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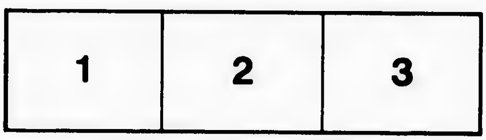

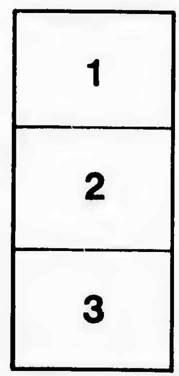

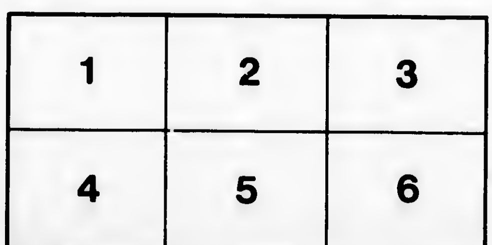

From the PHILOSOPHICAL MAGAZINE for January 1868.

CONTRIBUTIONS TO

THE MINERALOGY OF NOVA SCOTIA.

BY

PROFESSOR HOW, D.C.L.,

UNIVERSITY OF KING'S COLLEGE, WINDSOR, NOVA SCOTIA.

III. *Borates and other Minerals in Anhydrite and Gypsum.*

SILICOBOROCALCITE, *a New Mineral.*—In former papers I have pointed out the existence of two distinct borates in the gypsum of this vicinity, viz. natroborocalcite* and cryptomorphite†, both hydrated borates of calcium and sodium—the latter exclusively, the former occasionally, associated with glauber salt—and have adverted to the possibility of their being sometimes found together in intimate connexion with the latter‡. The very large quantity of quarried "plaster" (as both anhydrite and gypsum are called here) to be seen at Windsor, not less than 104,000 tons having been cleared in twenty-one months from this port, of which the greater part has been shipped from its own wharves, affords abundant material for the study of its varieties and the minerals they contain. A short time ago I observed natroborocalcite in plaster from two quarries distant from its original locality and from each other, but in the same district, as will be described further on,—and also a mineral, evidently different, which proved to be an addition to the short list of natural borates, and to the still shorter list of silicated borates. The mineral exhibits very different degrees of hardness; the hardest specimens are found in anhydrite, the softest in gypsum, both matrices occurring in the same deposit. The hard mineral is in white, rounded, often egg-shaped nodules, brittle, and of nearly even and smooth fracture, which is well shown in the broken masses giving almost flat surfaces continuous with those

* Silliman's Journal, September 1857; and Edinb. New Phil. Journ. July 1857.

† *Loc. cit.* 1861.

‡ Chemical News, 1867.

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of the anhydrite in which they are imbedded; these surfaces are dull. The nodules are generally about the size of filberts or pigeons' eggs, but occasionally larger; the largest specimen I have is a fragment about 2 inches in diameter: they sometimes show, when detached, a subvitreous lustre on the exterior. The mineral is translucent in thin fragments; under the microscope its powder is seen to be perfectly transparent and crystalline; the form, to judge from the cleavage, is possibly rhombic. The greatest hardness is about 3·5; specific gravity 2·55. Before the blowpipe, the hardest fragments decrepitate strongly, and all fuse readily to a clear colourless bead, making the inner flame green, deep green when the mineral has lain some time in water. Fragments fuse even in the flame of a lamp to a colourless blebby glass, which, when further heated before the blowpipe, froths considerably, and finally becomes quite clear. The transparent bead can be rendered opake by sudden insertion in, and removal from, the oxidizing flame, probably from the formation of bubbles of boracic acid which cannot escape till the mass gets further heated; for on re-fusion the bead becomes clear again, and remains so on prolonged heating. These reactions distinguish the mineral from natroborocalcite, which colours the flame yellow at first, and fuses readily to a clear colourless bead, which can also be rendered opake by the method just given, but which on prolonged fusion becomes so reduced in bulk as to leave the wire-loop nearly empty; the flame meanwhile becomes decidedly greenish yellow. In the former case the presence of silica is no doubt the cause of the permanent transparency. A minute quantity of either mineral with a drop of dilute hydrochloric acid gives the boracic-acid test with turmeric paper most readily. The new mineral before ignition gelatinizes perfectly in two or three minutes when its powder is stirred with cold hydrochloric acid,—after ignition also, when left in contact merely for some time. In a closed tube it decrepitates and gives much water. In the following analyses the results under I. were from a nodule in anhydrite; those under II. from several fragments, some of which were perfectly dull and opake, while others were lustrous in parts of the exterior. The absence of soda was proved by testing after removal of boracic and silicic acids by heating with fluor and sulphuric acid; the boracic acid was estimated by deficiency after gravimetrical determination of the other constituents in the regular way. Analysis of the air-dried hard mineral gave :—

definite

	I.			II.
			Mean.	
Water . . .	11·51	11·60	11·55	11·62
Lime	28·90	. . . .	28·90	28·04
Sulphuric acid .	. . . .	1·03	1·03	0·80
Magnesia . .	. . . .	trace	trace	
Silica	15·12	15·27	15·19	15·44
Boracic acid .	. . . .	. . . .	43·33	44·10
			100·00	100·00

The softest mineral, found in nodules imbedded in gypsum, is so unlike the preceding in hardness that at first I thought it might be effloresced glauber-salt which I had formerly met with in a similar matrix (see papers above referred to). It is like soft chalk or coherent flour, so that it is very difficult to separate pieces of the rock holding it without losing a great deal under the blows of the hammer. Its flame and blowpipe-reactions, except that it does not decrepitate, are those of the harder mineral; it colours turmeric and gelatinizes with equal ease. Analysis of a specimen like flour, obtained by myself among débris at the quarry, gave (air-dried):—

	III.
Water	12·20
Lime	28·85
Sulphuric acid	1·86
Magnesia	trace
Silica	14·64
Boracic acid	42·45
	100·00

These results agree so closely with the foregoing from different specimens in a distinct matrix, that there can be no doubt they all relate to a ~~different~~ definite mineral whose composition is constant in its varying physical conditions. The percentages correspond remarkably well with those calculated from the formula to which they lead. The results placed below as found are those of III., the analysis just given, after deduction of the quantity of gypsum equal to the sulphuric acid obtained, which is much greater in this than in the preceding analyses, whose numbers are so obviously similar that deduction in all is quite superfluous:—

	Calculated.		Found.
$5HO$ =	45	11·43	11·84
$4CaO$ =	112	28·44	28·69
$2SiO^2$ =	61·62	15·65	15·25
$5BO^3$ =	175·20	44·48	44·22
	393·82	100·00	100·00

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Of the various modes in which the constituents of the mineral may be arranged, I prefer the following, and therefore, using the notation employed in mineralogy, propose the formula

$$2CaO\,SiO^2+2(CaO\,2BO^3,\,HO)+BO^3,\,3HO$$

as that of the new mineral to which I give the name silicoborocalcite, chosen as companion to that of natroborocalcite, the essential chemical difference between minerals found in the same region, and even, as will presently appear, in the same matrix, occasionally being clearly indicated by these appellations: the formula of the latter, according to my own results, when rewritten so as to include some grouping seen above, is

$$NaO\,2BO^3,\,10HO+2(CaO\,BO^3,\,HO)+BO^3,\,3HO.$$

For comparison's sake, I add the formula of cryptomorphite (the other borate found in gypsum here), also rewritten,

$$NaO\,2BO^3,\,6HO+3(CaO\,2BO^3,\,HO)+BO^3,\,3HO,$$

so that relations can be traced between these geologically allied minerals.

The constituents of silicoborocalcite are those of datholite, the only other known hydrated silicated borate of calcium, for which Berzelius gave the formula

$$CaO\,BO^3+CaO\,2SiO^2+HO,$$

an expression exhibiting proportions very unlike those shown above to exist in the new mineral. In datholite, as in all silicated borates, the boracic acid is sometimes held to be basic*. On this view, excluding water,

In datholite the ratio of O in SiO^2 to that in the bases is 4 : 5
In silicoborocalcite „ „ „ 4 : 19

The ratio of the same to that in all the constituents is in the former 2 : 3, in the latter 2 : 12; the relations thus brought out in silicoborocalcite are so unlike those in any known compound, that silica cannot be the only acid present. The formula I have proposed contains two of Wollastonite, two of normal hydrated biborate of calcium, and one of Sassolin. While datholite and silicoborocalcite are quantitatively unlike and physically different on comparing the ordinary crystallized specimens of the former with the nodules of the latter above described, there is a remarkable resemblance between these and the exceptional state in which Whitney found datholite in a greenish magnesian silicate near Lake Superior. I refer to the perfectly white and opake nodules looking like the finest marble, or some kinds of Wedgewood

* Dana's 'Mineralogy,' 4th edit., vol. i. p. 207, and vol. ii. p. 335.

ware*. In the case of silicoborocalcite the crystals may be found, although it is best known in nodules; indeed, as will be mentioned immediately, it does sometimes appear crystalline. I carefully examined a specimen of anhydrite and one of gypsum, not earthy, holding the mineral, and detected in both a very small amount of silica, perhaps some two- or three-tenths per cent.

The small quantity of sulphuric acid recorded in the foregoing analyses arises from the presence of a little selenite, which is very frequently most intimately associated with the new mineral. In the hard form in anhydrite thin bands of selenite are often seen running through the nodules, which sometimes split so as to leave a plate of it on the exposed surface. In gypsum the nodules are sometimes distinctly banded with alternations of the two minerals, and are often quite cellular, walls of selenite standing up between cavities retaining more or less borate. The selenite sometimes carries Arragonite; and this or calcite is occasionally observed on the surface of the anhydritic matrix. Natroborocalcite occurs rather abundantly in an earthy gypsum holding the soft silicated borate, the minerals being independent nodules; and very well-marked coralloidal Arragonite or flos ferri is occasionally found in cavities along with the borate in gypsum: this newly observed fact is interesting, as it was in gypsum of Arragon that Arragonite was first found†. The locality to which the preceding description refers is Brookville, a property about three miles south of the Clifton quarry, close to Windsor, where natroborocalcite was first observed. Brookville is on the southern edge of the deposits of plaster in this neighbourhood, and Clifton on the northern; the deposits extend east for more than forty miles; and I have found silicoborocalcite in a pure-looking gypsum from a quarry on their range at Newport, about six miles to the east of Windsor. Here it does not seem to be so abundant as at Brookville; and it differs somewhat in external character, since it is in white flattened nodules of a *glistening crystalline* appearance, easily separable with a knife into rather gritty particles: it is closely associated with selenite. I identified it by the blowpipe-reactions and by qualitative analysis; the powder stirred with cold hydrochloric acid gelatinized perfectly.

New localities of Natroborocalcite.—Both Brookville and Newport are new localities for this mineral, which has been mentioned as occurring at the former in the soft blue earthy gypseous matrix of the silicated borate; it is much the more abundant of the two. It is in its characteristic nodules sometimes

* Supplements to Dana's 'Mineralogy,' Silliman's Journal, May 1860 and May 1861.

† Nicol's 'Mineralogy,' p. 296.

as large as a hen's egg, generally consisting of silky white fibrous crystals; these form with the dull blue matrix fine cabinet specimens. It is found also in common white gypsum, in selenite, and in fibrous gypsum; sometimes it has on its surface crystals of calcite or Arragonite. At Newport it appears to be much less abundant than at Brookville, and to occur in white gypsum only. At both these places the mineral is imbedded in the matrix in solitary nodules; in one case I observed a nodule in a cavity whose base was lined with crystals of selenite, among which it was implanted. The nodules lately found, especially at Newport, are not always visibly crystalline, and are generally, even when silky fibrous, much harder in the interior than on the outside, the difference being about as 3 to 1. Careful analysis, however, shows them to contain water, lime, boracic acid, and soda, the latter being unmistakeably found in essential quantity after removal of boracic and silicic acids by heating with fluor and sulphuric acid: the crystalline form was seen under the microscope to be distinctly prismatic. Hence there is no doubt of the mineral being natroborocalcite.

As regards the composition of this mineral, I gave at a former page a modification of the formula originally proposed by myself, which, as at first given, was

$$NaO\,2BO^3 + 2CaO, 3BO^3 + 15\,HO.$$

This was proved by Dr. Kraut (Chemical News, February 22, 1867) to express most correctly the results of the best analyses of the mineral by different chemists, but was objected to by Dr. Lunge (*loc. cit.*), who preferred the formula

$$2(NaO\,2BO^3) + 5(CaO, 2BO^3) + 42\text{ aq.}$$

The concordance of the analytical percentages with those calculated from these two expressions is as follows:—

	Lunge.		How.	
	Calc.	Found.	Calc.	Found.
Soda	5·82	5·58	7·82	7·21
Lime	12·95	12·69	14·12	14·20
Magnesia	....	·50		
Water	35·49	36·85	34·04	34·49
Boracic acid	45·74	44·38	44·02	44·10
	100·00	100·00	100·00	100·00

In my analysis all sulphuric acid was removed by washing with cold water, a previous examination having given sulphuric acid 1·29, and magnesia 0·04 per cent. Dr. Lunge says the mineral (he alludes probably to that from Peru) "is never found pure, but always mechanically mixed with, and often perfectly penetrated by, NaCl, $NaSO^4$, and $CaSO^4$, &c. [*sic*]. Besides, water has a decomposing action on the mineral." As regards purity, I formerly found only a trace of chlorine in addition to the MgO and SO^3 above named, and if any essential constituent had been washed out it should have been the soda; but my results certainly show no great deficiency of this. Respecting the whole constituents, on comparing the statement above given of the theoretical and actual percentages, I see no reason to abandon my formula for natroborocalcite for that newly proposed.

Probably this mineral will be found elsewhere in this district and in other parts of the province where plaster abounds; indeed, from the description of a quarryman, I have little doubt of its having been seen in another locality, unless the mineral described to me as "a stuff softer than plaster, about the size of eggs, coming clear out of the plaster and smelling like sulphur or the stones of a grist-mill," should prove to be Hayesine, a hydrated borate of lime sometimes confounded with natroborocalcite, which has not yet been found here, and which is described by Dana as having a peculiar odour: I have not perceived any odour in natroborocalcite. The other borates may of course be also expected in new localities; I have failed to find them in plaster brought to Windsor from several quarries.

Borates and other minerals, as characterizing the gypsum and anhydrite.—Of course, in addition to the interest attaching to a new member of the small class of mineral borates, and to the only known qualitative analogue of datholite, silicoborocalcite has that belonging to the first form in which combined silica has been found in the enormous deposits of sulphate of calcium here. It thus furnishes an addition to our means of learning the history of these rocks which are being shown to exhibit interesting analogies with similar formations elsewhere. I have thrown into a condensed tabular form the chief facts at present known with regard to the mineral contents of the plaster rocks in question, thus:—

Hants County, Nova Scotia, has deposits made up of	Gypsum, containing	Natroborocalcite, cryptomorphite, silicoborocalcite, glauber-salt, common salt, Arragonite, calcite, and selenite as distinct accessory minerals, and also, to be found on analysis, carbonates, partly of magnesia, and protoxide of iron, clay, and a very small quantity of silica.
	and	
	Anhydrite, containing	Silicoborocalcite, selenite, and Arragonite, or calcite as accessory minerals, and also, to be found on analysis, carbonates, partly of magnesia, and a very little silica.

The detection of glauber-salt with the borates, and of chloride of sodium* in gypsum of Windsor, marked a resemblance between it and similar rocks containing glauber and common salt in Spain &c., and, as regards boracic acid, with some in Germany containing boracite and Stassfurthite. Now the nodules of silicated borate in anhydrite and in gypsum of Brookville, both rocks containing a little silica, and in gypsum of Newport, bring these into the same class, so far as silica is concerned, with some gypsums (originally belonging to secondary strata) in the Hartz, which, according to Fropolli, contain nodules of silicate of magnesia, and with those of Montmartre near Paris, which hold soluble silica, or flints and chert†. Further analogy between these and other sulphate-of-calcium deposits is shown in the fact, which I have lately learned, that nearly every specimen of gypsum and anhydrite here yielding borates contains carbonates in notable but as yet unascertained amount, consisting to some extent of magnesia (of which traces appear in the borates as seen in my analyses), as well as in the detection now announced of Arragonite in cavities in gypsum, and of crusts of this mineral or calcite on the surfaces of gypsum and anhydrite, and also sometimes on the natroborocalcite and silicoborate in the former, and close to and underlying the silicoborocalcite of the latter.

These mineral contents and the numerous brine-springs of the gypsiferous districts here point to sea-water as the parent of the gypsum; but, as I observed in a former paper (1861) referred to above, ordinary sea-water would not furnish boracic acid. This acid, however, I afterwards found in a brine-spring issuing in a gypsiferous district here‡, and it has been met with in the waters of Aachen and Wiesbaden, and by Hunt in all the alkaline waters of Canada (Ontario and Quebec) examined for it, and in certain neutral waters of the same country§. These last waters arise from Lower Silurian rocks; and all those named as containing boracic acid may resemble Palæozoic sea-water rather than our own. An origin for the boracic acid in the borates has also been sought by myself || in volcanic waters containing sulphuric acid, such as Dr. Dawson considers to have produced the gypsums here by action on the deposits of carbonate of lime; but when we have it combined with silica and we consider the other contents of the rocks in question, sea-water certainly seems rather to be indicated. However we may derive gypsum directly by either of these methods, or by others¶, it is said

* *Loc. cit.* 1857–61.

† Hunt, Silliman's Journal, November 1859, pp. 366, 367.

‡ Trans. Nova Scotia Institute, 1865.

§ Geology of Canada, p. 560.

|| *Loc. cit.* 1857.

¶ See Hunt's elaborate paper "On the Formation of Gypsum, &c." Silliman's Journal, September and November 1859.

sometimes to originate indirectly from anhydrite by absorption of water. Here we must remember, as Von Cotta says, that "the supposed origin of gypsum from anhydrite leaves the greater difficulty unsolved of the original deposit of anhydrous sulphate of lime"*; and this rock we have here containing imbedded in it hydrated minerals, namely selenite and silicoborocalcite. The latter being in rounded nodules, may have been reduced to that form before being included; but the angular, lustrous, and transparent crystals of selenite cannot have been subject to action capable of so affecting a body originally angular as to render it a pebble. The nodules of hard silicoborocalcite are imbedded (so far as I observed—and I examined the accessible parts of some 300 tons of quarried rock piled in a low heap for shipment, and also saw the mineral *in situ*) exclusively in anhydrite, the soft exclusively in gypsum; there is an intermediate degree of hardness in the mineral found in a matrix composed of both these rocks. We might hence conclude that the soft results from the hard borate in consequence of physical changes accompanying the passage of anhydrite into gypsum: this is not impossible in some cases; but the gypsum holding the soft borate most abundantly is not only so much less pure a rock than the anhydrite holding the hard nodules that it could not have arisen by mere absorption of water, but there are frequently imbedded in it separate nodules of natroborocalcite, which I have never seen in anhydrite. As regards the passing of anhydrite into gypsum, what proofs are there of its ever occurring? Here we see alternations of these rocks below the surface: at Windsor, for example, large lenticular masses of anhydrite, from 2 to 10 feet thick in the centre and some 50 feet long, lie in the midst of gypsum brought to view by quarrying. In other places there are lofty cliffs composed largely of anhydrite on their surface: at Cape Canseau, for instance, I am told by Professor Lawson, the bluff, exposed to the wash of the ocean as well as the action of the atmosphere, is anhydrite, not gypsum. From a consideration of these circumstances, it appears to me that in sedimentary rocks even, where gypsum might be derived from anhydrite, but the converse is not probable, these minerals must sometimes have an independent origin. In the present case I think it must be so, because of the exclusive occurrence of the hard nodules of silicoborocalcite in anhydrite, and from the absence of natroborocalcite from this rock, while it occurs abundantly in the impure gypsum holding the soft silicoborocalcite with selenite. However these rocks and their borates may have originated, it is clear that as deposits they were contemporaneous.

* Rocks Classified, p. 292.

I am informed by Mr. Barnes that, in one locality in Cape Breton, gypsum is found containing titaniferous iron-sand; hence we may expect that, among the numerous sulphate-of-calcium deposits of the province, considerable difference will be found in the nature of their accessory minerals.

From the PHILOSOPHICAL MAGAZINE for March 1868.

ADDENDUM TO CONTRIBUTIONS

TO

THE MINERALOGY OF NOVA SCOTIA.

BY

PROFESSOR HOW.

MY attention has been drawn by Principal Dawson to some particulars mentioned in the paper named above which I shall be glad to state; at the same time I am enabled to give some interesting facts he has kindly communicated, and take the opportunity of giving an analysis of gypsum bearing on one of them, and of adding a few remarks on other points.

In the first place I have inadvertently named *Cape* Canseau as a locality of plaster, I should have said the *Gut* of Canseau. The former is some thirty miles south of the latter; and, as stated by Dr. Dawson, a large part of the peninsula, terminating at Cape Canseau, is occupied by white fine-grained gneiss with veins and masses of granite; there is also much mica-slate and dark-coloured slate; it is in fact quite destitute of gypsum. The Gut of Canseau is the narrow strait between Nova Scotia proper and Cape Breton; and on the Cape-Breton side is situated Plaster Cove, where the beds referred to are seen. They are thus described in a passage of 'Acadian Geology,' which I am sorry to have overlooked at the time when it would have been of great service to me. "About two-thirds of the thickness of the bed consist of crystalline anhydrite, and the remaining third of very fine-grained common gypsum. The anhydrite prevails in the lower part of the bed, the common gypsum in the upper; but the greater part of the bed consists of an intimate mixture of both substances, the common gypsum forming a base in which minute crystals of anhydrite are scattered, and bands in which anhydrite prevails alternating with others in which common gypsum predominates." In a subsequent page (283) an explanation is given of the mode in which the gypsum and gypseous marl may have been formed from sea-water containing sulphuric acid in varying quantities, and the fact stated that anhydrite must have been deposited with the gypsum, and that it seems difficult to account for its production, unless it may have been formed by acid vapours and scattered over the bed of the sea. Dr. Dawson does not think the existence of salt proves anything as to the origin of the gypsum, as, under any probable hypothesis, the rock must have been formed in the sea, and, as the marls and sandstones seem to indicate, in limited and probably shallow basins.

In speaking of ordinary sea-water not containing the boracic acid found in the borates in plaster here, I might have referred to the interesting discovery of the acid in *limited portions* of the Pacific Ocean on the coast of California, considered by Mr. Veatch to be due to volcanic action *. Rammelsberg has detected boracic acid in sea-water and in sea-weed; but where, I cannot say, as I have not access to his paper.

To the minerals found in gypsum, Dr. Dawson says, "I may add peroxide of iron and bituminous and carbonaceous matters." As regards the former, I should certainly have stated that it no doubt exists, and is the cause of the pink and red tints often observed, especially in fibrous gypsum. At one quarry, at Wentworth, Hants county, there is found a deep-red crystalline gypsum. With reference to the bituminous matters, I on one occasion analyzed a nearly black gypsum from near Walton, Hants county, with the following results:—

Gypsum	80·45
Anhydrite	2·84
Bituminous matter	1·53
Clay and sand	7·94
Carbonates of lime and magnesia, with alumina and oxide of iron	7·23
	100·00

Interesting additional facts are given by Dr. Dawson, who mentions that at Gay's River, Colchester county, a very singular bed of gypsum exists containing pure quartz-sand, and also that he has in his cabinet a specimen of gypsum from Cape Breton enclosing a crystal of mispickel.

With reference to the formation of gypsum from anhydrite, Dr. Dawson has long suspected, from the unusually disturbed condition of the beds near those of gypsum, that part of this rock, at least, may have resulted from absorption of water by anhydrite, or some similar process involving *increase of bulk*; but, owing to the obscurities caused by denudation and the unequal erosion of the gypsum, he has not been able to satisfy himself fully on the subject. The whole question as to how the beds of anhydrite could have been formed he thinks well worthy of study.

* Chemical News, vol. iv. p. 16.

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