contribute in some degree towards the solution of the very difficult problem of the systematic place of the *Rugosa.* As early as 1859 I communicated my views to Prof. Lovén, Mr. Davidson, Prof. Roemer, and others. I soon afterwards made them public in a paper on the *Brachiopoda* of Gotland (1860). In 1861, I showed the lamented Dr. S. P. Woodward a suite of my specimens, expressing my results, and he announced in a paper in the "Geologist" for October, 1862, that he shared almost the same views.

The oldest seas, then, were almost totally without these animals,[1] although their power of building coral reefs is of such great importance in the seas of the present day. They were preceded in the Palæozoic periods by species which sometimes in the structure of their solid parts have an illusive analogy with them, but which, as Agassiz has shown in the *Tabulata,* and supposes also in the *Rugosa,* belong to an inferior class, rather allied to the *Hydrozoa.*

NOTICES OF MEMOIRS.

I.—Professor Daubrée on Meteorites and their Composition.

With Critical Notes, by M. Louis Sæmann, Memb. Inst., etc.

[*Continued from the August Number,* p. 366.]

IN a fourth chapter, entitled "Importance des roches magnésiennes du type péridot tant dans le globe terrestre que dans notre systéme planetaire," the author tries to reconcile the contradiction, so striking at first sight, that almost all meteorites present the same petrographical characters, whereas their terrestrial representatives are comparatively rare rocks. If the characteristic form and the state of aggregation of meteoric stones are entirely unknown amongst terrestrial rocks, it is worthy of remark that the chemical type, the mixture of Peridote and Bronzite, is found on points of the globe most widely separated, sometimes in the condition of true rock, like the Lherzolite of the Pyrenees and the Dunite of New Zealand, sometimes accidentally, so to speak, and in a fragmentary state, in basaltic rocks. These basalts might very well be the result of an absorption of the feldspathic rocks which the Peridotic rock has encountered on its upward passage, and which it has been able to re-fuse by its very elevated temperature. It remains to be examined,

[1] Only two Actinozoa (*Zoanth. perforata*), *Protaræa vetusta* and *P. Verneuili* are cited by M. Edwards as found in the Silurian strata of North America. *Palæocyclus porpita* is also often cited as an exception (Agassiz, Contrib. iii. p. 128. Morton. "Geologist," 1863, p. 466) and is placed amongst the *Fungidæ.* But its compact and solid shell, not at all perforated as in those whose septa alternate with the exterior folds ("costæ"), and do not continue outwards through the walls of the shell, give it a place in the *Z. rugosa* and in the vicinity of the genus *Heliophyllum.* As *Palæocyclus,* during its youngest state, has been attached to other bodies with its apex, it is evident that it cannot be considered as an operculum.

by the aid of new experiments on heat, how much feldspar a fused Lherzolite can melt, or, to speak more correctly, what degree of heat a fused Lherzolite must possess to be able to liquify the quantity of feldspar necessary for forming basalt. The poverty of basalts in magnesia, which seems not to exceed six to eight per cent. when there is no Peridote visible, is unfavourable to this hypothesis. As distinctive characters of the Peridote type amongst rocks, M. Daubreé points out its basicity; there exists in nature no silicate of an igneous origin in which the oxygen of the silica is less than that of the base, and in Peridote the number of atoms is the same in both. The two silicates of magnesia easily crystallize in the dry way after a simple fusion, whereas the feldspathic type can never be produced at will in this manner;[1] lastly, the density of this kind of rock is higher than that of all the others (Lherzolite is 3·25 to 3·33), which is in accordance with the place which it occupies below them. A new series of experiments is calculated to prove that the final result never varies, whatever may have been the previous state of combination of the constituent elements. Silicide of iron, surrounded by calcined magnesia tightly packed, gave very malleable metallic iron covered externally with a crystalline incrustation of green Peridote. In this, as in many other experiments, it is to be regretted that the results were not what might have been anticipated from the analyses; it would have been interesting to see in what proportions the iron entered into the composition of the Peridote, when the operation seems rather of a nature to favour the production of a simple silicate of magnesia (the Forsterite of mineralogists). Another experiment explains in a very happy manner the peculiarity shown long since by Berzelius, that the Peridote in meteorites, even when enveloped by nickeliferous iron, contains no nickel, whereas terrestrial Peridotes almost all contain it. A mixture of ten parts of an alloy of iron with nickel (containing one-tenth nickel) with one part of phosphide of iron, one part of protosulphide of iron, forty-three parts of silica, and fifty-seven of magnesia, give, after fusion, a *culot* of Peridote mixed with an excess of metallic iron, and the Peridote obtained contains no greater traces of nickel than the Peridote of meteorites. It appears, therefore, that so long as the iron is in sufficient quantity the nickel remains in the metallic state; but it is moreover to be remarked, that terrestrial and nickeliferous Peridotes could not have crystallized in a "universal scoria" containing unoxidized iron. The sulphide and phosphide of iron behaved like the nickel; they fused without any oxidation of the metallic part of the *culot*.

The last paragraph of Professor Daubreé's third paper is headed, "Application to the mode of formation of our globe. Origin of peridote as universal scoria."

Going back to the discoveries of Sir Humphrey Davy, M. Daubreé seems disposed to take, as a starting point, a fused globe

[1] The observation of Prahtl (Mem. de l'Acad. de Vienne, t. ii., p. 230; Bischof, Chem. Géologie, vol. ii., p. 404) of feldspar crystallizing in a mass of glass requires also particular attention.

composed of oxidizable elements, and subjected to the simultaneous action of heat and of the oxygen of the air; thus would have been set up a continuous and superficial reaction—a kind of natural cupellation (Elie De Beaumont), or of scorification, of which the more immediate product would be Peridote, whence its name of universal scoria. There would be, in reality, no other difference between this scoria and meteorites than a smaller proportion of oxygen in the latter, shown by the presence of unoxidized metals.

After having summed up, with as much accuracy as possible, the labours of the learned and illustrious professor, who has just opened a new field to the exertions of geologists, I may, perhaps, be allowed to add some observations concerning only the theoretical conclusions.

It cannot have escaped anyone who closely observes the progress of geologists, that everything connected with the speculative part of the science has for a long time been in disfavour amongst them. They require facts and experiments; nothing more. This is an extreme reaction against the fantastic theories which hampered the beginning of the science. It is extreme because it is the cause and the source of an immense accumulation of heterogeneous matter, true and false, often contradictory and oftener useless. The same discovery was often repeated over again; for no one can keep account of, remember, or know, all that others have done. In what concerns the physical cosmogony it is evident that geologists are behindhand: one has but to observe the activity which prevails amongst astronomers to discover the true nature of the solar phenomena, and the results obtained for science by the work of the physicists on spectral and sidereal analysis; it is really not any too soon for geologists to contribute their share to this work.

The idea put forth by M. Daubreé of a universal scoria is a bold step in this direction. It is to be regretted that he should have rested satisfied with attributing its merits to geologists and the science of twenty-five years ago. In the first place, how can we understand a liquid scoria;[1] for to be capable of being erupted, to melt rocks on its way, it is necessary that Lherzolite, this universal scoria, should have been in a state of fusion—and how can it have been melted afresh if its first production be effected by scorification. Moreover, to be the universal scoria, it must necessarily have been the source of all that exists in a solid state in the universe. But, taking only our earth into consideration, it is evident that no action can extract from this scoria that which it does not contain. M. Daubreé knows well that neither liquefaction nor cupellation will make it give out the elements of granite and other rocks.

In dwelling on the density of Lherzolites and on the depth at which they are found, he shows us clearly the only conclusion to which his observations led. If, in fact, we find in practice that rocks are superposed in the order of their density, the heaviest

[1] By "scoria" Professor Daubreé may possibly mean a *fused* mass of oxides and silicates, such as blast-furnace slag, which, in England and France, is known by almost similar terms.

below, we cannot suppose that this arrangement was produced by chance, nor whilst the rocks were in their present condition. A separation of strata, according to their densities, can only take place in liquid; and if a separation took place under the form of icicles and in the solid state, one could never expect to find this product of scorification injected into overlying rocks. The idea of stratification of a liquid has, however, nothing in it contrary to the principles of the science, especially when considering a liquid of very complex composition, and in which chemical affinity tends toward a grouping of the elements.

Considered from this point of view, Lherzolite would occupy a a certain position in the interior of the globe, determined by its specific gravity; it would be overlain successively by basalts, by diabase, by diorites, and by trachytes; granites being, probably, the result of a metamorphic action on these last, or on their elements. This disposition would explain the order of appearance of each rock, and the geologist will have to enquire which are the strata that furnish a special type of rock, and what are the accidental products resulting from the contact of different strata; and, as all the primitive rocks at present known are insufficient to explain the extreme predominance of lime and of silica in all the sedimentary rocks, they might find an easy method of overcoming this difficulty by supposing the existence of, at least, one superficial stratum, whose peculiar composition would explain the abundance of these two bodies. One fact in support of this proposition seems the following: there is found, rarely it seems amongst the granites, in the environs of Miask, a variety of graphic pegmatite, in which the space appropriated to the quartz is left empty; and as it would be quite inadmissible to attribute this absence of the quartz to removal by solution, since the feldspar, which is infinitely more alterable, has remained unattacked, one cannot conveniently explain this phenomenon except by admitting that the quartz had filled the spaces left after the crystallization of the feldspar between the crystals of this last grouped in a parallel manner; but the hypothesis, which suggests itself here for the pegmatite, would also explain, in a most satisfactory manner, the formation of granite in general. If one could discover a source of silica sufficiently abundant to furnish all the quartz which, permeating the empty spaces in the feldspathic rocks, would have furnished the quartziferous rocks, it would seem that, by admitting the existence of a stratum overlying the feldspathic rocks, and formed of a silicate of lime, possibly alkaline, whose lightness would establish its place at the surface of the liquid globe, and whose composition should be such that it would be unable to resist the action of the waters when they became condensed—that such a disposition would explain the abundance of the silica and lime (and, if necessary, the soda in sea-water,) in sedimentary rocks. How otherwise can one explain that the percentage of silica in rocks diminishes in proportion to their depth? and how great a quantity of magnesia and oxide of iron must have accumulated if the silica and the lime arose from the destruction of a universal scoria, or even of pyroxenic rocks,—like basalt, for instance, which contains, on an average, only 45 per cent. of silica and 12 per cent. of lime.

Where are the residues of this immense lixiviation which has furnished these two elements to all the sedimentary formations, and the quartz to granites and gneiss?

The memoirs of M. Daubreé touch upon questions of another nature which promise well for the future of the science. The author inquires what can be the reason of this marked difference in the degree of oxidation observed between meteorites and terrestrial rocks? Native iron being quite unknown on the earth, to what must be attributed its predominance in meteorites? Is it preferable to suppose a reducing atmosphere (hydrogen, for instance) through which the meteorites must have passed? or is it rather to the scarcity of oxygen at the time of their formation that it is to be attributed? It is not probable that the circumstances could be so simple in nature. Nothing, in fact, shows that, in the interior of the earth underneath the Lherzolitic zone, there do not follow others which finally might well become identical with the meteorites. Imagination is lost in the numerous possible chemical actions which might have taken place on the first contact of the elements!—a contact which is considered, probably with reason, to have been the source of the primitive heat of the globe and of the present heat of the sun.

Chemical affinities are modified according to temperature. Mercury does not combine with oxygen at ordinary temperatures, but combines with it at its boiling point and gives it off again at an incipient red heat: here are three different states of chemical affinity within the limits of a few hundred degrees, and who would dare assert that at this last phase of separation the chemical action between these two elements ceases definitely and for all higher temperatures. But what is true of mercury and oxygen is likewise true for all other elements. In so far as regards the earth, there is, however, one combination which presents itself under such circumstances that one can hardly doubt its existence at all stages of the geological series: it is water, a result of the most powerful chemical affinity, which, by its volatility, is protected from the principal causes of destruction, and whose oxygen, liberated in the presence of any incandescent body, immediately recombines with the hydrogen, which no other element can permanently withhold from it. In fact one might say, without exaggeration, that water, as the ancients have long thought, is a true cosmogonic element; it lends itself to all sorts of reactions, but only temporarily, and as constantly returns to its former state. Following in the steps of M. Daubreé, it will, no doubt, be possible to prove experimentally that all the phenomena of oxidation are compatible with the hypothesis that they have been produced by the decomposition of water at different temperatures; and, in consequence, that the oxygenation of the earth in the advanced state it now presents travels from the surface to the centre, and that it is quite possible that there should exist in the interior a zone or nucleus of meteoric substance, stone or iron, of which the oxidation goes on slowly in proportion to the cooling. This being granted,

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we may conclude that the quantity of oxygen in the atmosphere must continually diminish—brought to the state of water by the liberated hydrogen which under some form or other re-ascends to the surface. Before the oceans will have been absorbed, the oxygen will have disappeared from the atmosphere, and all organic life will have become extinct.

A planetary epoch, that is to say, the duration and general results of the phenomena which have been produced from the throwing into action of the chemical elements of a planetary system, until the final and perfect establishment of their equilibrium, is nothing in reality but a chemical reaction on the grandest scale—a reaction prolonged by the changes which the chemical affinities undergo and of which the lowering of the temperature seems to be the most powerful agent. The development of organic life on each celestial body is only a transient accident, an evanescent mouldiness (*sic*), *since out of an average of 2,000 degrees of temperature that each* planet must pass through there are scarcely forty in which organic life is possible.

As a compensation, it must always be in progress somewhere. The sun passes, with a slowness proportioned to its volume, over periods of excessive length, and astronomers only can calculate what will be the duration of its geological periods, if we could only suppose them to be accomplished with regularity. The moon has run through her term with such rapidity that for a long time it has been terminated, and she can only expect a renovation by some catastrophe.

There is, then, in all these phenomena, a constant succession of cause and effect ruling all matter which is presented to scientific investigation such as is practised in our day.

M. Daubreé, in pointing out what he rightly or wrongly calls the universal scoria, has proved that he does not recoil from the boldest conceptions; he opens up a new school for geologists, he calls to his aid patient workers, and sets in action the immense resources of Paris; and if he shares the fate of the majority of scientific men, who seeking one thing find another, he will nevertheless be sure to create a branch of geology which will amply recompense for the work bestowed, and will satisfy the highest aspirations of human intelligence.

NOTE.—We have felt great pleasure in accepting M. Sæmann's carefully prepared notice of the interesting researches of Professor Daubreé, and we do not doubt that this communication will be welcome to many of our readers.

M. Sæmann regrets that the speculative part of the science of geology has been in disfavour, and that we have sought for facts and experiments and nothing more. Surely M. Sæmann, as a practical geologist, must see the prudence of this course. It is only necessary to point to such works as Figuier's "World before the Deluge," Marsden's "Footsteps of Creation," and a host of other quasiscientific works, issued during the last few years, to show the rashness of such crude and hasty speculations. Great and able generalizers and theorists are rare as compared with the mass of mere workers in the hive of science, and *necessarily so.* Even the ingenious theories of MM. Daubreé and Sæmann have carried them far beyond the legitimate conclusions deducible from Professor Daubreé's meritorious labours; and we find rhapsody too often taking the place of sound philosophical reasoning. No doubt the hardest of all lessons to the ardent physical geologist and mineralogist is to "learn to labour and to wait." The linking facts to facts, and proving all things by careful analysis, is slow and tedious work, but upon this solid and sure foundation can alone arise good and profitable and lasting generalizations.—Edit.

II.—Quarterly Journal of the Geological Society of London. Vol. XXII. Part III. August, 1866.

THE results which Professors King and Rowney have arrived at in regard to the nature of the so-called *Eozoön Canadense,* and which created a very animated discussion in the "Reader" of last year, are here published in full. In summing up the authors state "that every one of the specialities which have been diagnosed for *Eozoön Canadense* is solely and purely of crystalline origin;" and they hold, "without the least reservation, that, from every available standing point—foraminiferal, mineralogical, chemical, and geological—the opposite view (that held by Dr. Carpenter, etc.) has been shown to be utterly untenable;" they are inclined to believe that the "Eozoönal ophite" is a pseudo-morphic rock, that it existed at one time in the ordinary metamorphic state, perhaps as hornblendic or augitic gneiss, and that it is primarily of sedimentary origin. The paper is illustrated with two lithographic plates. A note by Dr. Carpenter follows, in which he confirms his previous observations on the Foraminiferal affinities of *Eozoön,* and states that he has detected similar organic remains in the fundamental gneissic formations of Central Europe and Scandinavia.

Mr. Godwin-Austen gives a description of the Upper Tertiary formations of Belgium. His account of the conditions of the Crag-Sea area is especially interesting, both as regards its physical and zoological features.

Mr. Locke Travers discusses the mode of formation of certain Lake-basins in the provinces of Nelson and Marlborough, New Zealand, believing them to owe their existence to moraine-dams.

Mr. Robert Dawson furnishes a short note on the presence of dead littoral shells in the bed of the German Ocean, forty miles off the coast of Aberdeen; they are specimens of *Purpura lapillus. Litorina rudis, Solen siliqua,* and *Mytilus edulis.*

Mr. Jamieson contributes a paper on the Glacial Phenomena of Caithness, illustrated with a small map and a number of sections. He gives a list of seventy-five species of shells found in the Drift-beds.

Mr. R. Lechmere Guppy describes and figures twenty-seven new species of Miocene Mollusca from Jamaica, three new species of Miocene Brachiopoda from Trinidad, and three new species of *Echinolampas* from the West Indies. He makes some interesting remarks on the relationship of the Miocene beds of Jamaica, and gives a list of the fossils and their distribution. Mr. Davidson adds a note on the Brachiopoda.

Dr. Young gives a detailed anatomical description of *Platysomus* and allied genera; also a note on the scales of *Rhizodus*.

Then come a number of abstracts of papers relating to the recent volcanic disturbances in the neighbourhood of Santorino, with which the Society has been literally deluged.

Mr. Jukes' exhaustive paper on the Carboniferous Slate (or Devonian Rocks) and the Old Red Sandstone of South Ireland and North Devon concludes this number of the proceedings of the Society.

In the Miscellaneous part are abstracts of papers by Herr von Koenen on the Fauna of the Lower Oligocene Tertiary Beds of Helmstädt, near Brunswick; by M. E. Hébert, on the Nummulitic Strata of Northern Italy and the Alps, and on the Oligocene of Germany; and by Professor Gümbel, on the Occurrence of *Eozoön* in the Primary Rocks of Eastern Bavaria.

III.—Quarterly Journal of Science, July, 1866.

Mr. Hull, of the Geological Survey, gives an account of the New Iron-fields of England. The supply of the Coal-measure iron-stones in the Staffordshire, Shropshire, and Glasgow districts is rapidly diminishing, while every year the demand for iron is increasing. "How this demand was to be met, without drawing largely on the resources of foreign countries, is a problem which received its solution just at the time when it began to occupy men's minds," by the discovery of the "New Iron Fields" here described. They occupy a broad belt of country extending from the Cleveland Hills of Yorkshire to the Cotteswolds of Gloucester and Somerset. The Iron-stone occurs at the top of the Marlstone, or Middle Lias, and at the base of the Great Oolite.

Mr. Boyd Dawkins, of the Geological Survey, contributes a paper on the Habits and Condition of the Two Earliest Races of Men. "He traces man from his earliest appearance on the earth down to the borders of history, and shows how, as he grew older, he profited by his experience, and slowly widened the chasm between himself and the brutes, by making his life more and more artificial."

Mr. Archibald Geikie, F.R.S., gives some hints to Home Tourists on the advantages of a knowledge of the elements of geology, and points out the study of our old British volcanoes as a "field of research where the reapers have not been so numerous as in some others adjoining, and where, in consequence, there still remain a good many sheaves to be gathered." [See Mr. Geikie's article "On the Permian Volcanos of Scotland," Geological Magazine, June, 1866, p. 243.]

There is an interesting review of Geological Maps, and the relation of Geology to Agriculture and the question of the Coal-supply.

In the Chronicles of Geology and Palæontology will be found discussions on several questions of theoretical interest, more particularly an account of Mr. Croll's "Speculations on Cosmical Causes of Changes of Temperature, and on the Submergence of the Northern Hemisphere during the Glacial Period," and of the papers by Messrs. Heath, Carrick Moore, and the Rev. Professor Haughton on the same subject, in the "Philosophical Magazine."

REVIEWS.

I.—Rocks Classified and Described, a Treatise on Lithology. By Bernard von Cotta. An English Edition. By Philip Henry Lawrence. Revised by the Author. 8vo. pp. 425. 1866. London: Longmans, Green & Co.

[1st Notice.]

A TREATISE on Rocks, by Bernard von Cotta, rendered into English by Mr. P. H. Lawrence, and revised by the author, is a book that must of necessity find a place in the library of every geological student. We are not altogether sorry, however, to find that it does not (as we anticipated it might have done) supersede our trusty referee, "Bristow's Glossary of Mineralogy,"[1] which still holds its own against the veteran invader.

Dr. Cotta's work consists of three parts. Part I. is devoted to Mineralogy; Part II. to Rocks, and Lithology proper; Part III. to the mode of formation and metamorphism of Rocks.

Without any desire to withhold the meed of praise due to the author for Parts II. and III. of this most valuable book, we cannot refrain from offering a few needful critical observations upon Part I. which we hope will undergo great revision in another edition.

In Part I. chapter the first (p. 3), the author observes:—"As to the much-debated question of classification of the minerals, we have adopted one which appeared to us best suited for our present purpose; it is not exactly that of any one author. We have placed a few of those minerals first which are of the most frequent occurrence; otherwise the arrangement adopted will be found to correspond in several respects with Dana's 'System of Mineralogy.'"

This attempt of Dr. Cotta's to combine several systems of classification in one has given rise, as will presently be seen, to many difficulties, for the *media via* of mineralogy does not here prove to be *tutissima*.

The classification of Minerals, or, in fact, of any other natural

[1] A Glossary of Mineralogy. By H. W. Bristow, F.G.S., Senior officer of the Geological Survey of Great Britain, 1861. 8vo. pp. 466. (Arranged alphabetically, with numerous woodcuts.) London: Longmans, Green, and Reader.