

FOREIGN CORRESPONDENCE.

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The Emerald and its green colour—Its analysis and formation—Green Gypsum in the Emerald mines—More artificial minerals—Hyalite, Wollastonite, and Aphophyllite—Quartz, Feldspar, and Pyroxen—Feldspar in the lava of volcanos—Petrifaction and Epigenesis—Spontaneous crystallisation of amorphous bodies—Hardening of rocks by exposure to the air—Extraordinary origin attributed to oolite rocks—Modern oolite discovered by Leopold Von Buch—More Footprints in the Jurassic formations.

One of the most interesting results has just been obtained by a thorough chemical investigation of the emerald. This interesting mineral, which has given rise to so much discussion as to its composition, its formation, its colouring matter, &c., may now be looked upon with still greater interest since the researches of M. Lewy have been made known. The ingenious chemist just named, in a visit to the mine called Muso, in New Grenada, Mexico, was lucky enough to procure some very fine specimens of emeralds, and of the rock in which these precious stones are found. The first thing that struck him, on receiving these specimens from the hands of the miners, was the excessive fragility of the stones: the largest and finest emeralds could be actually reduced to powder by a slight squeezing or rubbing between the fingers.

It is a well-known fact that the ancient inhabitants of this part of America used to judge the value of the emerald by its hardness. So little had they observed the phenomenon of which we speak, that their principal test consisted in striking a hard blow upon the stones as soon as they were extracted from the earth: if they resisted they were considered perfect stones, if not they were thrown aside as valueless articles. M. Bousingault remarks that in this manner, no doubt, a great number of very valuable specimens have, in former times, been destroyed.

A certain space of time and repose are required for these soft emeralds to assume the hardness which renders them valuable as precious stones. The fine specimens destined for the lapidary and the jeweller must be

stowed away with the greatest care for a few days. As to the *cause* of this hardening of stones recently extracted from their natural beds we shall have occasion of referring to it presently.

M. Lewy has shown also in his interesting paper (*Researches on the Formation and Composition of Emeralds*),* that the beautiful green colour, so much admired in the stones of which we are speaking; and without which they would, in all probability, be valueless, is owed to an organic substance somewhat similar to that called chlorophylle, which colours the leaves of plants. † The green colour of emeralds has always been attributed to a slight quantity of chromic oxide, which, although it certainly does play an important part in the coloration of other minerals, has positively nothing to do with that of emeralds. Analysis has furnished only an exceedingly slight quantity of chromic oxide; so small, indeed, that the distinguished chemist whose work we are analysing could not weigh it separately. Our readers have, perhaps, heard of, or seen, a mineral called ouwarovite, a sort of chromiferous garnet, whose green colour (which withstands heat, whilst that of the emerald does not) is exactly that of the emerald; but ouwarovite furnishes 23 and-a-half per cent. of oxide of chrome, whereas in emeralds, as we have seen, there is only a slight vestige of this green oxide. This is certainly a new and unexpected result.

A certain number of facts related in his memoir lead M. Lewy to affirm that emeralds have been deposited from water. It would, perhaps, be more rational to say that water has been active in their production ‡ —First, besides the organic colouring matter, emeralds contain about 2 per cent. of water. In the next place, the black white-veined limestone in which they are found contains fossil ammonites. This limestone, perfectly freed from the microscopic emeralds with which it is strewed, by digestion with dilute hydrochloric acid, gives in analysis a $\frac{1}{10000}$ th part of glucina.

Great uncertainty has prevailed as to the mineral constituents of the emerald and its true chemical formula; this has determined me to give here the numbers obtained by M. Lewy, and to corroborate them by

* Presented to the Academy of Sciences, Nov. 15th, 1857.

† It is, perhaps, as well to observe that M. Lewy has not ascertained if this organic substance in the emerald contains oxygen or not. He seems to consider it as a carburet of hydrogen.

‡ See further, the phenomena recently observed by M. Daubr e.

showing, at the same time, the results obtained, some years ago, by M. Moberg, in the analysis of some emeralds from Finland:—

Emeralds from Mexico (M. Lewy). Emeralds from Finland (M. Moberg).

Silica	67·9	67·359
Alumina	17·9	16·465
Glucina	12·4	12·747
Magnesia	0·9	—
Oxide of iron	—	1·49
Soda	0·7	—
Titanic acid	traces	0·28

Both these analyses show that the emerald contains 1 atom of alumina, 1 atom of glucina, and four atoms of silica. In that of M. Lewy slight traces of chromic oxide were weighed with the magnesia, and probably some titanic acid with the alumina. The green colour of the emerald is darker in those specimens which furnish to analysis most organic matter; it is completely destroyed by heat, the stone becoming white and opaque.

On the communication of these results to the Academy, M. Bousingault observed that he also, in former days, had visited the Muso mine, and that he had picked out of the strata in which the emeralds are found, pieces of gypsum of a beautiful green colour, resembling that of the emerald. He had no doubt, from M. Lewy's observations, that the green colouring with which the gypsum was impregnated was identical with that just discovered by M. Lewy in emeralds.

M. Daubr e has furnished us with some new and interesting details concerning the artificial production of minerals. By a close observation of the methods employed by nature, and a certain intrepidity in the laboratory, this enthusiastic geologist has had the good fortune to produce some crystallized specimens of minerals which have never before been purposely formed or accidentally found in scori e. He formerly observed in the mineral springs at Plombi eres, the waters of which contain silicate of potash and soda, and have a temperature of +70  Centigrade, the formation of certain well-known silicates and other minerals usually found in the veins of eruptive or primitive rocks. Most of these have been formed, since the time of the Romans, in the orifices of the mineral springs in question. An old Roman tap in bronze was found covered with a crust of sulphide of copper which,

from its aspect, its crystalline form,* and its other properties, it was impossible to distinguish from the Cornwall specimens.

The masonry near the springs was often seen to be impregnated with hyalite (a sort of transparent silica) in every respect similar to the hyalite found in basalt rocks; and sometimes apophyllite (silicate of potash and lime) showed itself in very neat crystals. We would observe here Wochler succeeded formerly in dissolving and crystallizing this mineral by the aid of water at 180° Centigrade.

M. Daubrée asked himself this question: If we find hydrated silicates formed slowly in mineral springs at no very high temperature, is it not probable that anhydrous silicates may be artificially and more quickly produced by the action of water at a higher temperature? Numerous experiments have answered this question in a most affirmative manner. They consisted principally in submitting the different substances in presence of water, to a heat of 400° Centigrade for a month together, in a closed glass tube, enveloped and protected by an iron case.

As glass formed part of the apparatus, it naturally occurred to him to determine first of all, what would be the result of this treatment on glass itself. It was soon found that this substance undergoes, by the simple action of water at this temperature, a complete decomposition: it first becomes opaque, earthy, and fragile, resembling kaolin, then it gradually and regularly swells and transforms itself into a host of minute crystals, which were found on examination to be wollastonite ($3 \text{ Ca O}, \text{Si O}^2$); at the same time the alcalis of the glass, and a certain quantity of silica, are dissolved. Soon, however, silica is deposited in the form of crystallised quartz, of which some of the crystals measure two millimeters in length. The presence of alumina modifies these phenomena; thus, when obsidian was acted upon in like manner, minute crystals of feldspar were obtained, resembling, *en masse*, granular trachyte. Clay and kaolin, which had been previously purified by washing, on being submitted to a similar treatment, gave birth to feldspar, mixed with crystals of quartz; and if the glass, in the first experiment, is decomposed in presence of oxide of iron, not wollastonite, but *pyroxen*, is obtained—the samples of which immediately remind us of the natural crystals found in the Tyrol, Piedmont, at the Somma, &c. They are

* The natural specimens of sulphide of copper are *dimorphous* with the sulphide of the laboratory.

beautifully crystallised, and possess both their green colour and their usual transparency.

From these investigations, M. Daubrée feels justified in concluding that a great number of silicates—perhaps all—found in the primitive crystalline rocks, have been formed by the influence of water at a high temperature; which temperature is, however, very inferior to that of the point of fusion of these silicates. He seems to think that the granite rocks themselves very probably owe their formation and crystalline appearance to similar causes. We must content ourselves here by indicating the result of experiment, and be silent as regards discussion. If the experiments just related, and which are being continued by M. Daubrée, are repeated with success, his conclusions will appear certainly very natural. The most striking feature in his paper is, without doubt, the formation, in the above circumstances, of feldspar—a rock so universally spread throughout nature, and which plays so important a part as constituent of almost all the primary or eruptive rocks. Although crystals of feldspar have been discovered in scoriæ, and, by Heine, in the refuse of a furnace for copper fusing,* it appears from Humboldt's statement † that they have never before been purposely formed:—"Nor have chemists," says he, "ever succeeded in artificially producing either feldspar or hornblend." It may be well to add that feldspar is daily formed under our eyes in the lava of volcanos. Since M. Daubrée's observations have come to light, this must doubtless be attributed to the abundant quantity of water incorporated in lava until it becomes completely solidified.

M. Kuhlmann, of Lille, has published a long memoir on siliceous infiltration or petrification, and on epigenesis. ‡ In this work the learned author, who has already done so much for the advancement of chemical and geological science, has presented us with nothing very new. He explains the curious phenomenon of petrification by the action of carbonic acid, or of carbonate of ammonia, on the silicates of potash and soda invariably found in spring water. A similar theory has been already professed and published by others, and, I believe, by M. Kuhlmann himself.

The phenomenon of petrification is certainly one of the most curious processes in nature. Is it not wonderful to find the soft stem of

* They were analysed by Kersten. † *Cosmos*, Vol. I.

‡ *Comptes Rendus*, Nov. 9, 1857.

some well-known plant transformed into a hard stone, and yet retaining most of its colour and external appearance? Let us see how this happens: In one of the paragraphs of our last article we had occasion to notice the action of water upon the so-called Plutonic rocks. We have seen that an alkaline silicate is invariably dissolved out of the rock by water. In nature this silicate is carried away by the rain-water to fertilize the earth; it is absorbed with the water by plants, many of which rob it of its silica in an extraordinary manner. Vegetables are known to evolve in the act of respiration, and more especially at night, a certain quantity of carbonic acid. We know also that this acid decomposes silicate of potash or soda, and in a few hours precipitates the silica of these salts. It is in this way that the different *grasses* and the plants of the genus *Equisetum*, &c., retain in their tissues considerable quantities of silica, especially in the green parts of the epidermis or cuticle, where the function of respiration is most active.* But when a piece of wood undergoes decomposition, and becomes brown and decayed, it also evolves a great quantity of carbonic acid, which acts on the alkaline silicates with which the wood is often imbued by the absorption of spring water, in the way we have just described, and precipitates their silica. In this manner, for every atom of carbonic acid furnished by the carbon of the decaying vegetable, an atom of silica is substituted; so that, after a certain space of time, the entire tissue of the plant is converted into a tissue of hard stone. † Animal substances, such as the bodies of polypes, mollusca, &c., furnish principally carbonate of ammonia by decomposition. This volatile salt acts upon the silicates of potash and soda in the same way as carbonic acid, explaining to us at once the manner in which the petrification of shell-fish and other animals takes place.

But to return to M. Kuhlman—the most important part of his memoir relates to *epigenic forms* (or the covering over or replacing of one mineral species by another, without change of form). He has en-

* It is a well-known fact that certain sugar-canes, bamboos, &c., will often strike fire with steel, on account of the large quantity of silica contained in the bark of their stems.

† The colouring matter of the bark of the trees being accompanied by tannic acid and other substances which have the faculty of preventing, in a great degree, putrefaction or decomposition, is often most beautifully preserved in petrified specimens of woods.

endeavoured to demonstrate that whenever, in nature, a chemical decomposition takes place *very slowly*, the products are crystalline, and assume the forms of the pre-existing body;* whenever the decomposition takes place abruptly we obtain, on the contrary, amorphous precipitates or bodies devoid of crystalline structure. Amongst other experiments, M. Kuhlmann has shown that a current of sulphuretted hydrogen transforms many salts of lead into sulphide of lead without producing a change in their structure, thus explaining certain anomalous forms observed in nature. A current of ammonia transforms pyrolusite into protoxide of manganese without producing a change in the form of the crystals of the first. Nascent hydrogen has the same effect whilst reducing certain metallic salts, &c.

The same author has, more recently, made a very interesting study of the spontaneous crystallisation of amorphous bodies. It has no doubt happened to many of our readers to pick up pieces of common flint in which certain parts are profusely crystallised, or studded with minute transparent crystals of quartz. It has been M. Kuhlmann's object to show how these crystals have been formed, and to explain other like phenomena. Numerous observations have shown him that amorphous or earthy matters in general have a great tendency to crystallise by slow desiccation; and he has shown by experiment that, in time, many substances, at first apparently without structure of any sort or kind, will take crystallised forms. This is perfectly illustrated by malate of lead, which, as every chemist knows, is produced in the form of an amorphous precipitate, but which after being allowed to repose for a certain time, shoots out into crystals. M. Kuhlmann has shown that in any substance the crystals produced in this manner are neater, or better defined when the drying has proceeded *very slowly*.† The siliceous deposits formed at the present time by the geysers of Iceland furnish numerous examples of the spontaneous crystallisation of which we speak.

It has been frequently observed that when a piece of rock, or a

* Thus we see sulphate of potash placed in damp chalk, transform itself slowly into gypsum without losing its crystalline form (according to Beudant).

† The same holds true, to a certain extent, for volcanic lava, both ancient and modern, which furnish very different products, according as their cooling has been rapid or slow. In the first case they often form a black non-crystalline glass; in the latter, a stony mass of crystalline structure.

mineral, is freshly taken from the quarry, it is often much softer or more fragile than when it has remained some time exposed to the air, as we have already remarked with regard to the emerald. This is very manifest, for instance, in newly-made marble slabs, which, if they are placed against a wall in an inclined position, are apt to bend, and become in a great measure valueless to the owners. After a few days' exposure to the air the rock or mineral becomes hard, losing at the same time a considerable quantity of water. M. Kuhlmann has endeavoured to prove that this hardening of the rock and expulsion of water are not owed to simple evaporation or drying, but to a process of crystallisation which takes place slowly from the moment the rock is exposed to the air.

Natural crystals are often found strewed on a rock of their own composition, which rock, in M. Kuhlmann's idea, has given birth to the crystals in question by a species of contraction or slow crystallisation, accompanied by loss of water—phenomena which he has artificially produced with sulphate of baryta, sulphuret of mercury, oxyde of copper, &c. He explains in like manner the origin of the beautiful crystals found in geodes.

M. Virlet D'Aoust, civil engineer, has lately presented to the Academy of Sciences a paper on the eggs of certain aquatic insects found in Mexico, and which he looks upon as the means by which oolitic rocks have been, and are still being, formed. However extraordinary—we might, perhaps, say mysterious—this origin of oolites may appear, we must not be too hasty in rejecting the statements brought forward by the author, whom we believe to be a man of some geological experience, and a clever engineer. Has not Ehrenberg shown that immense masses of the earth's surface owe their origin to a profusion of microscopic infusoria, foraminifera, &c.? M. Virlet D'Aoust, in his turn, endeavours to show that oolitic rocks owe their existence to myriads of minute eggs, the seed of some aquatic insects. Here are the facts observed:—

Everyone has heard of the great plain of Mexico, situated some 2,300 meters above the level of the sea. Near the centre of this tract of land are seen two large lakes.* The first, the water of which is

* It was from these large Mexican lakes that Humboldt brought back with him Scheuzher's *antidiluvian man* (*homo diluvii testis*), a large salamander belonging to the most recent freshwater formations.

fresh, goes by the name of Chalco, the second is a saltwater lake called Texcoco. The observations made by M. Virlet led him to discover that the bottoms of both these lakes are formed by a sort of grey limestone of modern formation, containing small oolites which, in the author's eyes, are in every respect similar to those found in the rocks of the Jura formation. He immediately made known this fact to Mr. Bowring, director of the salt works at Texcoco, who informed him that these oolites were owed simply to the incrustation of the eggs of water insects by the carbonate of lime daily deposited from the waters of the lakes. In a second excursion to the lakes the author remarked that their banks were strewed, under water, with an infinite number of insects eggs, about the size of a pin's head, and which appeared to be those of a new species of boat-fly (*Notonecta*). The Mexicans consume immense quantities of these eggs at their meals. They are extracted from the water by means of bundles of reeds or grass, on which the insects deposit their eggs by millions at a time. M. Virlet is not only convinced that these modern oolites of Mexico owe their origin to the eggs of a species of boat-fly, but seems to think also that the oolite of the Jura, and other ancient strata, must be attributed to a similar cause. "This explains," says he, "the irregular distribution of oolitic grains in the rocks of the Jurassic strata. Where the oolite is hollow, the egg has been enclosed before being hatched; where the oolitic globules are completely solid, the eggs have had time to hatch, and the cavities left by the exit of the larvæ have been filled up by the incrusting limestone.

If these facts are confirmed by future observation, it will not be without interest that we shall recall the Greek origin of the word oolite ($\Omega\upsilon\upsilon$, egg; $\lambda\iota\theta\omicron\varsigma$, stone). I would, however, on this occasion remind our readers that a small oolitic bed, bearing great resemblance to the Jura limestone, was formerly discovered by Leopold von Buch* near Teguiza in Lancercte—one of the Canary Islands. This oolite bed is also of modern formation, and probably continues increasing at the present time. It would, therefore, be of great geological interest to ascertain if the oolitic deposit made known to us by Leopold von Buch owes its origin to causes similar to those stated by M. Virlet in reference to the Mexican oolite. Such an investigation, which could

* Canarishe Inseln.

be easily made by the English vessels which frequently visit the Canary Islands, would be more likely to decide the important question than the examination of ancient oolites with a view to discover some organic remains that might be attributed to the eggs of insects.

In my last article I mentioned a curious discovery of footprints made by M. Daubrée in the Jurassic formations at St. Valberg. Since then, the celebrated naturalist, M. Paul Gervais, has brought forward some interesting facts of a similar kind. In a short paper addressed to the Academy of Sciences, he describes some footprints of extinct animals found in strata corresponding to those observed by M. Daubrée. The impressions he speaks of have been recently discovered by himself and some friends at Fozière, near Lodève, in the south of France. They were observed on the surface of slabs of sandstone alternating with beds of marl, and are exactly similar to the footmarks found some years ago at Hildbourghausen in Saxony, at St. Valberg in France, and, as M. Paul Gervais remarks, resembling those formerly discovered at Storton-Hill, near Liverpool. The learned author observes, that until further evidence can be furnished as to whether these footprints belong to mammalia or reptiles, he will maintain the opinion of those naturalists who consider them as being owed to large amphibious animals, whose bones and teeth abound in certain parts of the Trias beds. These amphibious reptiles are those which Owen, de Munster, Jaegar, Fitzinger, Hermann Meyer, and other naturalists have described as large Salamanders, Mastodonosauri, Batrachosauri, Labyrinthodonts, &c. Paul Gervais himself, and Hermann Meyer, first made known the remains of these animals in France, in the variegated sandstone near Soultz-les-Bains, (Bas-Rhin), and in the Muschelkalk at Lunéville, and Fleming (Meurthe).

The characters of the footprints observed by Paul Gervais, near Lodève, answer to the form of animal described by Kaup as *Chirotherium*, or *Chirosaurus Barthii*. The details given by the author as to the configuration, the strata, and circumstances in which they were found, &c., are precisely identical to those related by M. Daubrée (see our last paper). Like the latter, M. Paul Gervais has observed by the side of the larger marks, others, belonging evidently to some smaller animal, and showing four digital impressions; the author thinks these must be attributed to a species of palmipede. A third species of footprints was likewise observed, consisting of a star-like impression formed by four

toes of unequal length, and attributed to an extinct bird known to American naturalists by the name of ornitichnites.

An interesting collection of these footprints has been deposited by the order of M. Paul Gervais in the Geological Gallery of the Faculty of Sciences at Montpellier, where they may be examined at leisure by naturalists visiting that town.

LETTER FROM THE REV. C. KINGSLEY,
RECTOR OF EVERSLEY.

(To the Editor of the GEOLOGIST.)

DEAR SIR,—I have read with great pleasure and also great hope, your first number—and am especially delighted to find that you aim at spreading a popular knowledge of Geology. May I, in furtherance of this object, make a suggestion? Why not establish in your magazine a regular geological “Notes and Queries” department?

There are hundreds, if not thousands, who have no time to work out geological problems for themselves; who yet are most desirous of instruction, and would receive the results of the science frankly and trustfully. Artizans desirous of self-instruction, and ladies of rank desirous of instructing their children would, alike, be glad to know a hundred things which, not having books, time, or perhaps scientific habits of mind, they cannot find out for themselves. If a knot of wise men, and such a clergyman as Mr. Brodie among them, would deign to explain to these people their puzzles, they would be doing a noble work, and sowing good seed in many minds which would bear fruit in a future generation, by freeing it from childhood, from the bonds of many superstitions and traditions of altogether human invention.

May I give an instance in which I myself appear in the character of one begging for information?

Last summer, in the Isle of Purbeck, I was told of a wonderful rock, the Haggerstone,* which lay on the top of a hill in the northern moors of the Isle, overlooking Poole Harbour. “Would I go and see it?” For nobody agreed how it got here. “It was a proof of Noah’s

* QUERY.—Hag’s Stone; Hexe’s Stone; Witches’ Stone.