

FOREIGN CORRESPONDENCE.

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New method of obtaining Artificial Minerals and Precious Stones—White Corundum - Ruby—Sapphire—Green Corundum—Zircon—Cymophane—Gahnite—Staurotide—Silicate of Zircon—Emerald—Curious Decompositions—Action of Fluor—Compounds in the Natural Formation of Minerals—Rutile—Mode of Working the Sub-Alpine Tunnel between Modane and Bardonnèche—Employment of Compressed Air as a Motive Power for Boring and for Ventilation—Curious Phenomenon observed during these Works—Rate at which the Alpine Tunnel is Progressing—Thickness of the Alps—Ascent of the Muladetta and the three kinds of Granite in the Pyrenees and the Haute-Garonne.

MESSEURS. H. STE. CLAIRE DEVILLE AND H. CARON have lately published a remarkable memoir *On a new Method of producing, in a Crystalline state, a certain number of Chemical and Mineralogical Species.* It will be sufficient to state that sapphires, rubies, and other stones of the corundum kind, staurotide, cymophane, &c., have been obtained to make it immediately understood how great an interest is attached to these new investigations.

One of the most successful methods employed by those chemists, to obtain the artificial crystals in question, consists in the mutual action of certain volatile metallic fluorides on fixed or volatile oxygenized compounds. Now, as very few of the metallic fluorides are *not* able to be volatilized more or less completely, this method of experimentation is almost always applicable. We shall here enumerate successively the mineralogical species obtained by the authors, and the exact process they have employed to produce them:—

1. *White Corundum.* This substance was produced in very fine crystals by the following means:—Into a charcoal crucible a certain quantity of fluoride of aluminium is placed, over which is fixed a little charcoal cupel, filled with boric acid. The crucible, covered by its lid, and carefully protected from the contact of the atmosphere, is then heated to a white heat for about one hour—not more. The vapours of fluoride of aluminium and boric acid come in contact and mix together in the empty part of the crucible, and are mutually decomposed, producing corundum and fluoride of boron. Corundum—which, as our readers are aware, is nothing more than a peculiar state of alumina—is found, after the operation, crystallized in rhombohedrons, with the faces of the hexagonal prism. They possess all the optical, crystallographical, and chemical properties of the corundum found in nature, whose hardness they possess also.

By the above method, crystals as much as one centimetre in length, and at the same time very broad, can be produced; but they are generally wanting in thickness.

2. *Ruby.*—To obtain the ruby, or red corundum, the same process is resorted to, merely adding a small quantity of fluoride of chromium to the fluoride of aluminium employed. There is, however, another

difference. Instead of a charcoal crucible, a crucible of alumina is used; and instead of a charcoal cupel for the boric acid, a platinum one is preferred. The colour of the rubies thus obtained is identical with that of the natural specimens. The rosy-violet tint so much admired in the natural gem is present in the artificial one, where it is due to sesquioxide of chromium.

3. *Sapphire*.—The sapphire, or blue corundum, is produced under the same circumstances as the ruby. It is also coloured with chromic oxide, the only difference between them consisting in the proportion of the colouring substance. Perhaps, also, there is a slight difference in the degree of oxidation undergone by the chromium in the case of sapphire production. But in such cases analysis can teach nothing, as the quantities of colouring matter in either case is so extremely small. In some cases, the authors of the memoirs alluded to above have obtained, at the same time, crystals of ruby and crystals of sapphire, the former of a red colour, the second of a magnificent blue tint identical with that of the oriental sapphire.

4. *Green corundum*.—When the quantity of chromic oxide in these experiments is very considerable, the corundum obtained is of a brilliant green colour, similar to that of *Ouwavrovite*, a mineral to which we have already alluded in the *Geologist*,* as containing 33.5 per cent. of oxide of chrome (according to Dr. Lewy and others) but which, from M. Damour's analysis, appears to contain only 25 per cent. This green corundum is always formed in that part of the crucible where the fluoride of aluminium and the fluoride of chromium are placed; the latter becoming relatively more and more concentrated as the operation proceeds (on account of its being the least volatile of the two compounds), explains how it is that this green variety of corundum is produced in this case in preference to the ruby or sapphire varieties.†

5. *Zircon*.—Is produced by the same process as corundum (except that fluoride of zirconium is employed in the place of fluoride of aluminium). The zircon, or oxide of zirconium, shows itself in the shape of minute crystals regularly grouped in arborizations not unlike those obtained sometimes with sal-ammoniac. The chemical properties of zircon thus obtained are the same as those of the natural specimens; but nothing is stated concerning the mineralogical or crystallographical characters.

6.—The authors proceed to state that they have also obtained, by the above method of experimentation, crystallized oxides of other metals, *e. g.* of uranium, titanium, and tin. But neither their crystalline forms nor their chemical composition have yet been investigated sufficiently to be spoken of with certainty.

7. *Cymophane* or *Chrysoberyl*.—This mineral is an aluminate of glucina, *i. e.* a compound of alumina and glucina. It is much prized by jewellers, as it is capable of taking a fine polish, and produces a magnificent gem when well cut. The French jewellers call it *Chrysolite orientale*, whereby it is often mistaken for yellow corundum, which goes under the same denomination. The colour varies from yellow to greenish

* The *Geologist*, No. I., p. 66.

† All the above varieties of corundum are met with in nature.—T. L. P.

yellow. It is found in the pegmatite-granites of North America, or as rolled crystals in the sands of the Brazils and Ceylon. According to Messrs. Deville and Caron, it can be artificially produced by the new method above described. Fluoride of aluminium and fluoride of glucinum are mixed in their equivalent proportion, and their vapours are decomposed by vapours of boric acid. The crystals of cymophane thus obtained are completely similar to the fine samples that come to us from America. They actually present the striæ and the peculiar heart-shaped make which are so characteristic in the natural mineral.

8. *Gahnite*.—Gahnite, a rare mineral (which must not be confounded with *garnet*), named after the illustrious Swedish mineralogist Gahn, professor and friend of the afterwards celebrated Berzelius, is an aluminate of zinc, which hitherto has only been found in Sweden, and perhaps also near the town of Franklin, in North America. To obtain this mineral artificially, Messrs. Deville and Caron made use of an iron crucible, into which they introduced a mixture of fluoride of aluminium and fluoride of zinc. The boric acid employed was placed in a platinum cupel, and the operation conducted as before described.

In this experiment gahnite is deposited on different parts of the apparatus, where it crystallises in well-defined and brilliant octahedrons. They are rather strongly coloured by iron-oxide, which they obtain in all probability from the iron crucible; otherwise, the crystals resemble the natural specimens, which, moreover, are mostly grey or of a greenish tint.

9. *Staurotide, &c.*—If in the foregoing experiments we put the vapour of a metallic fluoride (for instance, fluoride of aluminium) in contact with *silica*, by placing the latter in the little cupel instead of boric acid, we shall find that certain silicates may be obtained in a crystalline state. The authors, whose paper we have before us, have thus succeeded in obtaining a crystalline substance possessing the aspect of staurotide, of which it has also many of the physical and chemical properties.

The same substance is very easily obtained by heating alumina to a high temperature in a current of gaseous fluoride of silicium. In this operation the amorphous alumina is transformed into a mass of crystals which possess, at least, the composition of staurotide.

A silicate of zircon has been obtained in the same manner; but the authors have not completed their investigations of the last-named substances.

In the foregoing methods of experimentation, when fluoride of silicium is decomposed by oxides, the compounds that result from this decomposition can only contain a comparatively small amount of silica; it is therefore difficult, if not impossible, to obtain in this manner silicates which are known to contain a large proportion of silicic acid. Thus, for example, the authors endeavoured to obtain emerald by the action of fluoride of aluminium and fluoride of glucinum on silica. But the experiment failed.* A substance was obtained that crystal-

* We have already shown in the pages of the GEOLOGIST, that according to the recent interesting experiments of Lewy and Daubrée, it is extremely probable that water has played an important part in the formation of this beautiful mineral species.—T. L. P.

lised in very hard hexagonal laminæ; but it was not emerald, for by analysis it was proved deficient in silica.

It will be perceived from what has just been related, that fluoride of aluminium decomposes silica to form fluoride of silicium and staurotide. And, also, that in the same manner, fluoride of silicium in contact with alumina gives fluoride of aluminium and staurotide. This is the reason why our smelting crucibles and other metallurgical apparatus are often entirely transformed into a rough mass of crystals, almost all of which consist of the mineral species staurotide. The preceding observations explain also how volatile fluor-compounds in the presence of argillaceous substances may become the means of obtaining crystals of substances which are perfectly insoluble or infusible at the temperatures at which these fluor-compounds operate. This remarkable influence of metallic fluorides in the production of crystallized mineral species must have played a certain part in nature—more particularly in the production of crystallized minerals in lodes and veins. At least, such is the opinion of M. H. Deville; and M. Daubrée seems already to have arrived at this conclusion in his beautiful memoirs on the metallic fluorides. At the end of their paper, Messrs. Deville and Caron state that they have likewise artificially obtained rutile, or titanite acid, an interesting mineral species, in decomposing a fusible titanite by silica. Titanite of protoxide of tin was preferred for this experiment. During the operation, the authors remarked dissolved in the metallic tin, a brilliant substance, crystallised in wide metallic laminæ, easily separated from the tin by dissolving the latter in hydrochloric acid, and which turned out to be an alloy of iron and tin, containing equal proportions of each.

It was stated several months ago, that the immense work of a tunnel under the Alps between Modane and Bardonnèche had commenced. We have now to record some interesting facts, which might perhaps never have been discovered but for the peculiar methods employed in this colossal operation. The crest of the mountain attains so great a height that the sinking of shafts, which is generally done in order to begin boring at several points at once, was in this case out of the question. Hence the tunnel could only be worked at its extremities, so that the labour by the ordinary process of working could not be accomplished in less than thirty-six years! Then, how was a depth of gallery of one or two miles, or more, and having but one orifice, to be aired? These were very serious obstacles.

MM. Élie de Beaumont and Angelo Sismonda having examined the mountain geologically between Modane and Bardonnèche, found it composed of micaceous sandstones and schists, quartzite, gypsum, and limestone, all easy to blast, the quartzite alone excepted; but the stratum of this is not likely to be very thick. The other difficulties alone, therefore, remained, and these were at length overcome by three Sardinian engineers, MM. Sommeiller, Grattone, and Grandis, who proposed to turn the abundance of water, for which the locality is remarkable, to account by applying it to a peculiar system of perforation and ventilation, which we will now endeavour to explain. The first apparatus imagined by these gentlemen consists of an hydraulic

air-condenser (*compresseur hydraulique*), which is nothing more than a syphon turned with its orifices upwards, and communicating by one of them with a stream of water, by the other with a reservoir of air. The water descending by the first branch enters the second, and, by the pressure it occasions, condenses the air, which is then forced into the reservoir. This done, a valve is opened by which the water contained in the syphon is let out, and the operation recommences. The emission and introduction valves are regulated by a small machine operating by means of a column of water; and the air in the reservoir is maintained at a constant degree of pressure by a column of water communicating with another reservoir above.

Thus with a waterfall twenty metres in height, the air is condensed to six atmospheres, equivalent to the pressure of sixty-two metres of water. This condensed air is used for two purposes—first, as a motive power; second, for ventilation. Two kinds of perforators * worked by condensed air instead of steam, are employed; and the manner in which these machines perform their duty affords the first practical demonstration of the possibility of employing compressed air as a motive power with advantage. By means of the perforators holes for blasting may be bored through the hardest syenite in one-twelfth of the time which would be required if ordinary means were employed. It may be stated here that in blasting rock three-fourths of the time are employed in boring holes, and the remainder in charging and blasting; hence, accelerating the former operation is a great advantage. Moreover, it is said, that by making use of the apparatus mentioned above, eighteen perforators may be set to work in a place where three couples of miners would hardly find room. So that by these ingenious contrivances, as well as by others for clearing away, &c., the perforation of the tunnel may be effected in six years instead of thirty-six.

The air that has been employed as a motive power is used to ventilate the gallery; but when the latter shall have reached a considerable depth, it will require 85,924 cubic metres of air every twenty-four hours to replace that which has been vitiated by respiration, torches, and gunpowder; and this quantity, in the form of 14,320 cubic metres condensed to six atmospheres, the reservoir can furnish. A curious phenomenon has been observed during these works:—When the air, condensed to the degree above-mentioned, is shot from the machine into the gallery, any water happening to be near the apparatus suddenly congeals, although the ambient temperature be about 18° (centigrade); an effect owing to the rapid dilatation of the air the moment it is expelled from the machine. Hence, when a large mass of compressed air is driven into a gallery situated at 1,600 metres below the outer surface of the earth—for such is the level of the Alpine tunnel—and where, consequently, the temperature must be about 50° (centigrade), the dilatation of the compressed air will produce a diminution of temperature sufficient to counterbalance the excess alluded to.

The progress now making per day in boring this tunnel is three metres on each side of the mountain, or six metres per day in all. The thickness of the Alps between Modane and Bardonnèche is estimated at

* One invented by Mr. Bartlett; the other by M. Sommeiller.

about thirteen kilometres, or rather more than two leagues and a half.*

In a letter, written at Luchon, to M. Cordier, member of the French Institute, M. Leymerie gives a description of an ascent of the Muladetta, and of the different kinds of granite he has observed in the Pyrenees and in the Haute-Garonne. The ascent, which lies entirely over granite, can now be made in two days, by following the route indicated in 1842 by M. de Franqueville. The summit of the Muladetta, called le Pic de Nethon (the highest summit of the Pyrenees, and, according to Reboul, attaining to 11,443 feet), which, from the port of Venasque, looks so acute, consists in reality of a small plateau, composed of accumulated blocks and fragments of rock very similar to the accumulated fragments observed at the summit of Mont Perdu.

The fundamental rock of the Muladetta is a small-grained granite, with white feldspar and nearly black mica, which M. Cordier has formerly described with great accuracy. But the summit of the Pic de Nethon offers a different kind of rock—a peculiar species, which may perhaps be classed between granite and quartziferous porphyry. In a quartzo-feldspathic cement of a dirty grey colour, the eye distinguishes, on the surface of this rock, bits of grey quartz, scarce lamellæ of mica, a few spots of amphibole and rectangular crystals of rose-coloured orthose (feldspar), which gives a rosy tint to the rock when viewed from a little distance. This last-named species of granite appears to predominate in the culminating parts of the mountain, and M. Leymerie supposes it to have penetrated through the former, which seems to have been uplifted in the solid state, together with the transition strata which overlie it.

The small-grained granite before alluded to must, therefore, have played a passive part in the formation of these high mountains, whilst the grey porphyroid variety has been the eruptive element.

It is not so, however, with the porphyroid granite, bearing large maclaed crystals of orthose, which forms the culminating portions of the Pyrenees from Maupas to Claribade, and which is very characteristic in the higher parts of the valley of Oo. This one, on the contrary, offers also unmistakable eruptive characters.

After a minute investigation of these rocks, the author comes to the conclusion that there are three principal sorts of granite rocks in the Pyrenees and the Haute-Garonne.

1. The small-grained granite which might be termed, according to M. Leymerie, "granite Pyrénéen," from its abundance in the Pyrenees, and which must be considered, in an eruptive sense, as passive.

2. The porphyroid granite of the culminating points. And,

3. The various granitic or feldspar rocks of Luchon, and the lower parts of the valley.

The last two have played an active or eruptive part in the formation of the Pyrenees, and have produced veins, dislocations, unmistakable phenomena of metamorphism, &c.

* The principal facts in the above have been extracted from a paper lately addressed to the *Academy of Sciences* at Paris, by L. F. Ménabréa, entitled—*Note sur le Percement des Alpes entre Modane et Bardonnèche*, which may be consulted by those of our readers who are desirous of further technical details.—T. L. P.