NOTES ON THE SECTION AT ONE TREE POINT, NEAR HOBART. Plates iii. to ix.

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1. Introductory Remarks.

More than thirty years ago Mr. R. M. Johnston, in a paper (1) read before this Society, pointed out the great geological interest of a section exposed on the western side of Brown's River-road, near One Tree Point. On the whole Mr. Johnston's observations hold good up to the present day, though some details have to be altered. Mr. Johnston has shown that we have here a volcanic rock of the Basalt-group overlying sedimentary rocks, which contain an abundance of plant remains. The most important of these Mr. Johnston sent to the late Baron von Mueller, who was able to identify them with species well-known from the auriferous drifts of Victoria. In itself this would be a most important fact, but the flora, according to the Baron's determination, is of such an extraordinary nature, that it would be almost unique, if his determinations could be accepted as correct.

Many years later Messrs. McLeod and White examined the Basalt, and came to the conclusion that it is a basalt in which Fayalite, the red variety of Olivine, has replaced the Augite and Olivine (2).

I have frequently studied this section, remarkable in more than one way, and I have come to the conclusion that it allows for an interpretation quite different from that given by Mr. Johnston. The main point on which I differ from him is of tectonical nature. Mr. Johnston thinks that the southern portion of the section has been thrown up, but a careful examination has convinced me that it is not the southern portion that has moved, but the northern one; further, there is not an up-throw of the

(1) Notes showing that the Estuary of the Derwent was occupied by a fresh water lake during the Tertiary Period. These *Papers and Proceedings*, 1881, p. 74.

(2) Notes on a Fayalite Basalt from One Tree Point.—These *Papers and Proceedings*, 1898-1899, page 77.

southern, but a down-throw of the northern portion. The ends of the leaf beds are turned upwards near the fault, and this admits of only one explanation, viz., that this part moved downwards in relation to the southern one. If this view be admitted, the interpretation of the section takes a different aspect at once, when we replace the down-thrown portion to its original level. I further noticed that the leaf beds of the northern portion are considerably thicker than those of the southern one. Therefore we must assume that, if the portions on either side of the fault originally formed one continuous layer, a considerable part of the leaf beds must have disappeared in the southern (remaining) portion. This observation holds good, whether the southern portion is thrown up as Mr. R. M. Johnston thinks, or whether the northern portion has slid down, as I opine.

The origin of the curious Breccia seems to me still somewhat doubtful. Mr. Johnston thinks it represents old landslips which fell in the "lake." There are, however, many objections to such a view, which I will set forth later on.

This section is perhaps the best illustration of the more modern geological history of Tasmania, and the sequence of strata, as well as its tectonical features, afford a wonderful mass of information regarding the latest phases of the geological evolution of Tasmania. I think it will, therefore, be advisable to describe first the section as it now stands, then to discuss its different members, and, lastly, to deduce those conclusions which seem to afford an explanation of the facts observed.

2. The Leaf Bed Series.

Though not exposed at One Tree Point, it is pretty certain that the lowest member of the whole series is a yellowish sandstone, but so far the contact of Sandstone and Breccia has not been observed (3). It may be that the latter rests immediately on the Sandstone, or that some beds of different, more argillaceous nature, intervene between the two. On the whole this is of little importance as far as the questions here discussed are concerned, if we always bear in mind that the Breccia does not form the base of the series.

(3) A little further towards Hobart a sandstone of yellowish colour appears from underneath the Breccia. There is no doubt that this sandstone belongs to the Leaf Bed series, of which it most probably forms the basal member. This question requires, however, further confirmation.

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Mr. R. M. Johnston has already noticed that the leaf bed series as a whole, wherever they occur, are not found higher than about 40 feet above the present sea level, and from this peculiar deposition he concludes that, excepting for the south-easterly dip, the leaf bed series is practically in the same position as it was when it was deposited. He further assumes that the strata in question are of lacustrine origin, and in his first paper he draws a vivid picture of the "lake" filling up the Derwent estuary. Assuming that Mr. Johnston's hypothesis be correct, it requires—

(a) That the valley of the Derwent existed almost in its present shape previous to the deposition of the leaf bed series.

(b) That the strata deposited in this lake gradually thin out towards the hill ranges on either side.

The first proposition assumes that the deep canyon of the Derwent was completed to about the present day level in Pre-Eocene times (4). In other words, that the greatest portion of the Derwent valley is geologically of very old age (5). This is a very fascinating theory, but it mainly depends on the age of the leaf bed series. There is every reason to believe that the Tertiary strata of Australia are much younger than Eocene; in fact, it is more than probable that they are not older than Miocene. Naturally this would greatly reduce the age of the valley in which the lake was whose waters deposited the leaf beds. This is a question which cannot be decided for the present, and we have to leave it an open one, but I do not think that the Derwent valley dates back as far as the Upper Cretaceous period. As regards the second proposition, we should expect that the leaf bed series gradually gets thinner towards the shore line of the old lake, which naturally must be somewhere along the Mount Nelson ridge, for instance, on the western side. Though I observed the leaf bed series on the lower part of the new road to Mount Nelson, I have not been able to ascertain whether they comply with this requirement of the lake hypothesis or not. If anything can be said from the rather unsatisfactory outcrops it is this, that the thickness of the leaf beds is not reduced towards the hillside.

On the other hand, Mr. R. M. Johnston's own sections,

(4) For the sake of argument I accept the view that the Leaf Beds are of Eocene age, though according to more modern researches this view is no longer tenable.

(5) Accepting the present view of the Eocene age of the Leaf Beds and the hypothesis as to their origin, the Derwent Valley, at least that portion above the present sea-level, would be of Cretaceous age.

particularly his Fig. 2, the section opposite Sandy Bay Point, offer a most serious objection to his own hypothesis; leastways they are capable of quite a different interpretation. As shown by him in Figure 2, the leaf beds abutting against the Palæozoic rocks are bent upwards. Now, such an effect will never be produced during sedimentation; only a subsequent downward movement of the strata can produce such an effect. Mr. R. M. Johnston's Figure 2 plainly suggests the existence of a trough fault; that is to say, that the leaf beds were deposited at a much higher level than they are now, and that subsequently the whole mass moved downwards along two great faults, one of which is running approximately parallel to the Mount Nelson range, and that during this downward movement it was broken, the different pieces acquiring the southern tilt. Of course, if it can be proved that the leaf bed series are preserved in a trough fault, the "lake" hypothesis, notwithstanding its seductiveness, has to be abandoned. Before we decide we will have to make further investigations, and I refrain from expressing my opinion one way or other; for the purposes of this paper I accept Mr. Johnston's lake hypothesis, because the main results will not be affected by it. Should, however, future investigations prove that the leaf bed series rest now inside a trough fault, many of the seemingly incongruous features would easily explain themselves.

Mr. R. M. Johnston has already noticed that the leaf bed series have a very uniform dip towards south, and are traversed by a series of faults, which run apparently nearly parallel in north-west, south-eastern direction. These faults have produced a feature known as step faults; that is to say, while one end of the mass of rock remained stationary, the other moved downwards. In the leaf bed series apparently the southern end of the mass between two faults moved downwards, while the northern end remained stationary. I may point out that this is a feature frequently observed in strata preserved in trough faults; for instance, in the coal basins of Giridih, in Bengal.

3. Description of the Section at One Tree Point.

The sequence of the strata as seen in the above section is as follows (see Plate iv.):—

(a) Northern part.

(5) Vesicular Basalt, about 18 feet.

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(4) Leaf beds.
  (b) Altered, 4 to 6 feet.
  (a) Normal, about 90 feet.

(3) Breccia, about 12 feet.

(2) Leaf beds, normal, about 40 feet.

(1) Breccia, about 80 feet.

(b) Southern part.

iv. Humus, about 4 to 5 feet.

iii. Basalt.
  (b) Normal.
  (a) Vesicular.

ii. Leaf beds.
  (a) Altered, about 4 to 5 feet.
  (b) Normal, about 40 to 42 feet.
  (c) Arenaceous, about 18 feet.

i. Breccia, about 130 feet.

The sequence of strata as given above shows that the two parts of the section north and south of the fault are somewhat different. The differences are slight only, and may not be material, yet they have to be noted.

The most important is the appearance of a Breccia bed in the lower portion of the leaf beds; where it reaches the surface it has a thickness of about 18 feet, but it very rapidly becomes thinner in the direction of the dip, and has probably died out completely before reaching the level of the road. This conclusively proves that though the deposition of the leaf beds was continuous, it was locally interrupted by layers of Breccia. In other words, the agencies which produced the Breccia continued to some extent during the deposition of the leaf beds, though on the whole it would appear that the Breccia is older than the leaf beds.

The leaf beds are overlaid by a fairly thick layer of vesicular Basalt, which is, however, of small horizontal extension, and rests unquestionably on altered leaf beds. The southern portion is somewhat obscured; the altered leaf beds form a conspicuous yellow band, which extends from underneath the Basalt up to the fault; above this are about five feet of leaf beds, which appear as if they had been worked up, and seemingly dip in northern direction; these are followed by a bed of humus appearing as a conspicuous dark band.

The remarkable feature is that the humus does not overlap the Basalt, but abuts against it, and the same applies to the worked up leaf beds. I shall have to deal with this feature presently. The southern portion appears to be more regular. Under a thick layer of Basalt which rapidly thins out in northern direction follows a layer of vesicular Basalt, which rests on altered leaf beds, of conspicuous yellow colour, of about 3 to 4 feet in thickness; below these are the normal leaf beds which get rather arenaceous towards the base, resting on Breccia of great thickness.

These leaf beds are again observed at sea level, about 40 to 50 feet below the main section, overlaid by massive Basalt, which is divided by a vesicular band (6).

4. Description of the Strata Observed.

A. *The Breccia.* (Pl. v. and vi.)

Mr. R. M. Johnston has given a most accurate description of this very rock, whose peculiar features he well noticed. It is "a motley assortment of coarse and huge angular blocks principally of the fossiliferous mudstone." This feature is exceedingly well shown in Plate vi.

Though without doubt the blocks of mudstone form far the majority, there occur many boulders of Diabase frequently of large dimensions (See Plate v.). These boulders are always well rounded, and thus sharply contrast with the angular blocks of mudstone. The boulders are imbedded in an argillaceous, somewhat gritty matrix.

At the northern portion a mudstone boulder of fairly large size is deeply pressed into the underlying leaf beds. (See Plate vi.). The dark lines of stratification seen in the white leaf beds closely follow the contour of the boulder, and this proves conclusively that it must have pressed into the leaf beds while these were still in a plastic state.

I have been greatly puzzled as to the origin of this Breccia. It unquestionably closely resembles a moraine produced by the action of glaciers, and I think that under other circumstances nobody would hesitate to consider it of glacial origin. On the other hand, no scratched boulders have so far been found, and I cannot quite imagine how a glacier could have passed over beds which were unquestionably in a soft and pliable state (7)

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(6) To judge from Mr. Johnston's figures the Breccia could be observed at sea-level in 1881. During my visits the Breccia was not visible, being covered under a layer of debris.

(7) Unless they were frozen hard.

without disturbing them further than pressing a boulder into the top layer. Mr. R. M. Johnston thinks that the Breccia represents the debris of landslips that fell into the "lake." This is a very fascinating theory, and looks very convincing at first, but on closer inspection there are many objections to it. To begin with, there are certain reasons against the lake hypothesis, but I will let that pass (8). The main objection to the landslip theory is the composition of the Breccia; how is it possible that in a debris produced by a landslip well rounded boulders are mixed with angular blocks? In all the landslips I have seen in the Himalayas the debris consisted of sharp angular fragments, which were, moreover, never imbedded in a matrix as seen at One Tree Point. Further, if the landslip fell into the water one should assume that the action of the waves started at once the process of sifting. Instead of preserving its present appearance, where blocks of all sizes are irregularly mixed up, the heavier blocks would have eventually settled towards the bottom, leaving the lighter ones near the top. In fact, I cannot imagine how an entirely unstratified mass remained as such in the water for any length of time. And, again, if the mass of debris fell from above, how is it that only one solitary block has been observed to be pressed into the underlying strata, which were, as it must be kept in mind, in a pliable state when the Breccia was deposited? If such a mass of debris, as shown in Pl. vi., fell on the top of a soft mud one should imagine that numbers of the hard boulders became imbedded in it. But though some large boulders were within an inch or so from the top layer of the leaf beds, they were not pressed into it, as is well seen in Plate vi. The whole appearance of the leaf beds and Breccia proves that the deposition of the latter on the top of the former must have been a quiet, rather than a violent, process. Further, the Breccia layer in the middle of the leaf beds in the northern portion becomes thicker towards north; that is to say, towards a direction where there were no cliffs from which the debris could have fallen, though I would not lay too much stress on this. Taking everything into consideration, this "landslip" hypothesis affords, therefore, such a lot of difficulties, that it is no longer tenable.

For the present I am unable to replace it by any other theory, and the origin of the Breccia is still a problem. If we could conclusively prove that it were a

(8) See above page.

moraine, many of the present difficulties would disappear. One of the chief arguments against the moraine hypothesis is the present position of the leaf bed series, but were the view that the leaf bed series rest in a trough fault, that is to say, are now in a lower position than they were originally, correct, one of the chief objections against the glacial origin of the Breccia would disappear.

B. *The Leaf Beds.*

The leaf beds represent a series of finely laminated clay of whitish colour, which towards its base on the southern section becomes somewhat arenaceous. When exposed to the air the leaf beds soon crumble away, and this unfortunately renders the preservation of the fossil remains most difficult (9).

Mr. R. M. Johnston has given a large number of figures of plant remains collected by him, and described by Ettingshausen and von Mueller. The association of this flora is rather a curious one; next to such genera like *Betula*, which occurs in cold and Arctic climates, or *Fagus*, which is essentially a genus preferring a cooler climate, or *Quercus* and *Salix*, also genera existing in temperate cooler zones, we have in *Cinnamonum*, *Sapotacites*, or *Cassia*, genera of essentially a tropical nature. It is very difficult to accept such conflicting evidence as final, and considering the very unsatisfactory state of preservation, I cannot help thinking that somewhere a mistake has been made (10.)

If it could be shown that the tropical genera have been erroneously determined as such, and that only genera indicating a cool climate occur, the theory of the glacial origin of the Breccia would gain considerable support. In that case the leaf bed series had to be included in the

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(9) At the same time it is pretty certain that a good many of the leaves were fairly macerated when they became deposited in the silt.

(10) During the discussion that followed the reading of this paper Mr. Rodway remarked that at that time when Ettingshausen determined these leaf-remains, phyto-palæontology was in rather a backward state, a remark with which I heartily agree. When I remember the unsatisfactory state of our knowledge of fossil plant remains, even as late as the end of the seventies or the beginning of the eighties, and when I consider the great progress made since, it is more than probable that Ettingshausen's determinations are more or less wrong. Mr. Rodway stated fossil leaves were usually given the names of those recent genera with which they had a general resemblance, a practice which is entirely wrong, because, without the knowledge of the fruits or blossoms, which are far more important than the leaves, the determination must always remain doubtful. I think that every palæontologist will agree with this, and that the many incongruities resulting from determining the geological age of a series of beds from plant remains alone result only from wrong identifications of such remains.

Pleistocene, and the Basalt would be cf Post-Pleistocene age. This view would much better agree with observations made along the north coast of Tasmania. I have repeatedly expressed the opinion that the view of the Eocene age of the fossiliferous beds near Wynyard is erroneous. In a subsequent paper I will show that these beds are most probably contemporaneous with the stanniferous drifts. Considering that Mr. R. M. Johnston identified one of the leaves found in the Wynyard series with one of the most common ones of One Tree Point, viz., *Sapotacites oligoneuris*, the synchronism of the leaf beds in the Derwent valley with the Wynyard beds can be taken as an established fact. Granting this, the leaf beds are of Pleistocene age, and another objection against the glacial origin of the Breccia would disappear.

On the other hand, if it could be proved that the genera indicating a cooler climate were wrongly determined, and the flora were really one indicating a warmer climate, the glacial origin of the Breccia would not be quite disposed of, because it would be quite possible that instead of one glaciation only there were several alternating with warmer periods, as in Europe and Northern America. This is a view that must not be entirely overlooked. For the present this question must be held in abeyance till a revision of the determination of the flora has been made, but on the whole I am inclined to think that the final verdict will be to consider the leaf bed series as of Pleistocene but not of Eocene age.

C. *The Basalt.*

(Pl. vii., viii., and ix.).

The Basalt overlying the sedimentary rocks shows some peculiar features. In the first instance it must have had a rather low temperature when erupted. This is conclusively proved by the small alteration or metamorphism the leaf beds sustained. Nowhere has any evidence of fritting been observed; all the alterations produced are a change of colour from white into yellow, and even this is not always maintained. The low temperature of the Basalt is further proved by the small alteration of the included fragments of rocks through which the magma broke. This frequency of inclusions is another peculiar feature; some of these are of large size, but unfortunately they have so far not been examined. Mr. Johnston incidentally mentions that they consist of fragments of the "surrounding stratified rocks." Now, though I carefully searched for fragments of the Palæozoic mudstone, I failed to find them. On the other hand, fragments of schistose rocks, which do not occur anywhere near, are most numerous. This seems to indicate that the magma only broke through beds belonging to the Pre-Cambrian schists (11). Probably the explosions preceding the eruption completely shattered the overlying Palæozoic strata, and when eventually the eruption of the magma took place it only filled the cauldron-like cavity produced by the explosions, enclosing and enveloping only rocks from greater depths. The examination of these inclusions is another problem that awaits solution, and probably much information as to the composition of the strata in greater depth may be gleaned from it.

Another feature of the Basalt is its absence of columnar structure (Pl. vii.); instead of the customary columns the Basalt is massive, and rather inclined to part in horizontal layers. This peculiarity makes it appear as if there had been several eruptions producing different flows. Of these I have not found any evidence; the Basalt presents the appearance of one produced by a single eruption. Sometimes it shows a vesicular appearance, particularly in contact with the underlying strata. But such a layer of vesicular Basalt right in the middle of the massive one is also seen at the southern end of the section. I attribute it to a particularly strong percentage of water in this particular part of the magma, but it must not be taken as proof of several eruptions (12). Even a casual examination proves that enormous masses have been removed, and that what we see now forms only a small portion of the original mass. The Basalt eruption at One Tree Point was therefore not a fissure eruption, but is produced in harmony with other occurrences by a single eruption of a cone-like mass, of which now a small portion along its western edge is preserved. (Pl. viii.).

Messrs. McLeod and White made a chemical and microscopical examination of this Basalt, and have proved the complete absence of magnesia. They have further shown that the small red grains represent the red variety of Olivine, Fayalite; Augite, according to the authors, is

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(11) This would indicate that in the Derwent Valley the Permian series most probably rests directly on Pre-Cambrian Schists.

(12) In the great Basalt stream flowing from the plateau of the Dscholan down the valley of the Yarmuk numerous layers of vesicular Basalt can be observed in the massive portions. These layers, which start as suddenly as they die out, are, in my opinion, due to local development of steam.

also absent. Accordingly the rock is considered a Basalt in which Fayalite has replaced Augite and Olivine. Whether under these conditions it is correct to term this rock a "basalt" appears somewhat doubtful to me, particularly when we consider that it greatly differs in its structure from the true Olivine Basalt. However, it would be confusing to introduce a new name, and until the terminology has been revised, I prefer to use the name Basalt.

Mr. R. M. Johnston states that he obtained some bones and teeth probably belonging to a small marsupial related to *Hypsiprymnus* in the cooling joints of an older sheet of Basalt. I have shown above that we have no reason to suppose that there was more than one eruption, and the probability that these bones are of much later age, and were washed into a cooling joint, has to be taken into serious consideration. As at the same time these bones are very poorly preserved, and do not allow for determination, except a vague resemblance to a family of marsupials, they might as well be left out altogether.

But if the possibility that the bones became subsequently washed into the cooling joints could be finally disproved, and Mr. Johnston's view become an established fact, the presence of the modern genus *Hypsiprymnus* would speak for a very recent age of the Basalt, and severely shake the opinion of its Eocene age.

5. Tectonical Features.

(Pl. iv., viii., and ix.).

A careful examination of the strata shows that the leaf beds of the northern portion are slightly bent upwards where they abut against the fault. This is conclusive proof that there is no overthrow, as Mr. R. M. Johnston assumes; but that the northern portion has slid down along the fault. Therefore, if we wish to know the position of the strata before their dislocation we must lift the northern portion for about 80 feet, and place it back in its original position.

I have attempted such a reconstruction on Plate ix., but we see that if the sunken portion is lifted and replaced in its original position a fresh difficulty presents itself. It has been shown that the total thickness of the leaf beds is much smaller in the southern than in the northern portion. Therefore, if the leaf beds of the northern portion are really the continuation of those of the southern one, a considerable portion of the latter must have been destroyed, and are now replaced by Basalt (13).

This is quite in harmony with the facts of volcanic activity. Before the eruption of the magma took place a considerable portion of the overlying strata is blown off by explosions. It is very probable that the peculiar mass of leaf beds above mentioned represents a portion of the destroyed leaf beds which fell back.

As the isolated patch of vesicular Basalt observed in the northern portion moves to a higher level than it is now, the boundary line between Basalt and leaf beds must have risen very rapidly towards north.

This indicates the former existence of a cauldron-like hole, which was subsequently filled with Basalt. In other words, the Basalt formed originally a cone, a great portion of which was subsequently destroyed.

We can now trace the history of the events which eventually resulted in the present features with the greatest accuracy, but for the moment we will refrain from expressing a view as to the geological time when they took place. In order to make the sequence of events clearer, we will not work backwards in descending order, but work upwards from the earliest event we are able to trace. On the supposition that Mr. R. M. Johnston's lake theory is correct, and that the leaf beds are practically in the same position now as they were when deposited, we have the following sequence of events:—

1. The formation by erosion of the Derwent estuary to nearly its present depth. This was followed by the formation of shore deposits, beginning with

2. Sandstone, followed by the deposit of

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(13) I may be permitted to point out still another difficulty; supposing that the amount of the downthrow is more than 80 feet, in other words, that the northern part of the section does not represent the direct continuation of the southern one. This would naturally mean that the portions of the section on either side of the fault are not contemporaneous, as he assumed, but that the southern portion is older than the northern one. In an undisturbed section we would have, then, the following sequence:—

(7)	Basalt.	Northern portion.
(6)	c Leaf Beds.	
	b Breccia.	
	a Leaf Beds.	
(5)	Breccia	
(4)	Sandstone (?)	
(3)	Leaf Beds.	Southern portion.
(2)	Breccia.	
(1)	Sandstone (?)	

In this case the mass of strata removed above those that are now to be seen would be far greater than here assumed; all the strata, (4), (5) and (6), and a great part of (3) would have been destroyed.

3. Breccia (a period of intense denudation), and terminated by the deposition of

4. Well stratified leaf beds. (The agencies producing the Breccia must have continued during the formation of the leaf beds, because layers of Breccia are intercalated in the leaf beds.)

5. Pause in the deposition of sedimentary rocks, during which the leaf bed series (including all the beds from 2 to 4) were laid dry. (It is very probable that during this process the leaf bed series acquire the remarkable regular dip towards south.)

6. Partial destruction of the leaf beds by volcanic explosions, followed immediately by the eruption of Basaltic magma of probably very low temperature.

7. Dislocation of the leaf bed series and the overlying Basalt by faults striking in an approximate north-western direction, and having a northern dip, going hand in hand with the destruction of the Basalt cone.

8. Period of extensive denudation and erosion of the bed of the Derwent below the present sea level. (Sea level lower than at the present day.)

9. Deposition of arenaceous beds on Basalt at Droughty Point.

10. Rise of sea to its present level. (Partial filling up of the Derwent valley with sea water.)

11. Formation of hill wash consisting of volcanic debris, ashes, etc., representing the present day soil.

12. Formation of shell deposits by the aborigines.

13. Present day deposits.

All these events can be traced with the greatest accuracy, and they must have followed each other in the above order. There can be not the slightest doubt that the period during which the Breccia was deposited in the lower parts of the Derwent valley must represent a period of most active denudation in other parts of Tasmania. Great masses of angular debris of sedimentary rocks mixed with well rounded blocks of Diabase were quickly moved and redeposited at convenient places. This period of great activity was followed by one of comparative rest, during which a fine silt was deposited which preserved the impression of delicate leaves floating about in the water. Occasional relapses of the former energetic denudation must have occurred, however, during this period, resulting in the deposition of Breccia beds between the well stratified leaf beds.

The climatic conditions of this period must have been different from those prevailing at the present day, because the list of plants given by Mr. R. M. Johnston would indicate a somewhat milder climate than that of the present day. However, as I pointed out above, the determinations of the species are not beyond doubt. One fact, however, appears to be certain, the annual rainfall must have been much heavier than it is now during the time the Breccia was deposited.

It is impossible to say anything as to the length of the period that lapsed after the leaf series had been tilted up and the outburst of volcanic action. In all probability it was not very long, however.

It further appears that the destruction and denudation of the newly-formed Basalt cone commenced no sooner than it had been built up. This destruction must again have taken place during a time of most energetic denudation. The River Derwent cut its channel right through the leaf series, probably deep into the underlying Permian beds. Simultaneously the whole series was broken by faults; the latter tectonic movements do not appear to have been very energetic, and they probably ceased very soon, while the denudation of the Basalt cone continued. Until the exact extent of the former cone is known, it is impossible to form an idea as to the quantity of matter removed, but it must have been of great magnitude, because what is seen to-day represents only a very small portion of the original bulk. (Pl. viii.). It is, further, probable that the process of active denudation came to a standstill when the level of the sea discontinued to recede, and a movement in the opposite direction set in. By this movement the valley of the Derwent became filled up to its present level; in fact, it almost appears as if it had been higher still. The data for this hypothesis are, however, very insufficient, and I do not wish to say more on this point.

6. The Age of the Leaf Bed Series and the Basalt.

Mr. R. M. Johnston, when speaking of the leaf bed series in his Geology of Tasmania, refers it to the Tertiary period generally, but on page 261 he states that in one of the leaf specimens of the *Turritella* group, near Wynyard, he recognised the well-known form *Sapotacites oligoneuris* Etting, which occurs in the leaf beds of the Derwent, notably at One Tree Point. Mr. Johnston, therefore, thinks that the infrabasaltic leaf beds belong to the Palæogene, and as he considers the fossiliferous beds of Table Cape to be of Eocene age, we must infer that he attributes the same age to the leaf bed series of the Derwent valley. Under these circumstances the erosion of the old Derwent valley in which the leaf bed series was deposited must have taken place in Pre-Eocene times; in other words, it would date back as far as the Cretaceous period.

More recent researches, particularly of Victorian geologists, have conclusively proved that Tate's views as to the Eocene age of the Australian Tertiary Beds are no longer tenable. All the Tertiaries of Australia are much younger; in fact, it appears very doubtful whether the Eocene is represented at all in Australia. It is more than probable that the Table Cape beds are of much younger age than hitherto assumed, and consequently the leaf beds of the Derwent are much younger than Eocene. If my views are correct, they cannot be older than Pleistocene, and we need not assume a Pre-Eocene erosion of the Derwent valley if, as I believe, the leaf bed series were at the time of their deposition in a much higher level than they are now, and only came to their present position by a downward movement which immediately preceded the eruption of the Basalt.

The Post-Pleistocene period represents, therefore, the time during which the leaf bed series were raised from the water, and it is probable that eruption of the Basalt took place during the same period, though it is by no means improbable that the latter is somewhat younger. The period following the eruption of the Basalt was a time of extensive denudation which destroyed an enormous portion of the Basalt cone and a large portion of the leaf beds. During the same period the Derwent valley was scooped out. As the sea level was then at its lowest, or nearly its lowest, this stage must represent the time when Tasmania was connected with the mainland of Australia. Towards the end of the Pleistocene, long after the glaciers had disappeared, a gradual rise of the sea level commenced, but previous to final separation from the mainland the present flora and fauna had settled in Tasmania. The remains of the former fauna were a few isolated specimens of gigantic marsupials which found a haven of refuge in Northern Tasmania, where they died out before they had time to spread. The last to follow were the aborigines, and very soon after their arrival the rising sea had completely severed Tasmania from the mainland.

The above results have been summarised in the appended table, which, however, requires a few words of explanation. Though the actual sequence of the strata is beyond doubt, the age attributed to the different beds is open to dispute. It all depends on the age of the leaf bed series. As far as this is concerned, one fact is certain, that it does not belong to the Eocene epoch, and we need not attribute a Pre-Eocene age to a pre-leaf bed Derwent valley. Even if my view as to the Pleistocene were not correct, the leaf beds are not likely to be older than Miocene.

Plates.

iii. General view of One Tree Point.

iv. Section at One Tree Point.

v. Diabase boulder in breccia.

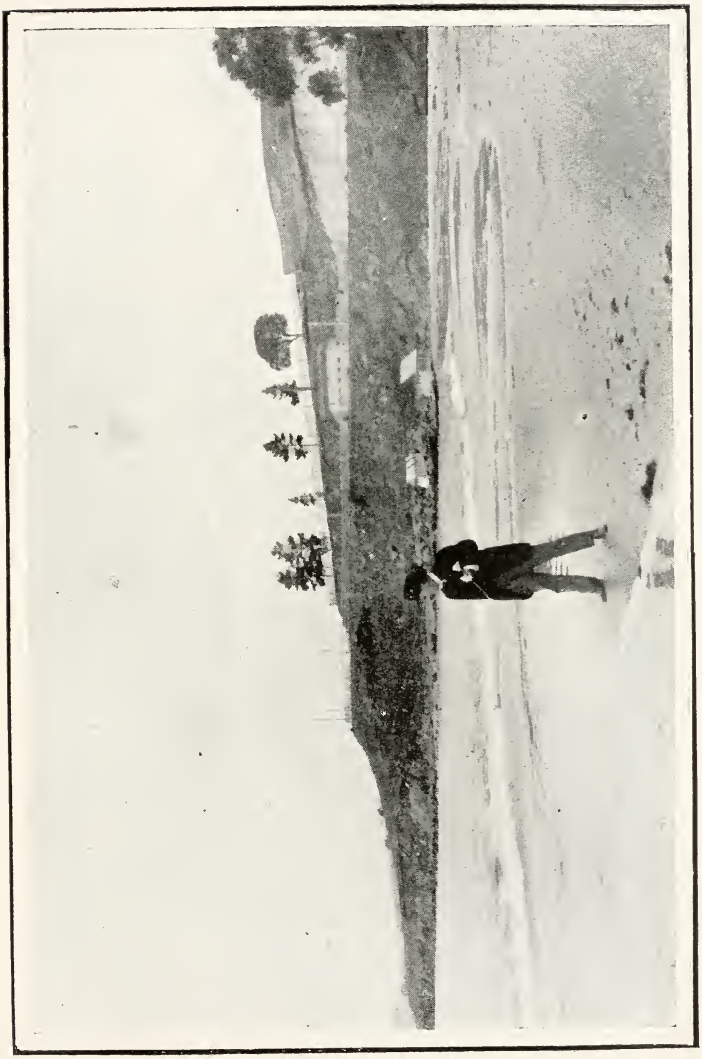
vi. Breccia and leaf-beds—boulder pressed into leaf-beds.

vii. Basalt overlying the leaf-beds.

viii. Section at One Tree Point.

ix. Partial reconstruction of One Tree Point Volcano.

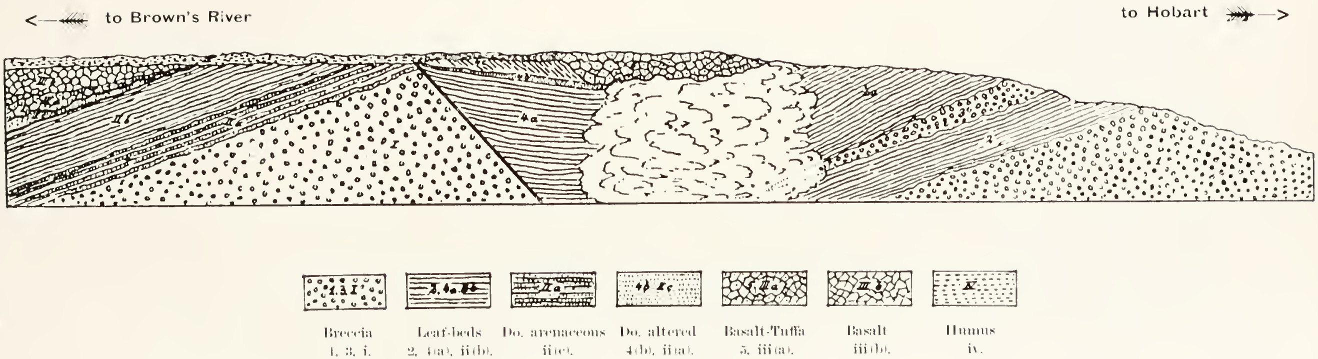
Geological Stages.	Deposits.	Fauna and Flora.		Climate.	Sea-Level.	Geological Agencies.	Tasmania's Connection with the Mainland of Australia.
Recent.	Hill-wash and Sand-dunes.	Present day Flora & Fauna.	Aryan Race since 1878.	Temperate.	Present day Sea-level.	Period of rest.	Tasmania completely separated.
			Aryan and Tasmanian Races, 1803—1878.		Gradual rise of Sea-level.		Tasmania connected by narrow isthmus with Australia.
	Shell-heaps.		Tasmanian Race, 5,000 B.C. till 1878 A.D.				
Post-Pleistocene.	Hill-wash and Sand-dunes.	Appearance of the present day Fauna. (Present day Flora may have appeared earlier).		Temperate.	Sea-level at least 250 feet below present level.	Period of most active denudation.	Tasmania connected by broad isthmus with Australia and forms its south-eastern part.
	Peat-deposits of N.W. Tasmania.	Extinction of the Gigantic Marsupials.		Moderately Cold.		Formation of present Derwent Valley.	
Pleistocene or Glacial.	Fayalite-Basalt.	Marsupials. (?)		Temperate (?)	Gradual rise of Sea-level, which probably reached its highest point during the deposition of the leaf-beds.	? (Perhaps same as before).	Tasmania forms an ice-clad island in an Antarctic Ocean. Lat. of Tasmania about 70°
	Leaf-beds.	Marsupials. Deciduous trees predominant (?)		Temperate (?)		Period of comparative rest.	
	Breccia.	?		Arctic.		Period of most energetic denudation.	
	Sandstone.	(Perhaps same as above).		(?)		Denudation.	



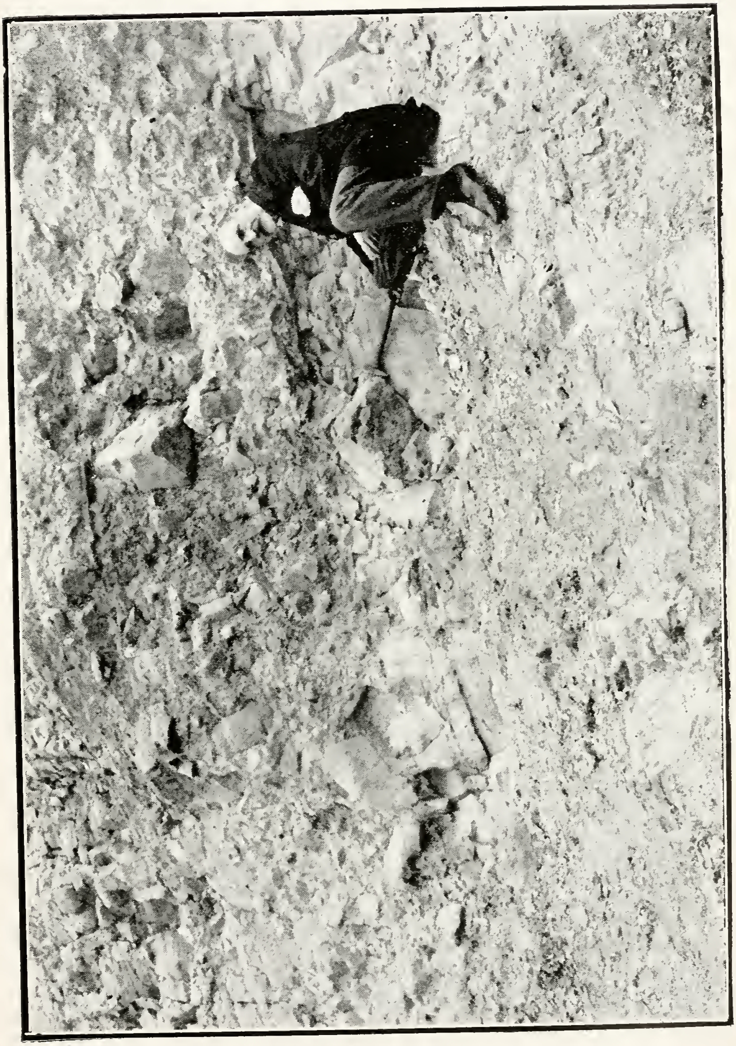
GENERAL VIEW OF ONE TREE POINT.

SECTION AT ONE TREE POINT, NEAR HOBART.

Heights drawn to scale. Scale: 1 mm. = 3 metres.



DIABASE BOULDER IN BRECCIA.

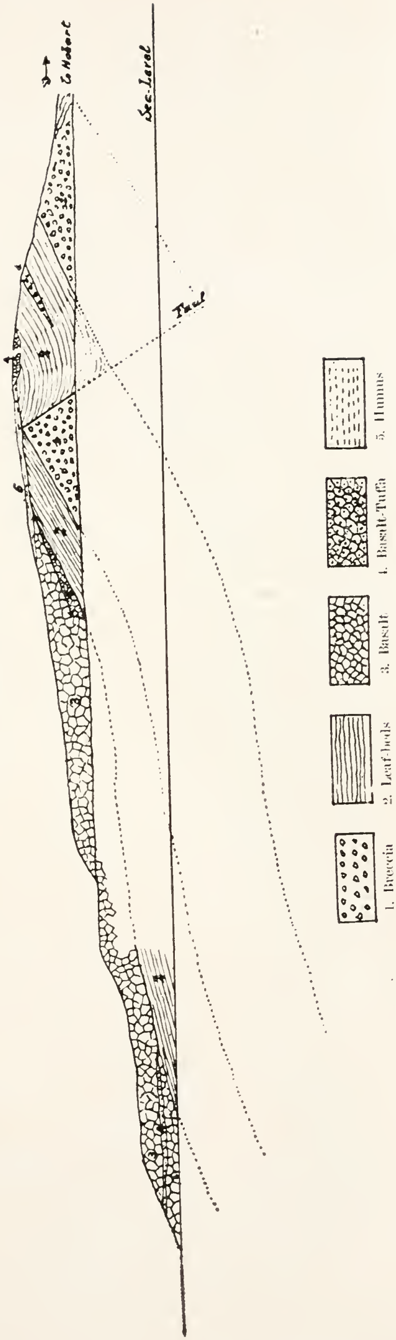


BRECCIA AND LEAF-BEDS. BOULDER PRESSED INTO LEAF-BEDS.

BASALT OVERLYING THE LEAF-BEDS.

SECTION AT ONE TREE POINT.

Scale : 1 inch = 131 yards.



PARTIAL RECONSTRUCTION OF ONE TREE POINT VOLCANO.

Original parts shown Red. Present parts shown Black.

Scale: 1 inch = 131 yards.