are also in some specimens traces of oxide of copper. The lead, which is more abundant than at Huntington, occurs in the form of ordinary galena or sulphide of lead, but so far no other ore, except manganese and iron, have been detected, although it is most probable that both cobalt and nickel, and possibly tin, may exist in small quantities.

With regard to the origin of these ores, or under what condition they were produced, I will not here venture an opinion. I believe they determine the lines of some important disturbance; but, however this may be, their occurrence at these particular and widely separated points is certainly curious, and worthy of investigation, and probably other sinkings in the conglomerates of the Chase will help to throw some light on the subject. How far they extend downwards in the conglomerates the present sinkings will of course determine; in August last, they had not been met with below 108 feet from the surface, but copper made its appearance much lower down. The Coal-measures I believe will be struck at about 240 feet from the surface, and I should not be surprised to find these ores mixed up more or less with the gravel and sandstone down to their base. I may remark that copper ore of this description occurs in Permian rocks near Barlaston and Trentham, and at other places in North Staffordshire, and it is also found in large quantities associated with lead, cobalt, and other commercial ores, in Keuper sandstone, at Alderley Edge, in Cheshire; but I myself am not aware that at any other locality than Cannock Chase have copper and lead ores been found in undoubted Bunter conglomerate in England. I do not in their present form, and in the face of richer deposits, attach much commercial value to them; but geologically they are of much interest, and it is these circumstances which have led me to publish the few facts I have been able to obtain in reference to them.

VI.—THE MICROSCOPIC CHARACTERS OF A SILO-CARBACID ROCK FROM CEYLON; AND THEIR BEARING ON THE METHYLOTIC ORIGIN OF THE LAURENTIAN "LIMESTONES."

By WILLIAM KING, Sc.D., Professor of Mineralogy and Geology in Queen's College, Galway.

THE rocks usually called metamorphic¹ may be conveniently divided into two great groups—Silacids and Silo-carbacids,

¹ The term *metamorphic* is herein restricted to rocks that have become *structurally* changed or mineralized. I propose the term *methylosis* (from *meta*, change; and *hyl*, substance) to express the various *chemical* changes which certain rocks have undergone since their formation by eliminations of, or additions to (both processes acting simultaneously, or one alone) their original substances to a more or less extent. The changes are analogous to those of pseudomorphism in minerals. This last term has occasionally been applied in the case of rocks; but some have, with much reason, urged that it ought to be confined, as originally understood, to chemical changes in crystals unaccompanied by any alteration of their form. A term similar to *methylosis* (but coming from different roots) is in use among chemists: geologists, however, are not likely to confound the two. *Methylosis* rocks, I feel persuaded, will prove to be commoner than appears to be known. They are not altogether confined to metamorphic associations; as some—such as coal, magnesian limestones, chloritic, and

depending on the nature of their respective acid constituent. The *first* comprises syenites, gneisses, and ordinary crystalline schists—all essentially composed of mineral silicates. The *second* includes ophites, urkalks,¹ and some others, which, in addition to siliceous minerals, contain more or less mineral carbonates.²

It is chiefly with the second group that the present communication is concerned.

Although a number of highly valuable researches on the microscopic structure of the silacid rocks have been published, it is remarkable that very little attention seems to have been paid to similar investigations in the silo-carbacid group. Excepting certain papers that have appeared respecting one of its members, noted for containing the so-called "Eozoon" (the constructors of which, however, took little notice of anything that was clearly of crystalline origin), geological literature presents a blank as regards the microscopy of the group; the more surprising, as, apart from the belief in the above reputed "organism," the silo-carbacid rocks form a subject of considerable importance in *theoretical* geology; the question as to their origin having evoked at different times some lively discussions, and the most opposite views. I cannot, therefore, too strongly recommend them for examination to investigators of micro-lithology.

Fortunately, the examination of the silo-carbacid rocks is comparatively inexpensive, and attended with uncommon facilities. No sections, unless for supplementary, or optical purposes, are required. Mere chips, after remaining in a weak solution of hydro-chloric acid for a few hours (decalcification, as it is called), will display under the microscope the siliceous minerals freed from the associated mineral carbonates, with every peculiarity of form, condition, and grouping, in a highly instructive manner.

In conjunction with my colleague, Dr. T. H. Rowney, I have lost no opportunity of late years in investigating the structure of these rocks; while in the joint memoirs we have published many of our observations are minutely described.³

serpentinous argillites, etc.—are intimately associated with unaltered rocks. A deposit in Co. Antrim, agreeing with typical beauxite in being a hydro-oxyferrous alumina (and which has been worked by Dr. Ritchie, of Belfast, who has kindly furnished me with specimens), is seemingly a methyloitic product, derived from basalt by the elimination of silica, and the addition of water, etc.

¹ I adopt this name from Werner, though it is restoring one about as objectionable as *gneiss* and some others current in Geology. I have long thought of proposing the name *akerlyte* for a similar crystalline calcareo-siliceous rock, occurring at Aker in Sweden; but probably one of Brongniart's names, *calciophyre* and *hemitrene*, of a later date than Werner's, will prove to be a synonym.

² Apatite and magnetite occasionally prevail to such an extent amongst the Laurentian metamorphics of Canada as to form phosphatic and oxidic sections of the silo-carbacid group. There are other rocks present, in which mineral carbonates occur so sparsely as to merge them closely into the silacid group; on the other hand, it is conceivable that others exist in which the mineral silicates may be reduced to a very small per-centage.

³ See Quarterly Journal of the Geological Society, vol. xxii., 1866; and vol. xxv., 1869; also Proceedings of the Royal Irish Academy, vol. x., 1870; and *Id.*, new series, vol. i., 1871.

Ophites and urkalks respectively represent two sections—hydrous and anhydrous—into which the silo-carbacids may be divided. The first consists essentially of the hydrated siliceous mineral, serpentine and its varieties, more or less intermixed with mineral carbonates, chiefly calcite and dolomite. The second is constituted of anhydrous siliceous minerals, related to amphibole and pyroxene, associated with mineral carbonates. Various other species—silicates and carbonates, and some with different acids—are rarely absent in both sections.

The presence of serpentines, or of amphiboles, is readily indicated; the former by having usually a conchoidal, and the latter an even-plane (cleavage) divisional structure. Both kinds of minerals also occur in the granular, asbestiform, lamellar, and other conditions.

Silo-carbacid rocks seem to be seldom absent wherever metamorphism has played an important part; and, although undoubtedly of widely different geological ages, they are found most extensively developed in the very oldest systems, especially the Laurentian. It was on this account that Werner named the rocks of the anhydrous section urkalks.

During the present year several varieties of ophite and urkalk from India and Ceylon have come under my notice. They are of such interest in many respects that I hope to be able, along with my colleague, to describe them in detail on a future occasion. I have thought it necessary, however, to draw up the present preliminary paper, as some time may elapse before our observations on all these acquisitions are completed.

Captain Bayley, P. and O. agent at Galle, has kindly furnished me with the specimens from Ceylon, as well as a number of precious stones. The former were procured on an estate of his situated adjacent to and below the Haughton Plains. I am not in a position to speak of the mode of occurrence or geological age of the rock, which for some reason or other is called dolomite; but being evidently a member of the great metamorphic series, so remarkably developed in the island, it may very probably be Primordial.

As is the case with many of the so-called dolomites occurring in Canada and elsewhere, the rock under notice contains but an insignificant amount of any mineral carbonates; silicates being the predominant constituents.

By slightly decalcifying portions of it, the carbonates, principally calcite, are partially dissolved out, and the silicates remain. Under the microscope the latter are seen to consist for the most part of what appears to be wollastonite (silicate of lime), in irregular-sized grains confusedly aggregated, or occurring singly,—each grain being distinguished by its individual set of cleavage divisions. At first sight this mineral might be taken for malacolite (silicate of lime and magnesia)—a variety of pyroxene; but careful observations show that it has two prismatic cleavage intersections, which form a more compressed rhombic solid than the one belonging to the last-named mineral; the prism, in short, more closely resembles the primary of amphibole. Dr. Rowney has not yet had an opportunity

of analyzing the mineral; but, considering it is slightly soluble in dilute hydrochloric acid, the solution gelatinizing when concreted,—that it has a somewhat pearly lustre, and is rather easily cut with the point of a knife, we are led to refer it to wollastonite rather than to any of the amphiboles: it moreover appears to agree with the former mineral in its cleavage.

The aggregations are generally in contact; but there are often separations between them varying much in width, and filled with calcite. The wide separations contain isolated aggregations, as well as single grains, of various sizes: those that have not dropped out or been detached consequent on decalcification remain partially imbedded in the undissolved calcite. Interspersed amongst both the wollastonite and calcite occur here and there microscopic gems of different kinds; while the common mineral silicates—serpentine, (?) chondrodite, and others—are occasionally present.

The precious stones, which appear to be variously-coloured spinels—purple principally, opalescent moon-stone, and green chrysolite, have no definite form; being spheroidal, egg-shaped, more or less cylindrical, or lobulated. They have polished surfaces, and seldom display cleavage. A few present traces of angles, edges, and planes, rendering it impossible to resist the conclusion that they are all defaceted crystals which have been acted on by solvents that penetrated their imbedding rock.

The same conclusion attaches to the wollastonite, as its various aggregations and single grains display the plainest evidences of waste, both internally and externally. Their cleavage divisions (each formed by two juxtaposed planes in *immediate* contact in minerals unaffected by disintegration) are of considerable width, and *filled with calcite*. The single grains, also, are without any definite form; and, although their cleavage is well suited for producing the bounding planes of a rhombic prism, their exterior is rarely otherwise than jagged, variously excavated, or irregularly rounded. Isolated fragments, reduced to mere skeletons, occur as plates, rods, films, and shreds; or under a variety of forms—arborescent, curving, and infundibular. When the latter are in clusters—with, as is often the case, a radiating, diverging, or brush-like arrangement in each cluster—their beauty, increased by their translucency and pearly lustre, altogether surpasses description. And the sight is still more striking where the field of view is additionally bedecked with different coloured gems.

The configurations of wollastonite vividly recall to my mind the typical examples of what have been erroneously considered as “casts of tubuli of the canal system of Eozoon.” Finer examples are not to be seen in the Canadian ophites. In these rocks they *invariably* consist of silicates,—generally serpentine, and occasionally a variety of amphibole, or of pyroxene.

It remains to be mentioned that the Ceylon rock has precisely the same characters as a spineliferous urkalk (akerlyte) occurring at Aker in Sweden. The principal mineral silicate of the latter was formerly considered by Dr. Rowney and myself to be malacolite; but we

are now strongly inclined to regard it as wollastonite: be this as it may, the beautiful configurations it has given rise to, and which have been elsewhere noticed by us,¹ are strictly *identical in every thing* with the previously described examples. The Aker urkalk does not appear to be so gemmiferous as the one from Ceylon, it having only yielded to us violet-coloured spinels and fragments of a green vitreous mineral that looks like chrysolite.

The late Dr. Davy, in his memoir, "On the Geology and Mineralogy of Ceylon," written in 1818, and published in vol. v. of the Transactions of the Geological Society, notices a "calcareous spar variety of Gneiss," and a "dolomitic rock": both are probably similar to the urkalk described in this communication. It would appear from his account that the silacid rocks form the matrix of the numerous precious stones found in the alluviums of Ceylon. I admit that carbuncles, topazes, chrysoberyls, etc., may have been derived from the gneisses, and the usually associated crystalline schists; but from what the urkalk reveals under the microscope I am led to believe that calcitic or dolomitic rocks of the kind have yielded the more valuable gems. I cannot speak with confidence that sapphire is present in any of Captain Bayley's specimens; but as it is found in the urkalks of the United States, Ural, Hindostan, China, and other countries, the fact may be accepted as strongly confirmatory of my belief.

It has long been known that the silo-carbacid rocks contain a variety of minerals with the angles and faces of their crystals frequently in a rounded condition. Some have suggested that this peculiarity is the result of partial fusion; while others contend that it is the effect of the solvent action of heated watery solutions. The latter is the view which has been adopted by myself and colleague. I am not aware, however, that any one, except ourselves, has offered the solvent theory to account for the present form of the various configurations in serpentine, malacolite, and wollastonite, characterizing ophites and urkalks; or that the process it involves eventually accomplishes their total removal. Careful observations show, as it were, the process in operation in these rocks,—commencing with the disintegration of their component mineral silicate,—next, gradually removing it (isolated portions of which, through irregular decrection, are made to assume all the imitative shapes characteristic of the configurations), with simultaneous replacement of dolomite, or calcite,—and ceasing on its complete elimination. The phenomenon is evidently due to chemical changes or methylosis, consequent on the presence in the rock of a permeating solvent containing carbonic acid (? atmospheric in its origin), simple, or in combination—an agent fully capable of displacing the silica of the configurations, and substituting a new constituent.

Furthermore, many geologists have been struck with the peculiar modes of occurrence of silo-carbacid rocks,—intrusive or eruptive-like, confusedly crumpled between comparatively undisturbed beds,

¹ Proceedings of the Royal Irish Academy, vol. x., 1870.

disconnected blocks and lenticular sheets,—peculiarities held to be inexplicable on the idea that they are in any way related to sedimentation. While some have left the difficulty to be cleared up by future investigations, a few who have studied pseudomorphism in minerals meet it by contending that in the cases referred to the same phenomenon, accompanied by new mineral arrangements, has been developed.

So much may be urged in favour of this view, that I, with my colleague, have decided on adopting it to explain, not only the origin of urkalks and ophites, including the rocks last noticed; but also the “great beds of limestone,” which in Canada characterize the Laurentian system. The same laws by which felspar, garnet, and other mineral silicates are changed into calcite (cases of the kind being well known), can operate under the necessary conditions—say, hydro-plutonic—in converting widespread strata of silicid rocks into the above so-named beds. Most of the latter, there are strong grounds for believing, are urkalks: some of them, however, may be so sparsely charged with mineral silicates as to justify to some extent, and in their particular case, the name that has been given to the entire series by the Canadian geological surveyors.

In considering the order of the changes which the Laurentians, as a whole, have passed through, according to the doctrine under discussion, it must not be overlooked that this great Rock-system includes, besides its vast beds of every variety of syenite, gneiss, etc., other members which, although essentially formed of the minerals constituting such beds, contain chrysolite, loganite, serpentine, malacolite, chondrodite, pyralloite, talc, pargasite, magnetite, wollastonite, apatite, etc.,¹ with appreciable amounts of mineral carbonates:² the members alluded to may be referred to the *first* stage. Typical ophites and urkalks, still largely made up of the above mineral silicates, but in which there is a notable increase of dolomite, or calcite, ought to be considered as belonging to the *second* stage. While the purer “limestones,” in which it may be assumed the mineral carbonates have gained the ascendancy, will have to be allocated in the *third* stage.

In conclusion, taking for granted that the Laurentian rocks are metamorphosed sediments (silicates) derived from earlier or pre-existing masses of similar chemical composition, I have no hesitation in accepting the conclusion—that the methylosis herein roughly sketched out, or some analogous process, began after the sediments, affected by it, had become mineralized into syenites, gneisses, and the like;³ and ended by their being converted into “limestones.”

¹ Whatever particular view may be taken of pseudomorphic processes, I am strongly inclined to believe that the various minerals mentioned in the text are secondary products, resulting from chemical changes in syenites, gneisses, etc.

² Kalk-diorite and kalk-glimmerschiefer of the Germans seem to belong to this group. Kalk-diabase and lherzolite appear to be younger rocks, whose calcite may be original, or it may have been derived from limestones older than themselves; and I am disposed to admit that much of the calcitic urkalk (not the dolomitic) of Conemara, apparently Lower Cambrian in age, may be a simply metamorphosed calcareous rock.

³ It is even probable that chemical changes commenced while the Laurentian

VII.—BIOGRAPHICAL NOTICE OF JOHN FAREY, GEOLOGIST.

By W. STEPHEN MITCHELL, LL.B., F.L.S., F.G.S.

Sources of Information.—The short notice in the "Monthly Magazine" for Jan.–June, 1826, is, so far as I know, the only printed source from which any account of his life can be obtained. The notices in the "Annual Biography and Obituary," 1827, the "Annual Register," 1826, and "Rose's Biographical Dictionary," are but re-prints from this, with some omissions and verbal alterations. His name does not, I believe, appear in any other biographical dictionary or register.

His Life.—He was born at Woburn, in Bedfordshire, in 1766, where he received a common school education; but showing studious habits he was at sixteen sent to a school at Halifax, in Yorkshire. Here the master was so pleased with him that "he gave him gratuitous instruction in mathematics and philosophy." [Query, What would the term 'philosophy' embrace?] He also studied drawing and surveying, and was recommended to the notice of the celebrated Mr. Smeaton. He had the good fortune to become known to the late Duke of Bedford, and in 1792 was appointed his steward, and lived at Woburn till the Duke's death in 1802. He married early, had a large family, and died at his house in Howland Street, London, Jan. 6th, 1826.

This is all we can learn from the Monthly Magazine. We are not told what was the effect of his introduction to Smeaton, nor what became of him after the death of the Duke. We know that during portions of the years 1807–10 he was engaged on a survey of "the agriculture and minerals of Derbyshire," and in his Report to the Board of Agriculture, published in 1811 (vol. i.) and 1813 (vol. ii.), he is described on the title-page as "Mineral Surveyor, of Upper Crown St., Westminster."

What important works Mr. Farey may have executed as a Surveyor I do not know. But Mr. Farey's publications have an interest for geologists from the fact that they contain the first printed reference to the discoveries of Wm. Smith, the first published geological map [that of the county of Derby], and the first printed list of the sequence of strata based on palæontological data. The paper in which he first refers to the discoveries of Smith is one in the Phil. Mag., vol. xxv. (1806), pp. 44–49, "On the Stratification of England: the intended Thames Archway," etc. Mr. Farey had met with Wm. Smith in 1802, and had learned from him the results of his discoveries.

Mr. Smith, in a letter to Mr. Richardson, of Bath, dated from Woburn, Feb. 1, 1802, writes: "The last week was spent in surveying distant properties belonging to the Duke, and investigating

sediments were undergoing metamorphism. Mr. J. Arthur Phillips has made known some highly valuable and suggestive facts, which seem to show that Cornish Killas or slate rock is marked by a decrease of silica and alumina, and an increase of water and magnesia (or lime in some cases), the more it assumes a metamorphic condition—thus passing into a substance approaching to serpentine. (See Philosophical Magazine, February, 1871.)

the country for many miles in different directions as far as Aylesbury, accompanied by the land steward (Mr. Farey) and Mr. Bevan, of Leighton, to examine the practicability of my arrangement of strata. They both returned complete converts,"—Phillips's *Memoirs of Smith*, p. 40.

From this time Mr. Farey was an ardent follower and warm advocate of Wm. Smith. Dr. Fitton, in an article communicated to the *Edinburgh Review*, vol. xxix., No. 56, 1818, writes: "Mr. Farey, the other . . . friend of Mr. Smith, is himself a geological observer of great activity and unwearied perseverance; and if zeal were the only qualification of an editor, there could not have been any person better fitted for the task. But the patronage of this gentleman is really a little too vehement, and of such a sort that if we wished to insure the failure of a valuable performance, we should begin by recommending it to his protection."

He wrote some very strong articles in support of Wm. Smith's claim to consideration as an original discoverer: for example, his papers in the *Phil. Mag.* on "Mr. Smith's Claims stated," "Geological remarks on Messrs. Cuvier and Brongniart's 'Environs of Paris,' etc., etc.

In 1811 Mr. Farey gave to the world a more careful account of the strata of England, as ascertained by Mr. Smith. He had been engaged by the Board of Agriculture to write the General View of the Agriculture and Minerals of Derbyshire for their County Reports, which they were then having made for the whole of England. There had been already a Report on Derbyshire by Mr. Brown, but this was superseded by the Report of Mr. Farey, which was therefore called a reprint. This work was written according to a plan laid down by the Board. But in Section 4, before the Description of the Soils, he inserted a series of paragraphs with the following titles¹:—

- "The Knowledge of Stratified Masses important" (p. 105).
- "Stratified Masses defined" (p. 106).
- "Sections, or Cutting of Stratified Masses, considered" (p. 106).
- "Application of the above to the Stratification of England, according to Mr. Wm. Smith, of Buckingham Street" (p. 108).
- "General dip, or Declination of Strata towards the S.E. (p. 108).
- "Continued Basset of Strata across the Island" (p. 108).
- "Discrimination of Alluvial Matters" (p. 109).
- "Particular Organic Remains peculiar to particular Lamina of Strata" (p. 109).
- "Order of the British Series of Strata" (pp. 111 to 116).
- "Bagshot-heath Sand, London Clay, and Blackheath Sand" (p. 111).
- "Flinty Chalk, Hard Chalk, Chalk Marl" (p. 112).
- "Aylesbury Limestone, Sands, Clays; Sussex Marble; Woburn Sand" (p. 112).
- "Clunch Clay; Bedford Limestone, Clay; Barnack Ragstone, Collyweston Slate, Sand, Bath Freestone" (p. 113).

¹ Farey's "Derbyshire," contents, p. xxviii.

"Portland, and Bath, and Ketton Limestone; Northampton Stone, Sands, Clays; Maidwell Limestone Clay" (p. 114).

"Lias Clay and Limestone Strata" (p. 114).

"Pozolanic, or Water Lime of Barrow-on-Soar, Leicestershire" (p. 114).

"White Lias, Balderton Sand, Red Marl" (p. 115).

Followed by a "Theory of Dislocated and Denudated, or Cut Stratified Masses," which is illustrated by fifty-six coloured drawings.

I do not know why Farey stopped at the Red Marl in giving an account of Smith's knowledge of the Strata, for Mr. Smith certainly had a knowledge that Coal and the Limestone come underneath.

At the end of the first volume of Sowerby's *Mineral Conchology* is a *Supplementary Index*,¹ arranging the shells described therein according to the several strata in which they are found imbedded, from the newest towards the oldest in the British series. The strata referred to are those as classified in Mr. Smith's map. This was kept up in subsequent volumes.

The Royal Society Catalogue contains a list of Mr. Farey's papers, to which he signed his name, among them are many on music. But there are many anonymous papers of his besides, such as those in the *Monthly Magazine*. I shall be glad to know if any one can say whether he did not write some of the articles in Rees' *Encyclopædia*, e.g. "Grand ridge," "Strata," etc.

As he was so warm a supporter of Smith, it seems strange that the memoir in the *Monthly Magazine* contains no reference to his having received his first geological knowledge from him, but, on the contrary, says he obtained his success from following the proposals of the Duke of Bedford. In many of the writings about this date there seems to have been an intentional suppression of reference to Smith in places where it might justly be expected. Can any explanation for this be offered?

NOTICES OF MEMOIRS.

I.—GEOLOGICAL SURVEY OF INDIA.

1.—MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA, Vol. VIII., Part 1. 1872.

THIS Part comprises an elaborate Memoir by Mr. William King, jun., B.A., on the Kadapah and Karnul Formations of the Madras Presidency. This series of rocks has been hitherto known by such names as the "Diamond Formation," "Clay Slate Formation," and "Old Red Sandstone," names which have proved inapplicable, therefore those of the districts they occupy have been applied for the two formations under which the different groups of rocks can be classed. Mr. King states there are good grounds for believing that they may eventually turn out to be partly representative of the great Vindhyan series of India, and of a possibly underlying

¹ "For this supplementary index I am (says Sowerby) indebted to my indefatigable friend Mr. John Farey."