REPORTS AND PROCEEDINGS.

Abstracts of Papers read before the Geological Section of the British Association at Montreal, August, 1884.

1.—Pennsylvania before and after the Elevation of the Appalachian Mountains.

By Prof. E. W. Claypole, B.A., B.Sc., F.G.S. Lond.

The paper, of which the following notes are an abstract, is intended as an attempt to handle, in a necessarily imperfect manner, and only to first approximations, a difficult but important and interesting geological subject. The method of treatment is, in the writer's opinion, one that has not hitherto been employed for the same purpose.

The object in view is to form some estimate, as near to the truth as possible, of the amount of compression or shortening produced at the surface by the corrugation of the upper layers of the coast into mountain chains, with especial reference to the American Atlantic seaboard.

In order to confine the paper within due limits, certain propositions must be taken as proved. The principal of these are:

1. That central contraction has developed tangential pressure in the crust.
2. That the tangential pressure has produced crumpling of the crust.
3. That to this crumpling are due long ranges of mountains.
4. That the Appalachian Mountains came into being in this manner in the later portion of the Palæozoic era.

These admitted, the conclusion necessarily follows that during the formation of the Appalachian Mountains a considerable contraction of the crumpled area ensued, in a direction at right angles to that of the chain.

The following points constitute the main features of the paper:

1. Short account of the great ranges of Pennsylvania, in plan and section, with diagrams.
2. Situation and account of the line of section adopted.
3. Limitation of the field to a consideration of eleven great ranges—

Blue Mountains	Blue Ridge Mountains
Bower Mountains	Jack's Mountain
Conecocheague Mountains	Standing Stone Mountains
Tuscarora Mountains	Tussey Mountains
W. Shade Mountains	Bald Eagle Mountains
Black Log Mountains	

4. Discussion of the different parts of this section—
   (*a*) The Mountain Region.
   (*b*) The Cumberland Valley.
5. Attempt to estimate or measure the curved line of the crumpled Upper Silurian (Medina) sandstone.
6. Inference that the sixty-five miles of the line of section

represents about 100 miles of surface previously to the crumpling of the crust and elevation of the mountains.

7. This result, for several reasons, below rather than above the truth.
8. Geographical effects of this contraction.
9. Development of the fact that such elevation of mountains by tangential pressure involves not only elevation, but considerable horizontal movement.
10. Diminution of motion to north-west.
11. A few words on the failure of attempts yet made to account for this contraction.
12. Suggestions and conclusions.

2.—A Comparison of the Distinctive Features of Nova-Scotian Coal-fields.

By Edwin Gilpin, Jun., A.M., F.G.S., F.R.S.C.;
Government Inspector of Mines, Province of Nova Scotia.

The Carboniferous rocks of Nova Scotia cover a large part of the northern side of the province, and are exposed in unusually good sections. The presence of workable Coal-seams has led to many surveys, etc., which have resulted in a good knowledge of their structure. The best known and most continuous sections are those of the Joggins in Cumberland county, and of the Cape Breton Coal-fields. There are numerous Coal-fields, the most important being those of Cumberland, Pictou, and Cape Breton.

The presence of east and west synclinal folds is noticeable in each of these districts. In the Sydney Coal-field these foldings are on the prolongation of the ranges of the Pre-Carboniferous rocks, and die out as they recede from them. In all these Coal-fields these flexures are not accompanied by serious faults, except where the older measures have interrupted or complicated them. Thus on the north side of the Cumberland Coal-field the measures are comparatively free from disturbances where no Pre-Carboniferous strata appear, while numerous dislocations are found on the south side, where they rest almost directly on the Silurian slates of the Cobequid mountains.

In the Sydney Coal-field the sections show the ancient centre of the Coal-field where the maximum of coal and the minimum of strata occur, from which it would appear that the distributing currents carried material principally from the north and the south; the source of part of the detritus being the bordering Lower Carboniferous strata. The slight difference of deposition, however, is marked by the presence of beds of bituminous and fossiliferous limestone, which, chiefly developed in the centre, extend almost from end to end of the district.

In the Pictou district a noticeable point is a horizon in the lower part of the section containing 1500 feet of shale, and coal in beds up to 38 feet in thickness. This curious formation is referred to the presence of a contemporaneous barrier-reef of shingle formed from the Millstone Grit, and allowing under its shelter an immense accumulation of argillaceous and carbonaceous sediment. In the

Cumberland Coal-field a long-continued alternation of the shale and sandstone allowed the formation of sixty-seven Coal-beds, only two of which in the "Joggins Section" are of workable size.

It is noticeable that in the Pictou and Cumberland Coal-fields the most productive horizon is at the base of the Coal-measures, and, comparatively speaking, of limited thickness. Thus at Pictou, the lower 1300 feet hold fifteen beds, yielding 119 feet of coal. At Springhill, in the Cumberland district, the lower 1000 feet of the Coal-measures hold twelve beds, containing 51 feet of coal. The overlying measures are more arenaceous, and hold a much smaller proportion of coal in both districts. In Cape Breton Coal-field there are now exposed only 1300 feet of productive measures immediately overlying the Millstone Grit, and holding the workable seams.

The question naturally arises if it might not be considered that at one time the Cape Breton Coal-field may not have had a total thickness of strata equalling that recorded in Pictou and Cumberland, and that possibly the upper section was similar in development.

The coals from these districts present several points of difference. Thus the slightly higher ash contents of the Pictou and Cumberland coals may be connected with the predominance of the including beds of Shale as compared with the more arenaceous measures of Cape Breton, and a low ash percentage in the coals.

Other differences between the districts may be referred to conditions of deposition, foldings, drainage, etc.

As yet the study of the fossils of the three districts does not show any points of difference calling for remark, but this subject has not yet received a share of attention equal to that bestowed on the points of economic interest.

The above and other differences between the districts are perhaps more justly considered due to local differences of the deposition extending over large areas than as marking distinctions between individual and isolated Coal-fields.

3.—The Value of detailed Geological Maps in Relation to Water-Supply and other Practical Questions.

By W. Whitaker, B.A., F.G.S., of the Geological Survey of England.

THOSE maps of the Geological Survey of England in which various divisions of the Drift have been coloured tell us, as a rule, a very different tale from the corresponding sheets in which the Drift is ignored, and it is only these Drift maps that really give us a true idea of the nature of the surface. Indeed in many districts a geological map that does not show the Drift is comparatively useless for most practical purposes, at all events in a populous country like England. Moreover, it is not enough merely to mass Drift as such, but its constituent members should be fairly distinguished, not merely with regard to their classification or relative age, but also as to their composition, whether of clay, loam, or gravel and sand. To illustrate this there are exhibited copies of the two versions of many of the Geological Survey Maps of the London Basin, with and without Drift, from which the following important points will be at once seen:—

1. Large tracts, shown as Chalk on one version, really consist, at the surface, of the generally impervious Boulder-clay, whilst over others the Chalk is covered by Brickearth and Clay-with-flints; all these beds being such as give an aspect to the country very different from what we find where the Chalk is bare.

2. Parts of the wide-spreading area of the London Clay (of the Driftless maps) are really quite altered and deprived of their clayey character, by the sheets, long strips, and more isolated patches of gravel and sand that occur so often, whether along the river-valleys or over the higher plains.

3. The sandy permeable Crags are in great part hidden by Drift, which, though often consisting of sand and gravel, is sometimes of Boulder-clay. Indeed, so widespread is the Glacial Drift in the greater part of Norfolk and Suffolk that only a Drift edition of the Geological Survey Maps of the eastern parts of those counties has been issued; a map without Drift would necessarily be a work of fiction.

To illustrate the important bearing which these Drift maps have on a great question, that of water-supply from the Chalk, the author also exhibits some special maps, which he has made to show the areas over which rain-water has access to the Chalk, as distinguished from those over which the surface-water cannot sink down into the Chalk, or can only do so very partially. These maps will be more particularly noticed in Section G.

4.—On the more Ancient Land Floras of the Old and New Worlds.

By Sir William Dawson, K.C.M.G., LL.D., F.R.S.

In the Laurentian period vegetable life is probably indicated, on both sides of the Atlantic, by the deposits of graphite found in certain horizons. There is good evidence of the existence of land at the time when these graphitic beds were deposited, but no direct evidence as yet of land plants. The carbon of these beds might have been wholly from sub-aquatic vegetation; but there is no certainty that it may not have been in part of terrestrial origin, and there are perhaps some chemical arguments in favour of this. The solution of the question depends on the possible discovery of unaltered Laurentian sediments.

The Silurian land flora, so far as known, is meagre. The fact that *Eopteris* has been found to be merely a film of pyrite deprives us of the ferns. There remain some verticillately-leaved plants allied to *Annularia*, the humble Acrogens of the genus *Psilophyton*, and the somewhat enigmatical plants of the genera *Pachytheca*, *Prototaxites*, and *Berwynia*, with some uncertain Lycopods. We have thus at least forerunners of the families of the *Asterophylliteæ*, the *Lycopodiaceæ*, and the *Coniferæ*.

The comparison of the rich Devonian or Erian flora of the two sides of the Atlantic is very interesting. On both continents it presents three phases, those of the Lower, Middle, and Upper Erian, and there is a remarkable correspondence of these in countries so wide apart as Scotland, Belgium, Canada, Brazil, and Australia. Examples of this were given in the Rhizocarps, at this period very important, in the Lycopods, the Equisetaceæ, the Ferns, and the Conifers. The number of coniferous trees belonging to *Dadoxylon* and allied genera, and the abundance of ferns, often arborescent, were especial features of the Middle and Later Erian.

The flora of the Erian age culminated and then diminished. In like manner that of the succeeding Carboniferous period had a small commencement quite distinct in its species from the Erian; it culminated in the rich vegetation of the true coal formation, which was remarkably similar over the whole world, presenting, however, some curious local differences and dividing lines which are beginning to become more manifest as discovery proceeds. In the Upper Carboniferous the flora diminishes in richness, and the Permian age is, so far as known, one of decadence rather than of new forms. Great progress has recently been made by Williamson and others in unravelling the affinities of the coal-formation plants, and we are on the eve of great discoveries in this field.

Throughout the Silurian, the conditions do not seem to have been eminently favourable to plants, but the few forms known indicate two types of Acrogens, and one leading to the Gymnosperms, and there is no reason to doubt the existence of insular land richly clothed at least with the few forms of vegetation known to have existed.

In the Erian and Carboniferous there seem to have been two great waves of plant-life, proceeding over the continents from the north, and separated by an interval of comparative sterility. But no very material advance was made in them, so that the flora of the whole Palæozoic period presents a great unity and even monotony of forms, and is very distinct from that of succeeding times. Still the leading families of the *Rhizocarpeæ*, *Equisetaceæ*, *Lycopodiaceæ*, *Filices*, and *Coniferæ*, established in Palæozoic times, still remain; and the changes which have occurred consist mainly in the degradation of the three first-named families, and in the introduction of new types of Gymnosperms and Phænogams. These changes, delayed and scarcely perceptible in the Permian and early Mesozoic, seem to have been greatly accelerated in the later Mesozoic.

5.—The Geological Age of the Acadian Fauna.

By G. F. Matthew, A.M., F.R.C.S.

IN this sketch an attempt is made, by comparison with the Cambrian fauna of other countries, and especially of Wales, to fix more exactly than has hitherto been done the position of the assemblage of organisms found near the base of the Saint John group. The Trilobites are taken as a criterion for this purpose. A brief statement of the position and thickness of the beds is given, showing the relation of the fauna to the formation as a whole.

It is shown that the genera and species of the Acadian Trilobites do not agree with those of the Menevian, in the restricted application of that term now in vogue; the great *Paradoxides*, with short eyelobes, and the genera *Anopolenus*, *Agraulos* (=*Arionellus*), *Erinnys*, and *Holocephalina* being, so far as known, absent from it. On the other hand, it shows very close relationships in its genera to the Solva group fauna, especially in the following species:

Solva Group.	Acadian Fauna.
Concoryphe solvensis (Hicks).	*Ctenocephalus Matthewi* (Hartt sp.).
Concoryphe bufo (Hicks).	*Conocoryphe elegans* (Hartt sp.).
Paradoxides Harknessi (Hicks).	*Paradoxides cteminicus* (Matthew).

As bearing on the question of the age of the Acadian fauna, the development of the eyelobe in *Paradoxides* is referred to, and it is shown that while in the Cambrian rocks of Wales the length of the eyelobe is in direct relation to age of the strata, the *Paradoxides* of the Acadian fauna, having continuous or nearly continuous eyelobes, are more primitive in their facies than those of the Menevian, and agree with the species found in the Solva group.

The family of Conocoryphidæ, restricting the name to such species as those described by Corda under *Conocoryphe* and *Ctenocephalus*, are a marked feature of this early fauna; and *Conocoryphe* has a characteristic suture not observed in the Menevian genera. The Acadian *Ctenocephalus* also differs in this respect from the Bohemian species.

6.—The Primitive Conocoryphean.

By G. F. Matthew, A.M., F.R.S.C.

RELATES to the development of the species *Ctenocephalus Matthewi* and other Conocorypheans of the Acadian fauna, and is considered under the three heads, viz. the Development of the Glabella; the Acquisition of Sensory Organs; and the Decoration of the Test.

Under the first head, it is shown that the peculiar glabella of the species above referred to is closely related to the early history of the Trilobite. The glabella, in its earliest stage, is very different from that of the adult, and in outline is not unlike that of *Paradoxides*: it also resembles this species in the position of the ocular fillet. At the next stage the glabella or axial lobe becomes trumpet-shaped, as in *Carauisa*, and in the third the glabella proper is developed by the segmentation of the axial lobe: the glabella and ocular fillets now resemble those of *Ptychoparia*. In the following stages the family characters of the Conocorypheans begin to assert themselves, especially the widening of the base of the glabella, the appearance of the canals connected with the ocular ridges, and the development of spines.

2.—*The Acquirement of Organs of Sense.*—The ocular fillet appears, in the second stage of growth, as a faint, narrow ridge, close to the anterior marginal fold, and extending but a short distance from the glabella. It is not until the fifth stage of growth that the ramifying branches which spread from the ocular ridge to the anterior margin make their appearance. The ocular lobe and sensory apparatus connected with it are more distinctly visible on the under than on the outer surface of the test, and the canalets connected with the lobe spread over the anterior slopes of the shield and extend to the anterior margin. In the tuberculated species they connect by hollow spines with the outer surface. In one species they cover a wider space than in the others, extending some distance behind the ocular ridges and over the front of the glabella.

3. *Decoration of the Test.*—In all the Acadian species of this group but one, the surface of the test at maturity is covered with tubercles and spines similar to the surface-markings of *Conocoryphe Sulgeri*, etc. In the earliest stages, however, no such tubercles are found, but the surface appears smooth or scabrous. In *Ctenocephalus Matthewi* the surface, in the first three stages of growth, appears smooth; in the fourth, tubercles begin to appear, and about the fifth stage all projecting parts of the test are studded with them. Those on the glabella and frontal lobe are arranged in transverse rows; those on the cheeks in interrupted rows conforming more or less to the periphery of these protuberances. Towards the adult stage these tubercles and spines become more irregular in position and number, conforming in this respect to the law of development in the Ammonites, expounded by Professor Alpheus Hyatt.

7.—On Fluxion-Structure in Till.

By Hugh Miller, A.R.S.M., F.G.S., Geological Survey of England and Wales.

It has long been recognized as one of the characteristics of the Till that its long-shaped boulders are striated lengthwise. They have, as it has been concisely expressed, been "launched forward end-on." From the minute and magnifiable striæ upon the smaller (*e.g.* almond-sized) boulders it also appears that these at least have been carried forward, involved in the matrix, and were glaciated chiefly by its particles. Under the microscope these particles exhibit most of the varieties of form and glaciation that are found among larger boulders. The structure of the Till in open situations shows that the axes of its stones have been turned by a common force in the direction of glaciation; it exhibits a rough structure comparable to the fluxion-structure of igneous rocks, the smaller boulders dividing around and apparently drifting past the larger, like the tide round an anchored skiff. These structures, which have been found by the author over many hundreds of square miles, chiefly in the North of England, indicate that at least a surface-layer of the Till was dragged along, with a shearing movement of particle upon particle, producing intimate glaciation within its mass. Proofs are adduced that this moving layer was in general a surface-layer only, and that the Till did not, as has often been supposed, move forward *en masse*, licking up its additions from beneath. This is the only intelligible explanation of the order (as well as the structure) of the Boulder-clays of which the author has any practical knowledge. In up-lying situations, where the drift consists of raw material, fluxion-structures are seldom detected. In sheltered spots they are not generally developed. They are characteristic of well-kneaded

Till in open situations, liable, however, to obscuration by contortions within the mass. Of twelve experimental attempts made near the watershed of England in East Cumberland, 600–900 feet above the sea, to determine the ice-movement from this structure alone, eight were correct, three indeterminate, and only one misleading. The pressure and movement capable of producing this widespread fluxion-structure seem to have been that of some mass vast and far-spreading—closely investing, slow-moving, and heavily dragging—such as glacier-ice. It needs only to be assumed that the confluent glaciers communicated something of their own movement and structure to the ground-moraine below.

8.—On the Southward Ending of a great Synclinal in the Taconic Range.

By James D. Dana, LL.D.

THE Taconic Range, which gave the term "Taconic" to geology, lies in Western New England, between Middlebury, in Vermont, on the north, and Salisbury, in Connecticut, on the south. In former papers, published in the "American Journal of Science," the author has shown, first, that the rocks constituting the range vary as we go from north to south, from roofing-slate and hydromica (or sericite) schist to true chloritic and garnetiferous mica-schists; secondly, that these schists lie mostly in a synclinal or compound synclinal; thirdly, that the crystalline limestone along the eastern foot is one with that along the western, the limestone passing under the schist as a lower member of the synclinal; and, fourthly, that since the limestone contains in Vermont (according to the discoveries of the Vermont Geological Survey, and also of Mr. A. Wing), and in the State of New York, fossils of the Lower Silurian, ranging from the inferior divisions to the higher, the Taconic schists are probably of the age of the Hudson River group or Llandeilo flags.

The author's papers further show that while a large part of the Taconic Range has an eastward dip on both the east and west sides, a southern portion about twelve miles long, consisting of Mount Washington in South-western Massachusetts, and its continuation into Salisbury, Connecticut, is a broad tray-shaped synclinal, the dips of the two sides being toward one another, like the sides of an ordinary trough. The width of the broad synclinal between the limestone belt on either side is about five miles.

As the result of investigation during the last two years, the synclinal character of this Mount Washington part of the Taconic Range is illustrated in the paper by new sections, and by facts connected with the dying out of the great synclinal (or compound synclinal) in the town of Salisbury.

The mean height of Mount Washington above the sea-level is about 2000 feet, and above the wide limestone region on either side and to the south, about 1250 feet. The synclinal virtually ends along an east and west line through the village of Lakeville, in the town of Salisbury, where a beautiful lake lies within the limestone area. The surface of the mountain region descends 1000 feet in the southern, or last, three miles; and in the latitude of Lakeville the width, as the map presented shows, diminishes abruptly from five miles to a narrow neck of six-tenths of a mile. The area south is of limestone, and the neck of schists referred to is hardly 150 feet in height above it.

The limestone may in some places be seen emerging from beneath the schist at a small angle; and at one locality a low oven-shaped anticlinal of limestone has the schist covering all but a narrow portion at the top; the quarrymen had to remove the schist to work at the limestone. Several narrow strips or belts of limestone, S. 15° W. in direction, corresponding with the direction of this part of the range, show out through the sides of the mountain where local anticlinals have had their tops worn off. Further, the dip of the schist over much of the southern slope is southerly, and at a small angle, but with many local anticlinals and synclinals. In addition, there are small areas of schist *in the limestone* region, like straggling portions of the dwindled mountain, which appear in general to be remains of local flexures.

There is the plainest evidence that the limestone formation of southern and south-eastern Salisbury comes out from beneath the dwindled, flattened-out, and worn-off mountain synclinal. And the reason why this limestone is exposed to view over plains miles in width, east and west of the Taconic Mountain, as well as to the south, is simply this, that the once overlying schist has been removed because in badly broken anticlinals and synclinals.

The paper closes with an allusion to the orographic, stratigraphical, and lithological interest of the facts, and to their important bearing on the question of the origin and chronology of certain kinds of crystalline rocks, such as chloritic, garnetiferous, and staurolitic mica-schists, as well as others less coarsely crystalline.

9.—Gleanings from Outcrops of Silurian Strata in Red River Valley, Manitoba.

By J. Hoyes Panton, M.A., Principal of the Collegiate Department, Winnipeg.

The country north of Winnipeg is apparently a very level prairie, but there are several places where Silurian beds crop out—sometimes from beneath the drift on the banks of the Red River and Cook's Creek; sometimes as rocks projecting above the prairie-level. The beds exposed are Limestones, which are worked for ornamental and other purposes.

There are four localities on the river banks, sixteen to twenty-one miles north-east of Winnipeg, which the author groups together as yielding much the same fauna; these are between St. Andrews (North) and East Selkirk. The fossils found here are *Palæophycus*, numerous Corals, and Cephalopods, some Brachiopods and Trilobites.

The localities north and north-west of Winnipeg give a rather different fauna. Stony Mountain rises in a horseshoe shape, about sixty feet above the prairie on the north and north-west sides, sloping gradually down to the prairie-level on the east. There is here also some drift, beneath which are very distinct glacial striæ running north-north-west. Brachiopoda are very numerous here. At Stonewall the glacial striæ are also very distinct, running in the same direction.

The author gives lists of fossils from the different localities. In many cases only the genera are as yet determined. The species will be numerous. The following table gives the chief characteristics :—

	Selkirk, etc.	Stony Mountain.		Stonewall.
		Lower beds.	Upper beds.	
Condition	Rather soft	Soft	Very hard	Hard and flinty
Action with cold acid	Much effervescence	Effervescence	None or slight	Slight effervescence
Colour	Mottled, dark, and light grey	Reddish grey	Light grey and ochreous	Very white
Fossils	Numerous	Many	Few	Several
Type	Corals and Cephalopods	Brachiopods	Corals	Corals

The relative positions of these, and their equivalents, appear to be as follows, in descending order :—

Stonewall.		Niagara limestone.
Stony Mountain.	Upper beds.	? ?
	Lower beds.	Hudson River.
Selkirk, etc.		Trenton.

10.—Tenth Report of the Underground Waters Committee,[1] drawn up by C. E. De Rance.

THE Chairman and Secretary of your Committee are both unavoidably obliged to be absent at the Montreal meeting, which is a source of regret to themselves; the more so that, this being the case, it has been thought advisable to delay presenting their final Report on the Circulation of Underground Waters in South Britain until next year, when the Committee will have been twelve years in existence. During these years particulars have been collected of the sections passed through by a very large number of wells and borings; a daily record has been obtained of the height at which water stands in many of these wells; investigations have been carried out as to the quantity of water held by a cubic foot of various rocks, by Mr. Wethered; and as to the filtering power of sandstones, and the influence of barometric pressure and lunar changes on the height of underground waters, by Mr. I. Roberts. During the present year the attention of the Committee has been directed to the remarkable influence of the earthquake which visited

[1] Consisting of Professor E. Hull, the Rev. H. W. Crosskey, and Messrs. James Glaisher, H. Marten, E. B. Marten, G. H. Morton, W. Pengelly, James Plant, I. Roberts, Thos. S. Stooke, G. J. Symons, W. Topley, E. Wethered, W. Whitaker, and C. E. De Rance (Secretary and Reporter), appointed for the purpose of investigating the Circulation of Underground Waters in the Permeable Formations of England and Wales, and the Quantity and Character of the Water supplied to various towns and districts from those formations.

the east and east-central counties of England, in March last, in raising the levels of the water in the wells of Colchester and elsewhere.

More detailed information is still required as to the proportion of actual rainfall absorbed by various soils, over extended periods representing typical dry and wet years. Information on these heads and on other points of general interest bearing on the percolation of underground waters, referring to observations made in Canada or the United States, would be gladly welcomed by the Committee, and would be incorporated in their eleventh and final report to be presented next year.

Your Committee seek reappointment, but do not require a grant, as they have forms of inquiry on hand, and did not require to expend the whole of the grant of last year, a portion of which only has been drawn.

Appendix—Copy of Questions.

1. *Position* of well or shafts with which you are acquainted? **1*a*.** State *date* at which the well or shaft was originally sunk. Has it been deepened since by sinking or boring? and when? **2.** Approximate *height* of the surface of the ground above Ordnance Datum (mean sea-level)? **3.** *Depth* from the surface to bottom of shaft or well, with diameter. *Depth* from surface to bottom of bore-hole, with diameter? **3*a*.** *Depth* from the surface to the horizontal drift-ways, if any? What is their length and number? **4.** *Height* below the surface at which water stands *before* and *after* pumping. Number of hours elapsing before ordinary level is restored after pumping? **4*a*.** *Height* below the surface at which the water stood when the well was first sunk, and height at which it stands now when not pumped? **5.** *Quantity* capable of being pumped in gallons per day of twenty-four hours? Average quantity daily pumped? **6.** Does the *water-level* vary at different seasons of the year, and to what extent? Has it diminished during the last ten years? **7.** Is the ordinary *water-level* ever affected by local rains, and, if so, in how short a time? And how does it stand in regard to the level of the water in the neighbouring streams, or sea? **8.** *Analysis* of the water, if any. Does the water possess any marked *peculiarity*? **9.** *Section*, with nature of the rock passed through, including cover of Drift, if any, with *thickness*? **9*a*.** In which of the above rocks were springs of water intercepted? **10.** Does the cover of Drift over the rock contain *surface springs*? **11.** If so, are these *land springs* kept entirely *out* of the well? **12.** Are any large *faults* known to exist close to the well? **13.** Were any *brine springs* passed through in making the well? **14.** Are there any *salt springs* in the neighbourhood? **15.** Have any wells or borings been discontinued in your neighbourhood in consequence of the water being more or less *brackish*? If so, please give section in reply to query No. 9. **16.** Kindly give any further information you can.

11.—On the Geology of South Africa.

By T. Rupert Jones, F.R.S., F.G.S., etc.

The contour of the south coast is parallel with the outcrop of the strata in the interior, from Oliphant's River (31° 40′ S. Lat.) on the west coast, southward to the Cape, and then eastward to about 33° 30′ S. Lat. Here the edges of the strata, formerly bending round to the north, have been swept away to a great extent; but their outcrop is again seen on the east coast at St. John's River (31° 40′ S. Lat.), where they strike northeastwardly through Natal, probably far up the country.

1. Gneissic rock and the *Namaqualand Schists* apparently underlie the others, coming out on the north-west and exposing a narrow strip on the south coast. 2. Mica-schists and slates, interrupted by granites here and there, form a curved maritime band, from about

30 to 70 miles broad, and are known as the *Malmesbury Beds* (Dunn). These and the beds next in succession (the *Bokkeveld Beds*, 3) are overlain unconformably by the *Table-Mountain Sandstone* (4), 4000 (?) feet thick, which forms patches and extensive ridges, and possibly dips over No. 3, to join No. 5, the *Witteberg Beds.* Nos. 3 and 5, together about 2100 feet thick, lie parallel, and form a concentric inner band. The former contains *Devonian* fossils; the latter is probably of *Carboniferous* Age (with *Lepidodendron*, etc.), and forms the Wittebergen and Zwartebergen in the Cape District, and the Zuurbergen in Eastern Province.

The *Ecca Beds* (6) come next; Lower Series, 800 feet; Conglomerate Beds (*Dwyka*), 500 feet; Upper Series, 2700 feet; conformable with No. 5; in the south much folded, and in undulations throughout, until it passes under the next set of beds, No. 7, in some places 50 miles to the north. The Ecca Beds have fossil wood and plant remains in abundance here and there, but these have not been clearly determined. This series has not been well defined until lately, and even now its limits are not fully determined. It includes the Karoo Desert, and therefore takes in the lowest members of Bain's great *Karoo Formation*, Nos. 12 and 14 of his map (1856), or the "Ecca," "Koonap," and part of the "Beaufort" Beds of Jones (1867). The series No. 7, horizontal and unconformable on the Ecca Beds at the Camdeboo and elsewhere, retains the name of *Karoo Sandstones;* and after a width of about 40 miles is conformably surmounted by a set of somewhat similar Beds (8) in the Stormberg; and thus No. 7 should be regarded as the *Lower*, and No. 8 the *Upper Karoo Sandstones.* The latter end off northwards in the Draakensberg, Natal, Orange-Free-State, the Transvaal, and Zululand, with the still horizontal *Cave Sandstone* and associated beds. The *Lower Karoo Sandstones* probably thin away northwards beneath the others. Below the *Karoo Sandstones*, and dying out southwards near the Camdeboo (Prof. Green), are the Shales (7*), which constitute the country around Kimberley, described as the "Olive Shales of the Karoo Formation," by G. W. Stow. These die out northward against the old rocks of Griqualand-West and the Transvaal. They contain Glacial conglomerates in their lowest (earliest) beds, in Griqualand-West, just as the Ecca series has its great Glacial conglomerate (the *Dwyka Conglomerate* in No. 6) in its lowest portion. As the *Stormberg Beds* (8) lie upon the *Olive* or *Kimberley Shales* (7*) in the Orange-Free-State, the *Lower Karoo Sandstones* (7) must die out northwards. The *Kimberley Shales* contain some Reptilian bones and plant remains, and some coal on the Vaal; the *Karoo Sandstones* are rich with Dicynodont and other Reptilian bones, and have some Fish remains; and their upper portion (*Stormberg*) contains Ferns and Cycadeous leaves, and some seams of Coal. A fossil mammal also has been fonnd in this series. Throughout its range the *Karoo Series* is traversed with igneous dykes.

Limestones and sandstones (9) with fossils of nearly pure Jurassic, but with some of Cretaceous type, occur unconformably in the Eastern Province. Their fossil Flora is like that of the *Stormberg*

Beds. Cretaceous strata (10) are known on the Natal coast; and Tertiary and Post-Tertiary deposits (11) form several patches on the East, South, and West coasts.

THE SOUTH-AFRICAN FORMATIONS.

11. Tertiary and Post-Tertiary, 100′?		
	~~	(Unconformable on several different rocks.)
10. Cretaceous.		
	~~	(Unconformable on Carboniferous?)
9. Jurassic.	Uitenhage Formation.	Trigonia Beds, Wood-beds, Saliferous Beds, Zwartkop Sandstone: 400′?; Enon Conglomerate, 300′
	~~	(Unconformable on Devonian and other old rocks in Albany.)
Triassic.	Karoo Beds. 8. Upper.	Cave Sandstone, 150′; Red Beds, 600′; Stormberg Beds, 1000′
	Karoo Beds. 7. Lower.	Sandstones and Shales, 5000′; 7*. Kimberley or Olive Shales and Conglomerates 2,300′
	~~	(Unconformable on Ecca Beds in the south, and on the old Vaal and Kaap series in the north.)
Carboniferous?	6. Ecca Beds.	Upper Ecca Beds, 2700′; Dwyka Conglomerate, 500′; Lower Ecca Beds, 800′
	5. Witteberg and Zuurberg Quartzites, 1,000′?	
	4. Table-Mountain Sandstone, 4,000′	
	~~	(Unconformable on the Old Cape Schists and Slates and on the Bokkeveld Beds.)
Devonian.	3. Bokkeveld Beds, 1100′	
	~~	(Probably unconformable to the Malmesbury Beds.)
Silurian?	2. Malmesbury Beds, Mica-schists and Slates of the Cape.	
	~~	(Probable unconformity.)
	1. Namaqualand Schists and Gneiss.	

12.—THE ACADIAN BASIN IN AMERICAN GEOLOGY.

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THE Acadian Basin, embracing the region bordering on and including the Gulf of St. Lawrence, together with the provinces of New Brunswick, Nova Scotia, Newfoundland, and Prince Edward Island, constitutes one of the natural physical divisions of the continent of North America, and exhibits many marked peculiarities of climate and floral and faunal distribution. In its geological structure, and in the history which this reveals, its individuality is not less clearly marked, being often in strong contrast with that of other portions of the continent farther west; and in some periods and features even exhibiting a closer relationship with the geology of Europe. In the present paper, the facts bearing upon this individuality are summarised and discussed; including the consideration of the varying land-surfaces of Acadia in different eras, the time and nature of its physical movements, its climate and its life. A review of recent progress in the investigation of its geological structure is also given.