REGARDING THE COMPOSITION AND EXTENT OF CERTAIN TERTIARY BEDS IN AND AROUND LAUNCESTON.

By R. M. Johnston.

(Read 12th August, 1873.)

GRAVEL.

In the immediate vicinity of Launceston, and scattered over the westward plains, are to be seen vast accumulations of water-worn gravel, lying here and there in pockets, but principally arranged in horizontal layers from 1 to 3 feet thick, and associated with clays and tuffs, more or less laminated.

Some of these gravel beds were extensively exposed for the purpose of obtaining ballast for the Launceston and Western Railway, and I was thus enabled, during my leisure hours, to glean some information regarding their contents.

The most extensively exposed deposit is spread over that elevated plain situated between Perth and Longford. This plateau is 115 feet above the present channel of the South Esk at Longford, or about 630 feet above the level of the sea.

The contents of these beds are principally composed of silicious pebbles and gritty concretions. The pebbles are all more or less rounded and waterworn, but the most remarkable feature is that their surfaces present the appearance of having undergone great alteration by heat subsequently. Frequently adhering to the smooth surface of these pebbles, are angular gritty concretions, which generally fracture before yielding at point of contact ;| when the gritty mass parts at point of contact with the pebble, it usually leaves a red burnt-like scar.

OPALIZED WOOD.

In great abundance and scattered throughout the whole extent of these gravelly accumulations. At altitudes varying from 50 to 700 feet above the level of the sea, are to be found the silicified fragments of fossilized trees. These fragments, though preserving some degree of angularity, are all water-worn, and also give evidence of having been subjected to subsequent heat.

The internal structure of these trees is in various stages of preservation; generally, the minute cellular network, interlacing the delicate medullary rays, is distinctly visible, and by the aid of a good lens, the structure exhibits great beauty.

In sections of smaller branches now in my possession, the medullary rays radiate directly to the circumference in a straight line. (*See Fig.* 24, *a*, *b*, *c*.)

In the sections of larger trees (*Figs.* 25-6), however, these rays appear to be ranged more closely together, and become wonderfully twisted and contorted, especially so at the several stages which mark the periodic concentric layers. Whether this peculiarity indicates a different variety, I am not yet prepared to decide.

FRAGMENTS OF LIMESTONE.

Intimately associated with these opalized woods, are to be found waterworn fragments of three different varieties of limestone.

The first is replete with two or three forms of *Bryozea*, particularly *Fenestella ampla.* It also contains casts of *Spirifer*, *Pecten Avicula*, and *Platyschisma.* This, possibly, is the impure limestone or *blue mudstone* rock, abounding in the neighbourhood of Hobart, Chudleigh, and York Town.

The second is a close grained cream coloured limestone, not so commonly distributed as the first, and only contains the remains of a branching coral, possibly a variety of *Stenopora.*

The third, more frequently to be met with, is light and porous, and is principally composed of finely comminuted shells. It contains abundant casts of *Spirifer* and *Platyschisma; Fenestella* is absent. All these limestones are greatly altered, and are not acted upon by acids.

FOSSIL IMPRESSED GREENSTONE.

Among the gravel I also discovered a fragment of close grained greenstone, containing the well defined cast of a branch of a tree repeatedly divided. The fragment is quite angular, and does not appear to have been waterworn.

ENQUIRY WHEN, AND UNDER WHAT CONDITIONS, DISTRIBUTED.

With regard to the distribution of these accumulations, there are two important enquiries, viz :—The means by which they were distributed ; and the period during which such distribution took place.

It would appear probable that subsequent to marine denudation, which planed down the rocks of the *Permian* and *Carboniferous* age—and at a period prior to the deposition of the Windmill Hill beds, Launceston—there existed all over the westward plains, and the Campbell Town Valley, a dense and luxuriant growth of vegetation ; that upon the commencement of the later volcanic eruptions, the natural drainage to the sea was dammed up either by a stream of lava, filling up the old watercourse to the sea, or by dislocation, and so converted the valley of the Tamar and the westward plains into one great lake. The vegetation thus deluged by water, chemically

affected by constant showers of scoriæ, and heated by streams of liquid lava from the adjacent igneous centres, would, no doubt, undergo great change, such as already described. While such a large surface of the water acted upon by winds would heap together upon its shallow banks and shores, its own water-worn fragments together with the re-arranged detritus of a former period; and away beyond these shallows towards the outlet to the sea it would bear the finer particles of scoriæ sand, mud, and carbonaceous matter which forms the lignites and the four to five hundred feet of laminated clays and sands upon which the town of Launceston is built.

It is evident from the contents of the latter beds that around the margin of this vast lake a rich vegetation still continued to flourish, notwithstanding the activity of the surrounding igneous centres, and it is also evident, from the following circumstance, that the deposition of the Launceston bed took place very slowly. These beds are composed of fine clay and tufaceous sand, and they are for the most part separable into very fine laminations.

Between the laminated clays and sands, however, and forming a direct chain through the whole series, occur thin beds of fine blue clay, in which there is little indication of horizontal lamination. They contain the remains of water plants which grew *in situ* while the fine mud was being formed into clay around them.

That these water plants grew vigorously and in great abundance is proved by the fact that the leaves falling elsewhere in myriads upon the lake bottom, are never found to penetrate this subaqueous thicket. Fragments of branches and twigs occur among these plants abundantly, being heavy, but the feathery leaves would be too light to penetrate their tortuous branchlets, and would thus become speedily decomposed, being unprotected by a muddy envelope.

The type of leaf most abundant in these beds, appears to be a kind of elm. (*See Fig.* 1.)

Although there are plenty of other forms like to the leaves of maple, laurel, plane, and coniferous trees, ferns of Lycopodon are also well represented. (*See Figs.* 1 *to* 10 *inc.*)

Of the fauna I have not been fortunate as yet in obtaining any trace, with the exception of two or three *Unios*, picked up further north. (*Fig.* 2.)

The carbonized tissue of various woods occurs abundantly in some beds of clays together with the well-defined structure of the bark of large trees composed principally of the oxide of iron. This presents a large field for the palæontological microscopist. I am sure valuable information would be yielded to science were these beds to be minutely investigated.

The distribution of the water-worn fragments of opalized woods already referred to, bearing testimony directly upon the age and extent of this old lake basin and its effluents, is of considerable importance. The only link wanting appears to be the relative age or position of these trees with respect to the various distinctive beds within the Tamar Valley.

In a cutting of the Launceston and Western Railway beyond Breadalbane a section of tufaceous basalt is exposed. Embedded in some cases in the softer, but more frequently in the harder, rock are numerous trunks and branches of fossilized trees, generally disposed horizontally. The difference between these remains and the silicified fragments so abundant in the gravelly beds is as follows :—

They are chiefly composed of lime, and consequently, while the harder parts of the structure appear more boldly in relief, the fine cellular structure, so common to the silicified specimens, is scarcely discernible. The thickness of these is generally from two to three feet, and the trees appear to have been very resinous. The centre from which the medullary rays spread is generally one mass of amber-like matter, and when it has been exposed for any length of time to the atmosphere, it assumes a white, twisted, asbestos-like appearance.

FOSSIL FRUIT.

Intimately associated with these trees I discovered a cluster of fruits, also preserved in lime.

They are small, egg-shaped nuts, grooved longitudinally,—length, $\frac{1}{2}$-inch ; breadth, $\frac{1}{3}$-inch.—(*See Fig.* 27.)

If any of the trees here referred to could be identified with the silicified fragments scattered throughout the upland plains, we would be enabled to indicate the position of the latter with respect to the Launceston beds, as the enveloping basalts and tuffs immediately overlie the bed of lignite at the Railway "Big Cutting," near to the Fossil Tree Cutting already referred to.*

The bed of lignite at this point, although it has not been penetrated, has been ascertained to be of considerable thickness. It is for the most part very impure, and is thickly studded with small beads of resin, which on ignition flame briskly.

Compressed branches and stems (*Fig.* 25) occur in great

* Since writing the above, I have been aided by Mr. E. D. Harrop, of the Commercial Bank, Launceston, in making microscopic examinations of the various fossilized trees found either as trunks *in situ*, or in the form of water-worn pebbles ; and while we consider that there is an indication of different varieties, yet all such remains are evidently coniferous. This also applies to those preserved in a ferruginous form. It is very remarkable, considering the greater abundance of leaf remains of other trees, that only coniferous woods are preserved to us in the manner already described.

abundance, and although highly bitumenized, the concentric layers may frequently be traced. Sections of these, prepared for the microscope, will doubtless shed some additional light upon the subject.

A bed of lignite crops out in the channel of the River Tamar, and from its position it seems to be one of the lowest members of the Launceston series.

It lies unconformably upon inclined *Greywacke*, a short distance below Rostella.—(*See Fig.* 31.)

A section of the greywacke beds is exposed along the shore of the West Tamar, upon Dr. Maddox's property, where a quarry has been worked for some time, and from which the freestone for the Launceston Mechanics' Institute has been obtained.

The strike at this point is in an easterly direction across the *Tamar*. Dip about 30 degrees to the horizon south-east. From a rough computation of the oblique, or exposed, surface I obtained the following measurements, viz. :—

	Thickness.
1. Intrusive greenstone	—
2. Close-grained greenish-grey sandstone, worked some time for building purposes	100 feet.
3. Micaceous flagstone	78 ,,
4. Reddish fissile shales	60
5. Laminated flags and shales	100 ,,
6. Sandstone	60 ,,
7. Band of black homogenous shale, with peculiar grooved markings	2 inches.
8. Sandstones and shales, obscured by stone boulders and gravel	—
Total thickness exposed, say	400 Feet.

(*See Fig.* 31.)

The bed of lignite which rests upon, or is flanked by these beds, is very probably a continuation of the Breadalbane deposit, and should it prove to be so—it, together with the distribution of the opalised woods—will be of good service in determining the relative positions of the several beds within this hitherto neglected series.

It would be premature on my part to attempt to define the relative position of these beds as the data at the command of *one* individual is too meagre to form a conclusion with any degree of confidence. Notwithstanding this, there are sufficient grounds for the determination of three zones within the Tamar valley. These I may call the Upper, Middle, and Lower Zones. I do not mean that these zones are to be considered as distinct, because of a marked difference in the

types of fossils to be met with. Indeed, I am of opinion that the types as described in figures No. 10 to No. 23, may yet prove to be common to all the members of this system.

The only purpose for which I propose this nominal division is for the better determination of *sequence* by an attempt to classify the several members of the system from the data now before me.

To be able to do this properly, one should be thoroughly acquainted with the rock systems which on every side flank its borders. Unfortunately I have not sufficient leisure to investigate this matter personally; and with the exception of the reference made by Strzelecki in his *Fourth Epoch*, I am not aware of anything being done towards its identification.

BOUNDARIES.

Although Strzelecki inaccurately extended the variegated sandstone as dipping towards the north at Launceston, in a section running from "Dry's Bluff to Launceston," yet I have reason to believe that he is correct in showing the sandstones and fossiliferous limestone as dipping at a considerable angle to the north-west on the Norfolk Plains, near to the Tiers.

Flanking the north-west side of the Tamar basin, and to the north of Norfolk Plains—at the village of Hadspen—a variegated porous sandstone, with flakes of mica, dips towards the south.

On the north we have the greywacke, dipping at an angle of about 30 degrees to the south-east, and upon the west the basin is flanked by a series of greenstone ridges, which stair-like, forms an inclined plane, having Ben Lomond for its summit. It would thus appear that this tertiary deposit lies in a trough or hollow, of upper and lower primary strata, and conceals the point of junction between these older systems, probably near to Longford, thus (*See Fig.* 29).

LOWER ZONE.

Having thus briefly sketched the principal boundaries of the Tamar basin, I shall now address myself to describe the peculiarities which characterise the division within, and which I have arbitrarily divided into three zones,—the Upper, Middle, and Lower.

The most destinctive feature marking the lower zone is the formation of lignite which is found to rest inconformably upon greywacke on the West Tamar.

A fine section is exposed at Muddy Creek on the West Tamar. It is composed of a series of beds of blue and white clays, occasionally interlaminated with thin bands of tenacious clay containing leaves, the predominating types of which are roughly sketched in *Figs.* 10 *to* 23.

There is a marked absence of tufaceous sands, and it is upon this circumstance chiefly that I infer the lower zone marks the epoch immediately preceding the later volcanic eruptions. At any rate its deposition occurred during a time of repose, as the clays are not impregnated with the oxide of iron, which so distinctly colours the upper members.

The remains of leaves (which are those referred to in my former letter to this society) imbedded are preserved to us in a carbonized form. This I consider is a very important feature, for among the thousands of leaves exposed by me in the upper beds, there was not one preserved in a carbonized form; only the ochreous casts remained.

Unlike the shifting beds at Windmill Hill, Launceston, the laminations are conformable with each other, and they dip very slightly to the north-west, *i.e.*,—in an exactly opposite direction to the series of greywacke beds which flanks the northern extremity.

Mr. Gunn also informs me that the lignite appears on marshy ground near to the Western Tiers.

Generally we may indicate this zone as a deposit formed prior to the more recent volcanic eruptions.

MIDDLE ZONE.

The Middle Zone is well represented by that series of beds which forms the Windmill Hill, Launceston.

They are chiefly composed of shifting beds of clay and tufaceous sand. These beds admirably illustrate the mode in which mud and sand is precipitated in running water.

Wedge-shaped beds are cut through and overlie similar beds, in the most wanton unconformity.

They generally present a wavy horizontal appearance, but they intersect each other repeatedly throughout the series, in a manner difficult to describe.

Very probably these beds were thrown down in the channel of running water from the upper lake, by the conflict of two currents meeting each other at right angles.

From the appearance of that valley running from First Basin to Glen Dhu I infer that a considerable stream, emerging or flowing by way of that rocky fissure, which forms the channel of the South Esk, would be diverted into Glen Dhu by an obstruction at that romantic gorge which now forms its narrow outlet. The division of a powerful volume of water from this rock basin in the direction of Glen Dhu, and meeting the main body of water by way of the North Esk valley, would no doubt help to precipitate the mud and sand held in suspension by both streams.

This supposition would also account for the peculiar horse-

shoe shaped indentation, within which the town of Launceston is situated, and for the ever-shifting series of beds which compose the Windmill Hill.

An important feature in the Launceston beds is the alteration that appears to have taken place in the tufaceous sands. Here and there, in irregularly disposed horizontal bands, occur indurated ferruginous nodules of tufaceous sand or clay. These nodules have frequently for their centre a core of blue clay, which has in most cases filled up the cavity of a hollow tree or branch.

On splitting open one of these nodules it invariably presents the appearance of a section of an exogenous tree, with regularly disposed concentric rings round an indurated vitreous or ferruginous pith.

On closer examination, however, we observed that although the iron-coloured rings present the appearance of a nodule formed by a succession of layers, like the coats of an onion, yet the laminations are disposed horizontally, as in the surrounding strata. This is more fully substantiated by the casts of leaves being disclosed in laminæ at right angles to the ferruginous rings, which envelop the nodule where these latter rings are at right angles to the surrounding beds.—*(See Fig.* 25*a.)*

It is thus proved that, subsequent to deposition as a soft, porous mass, the ferruginous particles have, by a process of segregation, gathered together in rings round an attracting centre; these rings approaching closer and closer to the centre as the process continued, until in many cases the nodule is converted into brown hematite.

It would appear, therefore, that the beds of the Middle Zone are in most cases principally formed of the scoriæ and ashes of active volcanoes in the immediate vicinity of Launceston; that the waters, although locally and periodically affected chemically by the substances with which it comes in contact, was on the whole, capable of sustaining animal and vegetable life, while its borders supported a most luxurious vegetation of types as shown. (*Figs.* 1 *to* 10.)

Generally, then, we may characterize the Middle Zone as a series of beds, deposited during the period of volcanic activity.

THE UPPER ZONE.

The Upper Zone is well represented by those low rounded hills and terraces flanking the present course of the River Tamar. They are principally composed of alternate beds of conglomerates, breccias, and gravels, and the detritus of the lower zones. (*Fig.* 30.)

Prominent among them all, we recognise the partially

water-worn, though angular fragments, of the ferrugineous nodules so characteristic of the Windmill Hill beds; the beaches all along the Tamar are principally composed of them. Some of these ridges and terraces are about 100 feet above the present river.

It is very probable that the water flowing over the barrier which had dammed up the old valley and river course into a lake, would during this period rapidly cut and wear out a new channel for itself; and that to the gradual deepening of this channel, and the consequent shallowing of the upper lake levels, we may ascribe the scooping out of most of

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ERRATA.

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	17th	39	when	where
	14th	,,	(.) (capital) At	(,) —at.
11th	—	40	"*Bryozea*"	*Bryozoa.*
9th	—	41	"forms,"	form.
	11th	,,	after coniferous trees (",")	(period) (.)
	,, & 10	,,	"ferns of Lycopodon."	Ferns and lycopodiums.
	7th	,,	*Fig* 2.	*Fig.* 11.
	7th	44	"inconformably"	unconformably
	20th	45	"mud *and* sand"	mud or sand.
	6th	,,	"division"	diversion
	15th	43	*("see Fig* 31")	(see Fig 32)
	12th	47	"Muddy creek"	Muddy Creek
	14th	,,	"muddy creek"	Muddy Creek.

embedded in scoriæ.

Fig 28.—Reed-like impression. Windmill Hill.

NOTE.—All leaf figures are drawn at from half to one-third natural size.

Fossil Ferns

Fig 1

Fig 2.

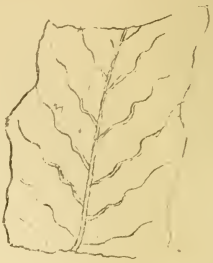

Fig 3.

Fig. 8.

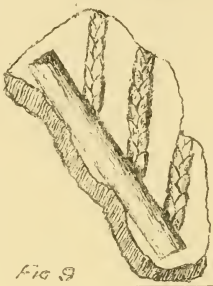

Fig 9

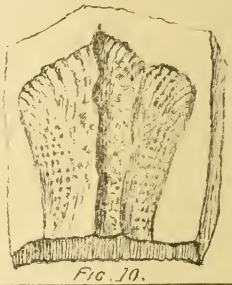

Fig. 10.

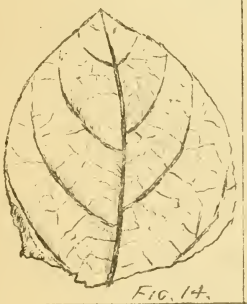

Fig. 14.

Fig. 15

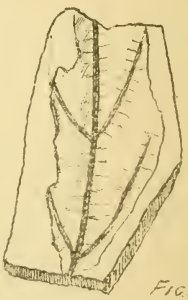

Fig 16.

Fig. 23

Fig. 24.

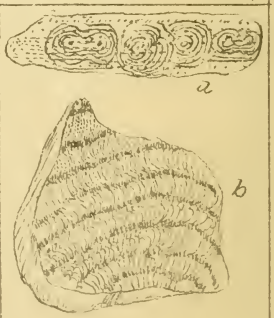

Fig. 25

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FIG. 4.

FIG. 5.

FIG. 6. FIG. 7.

FIG. 11.

FIG. 12.

FIG. 13.

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FIG. 17. FIG. 18.

FIG. 19 FIG. 20

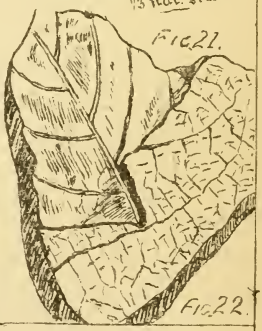

FIG. 21.

FIG. 22.

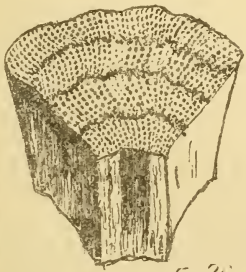

FIG. 26.

FIG. 27

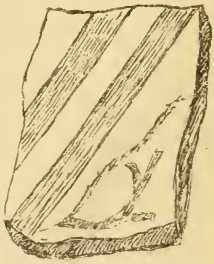

FIG. 28

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(29.) Imaginary section shewing position of Tertiary beds near Launceston

Upper zone River Near Mr. Isling's
(30.)

Tertiary resting unconformably upon Greywacke? near Muddy Creek
(37.)

Greywacke? dipping South-East
On Maddox's property West Tamar
(32.)

Transverse section of North Esk Valley
Near Cotta-Lynn
(38.)