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Physical Structure and Geology of Australia.

By the Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c.

The Physical Geography of Australia gives a key to its Geology. It is an immense table land, with a narrow tract of land sometimes intervening between the edge of this elevated area and the sea. The east side is the highest, averaging about 2,000 feet above the ocean. The west side is not more thon 1,000 feet above the same. The north is a little higher. The south side is either level with the ocean, or abuts in cliffs upon the sea, ranging from 300 to 600 feet in height. The general character of all the seaward side of the table land is precipitous; but on the south-east angle of the continent the tabular form disappears, and there is a true cluster of mountains (the Australian Alps), whose highest elevation is a little over 7,000 feet. This group is near the sea (Bass' Straits), and then after an interval of about

200 miles of ocean, there is another group of almost equally high mountains which forms the island of Tasmania. The inland portion of the table land slopes by a very gradual incline towards the central depression, which is south and east of the true centre of the continent. Thus the incline is greater and shorter for the east side of Australia, and it is on this side alone we find what can properly be termed a river system. The elevation of the west side of Australia being only half that of the east, or even less, and the distance to the central depression being twice as great, we have no drainage towards the interior at all. Whatever water falls from the clouds collects in marshes, which are generally salt. The soil is composed of disintegrated granite rocks which are sterile and dry, forming little better than a sandy desert. All the table land is more or less interrupted with ranges of mountains which do not run for any distance, and are not sufficiently high to give rise to a river system. The general direction is north and south, or east and west. These mountains seem to be quite independent of each other and of the general axis of the Continent. The most conspicuous of them is the Flinders Range, which rises at Cape Jervis on the south coast, and continues without interruption for five or six hundred miles into the salt lake area, where it abruptly terminates. This chain is of an exceptional character. It differs from the other ranges of Australia in many particulars, and is probably older.

The base of all this table land of Australia is granitic. Isolated mountains of granite crop out all through the southern and western deserts. It forms the axis of the Australian Alps, and the summits of a great portion of the table land on the west and east coasts are of the same rock. There are also considerable tracts in which the granite is replaced by upturned Paleozoic strata, mostly in the form of Slates and Schists, with an almost vertical dip. It cannot be said that the granite is the cause of this uplifting, for it has been mostly derived from the same slates, and bears marks in some cases of stratification, inclined at various angles. Instances are common of the granite passing into schists, gneiss and slates.

The inclination of the Paleozoic rocks is of a very ancient origin, and has no connection with the present outline of Australia. The slates show the same foldings and contortions which such rocks display elsewhere.

Above the older Paleozoic rocks and granite, and lying unconformably upon them, are certain basins of coal-bearing rocks, belonging to both the Mesozoic and Paleozoic periods. These are found mostly on the eastern and southern edge of the table land, but there is good reason for believing that they are only thinly covered elsewhere, and that a most extensive coal-bearing area may be looked for on the western slopes of the same part of Australia. Over the coal measures on the edge of the table land all round the Continent there is a horizontal sandstone with oblique laminations. This formation is also seen in the interior, and I regard it as an eolian deposit. In most places there is no other rock above these strata.

The great central depression or basin of Australia is like the Sahara Desert, of cretaceous age. Its limits are unknown; but abundant fossils in blue marl are found on the very summit of the watershed on the east side of Australia north of latitude 28·0 S., nearly to Cape York, and all round the Gulf of Carpentaria. The western limits of this great cretaceous basin are unknown. Fossils belonging to it have been collected considerably west of the overland telegraph line, as also fossils from Oolitic beds.

On the south side of Australia, from the commencement of the Great Australian Bight, the land is, with little interruption, formed by a series of tertiary rocks, representing all the European deposits, from the Eocene upwards. It is not known how far they may extend inland. They extend some 300 or 400 miles at the least, but they are not seen at any height above 600 feet. On the Australian Bight the Miocene beds of limestone, full of fossils, abut on the sea in cliffs of from 300 to 600 feet in height. On other parts of the coast raised beaches with recent shells are common, notably round the sea boundary of the colony of Victoria.

In the interior all these deposits are overlaid by either volcanic tertiary lavas or by sands, clays, and marls which have been derived from the sub-aerial weathering of the granite and other rocks. The highest portions of all the edge of the table land, and consequently the sources of all our rivers, are in recent volcanic emanations. This is true for the whole extent of Australia. These volcanic emanations are tertiary, and they are all near the edge of the table land. They sweep round the eastern side from north to south, curving round the south side. As far as the Australian Alps they maintain a very uniform age, which appears to be Miocene or later. West of Melbourne they change their character, and become much more modern. Distinct ash cones of craters are preserved, and ash beds, with remains of the existing fauna and flora, are found. The extreme western limit of this volcanic activity is about 100 miles south of the mouth of the River Murray, and here it would seem that the volcanic forces in Australia died out. The raised beaches are found near these craters, and have been, doubtless, elevated in connection with the volcanic outbreaks. In this brief sketch no details of the nature of formations have been given, and they will be now considered a little more closely.

GRANITE.—Two formations of Granite have been recognised in Australia, and there may be more. That which forms the central axis of the table land has a peculiarity which differs from the outer parts of the granitic axis in this, that it is rich in mineral veins. It is in such formations that the valuable deposits of tin are found. They also contain veins of silver, lead, and copper. Gold has also been found in granite, but this metal is more common in a formation to be mentioned presently. The most of the richest Australian tin deposits are stream tin, that is to say, tin washed out of Granite by streams and found in their

beds. But veins of tin have also been found in Herberton (Queensland) as rich as any in the world.

EARLIER PALEOZOIC ROCKS.—In connection with the Granites, the Slates and Schists of the Cambrian, and probably Laurentian periods, are found. In these are the veins containing gold and other metals. As a rule, the veins consist more of Felspar than any other mineral, and their direction is more often meridional than otherwise. It appears that the auriferous veins in the Cambrian formation of the colony of Victoria are much more nearly north and south than those of the Silurian.*

The gold veins in Cambrian Rocks in the same colony are probably eight times more numerous than the Silurian. As a rule the greater number of veins run parallel with the strata in which they are enclosed, and the greater number of the richest veins strike west of north. In California and Brazil veins run parallel to the mountain chains. In Australia they do so on the eastern side of the Continent, but where the edge of the table land bends round to the north-west the veins still keep their north and south direction. They are therefore independent of the present configuration of the land. East and west veins are usually poorer than the meridional ones, which is not the experience of other countries. It would appear also that, as a rule, gold is not embedded in the quartz, but occurs in a comparatively loose state in the midst of cavities and laminations.

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* The terms used in the Geological Survey of Victoria are those of Murchison and his divisions of upper and lower Silurian are followed in that colony. But this system and nomenclature are not generally adopted, from the injustice it does to Sedgwick's prior investigations. Following the example of many Geologists, I restrict the term Silurian to Murchison's Upper Silurian (Ludlowiks, Wenlock, May Hill, or Upper Llandovery). The Buala or Caradoo are Siluro-Cambrian, and all the rest of Murchison's Lower Silurian are Cambrian, But instead of using the term Siluro-Cambrian 1 should much prefer that proposed by Prof. Lupworth (Geol. Mag. for 1879) *Ordovecian* which has much to recommend it.

Very rich copper veins have been found in rocks of probably Cambrian age in South Australia. The ore is sulphide. As a rule, deposits of carbonates of copper in Australia have not proved permanent. Manganese, Antimony, Bismuth, and Graphite are also found in the Cambrian Rocks, but are not worked.

Characteristic Cambrian Graptolites are found in connection with gold-bearing veins. The species are identical with those found in Sweden, Bohemia, Wales, Ireland, Scotland, and the United States of America. Rocks which, by their included fossils, are seen to be the equivalents of the Silurian of Europe and America are found in Victoria (Kilmore), New South Wales (Yass, &c.), Queensland (Rockhampton), and Tasmania.

Fossils identical with species of the Wenlock and Ludlow beds and those most abundant forms of Bohemian Silurian life, as *Phacops (Portlockia) fecundus*, Barrande, are equally abundant in the Yering beds, near Melbourne.

Devonian rocks, with characteristic fossils, often identical with those of Europe, are found very extensively developed in Victoria (North Gippsland), in New South Wales (Mount Lambie, Sofala, Lachlan River), in Queensland (Gympie, Burdekin, Mount Wyatt). In connection with upper Devonian Rocks we have metalliferous veins, gold, and copper. The mines in Gympie are of great richness. Devonian copper veins have not hitherto proved very productive.

True carboniferous plants are found in a few places in New South Wales; not, however, in connection with coal, as at Stroud, Arowa, and in Queensland, the Drummond Range. Marine carboniferous fossils are found in the basin of the Hunter River, generally throughout Tasmania, and in Queensland (Bowen River). It is a remarkable peculiarity of these marine beds that they are interstratified with plants of a character which is considered Lower Mesozoic in Europe and India. They are probably Permian or Triassic.

An entirely different series of plant remains, which seems to have nothing or very little in common with those of the Hunter River, are found in connection with rich coal seams in Queensland, Ipswich, Barrum River, Bundaberg. The characteristic fossils of these beds are *Thinnfeldia odontopteroides*, *Equisetum rotiferum*, and species of *Palmaceæ* and *Cycadaceæ*. These beds are also found in Tasmania. The age to which they can be referred is still a matter of doubt. They cannot be older than the lias, and possibly considerably higher in the secondary series. In many respects they have considerable resemblance to the Indian (Raniganj) coal plants. Some plant remains found at Bacchus Marsh, the Wannon River, and at Bellarine (all at places at considerable distances from one another in the colony of Victoria), are referred to the same age. The evidence of the connection so far is not very strong. There is no coal associated with such remains, whereas it abounds in Queensland if worked profitably.

It is just possible that the Wiannamatta beds of New South Wales may belong to this formation, but if so, it must be under the Hawkesbury Sandstone, which is a different horizon from that hitherto given. This is only a suggestion, which more careful examination may confirm or disprove.

Covering these remains is a sandstone in thick layers with much cross-bedding and oblique lamination, and containing coniferous wood with equisetaceous stems, leaves of cycads or palms and ferns *(Thinnfeldia)*, &c. The species are often the same as those of the Ipswich coal basin. The contained grains of sand are rounded, and the deposit is in my opinion a sub-aerial one, mingled no doubt in places with swampy and fresh water remains. Near Sydney such strata reach in the Blue Mountains a thickness of over 1,000 feet. The same kind of formation is scattered throughout the Continent in isolated masses of various extent. They are generally precipitous, and consist, in my opinion, of hardened cores of aerial accumulations. The stratification is entirely that of wind-blown rocks with ferruginous bands, which are the remains of surface vegetation, from which the carbonized roots of trees may often be seen depending. Unless by the included organic remains, and superposition, we have no means of determining what is the age of these beds. But it would be wrong to attribute them all to one period. Similar conditions would produce the same kind of rock in any epoch.

In New South Wales such beds lie upon the coal beds (Permian and Lias) but not always conformably. In Queensland they lie upon the Cretaceous, and are clearly tertiary. It would be very difficult, indeed, to draw any line of distinction between the Queensland Sandstones, and those of New South Wales or Hawkesbury Sandstones as far as lithological character is concerned, and the included plant remains are common to both. But in portions of the Hawkesbury Sandstone, fossil ganoid fishes of the genera *Cleithrolepis* and *Myriolepis* are found, which have strong resemblances (as far as imperfect specimens would admit of a comparison) to Devoninn forms. In beds above the coal bearing strata termed Wiannamatta, the Permian genus *Palæoniscus* is found. Nevertheless it would be absurd to consider the Hawkesbury Sandstone as of Paleozoic or even lower Mesozoic age. The anomaly of the fish remains, we must explain, by recalling that we have amongst us two species of the Liassic and Triassic genus *Ceratodus*, actually living in Queensland rivers. Throughout Australia, therefore, we may consider that in desert or sandy regions an eolian or aerial deposit has formed or is forming. It hardens into stone in certain portions, and thus gives rise to the precipitous sandstone cliffs and flat-topped mountains which are so characteristic of Australian scenery. These formations are mentioned in this place because there is a complete blank between them and the lower Mesozoic rocks in most places in the colonies. Nevertheless we have some missing links of the secondary deposits now to be specified.

In Western Australia, on the Greenough River, apparently on the margin of the table-land, there are beds containing fossils, which appear to belong to the Upper Lias and the Lower Oolite or Jurassic. Many fossils common in Europe are found there, such as the following from the Upper Lias—*Ammonites salensis*, *A. radians*, *A. walcottii*, *Nautilus semistriatus*, *Gresslya donaciformis*, and *Myacites liassianus*, the last rather referable to the Middle Lias. From the Oolitic beds of the same locality, we have the following fossils, common to European formations—*Ammonites macrocephalus*, *A. brochii*, *Belemnites canaliculatus*, *Cucultæa oblonga*, *pholodomya ovulum*, *Avicula munsteri*, *A. echinata* *Pecten cinctus*, *P. calvus*, *Lima proboscidea*, *L. punctata*, *Ostrea marshii*, *Rhynchonella variabilis*, *Cristellaria cultrata*. The peculiarity of these deposits is that they are lithologically similar to the contemporaneous strata in Europe. Thus the Lias fossils are inclosed in a matrix perfectly identical with a ferruginous or variegated limestone of the Upper Lias occurring near Bath, and the Middle Lias, or marlstone, is not left unrepresented. The matrix of the Oolite fossils was equally characteristic. Mr. Charles Moore in his paper on Mesozoic Australian Geology (Quar. Jour. Geol. Soc., London., 1870, p. 227,) says "that even had no distinctive fossils been present, a geologist acquainted with the secondary rocks of England and Europe would hardly have failed to refer the greater number of the specimens to the horizon of the Lower Oolitic rocks." In this way, lithologically and almost without the evidence of the fossils they contain, the Western Australian specimens might be decided to be contemporaneous with the lower Oolites, and the upper and middle Lias of this country, from which they are so many thousand miles separated. It is probable also that in the same locality Cretaceous rocks are to be found.

On the other side of the Continent, and on the edge of the table, though like Western Australia within the ocean watershed, a number of fossils have been found which may be thus enumerated—lower Oolite, Gordon Downs, containing *Ammonites*, *Pleurotomaria*, *Homomya*, *Pholodomya*, *Myacites*, and *Tancredia*. About 120 miles south of these beds we find strata of a similar or liassic character in the following localities:—Fitzroy Downs, Wollumbilla Creek, Mitchell Downs, the Amba River, the Nive, the Upper Maranoa, Mount Abundance, Blythesdale, and Bungeeworgorai.

A peculiarity in most of these fossils is that they occur in rounded, nodular, or concretionary boulders imbedded in a brittle marl in the creeks. This is also the case with outliers of the Cretaceous rocks when they are found on the highest levels of the watershed on the table-land. Thus, at the Palmer River, in North-east Australia, we find Cretaceous fossils in nodules of blue clay, with septaria, in widely separated localities, but no traces of the original beds. The explanation of this may be that the Oolite and Cretaceous underlie all the interior and that these are fragments of outlines broken up and denuded at the upheaval of the table land.

The species identified with the European Upper and Middle Lias from Western Australia are much fewer in number, but this is partly owing to the fragmentary and imperfect character of the remains. Above these beds and horizontally stratified, with but little disturbance, there is an immense area of the interior of Australia covered with Cretaceous deposits and characteristic Cretaceous fossils—*Ammonites*, *Belemnites*, *Crioceras*, *Cyprina*, *Trigonia*, &c., with reptilian remains of *Ichthyosaurus*. The fossils have been but slightly examined, but of their wide extent there can be no doubt—perhaps covering the whole interior area of the Continent.

The tertiary beds already referred to as covering so large a portion of the south portion of the Continent are apparently divisible into regular horizons similar to those of Europe. The chronological sequence ascertainable by the proportion of exist-

ing species, enables us to correlate them as follows:—They are divisible into three basins. 1. The Murray Basin. 2. The Aldinga and Southern Yorke's Peninsula. 3. The Great Australian Bight, or, to use the nomenclature of Professor Tate, the Bunda Plateau. The Murray Basin not only includes the basin of that river, but passes across into the colony of Victoria, extending to the western side of Port Phillip and North Tasmania. The second basin, according to Professor Tate, occupies disconnected areas on the east side of St. Vincent's Gulf, and the strata are found across Yorke's Peninsula, and probably continue round the shores of St. Vincent's Gulf. According to Professor Tate (who has given much attention to the subject, and whose researches I can confirm as far as an extended examination of the fossil corals are concerned), the Lower Aldinga strata are Eocene, and contain scarcely three per cent. of recent forms. Mount Gambier limestones are the equivalents of these in the south-east, and so is the greater portion of the lower beds of the Australian Bight. The Murray basin, including the Hamilton (Muddy Creek), and Geelong beds (Corio Bay), are Miocene. All the beds are rich in fossils; but in the Murray basin, in all places, extremely well preserved. From a careful comparative examination of the Miocene fauna of these rocks, I have come to the conclusion that about 8 per cent. of the organisms are living at the present time.

The Pliocene beds are not so extensively or so richly represented They are found generally as highly ferruginous outliers, with a few fossils not easily identified. The Flemington series, near Melbourne, are the best instances, some of the organic remains of which have been illustrated by Professor M'Coy. The fauna of all these deposits is characterised by its local character, which though almost thoroughly distinct from the present Australian fauna has still certain features in common. It has been stated that the same tertiary fauna was found in New Guinea, as seen in some fossil specimens brought by the Hon. W. Macleay from Hall Sound. I am enabled, however, to state that this is not the case. There is nothing in common with our tertiary rocks amongst any of the New Guinea fossils, all of which I have carefully examined. There is no satisfactory evidence of any former participation in the great ice age by the Continent of Australia. One or two instances of grooves or striations are recorded, but standing alone in so vast a territory the ice origin is very doubtful. On the whole, the evidence afforded by the animal remains is decidedly in favour of a warmer climate for Australia than that which now prevails, and this is borne out by the plant remains.

While the south portion of the Continent was slowly submerging under the tertiary sea, there is every reason to believe that the eastern side of the Continent was raised above the sea level. The period of this elevation must have been subsequent to the Cretaceous, as marine fossils of that period are found on both sides of the watershed, and on the table land. We have no marine tertiary beds on any portion of the eastern side of the Continent, except a few post tertiary marine shells preserved in ash-beds, which are scarcely above the sea level, and are only seen where the shallow sea has been dammed back by a bank of volcanic mud. Such an instance has been observed by me at Cleveland, in Moreton Bay. The volcanic disturbance must have occurred in places where our present fauna existed.

We have on all the east side of Australia, and in many places in Victoria, instances where vegetable remains are found in the old drainage channels covered by lava streams. These have been named and described by the illustrious Baron von Mueller. They show a remarkable series of fruit-bearing trees, different from those which occupy the same areas at the present day. Though fruits were abundant it was not considered in most cases safe to attempt to determine even the order to which the trees belong. The only exceptions were in the case of a coniferous tree, and one belonging probably to the *Sapindaceæ*. No conclusions could be drawn from the remains as to the age of the beds, but as they

were identical when found in widely separated places, sometimes 600 miles apart, it was seen that we here meet with a flora, which has disappeared, but which must have occupied all the table-land.

Distinct from these deposits, and imbedded in siliceous rocks, other plant-remains are very abundant on the edge of the table-land. These are mainly distinguished by their resemblance to such trees as Cinnamon and other Lauraceæ and Myrtaceous plants, Palmæ, Cycads, and Ferns. The peculiarity of these remains is that they are not usually accompanied by any carbonaceous matter, but rather impressions in silex, probably derived from thermal springs. There are not wanting proofs that these are portions of the same flora to which the fruits, &c., belong, which are covered by volcanic deposits. They are certainly late tertiary, and may be pliocene, or even later.

The most recent of all our formations are the raised beaches and the various drifts and Eolian formations throughout the Continent. The raised beaches are confined to the south side of Australia, as far as we know, and they are of very limited extent. The drifts are more extensive, and probably deposited at different times and under different conditions. Two are distinguished by Mr. Selwyn for Victoria, and they are of different ages, according to his opinion, namely, Miocene and Pliocene. Such formations are extremely important, as they contain the remains of those strata which denudation, during immense geological periods, has left to us. Thus they also retain the gold which has been derived from the Cambrian and Silurian rocks. Wherever these drifts are found overlying auriferous quartz veins, they are also rich in alluvial gold, and they have proved the richest deposits in the colonies, besides being the source of all those large masses of gold which are called "nuggets," some of which have been of enormous size and weight. The alluvial is shallow, and easily worked, but there are instances where it has been covered with outpourings of lava of 300 and 400 feet thick.

This is the proper place to mention that the surface and some small portion of the upper part of gold veins are usually found to be of much greater richness than the lower parts; and this is not because gold favours one portion of a vein more than another, but because the surface represents the gradual detrital accumulation from slow weathering in the course of ages.

The drift or sub-aerial deposits belonging to recent geological periods are in Australia very important and extensive. An illustration from one portion of Australia will explain the whole. In the Murray basin, and through much of South Australia on the west side of Spencer's Gulf, and north-west of Port Lincoln, there are many isolated granite hills, which are the outcrops of the basis of the whole continent. All around them is a sandy desert supporting low shrubby thickets or "scrubs" of *Acacia*, *Eucalyptus*, *Cryptandra*, *Melaleuca*, &c. The sand is a mass of rounded grains of true desert character, that is of grains rounded by having been blown about. It frequently lies in ridges and hills like the waves of the sea, but generally covered with vegetation. The hills are interrupted by yellow clay flats, with an open forest and a soil which a very little moisture renders boggy. Both these accumulations arise from the slow subaerial weathering of the granite. The quartz grains resist decomposition, and get carried about by the wind. The felspar and mica decompose rapidly, and form the basis of the clays to which the small portion of iron per-oxides gives the yellow colour. It is remarked that wells sunk into this clay only furnish an almost undrinkable brackish water, doubtless from the salts of soda, potash, and iron which the felspars contain. An analysis of these waters shows them to contain such salts as chloride of sodium, sulphates of soda, lime, magnesia, and potash, with variable proportions of silica and iron. All these can be referred to chemical decomposition from granites, notably felspars and mica. The taste of salt (sodium chloride) by no means predominates in them. The general surface of this kind of country, with the exception of the

sand-drifts and isolated granite mountains, is perfectly level, and the sand lies loosely upon it. But in crossing such drift ridges one would often be deceived as to their character. They are like mountain ranges, and the partly consolidated sand, which forms isolated masses of calcareous sandstone, lends a support to this impression. It may safely be stated that the greatest part of Australia is covered by formations such as these.

Referring now to the fertile character of the country according to its physical structure, it may be stated generally that the narrow strip which lies between the table-land and the sea is well watered by mountain streams, and the alluvial land in the neighbourhood of these channels is rich and fertile. This includes the larger portion of such areas. On the table-land, where the mountains are not too rocky and rugged, the soil includes many fertile areas; but that is generally on the volcanic strata, which are fortunately of wide extent. We may feel astonished at the immense scale on which volcanic disturbance existed in Australia in tertiary times, but probably it is less in proportion to the area than that which took place in Miocene times in Britain. Thus in the North of Ireland there is a basaltic flow, 500 miles long by 30 wide, or about 1,200 square miles, which attains in many places a thickness of 900 feet.

The lands of the interior are, as a rule, poor, except in the river valleys. Towards the central basin of the Continent they are in all respects like the Sahara, or the table-lands and prairie lands of America. The colony of Victoria is better situated with regard to its lands than any other. It is well watered, and has a larger share of the fertile areas (basaltic) between the table-land and the sea. The portions of the table-lands themselves which fall to its inheritance are also rich in volcanic tracts.

The colony of South Australia may be said to be, as far as the richness of its lands is concerned, all the valleys and slopes of the Flinders Range. As this is about 500 miles long, and of gentle elevation, the tracts available for agriculture are considerable. Towards the north of a line parallel with the head of St. Vincent's Gulf, the rainfall is small and uncertain, which renders proprietors, both agricultural and pastoral, subject to great losses from drought. The geological age of this range has never been exactly ascertained. It is undoubtedly paleozoic, but so singularly destitute of fossils throughout its whole extent that nothing more definite can be stated.

New South Wales and Queensland are relatively in the same position with reference to the table land. The capitals of the colonies are built on the slopes between the plateau and the sea. The portions of the upper part of the high lands included in both colonies have much of the volcanic areas of great richness. The lower lands are poor and sterile, except, as already stated, in the river valleys. In the southern portions of New South Wales these are very numerous.

It has been noticed that the actual amount of the rainfall on the interior slopes must be largely in excess of the drainage by the rivers, and that therefore a great portion soaks into the ground and drains along the incline towards the interior. On this account the structnre of the central basin must be especially favourable for the formation of artesian wells. This was drawn attention to by me in a paper read for me by Sir Roderick Murchison, at the meeting of the British Association at Newcastle-upon-Tyne, in 1863. In 1866, in a series of papers furnished to the *Australasian*, I have advocated the same view. But it did not receive much attention until recently, when the subject has been revived with most beneficial results to the settlers of the interior. One fact in the physical structure of the continent should have indicated such stores of water in the interior. In the central depression of the Continent there is a line of groups of thermal and cold springs covering several hundred square miles. These send forth water from great depths, and are, no doubt, derived from a central underground reservoir whose sources

are on the slopes of the table land. That the waters come from great depth is seen from the fact of the temperature, and the mounds of sinter or travertine around them. This, no doubt, is the silica, &c., once held in solution by the thermal waters under pressure, but liberated on arrival at a level where the pressure was removed.

In these mounds are found deposits of bones, teeth, and other remains of those gigantic marsupials which once roamed over this Continent, but which are now totally extinct. We find also the remains of extinct Crocodiles, even within the limits of New South Wales, as well as a gigantic Lizard, Tortoises, &c. The largest of our extinct Marsupials, the *Diprotodon*, must have been as large as an Elephant, and the abundance of its remains in almost every cave and river bed shows that it was very numerous and wide-spread. Its disappearance from the Continent was in very recent times. In 1866 I found the remains of a Struthious bird, much larger than the Emu, in one of the kitchen-middens of the natives in South Australia. The bones were marked by the scrapings and cuttings of flint knives of the blacks. I then stated that there was evidence that Australia had been formerly occupied by a wingless bird much heavier and larger than the Emu and I proposed for it the name of *Dromaius australis*. It has since been named *Dromornis australis* by Professor Owen, who has found that the bird had formerly a wide range in Australia.

It is generally thought that Australia is a Continent quite recently upheaved from the ocean. There is, however, no evidence of such an origin, at least for the whole. The facts of which we can be certain are these: Since the Miocene period the southern portion of the Continent for its whole extent has been upraised to a height of about 600 feet. Subsequently or contemporaneously there has been a large amount of volcanic disturbance with outpouring of basaltic lavas. After this there has been a subsidence, not very considerable in depth, but extensive. This, is seen, as Professor Tate has pointed out, by the fringe of Eolian

Calcareous Sandstones which for a short distance out to sea, surrounds the south coast. There has then been over a limited area on the south-east side of the Continent a renewal of volcanic activity and slight elevation of the coast. On the east side there is no evidence of upheaval for its whole extent, but there are very decided marks of subsidence in, probably, tertiary times. A long fault occurs at the edge of the Blue Mountains near Penrith, and for many miles north and south, there is a down-throw which brings the Hawkesbury Sandstone nearly to the level of the sea, when it forms the romantic castellated fiords and diversified scenery of Port Jackson, Broken Bay, &c. The existence of the Barrier Reef on the north-east coast is also generally regarded as marking a slow period of subsidence. This view is confirmed by the general conformation of the coast line, mountain system, and islands. The subsidence must have been in tertiary times, because the recent alluvial drifts are disturbed by it.

The upheaval of the coast line of the Australian Bight must have been of a very rapid character. Friable limestone cliffs, 600 feet high, abut upon the sea. Had there been any pause, even of a few months, in the uplifting, there must have been some traces left by erosion, but no such marks are found. It might be an interesting speculation to inquire if the subsidence on the east coast was a compensating phenomenon for the upheaval on the south, since the extent is about the same. The phenomena represented are at any rate out of even extraordinary terrestrial experience. The west coast seems also to have participated in the upheaval. Shells of a recent age were forwarded to me from Fremantle, which showed the existence of raised beaches. The only difference between the marine fauna and that at present existing was that it included tropical species only now found in North Australia.

As to the epoch to which the oldest dry land in Australia may be referred there are no very certain data. The fauna and flora would incline us to believe that we have relics of the later

Mesozoic or earlier tertiary times ; but it would be premature to build any solid theory on these facts.

The above are general outlines of the Geology and Physical structure of Australia. A closer examination of the details may amplify or elucidate the the conclusions ; but the brief exposition of the facts is made on observations which are not likely in future to be disturbed or changed.