It is evident from the above tables that acetylene is governed by the same laws as other compressible liquids, that is to say, its compressibility increases as the temperature rises, but diminishes as the pressure increases. For instance, at a pressure of 95 atmospheres it is three times as compressible at 35° C. as at 0° C.

The volume being the same, the compressibility appears to be nearly the same at different temperatures, which is really due to the curves at high pressures running nearly parallel, thus introducing a corresponding difficulty in the estimation of small differences.

On comparing the compressibility of liquid acetylene with the results obtained by M. Amagat ("Annales de Chem.," 1877) in the case of benzene, it appears to be about seven times as compressible as the latter body, at a temperature of 16° C., and under a pressure of 40 atmospheres. The comparison could not be carried out at higher temperatures, for whereas M. Amagat reaches a temperature of 100° C. with the benzene, I was not able to go beyond 35° C. with the acetylene.

XIX. On the Origin of the Mineral, Structural, and Chemical Characters of Ophites and related Rocks." By Professors W. King, Sc.D., and T. H. Rowney, Ph.D. Communicated by the Treasurer, R.S. Received May 12, 1879.

(Abstract.)

The authors, beginning with (A) "The different kinds of rocks treated of," in their memoir, divide them into two groups. The first, "Silacid Ophites," is represented by serpentinite (common at the Lizard) and other rocks, essentially composed of serpentinous minerals: it includes a subsection, comprising peridolites and some others, all slightly hydrated. The second, "Silocarbacid Ophites," consists of rocks, which, in addition to serpentinous minerals, contain a mineral carbonate—for example, ophi-calcite: its subsection is represented by hemithrenes. The relation of the first group, through its subsection, to ordinary metamorphic rocks, also of the second group, through its subsection, to carrarites and dolomites is pointed out.

As regards (B) "Their mineral character," it is stated that ophites, &c., embrace some fifty or more different minerals, all containing more or less hydrous silicate of magnesia; in addition to which, dry silicates and carbonates are often present. The relation of these minerals to others, essentially anhydrous, as hornblende, diallage, and peridote, is noticed.

Treating on (C) "The structural character of ophites, &c.," the protean nature of their essential mineral, serpentine, is shown by

a description of its fibrous, arborescent, coccolitic, platy, and other allomorphs.

With reference to (D) "The origin of certain mineral, structural, and chemical characters of ophites, &c.," the subject is treated of under different heads:—(1) Fibrous layers in peridote from Elfdalen, in "graphic granite" from Harris, in perthite from Siberia, and in other instances. (2) The alternation of different minerals in laminated ophicalcite and ophi-malacolite has its parallel in other and totally different rocks. (3) The change of the fibres of chrysotile into aciculæ, separated by calcareous interpolations, is illustrated by figures taken from decalcified and polarised specimens of this allomorph from Canada; also from a characteristic specimen of the same from the type-locality, Reichenstein. (4) Branching configurations, such as are assumed by serpentine, are common in hemithrenes from widely different regions: the authors refer to examples, showing that they are residual, resulting from the waste of crystalloids of malacolite. Beautiful examples occur in the calcaire saccharoide (a hemithrene) of St. Philippe, near St. Marie-aux-Mines, in the Vosges, rivalling those in Canadian ophite: and not only are the associated lobulated grains of pyrosclerite covered with a fibrous layer, closely resembling chrysotile in structure; but its fibres are occasionally converted into aciculæ, separated by films of calcite. (5) The presence of calcite under the latter condition, and in connexion with configurations of serpentine and malacolite, as well as lobulated grains of these and other minerals, the authors ascribe to chemical changes similar to pseudomorphism among minerals. (6) It is contended that no minerals are incapable of resisting changes of the kind, even those regarded as the most insoluble. The experiments of Bischof, the Professors W. B. and R. E. Rogers and others, show that hypersthene, enstatite, serpentine, and various mineral silicates, digested in water containing carbonic acid, are convertible into carbonates. (7) Cases are mentioned of rocks, essentially composed of mineral silicates, which have thus become changed; as diorite from Jersey, granite and a porphyritic feldsite from near Galway, which have had certain of their mineral silicates replaced by serpentine and calcite.

The latter cases bring on a chapter (E) "On rock-metamorphism generally." The authors divide metamorphic rocks into two groups—mineralised, and methylosed; the former consisting of members which have had their original sedimentary components mineralised into gneiss, hornblende-schist, &c.; and the latter of members, thus mineralised, but which, through the intervention of chemical reactions, have been converted into ophites, &c.: methylosis is to rocks the same as pseudomorphism to minerals. After briefly referring to the theory promulgated by Leibnitz in his "Protogæa," which anticipated many points now generally held as to the origin of the metamorphics, they

examine the doctrine advocated by Sterry Hunt; and contend that it is altogether untenable, both from his own arguments, and a body of unquestionable counter-evidence. Repudiating a doctrine which regards the rocks in question as still being in their original or quasi-original condition, formed at the bottom of a primæval ocean, through the chemical precipitation of substances which it held in solution, the authors express themselves in accordance with the prevailing opinion that they were originally ordinary argillaceous, arenaceous, and other sediments, which, through being buried at great depths, have undergone various changes—some ending in their mineralisation and others in their methylosis. Sterry Hunt's doctrine is further contested by evidences adduced of regional metamorphism pertaining to various post-Archæan periods, whose crystalline or mineral effects are identical with those which he restricts to pre-Cambrian ages, and which he presumes to have been produced by chemical precipitations from seas of the time.

The mineralised metamorphics having thus far principally engaged their attention, the authors next touch upon the (F) "Methylosed metamorphics—ophites." Taking, as their standpoint, the carefully worked out conclusion of Blüm, Bischof, Rose, and others, that serpentine, as a mineral, is in all cases the product of pseudomorphism, it is contended that rocks essentially made up of it, adding other secondary minerals in certain kinds, have necessarily undergone chemical changes. Cases are cited, such as the serpentinite of the Lizard, which they were the first to show, from its containing pseudomorph crystals after augite, had been originally a porphyritic dolerite. One of the Cannover Isles, in Lough Corrib, contains a mass of serpentine, which is shown to be a methylosed diorite or tremolitic rock.

The evidences offered by Bischof, Heddle, and other writers, as to the conversion of serpentinous and other siliceous rocks into calcareous masses are adduced by the authors in confirmation of their view respecting (G) "The methylotic origin of hemithrenes, &c." Additional original evidences are brought forward with the same purport. A volcanic or doleritic dyke intersects gneiss on Mr. Frederick Twining's estate, adjacent to Cleggan Bay, Connemara; where, not only is the gneiss converted into hemithrene, consisting of malacolite, peridote, serpentine, calcite, and other minerals, but the dyke itself is charged with calcitic matter. Another case occurs at St. Philippe, Vosges, where gneiss incloses dyke-like masses of hemithrene, as to conclusively prove, in the opinion of the authors, that the latter are chemically changed products of the former, effected by permeating streams of heated water containing a carbonate in solution. The labours of Delesse have shown that the region around abounds with masses of the kind.

The rocks described having undergone such remarkable changes,

the authors have been induced to make investigations as to (H) "The origin of the minerals characteristic of ophites, &c., especially peridote." With certain exceptions the minerals referred to are considered to be of secondary origin, the exceptions being those remaining unaffected by secondary agencies. Serpentines, malacolite, phlogopite, chlorite, enstatite, and a number of others are all considered as secondary minerals. Peridote, notwithstanding that it is generally considered to be an original mineral in the same sense as the hornblende, feldspar, mica, &c., of granite and other plutonic rocks, is regarded by the authors as a product of alteration in all its relations, and circumstances of occurrence. Its presence in granites, basalts, and lavas has given rise to the belief that it is of igneous origin: nevertheless its occurrence in mineralised and methylosed rocks (gneiss, and ophite of the sedimentary section) is held as proving the contrary: and the authors feel themselves justified in assuming that it is as much a secondary product as the zeolites and pseudomorphs found in granites, basalts, and lavas. Many of the crystals occurring in basalts and lavas, which have been taken for peridote, are in their opinion pseudomorphs after augite and hornblende.

Repudiating the doctrine that the Archæan rocks are the result of chemical precipitations, and entertaining the strongest doubts that life has been to any extent concerned in their formation, the authors, in a chapter (I) "On the origin of the Archæan crystalline limestones of Canada," apply their views on hemithrenes to the present subject; and they arrive at the conclusion, from various considerations, that the rocks in question are methylosed products; but which, before this change took place, existed as gneisses, hornblende-schists, and other mineralised silacid metamorphics.

The question (J) "Why limestones are so rare in formations immediately succeeding the Archæans" is discussed in connexion with the facts that calcareous organisms are rare or not present in the formations referred to, and that calcareous rocks are abundant in the preceding systems—the Archæans. These facts are held to be in unison with the authors' conclusions stated in the last chapter, and to favour the view that the Archæan limestones with their present constitution were not available as materials for the production of calcareous rocks in the earliest Cambrian age.

(K.) "The genetic difference between mineralised and methylosed metamorphism" is explained by assuming that water has been an important factor in both cases; but as the minerals in the first group are for the most part anhydrous or dry species, it is assumed that the original (? hygroscopic) water, which its members contained in their condition as sediment, was sufficient for their mineralisation; on the other hand, as the minerals composing the members of the second group are chiefly hydrous, it is contended that their methylosis has

been effected by additional water penetrating them, and flowing from extraneous or foreign sources. Compared with each other, mineralised rocks may be classed as xerothermal, and methylosed as hydrothermal.

Various evidences are adduced to show that (L) "Some ophites have been originally igneous, and others sedimentary rocks,"—a conclusion favouring their secondary, and consequently their methylotic origin.

(M.) "Some crystalline limestones are simply mineralised," such as carrarite; though rocks closely related to them,—viz., "Dolomites, have undergone methylosis." With regard to the latter, however, the authors do not accept Von Buch's theory of dolomitisation in its general application. Admitting various kinds of this phenomenon, they conceive the change in certain well-known cases has been effected by the action of the magnesian constituents of sea water on subjacent beds of limestone; for example, during the closing portion of the Triassic period, as strongly supported by geological evidences, determined by Ramsay and others, the seas in certain European regions became dried up or reduced; and their water, loaded with magnesian salts, sank through the subjacent sandstones and marls into the Permian limestones, thus converting them into dolomites. Irish corroborative cases are mentioned. The dolomites of the Tyrol are held to have originated in the same way; but it is admitted to be probable that the predazzite of the Canzacola mountain, Val di Fassa, was dolomite that became hydrated by the heated water which accompanied the eruption of the immediately adjacent and overlying monzonite. "Serpentinisation effected in deposits without the intervention of mineralisation" is admitted in the production of the magneso-argillite at Vallecas near Madrid, also of that in the Paris Basin, and other localities; for Sullivan and O'Reilly have shown that it was originally a non-magnesian deposit.

The authors conclude by treating of (N) "The Chrono-geological range of Ophites, &c., and the age of their methylosis." Offering merely possible suggestions as to the age in which this phenomenon took place in what may be regarded as the oldest ophites (as the subject is beset with considerable difficulties), instances referable to secondary periods, as the dolomites and serpentine rocks of the Tyrol, &c., are briefly noticed; but they refer more confidently to the methylosed euphotides, &c., of Northern and Central Italy, which, having burst through Cretaceous limestone (alberese), Eocene sandstones and schists, have incontestably produced gabbro verde during late Tertiary ages. Moreover, it would appear, from the discoveries of Achiardi, that argillaceous schists, in Tuscany, are now being serpentinised by the action of magnesiated water. And, taking the wide range of evidences, which have been adduced, into consideration, it can scarcely be doubted that the same process is still in operation in deep-seated rocks, permeated by heated waters.