

has increased very considerably; but there are also plenty of others in which this is not the case, even with highly altered rocks close to the contact, the normal excess of potash over soda having remained undisturbed; and the evidence, as will be seen, is rendered all the more contradictory by the fact that in a given vertical section of beds we may have a rock quite near the Whin, showing this chemically unchanged condition, whilst another one, further away from contact, shows a great increase of soda relatively to the potash.

As previously pointed out, the rocks along the Whin Sill are not specially favourable for the study of the chemical aspect of the metamorphism, inasmuch as the igneous mass is intruded parallel to their strike, and we cannot take any one bed at a distance and follow it gradually up to the contact. All we are able to do is to rely on the fact that, apparently without any exception, the normal shales of the Carboniferous show an excess of potash over soda within certain limits. All the trustworthy chemical evidence available shows this to be the case, and I have myself confirmed it by large numbers of careful determinations, published and unpublished, on specimens from various localities; the two latest being a fireclay and a shale which I took from the neighbourhood of Bardon Mill, near to the exposure of the Whin Sill and its contact-rocks, but quite outside the area of its metamorphic action. The alkalis contained are respectively:—

Potash	...	...	...	2.62 per cent.	and	2.66 per cent.
Soda	...	...	...	0.98	,,	and 1.24

The three analyses given above of calcareous adinoles are all striking instances of a large increase in soda. The total alkali-contents are all three high, though not higher than may be seen in some cases of chemically normal shales. But soda far exceeds potash in all of them. No shales of similar composition exist outside the contact-zone, and however we may *explain* the transfer of soda, we cannot very well deny its occurrence. This increase of soda, as a chemical fact, is accompanied by the mineralogical fact of the appearance of albite in the altered rock. Had we these cases only before us, there would not seem to be much difficulty in accepting the statements of previous observers on the subject.

(To be continued.)

NOTICES OF MEMOIRS.

I.—SOME CHARACTERISTIC GENERA OF THE CAMBRIAN.¹ By G. F. MATTHEW, LL.D., D.Sc., F.R.S.C.

THE paper gives in brief the history and use of several generic names, and the distribution of certain species to which they have been applied. These genera have an important bearing on the antiquity of the *Olenellus* Fauna. *Bathyuriscus*, Meek, known as a Middle Cambrian genus in Montana and Nevada, occurs in the *Olenellus* Fauna of Eastern North America. It is nearly allied

¹ Paper read in Section C (Geology), British Association, Toronto, August, 1897.

to the following genus—*Dolichometopus*, Angelin, of the Upper *Paradoxides* Beds of Sweden, and is found in beds of similar age in Eastern Canada. With it is associated *Dorypyge*, Dames (= *Olenoides* in part of Walcott), which is a Middle Cambrian genus in Montana and is found also in the *Olenellus* Fauna of Eastern North America. *Microdiscus*, a genus of small trilobites, extending in Eastern Canada up to the Upper *Paradoxides* Beds, is found in the *Olenellus* Fauna. *Agnostus* has a peculiar development in the Upper *Paradoxides* Beds in the appearance at that horizon of the section *Lævigati*; the *Brevifrontes* also abound there. These two sections appear to be present in the fauna with *Olenellus*.

If we accept the view that there has been a regular development of the faunas through Cambrian time, it is difficult to understand how *Olenellus* can be at the base of the Cambrian succession and yet found in company with so many genera and subgenera which are known members of the Middle Cambrian fauna, or that of the Upper *Paradoxides* Beds. *Olenellus* has not yet been found below the *Paradoxides* Beds, and the evidence adduced indicates that it extended *above* rather than below this part of the Cambrian system.

II.—PROBLEMS IN QUEBEC GEOLOGY.¹ By R. W. ELLS, LL.D., F.R.S.C., of the Geographical Survey of Canada.

THIS paper is a brief review of the geological work done in the province of Quebec since the appearance of Dr. Bigsby's first paper on the geology of the province in 1827. It contains a short statement of the conclusions arrived at from time to time by the various workers in this field regarding the structure of the rock formations east of the St. Lawrence, as well as of the Laurentian complex to the north of that river. A summary of the latest views reached from the detailed study of these areas during the last fifteen years, which has appeared in the last volume of the Geological Survey's Report, is also presented.

In regard to the structure of the older crystallines north of the St. Lawrence and Ottawa rivers, it may be said that the opinion once held, that these rocks were originally of sedimentary origin, has now been greatly modified. The Laurentian rocks of Logan are now divided into two great groups. Of these, the lower is essentially a gneiss formation, and may be styled, for the sake of distinction, the Fundamental Gneiss. This is clearly older in point of time than the series of crystalline limestones, quartzose grey gneisses, and quartzite with which they are often so intimately associated as to render the determination of their true relations in the field difficult, but which at other points are clearly situated above the lower gneiss formation.

These newer gneisses and limestones, which have been styled by Logan the "Grenville Series," are, without doubt, for the most part of sedimentary origin, though they are invaded in all directions by masses of granite, greenstone, and other forms of igneous rock. As for the Fundamental Gneiss, also once supposed to be largely of

¹ Abstract of paper read in Section C (Geology), British Association, Toronto, 1897.

sedimentary origin, it has been very conclusively demonstrated, chiefly through the agency of the microscope, that this is for the most part at least an altered igneous rock, and that the supposed bedding planes owe their existence to other causes than those of sedimentation.

The original Upper Laurentian division, which included the great area of the Anorthosite rocks, also supposed at one time to represent altered sedimentary deposits, has been removed from the position it once occupied, since it has been proved, both by the evidence in the field and in the laboratory, to be of igneous origin and subsequent to the deposition of the limestone and quartzite series with which it is associated, so that the Grenville Series, according to the earlier view as to the succession of strata, may now be taken to represent the upper portion of the Laurentian system.

It may also be assumed to represent the lowest division of the clastic or sedimentary rocks in Canada. The relations of these to the rocks which have been styled the "Hastings Series" in Ontario are such that they may, in part at least, be regarded as portions of the same series which have been described in different portions of the field under different names; but whether these be regarded as belonging to the Laurentian or Huronian systems, is of small moment so long as their true relationship to each other and to the underlying Fundamental Gneiss is clearly understood.

To the east of the St. Lawrence the old dispute as to the age of the fossiliferous rocks near the city of Quebec, as well as of their relations to the crystalline schists of the mountain area in the interior of the province, may now be considered as satisfactorily settled. The former hypothesis by which the crystalline schists were regarded as the equivalents, in point of time, of the fossiliferous sediments of the St. Lawrence Valley has been clearly shown to be unfounded, and the schists of the Sutton Mountain area are now assigned to the Huronian system, or are at least beneath the lowest Cambrian of the district. The relative position of the several divisions of the fossiliferous Quebec group has also been ascertained, and it is now established that the Sillery division is situated stratigraphically beneath the Lévis, instead of being, as was at one time supposed, above it. As regards the age of the several divisions of the Quebec group (fossiliferous), it may be said that the Lévis is the apparent equivalent of the Calciferous formation, and that in its upper portion it approaches the Chazy; while the upper portion of the Sillery is the apparent equivalent of the Potsdam Sandstone formation. Between the upper Sillery and the great mass of the rocks which have been referred to this division, there is a fault of considerable magnitude, so that the lower portion of the Sillery presumably includes rocks which have been elsewhere classed as Cambrian, and these may extend as low as the *Paradoxides* zone or division of that system.

The areas of black slate and limestone, which, in the General Report for 1863, were regarded as beneath the crystalline schists and referable to the Potsdam formation, have been determined, on

the evidence of the contained fossils, to be much newer, and to be in fact the equivalents of the lower portion of the Trenton formation; and to this horizon may also now be assigned the greater portion of the strata in the city of Quebec. Here, however, there are a number of anticlinal folds, and the presence of certain fossils, similar to those obtained from the Lévis beds, indicates that along some of these folds beds of that horizon may be found. The same age may be assigned to the great extension of the black slates and limestones which occur at intervals along the south shore of the St. Lawrence, nearly to the extremity of the Gaspé Peninsula, and which appear to dip beneath the strata of the Sillery formation at many points.

In regard to the use of the term Potsdam a distinction must now be made between the Potsdam formation and the Potsdam Sandstone. The latter has been clearly proved in Canada to be the lower portion of the Calciferous formation, and is not separable from it, while there is a manifest break between this and the lower beds, or the Cambrian proper. The term Potsdam formation in Canadian geology was a comprehensive one like the term Cambrian, and like it included all between the Calciferous formation and the Huronian. The discriminate use of the terms has led to much confusion, and as the divisions of the Cambrian have now been properly determined the expression Potsdam formation has practically no meaning in Canadian geology.

R E V I E W S.

MEMOIRS OF THE GEOLOGICAL SURVEY, SCOTLAND: THE GEOLOGY OF COWAL, including the part of Argyllshire between the Clyde and Loch Fine. By W. GUNN, F.G.S., C. T. CLOUGH, M.A., F.G.S., and J. B. HILL, R.N.; with Petrological Notes by J. J. H. TEALL, M.A., F.R.S., Sec. G.S., and Dr. HATCH, Ph.D., F.G.S. 8vo; pp. 333, with index, numerous illustrations in the text, and 10 plates. (Edinburgh: Neill & Co. Price 6s.)

THE Director-General of the Geological Survey observes, in his Preface to this Memoir, that the district known as Cowal “embraces the south-western extension of the various bands of metamorphic rocks which form the southern edge of the Highlands. Bounded on three sides by coast-lines, and penetrated by a number of sea-lochs, it affords better and more continuous sections of these rocks than are generally to be met with in the interior of the country. . . . From the detailed study of this part of the Highlands much information has been obtained by the Geological Survey regarding the structures of the schists and the successive movements by which these structures have been produced. Originally most of the rocks described in the following chapters formed a thick series of sedimentary deposits, the geological age of which still remains to be determined. These strata have been found to have undergone a remarkable series of repeated movements. After being thrown into folds and having been cleaved so as to acquire a first