

## NOTES ON FURTHER PROOFS OF GLACIATION AT LOW LEVELS.

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(Read 14th August, 1895.)

Before giving notes on my late observations on the above subject, I take the liberty to begin with an extract from a letter by Professor R. V. Lendenfeld, of the University Czernowitz, relative to my paper on the discovery of the first proofs of land glaciation in Tasmania. The views of so able an authority, who was the first to discover positive proofs of land glaciation in Australia, will, I am sure, be interesting to the Fellows of the Society.

Professor Lendenfeld says :—"Your map shows that in the Tasmanian hill country delineated the character of the country, lakes, etc., is exactly alike the character of the Niederen Tauern in Carinthia, Salzburg, and Styria, at an elevation of about 2,500 metres. It is very certain that there—in the Niederen Tauern at that elevation—there have been glaciers a relatively short time ago, and I would say that in the similar country in Tasmania glaciers must have been *very recently*, for otherwise the lakelets would have already been filled up with debris. The glaciation deducible from your map should, I think, be placed in a more recent period than the glaciation of the Australian Alps. As to the glacial evidence itself, anyone acquainted with the subject must agree that the character of the country depicted in your map is a *certain proof* of the past glaciation of Tasmania."

Now I will pass on to discoveries made within the last few months up to the first week in November, 1894, of further proof of land glaciation at low levels, in substantiation of my paper on this subject read before the Royal Society last August.

Upon examination of the banks of the King River, which flows into Macquarie Harbour between Pine Cove and the settled portion of the town of Strahan, I discovered large ice-worn boulders striated and grooved in the deep gorge of the river situated at the Upper Landing ; also similar glaciated boulders in Harvey's Creek at a distance of a quarter of a mile from its junction with the King River at the Landing.

The boulders are large, many tons in weight, and are composed principally of Silurian sandstone. The planed surfaces, grooves, and striæ are fairly distinct, proving beyond doubt that as the ice marks are not obliterated in so



friable a rock that the period of their transposition by ice is of a very recent date. As there are conclusive proofs that the whole mountain chain comprising the West Coast Range has been covered with a vast sheet of ice, we must conclude that rivers of ice have flowed down the damp, sunless, slate gorges of the King River, collecting as they went masses of sandstone from the surrounding heights, leaving them at a altitude of not more than 100ft. above sea level in their present shape and position at the Upper Landing and Harvey's Creek, distant about four to five miles from the range.

In the same locality, on the southern bank of the river, 150ft. above its bed, a large moraine occurs, composed of rocks brought from the inland mountains. Here we find mica slates, large boulders of greenstone, and many other formations not met with in the country west of the coast range. These boulders and pebbles are embedded in a clay or slaty matrix, and have been brought down the river gorge, probably at the beginning of our glacial period, before the erosion of the present bed of the stream.

During the recent substantial improvements to the Strahan-Lyell highway, a very interesting phenomenon of our glacial action has been exposed, through the accumulation of rubbish and moss being removed from the cuttings and drains of the road. As this phenomenon is so accessible on the way to the greatest mine in the island, which many scientists and geologists are sure to visit, it is to be hoped that more able men than myself will give views as to its age, origin, and nature.

A moraine commences about one mile from Strahan, and extends along the road towards Mount Lyell for a mile and three-quarters in width. A portion of the moraine near the surface is composed of yellow clay containing a few embedded pebbles; this rests on a recently formed conglomerate, with a binding of the same coloured matter, in other parts the yellow colour gives place to a conglomeration of pebbles in a blue slaty or clayey nature.

The texture of the binding material or "till" is fine and of rock-like hardness. It contains pebbles of all sizes, from mere atoms up to boulders a foot in diameter; the stones are either rounded, grooved, or planed, and many are covered with scratches and scored in various cross directions. All are of local origin, as no rock foreign to the West Coast can be found. Sheared pebbles of conglomerate and quartzite, similar to those found by Mr. E. J. Dunn, F.G.S., and myself in and derived from the Devonian conglomerate round Mounts Tyndall and Sedgwick are embedded in the moraine matter.

At two and a half miles from Strahan, in a cutting of the road a quarter of a mile from where the "till" is last trace-



able, the best section of the country can be seen. Here an outcrop of the bed rock for the first and only time in the "till" is observed, a blue slate lying at an angle of 80 degs., slightly distorted, but similar in character to the binding material of the glacial conglomerate. At this point we find an illustration of a "giant's kettle," a wide crevasse in the rock filled with "till," the outer wall being at the termination of the deposit. The excavation of the cutting is not sufficiently deep to show the whole depth of the filled-up crevasse, nor to allow me to give an estimate of the probable depth of the whole formation.

During former explorations of the country I found the deposit two miles further distant, in a north-east direction on Gould's old track of nearly forty years ago, re-opened in 1883 by the Meredith Brothers. Taking this and other enumerated facts into consideration, I arrive at the conclusion that the trend of the glaciers have been from the north-east, possibly from the highlands of Tyndall and Sedgwick, which are in that direction, and that the deposit is a moraine profonde, and if not precisely similar to the boulder "till" of the more ancient glacial epochs of other countries, it is the till of a more recent glacial period in ours. The moraines on the edge of Kelly's Basin, spoken of in a previous paper, are similar in character to the one just described, with the exception that as far as I have observed the pebbles are all embedded in a yellow clay.

The recent conglomerate or till on the Strahan-Lyell road is at an altitude of 150ft. to 200ft. above sea level. It is in no way identical with the ancient permo-carboniferous glacial conglomerate found by Mr. Dunn near Mount Read, nor with those referred to in my former paper on West Coast Glaciation as occurring at Mount Sedgwick and near Zeehan. The recent find is composed of rocks belonging to the district, principally slates, diorite, conglomerate, and quartzite, which are embedded in a matrix derived from the wearing down and grinding action of the ice over the local slate rocks, the general formation found in the lower lands of this territory.

The ancient conglomerate contains not only pebbles but large sized boulders quite foreign to the country; it is more consolidated, also of a much harder character, and the binding material is of a gritty sedimentary nature, showing that the deposits were formed under water and have a different age and origin.

After the discovery of the Kelly's Basin moraines and the huge ice-marked boulders in the vicinity of Farm Cove, I was convinced that our glaciers had in some instances descended to sea level, and since the finding of further proofs in the low levels at a considerable distance (18 to 40 miles) from the



highlands, the most sceptical must now allow that the descent of these to sea level has been general.

Let us now consider the evidence we have regarding the age of our glaciation. Professor R. V. Lendenfeld's deductions are, that the glaciation of the Tyndall and Sedgwick country appears to belong to a more recent period than the glaciation of the Australian Alps. If this is allowed we have two glacial epochs in Australasia, or one long continuous period besides the ice age of the Permo-carboniferous era. In Western Tasmania our land glacial action has not been earlier than the Pliocene period, or we should find some evidences in the palæogene deposits round the shores of Macquarie Harbour, especially in the region of the ice-marked and worn boulders near Farm Cove. Let us assume that the glacial action in the highlands is of a more recent date than that of the deposits lately described, accounted for in this way: that the refrigeration of the climate was more intense at the commencement and middle of our glacial epoch than towards its close. During the intense period the ice has not wholly covered the land, but has extended far down into the low-lying valleys, and glaciers have descended even to sea level, or in cases nearly so, as proved by the moraines at Kelly's Basin, Farm Cove, King River, and Strahan. Towards the end of our glacial epoch the climate has become milder and the ice has retired from the lower valleys, still leaving a vast sheet on the highlands, which by subsequent local flows caused the more recent striations, etc., on the bed rocks, and on melting left the extensive moraines in close proximity to the mountain peaks.

The Australian Alps being further from Antarctic influence in a warmer latitude than our West Coast, possibly the refrigeration of the climate there has not been so intense. For, according to Professor Lendenfeld and other authorities, the glaciers have been local, being confined to mountains higher than our own, and the rocks now show less marked signs of ice influence than those in our islands. This would point to the fact that the age of glacial action in the Australian Alps may correspond with the more intense period of our glacial era, for assuming that the climate on the continent was milder, the ice sheets would therefore be confined to the higher mountains, and would probably have melted when our rivers of ice and glaciers disappeared from the lowlands. After the disappearance of all ice from Australia, the highlands of Western Tasmania would still be covered, causing the recent glaciation at the close of our glacial epoch.

Perhaps by some I may be considered an infatuated enthusiast, who has recorded actual facts of observation carefully; granted this is correct, still it is only by actual observation and



the discovery of fresh proofs of glacial phenomena, that the age and intensity of our Glacial Period will be determined.

Trusting my recent discoveries may throw more light on so interesting a subject, and that some eminent authority, not too biassed by past theories, may examine them and give his views, either negatively or in concurrence with my statements, as to the existence of boulder till in the lowlands of the West Coast of Tasmania.

Illustrative specimens forwarded for the Tasmanian Museum from boulder till, Strahan, Lyell-road, viz.:—

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|-------|---|---|
| No. 1 | } | A series of coloured conglomerates.     |
| 2     |   |   |
| 3     |   |   |
| 4     |   |   |
| 5     |   |   |
| 6     |   | Binding materials of conglomerate.      |
| 7     |   | Scored pebbles from above conglomerate. |
| 8     |   | Sheard Devonian pebbles from ditto.     |