieties, any principle upon which it was possible to rely, was almost entirely wanting. Destitute of the means now afforded to the mineralogist, WERNER has, in the present instance, displayed that remarkable acuteness, by which he often discovered the close natural-historical relation of certain minerals of a very different aspect, whilst, on the other hand, he pointed out a difference between substances, very much resembling each other, which it required a long period of time to demonstrate by examining their properties with the greatest accuracy. But even WERNER has often been deceived, by founding his determinations upon mere ocular inspection; and we shall be the more disposed to abandon so deceitful a method of observation, the more we are able to ascertain those properties of mi-

* Voyages dans les Alpes, t. v. § 1313.

† *Traité*, t. iii. p. 125.

‡ HOFFMANN, "Handbuch der Mineralogie," continued by BREITHAUP, Th. ii. 2. s. 300.

nerals, which are capable of being expressed by numbers, for they must uniformly appear the same, to all who examine them with the necessary accuracy. WERNER's collection at Freyberg, contains as granular Actinolite the varieties from Corsica, those from the valley of Saass, at the foot of Monte Rosa, and those from the Bacher in Stiria. It is to the last of these that the epithet of "granular" more particularly refers. KARSTEN * assumes the varieties from Corsica as a particular species he calls Schmaragdite, which, however, he mentions as including only a part of the Smaragdite of SAUSSURE, the other belonging to chatoyant Hornblende (diatomous Schiller-spar). He was thus forced to acknowledge the high degree of resemblance among the less distinct varieties of Smaragdite and common Hornblende. In the same manner STEFFENS † enumerates in his system a particular species, of which the Smaragdite of SAUSSURE forms the most distinct variety; yet this author confesses himself uncertain with respect to an exact natural classification, in regard to that species, and to those of the genus Schiller-spar in general, and therefore gives his determination merely as a temporary one, till further researches should decide its correctness. An opinion widely different from the preceding is entertained by HAUSMANN. His system ‡ joins in the substance Heterotype, the formations of Hornblende (hemiprismatic Augite-spar), — Diallage, — Bronzite (hemiprismatic Schiller-spar), — Hypersthene (prismatoidal Schiller-spar), — Anthophyllite (prismatic Schiller-spar), — together with several others that belong to the natural-historical species of hemiprismatic Augite-spar. As farther subdivisions, Diallage contains the follow-

* Tabellen, 1800, p. 70.; 1808, p. 40.

† Handbuch, Th. i. s. 326.

‡ Handbuch, Th. ii. p. 712.

ing kinds, viz. 1st, The real *Smaragdite*, of a grass-green colour ; 2d, The less distinct varieties of the same, as *common* ; and, 3d, The diatomous Schiller-spar from the Hartz, as *talcous Diallage* ; part of the latter forms probably also the 4th kind, or *Schiller-stein*. HAUSMANN endeavours to explain the single or monotomous cleavage of the different species of Schiller-spar, and the splendid laminae of Diallage, as produced out of the two faces that occur in Hornblende, by supposing one of them to become more perfect at the expence of the other, whereby, in most cases also, “ the angle of inclination is changed, and approaches more or less to a right angle.” A supposition of that kind, if granted, would be sufficient to overthrow the whole of crystallography, and that which has just now been quoted, has, for this reason, been very strongly objected to by HAÜY *. The substances and formations, in fact, of HAUSMANN’S system, do not allow of any strict comparison with either genus and species, or with species and subspecies ; hence it will be impossible to assert, whether or not HAUSMANN means to comprehend Smaragdite under the species of Hornblende.

This latter opinion, very often quoted, indeed, but more commonly with the view of refuting it, seems in general to have gradually disappeared ; and the most recent systematical mineralogists agree in considering the perfectly foliated green varieties of the Smaragdite of SAUSSURE as a particular species, which they place accordingly in their systems. Yet among the vast number of works that more especially treat of the present subject, there is none which does not attempt to reproach the rest with the uncertainty of their determinations, and the want of distinctness in their descriptions, though its own assertions can

* Journal des Mines, xxxviii. p. 161.

only serve farther to increase the embarrassment, for it is not under such circumstances that a complete list of quotations, or a thorough knowledge of the authors consulted, can be of any use. We must, therefore, recur to Nature herself, and conform our opinions to her dictates.

The principal properties in which Diallage, in its most distinct varieties, is said to differ from other minerals, more or less resembling it, consist in the grass-green colour, and in the facility of being reduced by fracture into thin laminæ, of a bright pearly lustre. All the works hitherto published on the subject, state these to be produced by cleavage, and yet they are not owing to *cleavage*, but merely to *composition*.

It has been reserved to the most recent period, to ascertain the real and important difference between faces of cleavage and faces of composition, which, indeed, are sometimes hardly distinguishable, if the latter possess a regular disposition in the interior of massive or crystallised varieties that seem to consist of a single individual. As far as I know, Professor MOHS is the first author who succeeded in giving an accurate definition of the phenomenon of cleavage in crystallised bodies. He confined it to the property of a *simple* mineral, of allowing its particles to be separated in more or less regular faces, in various yet determined directions. Only this property, and not the faces themselves, exist before the cleavage had been rendered visible by the assistance of mechanical force *. It is quite another thing with those faces of composition, which preserve constant directions within regularly formed crystals of certain minerals. They really exist before the mechanical division of the particles has been effected. This can be proved by many examples, and, among others, with a peculiar degree of evidence, by one of the most common in na-

* MOHS' Grund-Riss. Th. i. p. 264., &c.

ture, taken from Calcareous-spar. Here the faces of composition are parallel to those of $R-1$, the rhombohedron truncating the terminal edges of R , or the fundamental form; they are always the consequence of thin laminæ, or films of the same substance, engaged in the mass in an opposite sense, whose exact directions we can geometrically construct, by supposing one part of the mass contained between two faces parallel with each other, and with one of the faces of $R-1$, to be revolved 180° round a line perpendicular to these faces, considered as their axis of revolution. Not even the perfectly transparent varieties from Iceland are free from such laminæ; their action upon light has led Dr BREWSTER to ascertain their existence. If they occur in greater number parallel to only one of the faces of $R-1$, they give rise to a variety, in which only one of the faces of cleavage, parallel to R , is very deeply striated in the direction of its horizontal diagonal. The seeming difference in the angles, owing to that composition, has induced BERNHARDI to consider these varieties as belonging to a particular species, which he calls *Streifenspath*, or *Striated-spar*. It is necessary, therefore, to be very careful, in ascertaining whether an observed face in the interior of a crystal or of a cleaveable mass, be really produced by cleavage, or whether it owe its existence to regular composition.

Certain faces of cleavage, not parallel to the primitive form, have been said by HAÜY to pass alongside of the molecules, without touching or intersecting them, which faces, for that reason, he called *des joints surnuméraires*. This explanation applies remarkably well to the above mentioned faces of composition, which have been so accurately described by HAÜY * in a variety of green Diallage, where their pearly lustre is peculiarly bright.

* *Traité*, 2^de Ed. v. ii. p. 462.

But this variety, likewise, contains real faces of cleavage situated in other directions, which intersect the former in oblique angles. They are but slightly marked, and rather incohering, wherever the brightest green colour is joined to a more perfect appearance of the laminæ; whereas they assume a higher degree of distinctness in the darker blackish-green varieties, into which the former pass without in the least changing their parallel position, exactly as is mentioned by HAÜY. There are two such faces of cleavage, intersecting the faces of composition at an angle of 152° , while they intersect each other at an angle of 124° . Accurate measurements, taken by means of Dr WOLLASTON's goniometer, have yielded the angle formed by the two faces of cleavage in hemiprismatic Augite-spar $= 124^\circ 13'$, very little different from $124^\circ 15'$, the result of NORDENSKIÖLD's observations, both of these being different from $124^\circ 34'$, the angle indicated by HAÜY. If, according to the crystallographic method of Professor MOHS, we designate this prism by $(P\bar{r} + \infty)^3$, which sign it receives by being considered in connection with the rest of the simple forms in the same species, the face of composition, parallel to the greater diagonal of this prism, or to the lesser one of $P + \infty$, will be expressed by the sign $P\bar{r} + \infty$.

The regular composition of the twin-crystals of the present species, is parallel to the very same face $P\bar{r} + \infty$, of which, among many well known examples, I shall only mention the varieties found in the basalt of Bohemia. Several varieties of common Hornblende present a similar composition, as, for instance, that contained in the zircon-syenite from Friedrichsvärn in Norway; but none of the varieties, not even those of green Diallage, exhibit these faces of composition so perfectly smooth and even, as the greenish-black Hornblende from the Kiernerud mine near Kongsberg in Norway; and yet this has never been considered as a variety of Diallage.

HAÜY quotes among the peculiarities of certain *joints surnuméraires*, that they contain films of heterogeneous minerals, a property in which they likewise agree with the above-mentioned faces of composition. Thus the black Hornblende from the Kiennerud mine, contains laminæ of Talc (prismatic Talc-mica); many varieties of the green contain laminæ of paratomous Augite-spar.

If we try to determine the specific gravity of two varieties of Diallage of a different colour, the grass-green and those of a darker shade, which, at the same time, are found to occur in one identical specimen, we meet very often with a difference amounting to, or even exceeding, one-tenth. Thus, in one instance, where both the varieties were remarkably distinct, I found the specific gravity of the green, at a temperature of 15° centigr. (59° Fahr.) to be = 3.129 (agreeing with SAUSSURE's statement of 3.140), whilst that of the greenish-black was only = 3.007,—a difference, the cause of which I was naturally led to inquire into more closely. When examining the darker parts, and comparing them with the green, I found that in the latter there were thin laminæ of another mineral, interposed between the particles of hornblende, the face in which they meet being that of $P\ddot{r} + \infty$. These laminæ are not at all cleavable in the direction of the faces of $(P\ddot{r} + \infty)^3 = 124^\circ 13'$, but they may be cleaved in other directions, intersecting the axis of that prism under oblique angles, the latter faces of cleavage being much inferior to the former, both in lustre and continuity. In several of the varieties of this mineral from the Bacher, the interposed laminæ have increased in thickness, so far that the hemiprismatic Augite-spar, entirely disappears from the composition, and we are led to a mineral, which, with all its peculiarities, except the colour of grass-green, we must acknowledge to be a variety of paratomous Augite-spar. Now, we find the specific gravity of this

$= 3.232$, and its cleavage, exactly like that of all other varieties of paratomous Augite-spar, to take place in the directions of $(P\ddot{r} + \infty) = 87^\circ 33'$ (according to NORDENSKIÖLD, $= 87^\circ 42'$ according to HAÜY), and in those of its diagonals $P\ddot{r} + \infty$ and $P\bar{r} + \infty$. There is a face of composition still conspicuous in these varieties, but this face is parallel to $-\frac{P\ddot{r}}{2} = 73^\circ 54'$ (according to HAÜY) in paratomous Augite-spar, as in the varieties called Salite, some of the Mussite and common Actinolite of WERNER; whereas in the hemiprismatic, we have found it parallel to $P\ddot{r} + \infty$. Yet there exist varieties of paratomous Augite-spar, which are likewise compound, parallel to the face of $P\ddot{r} + \infty$; this is the case in several Mussites, common Actinolite, &c. The specific gravity of 3.350, mentioned by BREITHAUP in HOFFMANN'S *Handbuch*, after the authority of WERNER, for his granular actinolite, refers to granular varieties of paratomous Augite-spar, since it is comprehended between the limits of the specific gravity of paratomous, but not between those of hemiprismatic Augite-spar.

From these observations we may conclude, that green Diallage, even in the most distinct varieties, is not a species of its own, but that it consists of the varieties of two other species, of paratomous and hemiprismatic Augite-spar, into each of which it insensibly passes, when the relative proportion of the other by continual diminutions finally disappears. Yet a passage of this kind never can entitle us to consider Smaragdite as the link which would join the two species, and consequently prove them to be but a single one; it proves nothing else but that Smaragdite is a mixture of both. This mixture of the two species in the perfectly foliated varieties of Diallage has been excellently described by HAÜY, in giving its geometrical character in the first edition of his *Traité*, where he mentions that the single laminæ are very

often cracked in other directions than those of the less distinct faces of cleavage, the latter of which correspond to $P\bar{r} + \infty$ of hemiprismatic Augite-spar, and that *they shew a tendency of separating into rhombs*,—a property owing to the real faces of the cleavage of paratomous Augite-spar, which is spread in thin laminæ throughout the mass of the hemiprismatic. As long as it is within the powers of our senses to distinguish, and to separate these heterogeneous substances, the application of the *Characteristic* will clearly lead to their respective species; and no doubt in regard to their determination can ever remain, as long as their natural-historical properties can be ascertained with a sufficient degree of exactness.

Professor MOHS, very long ago, and even during his residence at Gratz, in consequence of accurate investigations, had recognised the granular varieties from the Saualpe and the Bacher, as belonging to paratomous, the latter also in part to hemiprismatic Augite-spar, and united them accordingly with these species. The only varieties still doubtful were those from other countries, so very much distinguished by the perfection and high pearly lustre of their laminæ. The establishment of Smaragdite into the species of axotomous Schiller-spar in the *Characteristic* of MOHS, was almost entirely founded upon foreign authority. It disappears now from the series of particular mineral species, all its varieties having been referred to those of hemiprismatic and paratomous Augite-spar, in the properties of which they partake.

Although whatever belongs to the determination of the species has thus been completed, and therefore the more peculiar object of this paper attained; yet I shall conform to the usage hitherto received in mineralogy, not to pass over entirely the instruction derived from other sciences foreign to natural history, in respect to the species under consideration, and shall therefore give a brief account of the chemical constitution of

Smaragdite, of its geognostic position, and concomitant minerals. Fortunately the labours of some of the most celebrated chemists and geologists afford the means of doing so.

The following analyses of the Smaragdite have been published for some years.

	1. Green Smaragdite, according to Lelièvre.	2. Green Smaragdite, according to Vauquelin.	3. Grey Smaragdite, according to Lelièvre.	4. Granular Actinolite from Stiria, according to Klaproth.
Silica, - - -	51.0	50.0	50.0	56.0
Alumina, - -	13.5	11.0	7.0	3.25
Magnesia, - -	5.0	6.0	8.0	18.5
Lime, - - -	14.5	13.0	17.0	15.5
Oxide of Iron,	8.0	5.3	14.5	4.75
Oxide of Copper,	0.5	1.5	0.0	{ A trace of Oxide of Manganese.
Oxide of Chrome,	4.0	7.5	0.0	
	96.5	94.3	96.5	99.0

The agreement between the three first of these analyses, and the results obtained by analyzing the several varieties of Hornblende, is as obvious as the coincidence of that by KLAPROTH with the components of certain varieties of Augite, although, in general, these two species themselves do not present any striking difference in the proportions of their constituent parts.

The geognostic relations of what has been called Smaragdite and Diallage, seem to present more peculiarity. It is principally to VON BUCH that we are indebted for having ascertained its geognostic position, and a great number of its localities, of which he has published the accounts in several of his works, and especially in two papers on *Gabbro*, inserted in the *Memoirs of the Berlin Society*. Throughout these papers he

has adopted HAÜY's opinion, that Green Diallage is different from either Hornblende or Augite, and that it constitutes but one and the same species with *Diallage métalloïde*; and, in many instances, even the determination of the rocks is founded upon this supposition.

The mineral most commonly accompanying green Diallage, is *Saussurite* or *Jade*, a species considered as a variety of compact Felspar, by both WERNER * and HAÜY †, although it had long before been pointed out as a particular species, and acknowledged as such by a great number of mineralogists. HAÜY takes for granted that the forms are identical, but even these deviate in *Saussurite* from the forms of the different species of Felspar: for it is possible to obtain its forms of cleavage, out of certain granular varieties, in the shape of oblique-angular four-sided prisms, of nearly 124° and 56° , which can very easily be cleaved, parallel to their faces, and with a less degree of distinctness, also parallel to their short diagonal. The difference between the specific gravity of *Saussurite*, and that of the Felspars, is as remarkable, and still more easy to be ascertained; the limits of the former being 3.2 and 3.4, whereas the latter never exceeds 2.8. The specific gravity of a compact *Saussurite* from Corsica, I found = 3.206; that of two specimens of the granular variety, one from Piedmont, and another from Bayreuth, = 3.253; of a compact one from the shores of the Lake of Geneva, = 3.343. The hardness of *Saussurite*, is by many authors said to be superior to that of rhombohedral Quartz; yet it is no higher than 5.5 of the scale of MOHS, (between Apatite and Felspar), if taken with the necessary precautions by the assistance of a file. On account of its remarkable toughness, it nevertheless very often scratches rhom-

* HOFFMANN's Handbuch, Th. ii. a. s. 339.

† Traité, 2^{de} Ed. T. iii. p. 95.

bohedral Quartz, and emits lively sparks, if struck with steel. Of the rest of the minerals generally occurring along with Diallage, the most frequent are ; *Garnet*, of a reddish colour, inclining to grey, lustre resinous, hardness = 7.5, specific gravity = 3.647; likewise *Talc* and *Kyanite*. These species, if intermixed with each other, constitute that rock which has been called Gabbro by VON BUCH ; but the relative quantities of the ingredients not being every where the same, I shall shortly mention those in some of the most generally known varieties.

The beautiful *Verde di Corsica duro*, almost entirely consists of compact Saussurite, of different shades of bluish-grey, in clouded delineations, containing small imbedded masses of green Smaragdite, which is very nearly pure hemiprismatic Augite-spar. Its specific gravity is = 3.000 ; the face of composition is not very distinct, and rather incohering, while the real cleavage, parallel to the faces of the prism, is more distinct, from the co-existence of which and the former the silky lustre is derived, particularly if its varieties be cut and polished. It contains, moreover, small masses of Talc, with delicate acicular crystals of that variety of hemiprismatic Augite-spar, which has received the name of Actinolite.

The Saussurite, forming the paste of the Gabbro, from the Valley of Saass, is greenish-grey, and nearly compact ; the Smaragdite which it includes, sometimes in masses of considerable dimensions, is mountain-green ; it presents very little lustre upon the faces of composition, and almost no traces of cleavage. Yet these varieties of hemiprismatic Augite-spar, seem to contain but little heterogeneous matter, their specific gravity being = 3.056. The faces of cleavage, appear more distinctly, in certain veins of perfectly pure varieties of the same species, which traverse in all directions the larger masses of Smaragdite, with which, however, they always remain in a parallel position. In this variety of Gabbro, we likewise meet with particles of Garnet and Talc, con-

taining crystals of Kyanite. Several other varieties from the same locality, and from Piedmont, are composed of a coarser grained greyish-white Saussurite; they contain a greater proportion of Garnet; their Smaragdite is accompanied and intermixed with Augite (paratomous Augite-spar), gradually increasing, so that the laminae, in many instances, entirely pass into the latter species. Sometimes it is accompanied by a dark-green granular mixture of Saussurite and hemiprismatic Augite-spar.

The gabbro from Bayreuth consists of greyish-white Saussurite, and paratomous Augite-spar, of nearly the same variations of colour, slightly inclining to green. The specific gravity of the latter is = 3.255.

The varieties from the Bacher mountain, in Lower Stiria, are among the most remarkable. In comparison with those described above, they contain only a small quantity of Saussurite, but a great deal of Garnet, and also Kyanite, in beautiful blue crystals and grains. The large foliated masses of Smaragdite are seldom to be met with among them; more commonly their constituent parts separate into granular aggregates of the two species, paratomous and hemiprismatic Augite-spar, the colours of the former being more lively grass-green or greenish-grey, whilst those of the latter incline to brown, since they are, in general, either leek- or pistachio-green. They also differ in point of transparency, the hemiprismatic presenting a higher degree than the paratomous Augite-spar. The most instructive specimens in this respect can be gathered from the stone heaps prepared for the improvement of the road between Windisch-Feistritz and Gonnewitz, in Lower Stiria.

I have not found an opportunity of examining the composition of the Norway varieties of Gabbro. To Dr NAUMANN of Jena, I am indebted for several very distinct specimens of the Diallage contained in the varieties from Vaage and Gulfield. They are pure hemiprismatic Augite-spar, perfectly cleavable pa-

parallel to the prism $(Pr + \infty)^3 = 124^\circ 13'$; and although compound, in the direction of the faces of $Pr + \infty$, they nevertheless present but a very inferior degree of lustre, upon these faces of composition, if compared with those of cleavage. The colour is a dark greenish-grey, and the specific gravity = 3.043.

Besides the rocks described, there are still a great many whose characteristic ingredient is said to be Diallage, which, however, do not contain any hemiprismatic Augite-spar at all, but only the varieties of the paratomous. Thus, the *Eclogite* of HAÜY, found in the Saualpe in Carinthia, is a mixture of red Garnet and leek-green, paratomous Augite-spar, of the variety called Omphazite by WERNER. The rocks from Austria and Bayreuth, which contain Omphazite, though smaller grained, are exactly of the same composition. The variety from the Saualpe occasionally contains small greenish-white prisms of *Zoisite* (prismatoidal Augite-spar).

VON BUCH has sufficiently ascertained the remarkable geognostic relation between Gabbro and Serpentine, in many places which he visited during his travels. The Bacher in Lower Stiria, gives another proof of this fact. Here the Gabbro rock appears to constitute considerable masses in the Serpentine, nearly in the same way in which the masses of ore usually occur in beds, or still more distinctly in metalliferous veins, if we may indulge ourselves in considering the latter as points of comparison. Yet it has not been possible to strengthen this opinion, by observing the immediate contact of the two rocks; it is rather the consequence of their distribution over the surface of the country.

It is attended with less difficulty to determine the position of the rock from the Saualpe. It constitutes a subordinate bed in the gneiss, and mica-slate formation of the Alps, and has been opened by a quarry situate at the southern extremity of the Saualpe, in

the neighbourhood of a spring called the Kupplerbrunn, from which quarry the country around is supplied with a coarse kind of very hard mill-stones. The rock contains in this quarry thin layers of Quartz, filled with a great number of beautiful varieties of the Carinthine of WERNER (hemiprismatic Augite-spar), of Kyanite, of Zoisite, of crystallised varieties of Rutile (peritomous Titanium-ore), and of many other minerals we admire in collections. The same rock is also met with in the north part of the same mountain; and Professor MOHS has found it in his travels through the Stirian and Carinthian mountains, to extend to the Koralpe, and the more western parts of the Bacher, the east end of which is occupied by the Gabbro described above.

It would too far exceed the limits of the present paper to enter into similar details upon another class of rocks, likewise called Gabbro, or Euphotide, the chief ingredients of which are, not the green, but the metalloidal Diallage (hemiprismatic Schiller-spar), Labrador-felspar, and partly also Serpentine; as, for instance, in that from the Monte Ferrato, near Florence*. I only venture to add a few remarks as to the last of these species.

Serpentine has been pronounced by VON BUCH to be nothing else but a fine-grained mixture of *Gabbro* and *Talc*,—an opinion rather too much the result of mere speculation, than should ever be the case in a science connected with nature; yet the doubts respecting the existence of a particular species of Serpentine, which he derives from this opinion, are strongly supported

* According to the descriptions given by Drs HIBBERT and MACCULLOCH, the Diallage-rock from Shetland belongs likewise to this class. I cannot pass entirely unnoticed their labours in ascertaining the geological positions of these rocks; but not yet having had an opportunity of examining the rocks themselves, and having only recently become acquainted with the accounts published by Dr HIBBERT in his Description of the Shetland Islands, p. 372., and by Dr MACCULLOCH, in the Quarterly Journal of Science, Literature and the Arts, vol. x. p. 103., I cannot at present dwell any longer upon this subject.

by the highest authorities. Among all the proofs for the peculiarity of a species, there is none more evident than that founded upon the existence of crystalline varieties. It seems that the rarity of crystals of Serpentine, has been the reason of their not sooner having been noticed by mineralogists; although, perhaps, they have long ago been observed, but not sufficiently distinguished from other substances.

The forms of Serpentine are combinations of the Prismatic System of MOHS. One of its most common varieties is that represented in the annexed figure. According to the method of designation of Professor MOHS, its crystallographic sign is,

$$\begin{array}{ccccccccc} \text{Pr.} & \text{P.} & (\text{Pr} + \infty)^3. & \text{Pr} + \infty. & \text{Pr} + \infty. & & & & \\ o & P & d & b & s & & & & \end{array}$$

The measures of the angles of P, the fundamental pyramid, are: $139^\circ 34'$, in the place of its more obtuse terminal edges; $105^\circ 26'$ in that of the more acute ones, replaced in the represented variety by the planes *o* of the horizontal prism Pr ; $88^\circ 26'$ at the basis. The ratio of the axis, and the diagonals $a : b : c$ is $= 1 : \sqrt{4.3} : \sqrt{1.4}$, which, however, must not be taken for any thing more than an approximation, the dulness of the faces being prejudicial to the employment of the reflecting goniometer. The angles of the prisms are the following: $\text{Pr} = 128^\circ 31'$, the angle contiguous to the terminal edge; $(\text{Pr} + \infty)^3 = 97^\circ 33'$ in the place of *b*, $= 82^\circ 27'$ in that of *s*, the faces *b* and *s* forming truncations upon the respective obtuse and acute lateral edges of the prism *d*. Several of these crystals have one-fourth of an inch, or even more, in their greatest extension: they adhere to the sides of small cavities in the interior of a massive Serpentine, which moreover contains particles of Calcareous-spar.

I could get no information respecting their locality; but there exists a variety of the same species in roughly terminated imbedded crystals in the Weiss-stein of Chursdorf, near Penig in Saxony, where they occur in small irregular veins, composed of Felspar, Quartz and Tourmaline. The crystals of Serpentine are not pseudomorphous; for, besides the peculiarity of their series of crystallisation, they present very distinctly, faces of cleavage in the direction of the prism $(Pr + \infty)^s = 82^\circ 27'$, and of $Pr + \infty$, its greater diagonal, exactly agreeing with their external form. The imbedded crystals, too, distinctly exhibit these faces of cleavage, even if the external form should be entirely obliterated by their contact with other minerals.

Yet an exact knowledge of the forms was not required; and even without it, the specific gravity, if properly attended to, would have been an argument not to be refuted, against the opinion that Serpentine is identical with a mixture of Gabbro and Talc. The component parts of Gabbro are the following species:

Saussurite, the specific gravity of which is	-	above	3.2
Hemiprismatic Augite-spar,	-	above	2.9
Paratomous Augite-spar,	-	above	3.2
Labrador,	-	above	2.69
Talc,	-	above	2.7

Now, the specific gravity of Serpentine being $= 2.507$, in the above-mentioned crystallised variety, and $= 2.488$ in the cleavable one from Saxony; it appears not only below a mean term of all the specific gravities of the above-mentioned minerals, but far less than the lowest limit of any one of those species taken separately, which are said to produce the mixture.

Yet there exist some varieties of Serpentine, which, to a somewhat higher degree of specific gravity, join distinct traces of a crystalline formation. Thus the variety from Monteferrato gives 2.716; it contains no magnetic (octahedral) Iron-ore, as it does not affect the magnetic needle, which is the case with other va-

ieties that shew a higher specific gravity, namely, the Serpentine from Matrey in the Tyrol, $G. = 2.700$, from the Hartz, $G. = 2.684$, from Lower Stiria, $G. = 2.667$. The difference of the latter can easily be explained by an admixture of Iron-ore, for 8 per cent. of this mineral mixed with 92 per cent. of a Serpentine, whose specific gravity is $= 2.5$, will suffice for raising that of the compound to 2.72 ; but the same explanation cannot apply to the Serpentine from Monteferrato, and a difference of that kind, not yet accounted for, must, of itself, be sufficient for directing the attention of mineralogists towards a more accurate examination in future, of the different varieties of Serpentine.

Thus, mineralogy being the natural history of the mineral kingdom, must correctly determine the different varieties, and collect them within well defined species; but in this, it has fulfilled its duty, at least as far as respects the establishment of the species, and it must leave a great deal of valuable information to be obtained from other sciences, which likewise refer to the mineral productions, as, for instance, from natural philosophy, geology, chemistry, the art of working and smelting ores, &c. The first determination of a mineral, if incorrect, is very often prejudicial to all the subsequent inquiries, and it would not be difficult, from more than one example, to support this observation. An accurate investigation of the rocks, can alone enable the geologist to ascertain the nature of the materials of which mountains are composed, the grand object of his researches; and hence the fundamental knowledge of the mineral species which natural history affords, is as necessary to him, as it is to the chemist, who intends to subject them to his analysis.

G. ROSE has given us a beautiful example of the latter, in his memoir on the different substances hitherto indiscriminately comprised under the name of Felspar*. The difference among

* GILBERT, *Annalen der Physik*, &c. 1823.

these minerals is so obvious, that it will be easily found in nature, even by those mineralogists, who have not been aware of it, previous to the publication of that paper; and no doubt but the resolution of what has been taken for only one species into several, must prove of great influence upon the former, namely, the determination of the rocks. In this respect, besides its pure natural-historical purpose, the above examination of Smaragdite will, I believe, not be found entirely devoid of interest.