

21. *On an INTRUSION of DIABASE into PERMO-CARBONIFEROUS ROCKS in FREDERICK HENRY BAY (TASMANIA).* By T. STEPHENS, Esq., M.A., F.G.S. (Read December 20th, 1899.)

[PLATE XXII.]

THE most striking features in the geological structure of by far the greater part of Tasmania are the lofty mountain-ranges, which, to the casual observer, appear to consist solely of diabasic greenstone, or dolerite, as it is variously termed. Tasmania is in extent nearly as large as Ireland, and this rock occupies the summits of all the mountains in the eastern half of the island, extending well into the western half in the central and southern districts, and reaching a maximum altitude of 5069 feet above sea-level. But the diabase is not confined to the mountain-ranges. It crowns almost every considerable hill within the area described; it is exposed at numerous points in the river-beds and valley-bottoms; it fringes the margin of basaltic lava-flows of Tertiary age; and its presence has been detected elsewhere by boring through overlying sedimentary strata.

The oldest sedimentary rocks exposed in the south-eastern quarter of Tasmania belong to that division of the Upper Palæozoic Series which in Eastern Australia and Tasmania is classed as Permo-Carboniferous. The question of the relations of these sediments to the diabase has often been raised. Were they quietly deposited during a long unbroken period against and around vast masses of igneous rock previously cooled and denuded? Or is the diabase an intrusive rock, the existence of which in the shape of vast dykes and sills has been disclosed through the removal of overlying strata by the ordinary processes of denudation? The former theory seems to have been widely accepted as the basis of the geological history of the eastern half of Tasmania, though not without occasional adverse criticism from competent observers who had noted evidence to the contrary at isolated points. My own opportunities of observation over the whole area in question have long since led me to conclude, firstly, that the central plateau is not a vast boss of ancient volcanic rocks, but rather a ring or network of massive dykes and sheets of diabasic greenstone, which traverse all the sedimentary rocks of pre-Tertiary age; and, secondly, that there is no known instance in which the diabase of Eastern Tasmania can be proved to be anterior to the deposition of the Permo-Carboniferous Series.

The question is one of considerable importance, even from an economic point of view, for the principal coal-seams crop out on the flanks of lofty ranges in which the diabase is a pre-dominant feature. The problem is one of those which can never be fully solved without a systematic geological survey of the whole country, and this, unfortunately, has not yet been under-

taken in Tasmania. All that can be done at present is to collect materials for safe generalization by noting and sifting the evidence obtainable from natural sections, or otherwise; and the primary object of this paper is to correct a misapprehension which appears to have been founded upon a paper brought before the Geological Society rather more than half a century ago.

In the Quarterly Journal for 1847 appears a communication by the late J. B. Jukes<sup>1</sup> which gives an admirable general description of the chief geological features of the south-eastern portion of Tasmania. Speaking of these in general terms, and remarking that he had no time for a detailed examination of the country, the author says (*op. cit.* p. 245):—‘The two principal rock-masses of the south-eastern portion of Tasmania are a very massive, rudely columnar greenstone, and the sandstone of the Palæozoic formation. . . . The sedimentary and the igneous rocks are so interlaced and entangled one with the other, and their apparent relations at the surface so different in different localities, that nothing but a careful and minute survey, laid down on maps of a large scale, will ever be able thoroughly to elucidate them.’ Of the relations of the sedimentary rocks to the greenstone of Mount Wellington, Jukes speaks in carefully guarded terms; but he mentions two sections on the other side of the Derwent estuary, as affording evidence of the non-intrusive character of the igneous rock. With reference to one of these, which is described as being ‘about a mile from a place called Ralph’s Bay Neck, on the S.E. side of North Bay,’ he says (*op. cit.* pp. 246–47):—‘In this case a dark, rudely columnar trap-rock ended in a succession of small cliffs and terraces in one direction, upon which terraces and against which little cliffs rested the sandstone perfectly undisturbed, and evidently in the position in which it had been originally deposited. A parallel instance was observed in the cliffs a little to the eastward of the entrance of Port Arthur. It appears, then, that there are masses of greenstone both of more ancient and more modern date than the Palæozoic rocks.’

When my attention was first called to this passage, I had some difficulty in determining the position of the section described, for no such name as North Bay appears on any map of the present day. Ralph’s Bay Neck was easily identified; but I had already examined all the coast-sections in the neighbourhood, except a small projecting point on the shore-line of Frederick Henry Bay, which was at the time inaccessible, owing to a high tide. A second visit to this point cleared up all doubt as to its identity with the first of the two places mentioned. Here, on the face of a cliff rising to a height of about 80 feet above high-water mark, are the ‘small cliffs and terraces of trap-rock,’ which, to an observer at a distance, would appear to be supporting a mass of sandstone, or other similar rock, ‘undisturbed and . . . in the position in which had been originally deposited.’

<sup>1</sup>Notes on the Palæozoic Formations of New South Wales & Van Diemen’s Land,’ vol. iii, pp. 241–49.

An examination of the section, however, reveals very different conditions. The sedimentary rocks to the left have been so indurated and altered, that the planes of stratification are in many places traceable only on the weathered face. From the same cause the rock, at first sight, appears to be barren of fossils; but I found sufficient traces of *Fenestella*, *Spirifer*, *Productus*, etc. to identify it with the limestones interstratified with shaly bands, which constitute the lower members of the Permo-Carboniferous Series in South-eastern Tasmania. The shale has been converted into chert, and the limestone in some places into an intensely hard whitish marble. The direction of their dip is about west-south-west, and the face of the section is nearly in line with their strike. They occupy the whole of the rocky point to the east and south of the section, the mudstones and sandstones of the upper portion of the marine series showing themselves to the south and west at no great distance, with some indications of an intervening fault throwing up the lower portion of the series.

The dark rock to the right, in the lower part of the section (see Pl. XXII), is the ordinary diabase of Eastern Tasmania, showing the finely crystalline, granular structure, which is noticeable in this rock wherever it is found in contact with the original cooling-surface. Its main constituents are plagioclase-felspar and augite, and a microscopic examination would probably disclose the ophitic structure, which has been shown by a competent local authority, Mr. W. H. Twelvetees, to be an invariable characteristic of the Tasmanian diabase. The rock is rudely columnar where exposed on the coast, and it extends for a few hundred yards to the north and west, being succeeded by Permo-Carboniferous mudstones apparently undisturbed, but extensively denuded. The junction is hidden from view by the mud-flats and sand-dunes of Ralph's Bay Neck.

The diabase, with a more coarsely crystalline structure, appears again at many points within a radius of a few miles in the massive form described in the first part of this paper. Of its intrusive character at the point described there can now be no doubt, and the evidence afforded by the section seems to show that this is not a case of an ordinary lateral thrust. It suggests rather that the whole mass of the altered rocks has been bodily lifted from its original position by the intrusive sheet, and that, to match the peculiar fracture of the bedding-planes exhibited by the section, there must be, far down below the present sea-level, a corresponding series of steps, or 'benches,' in the undisturbed formation, from which the portion now visible on the surface has been torn away.

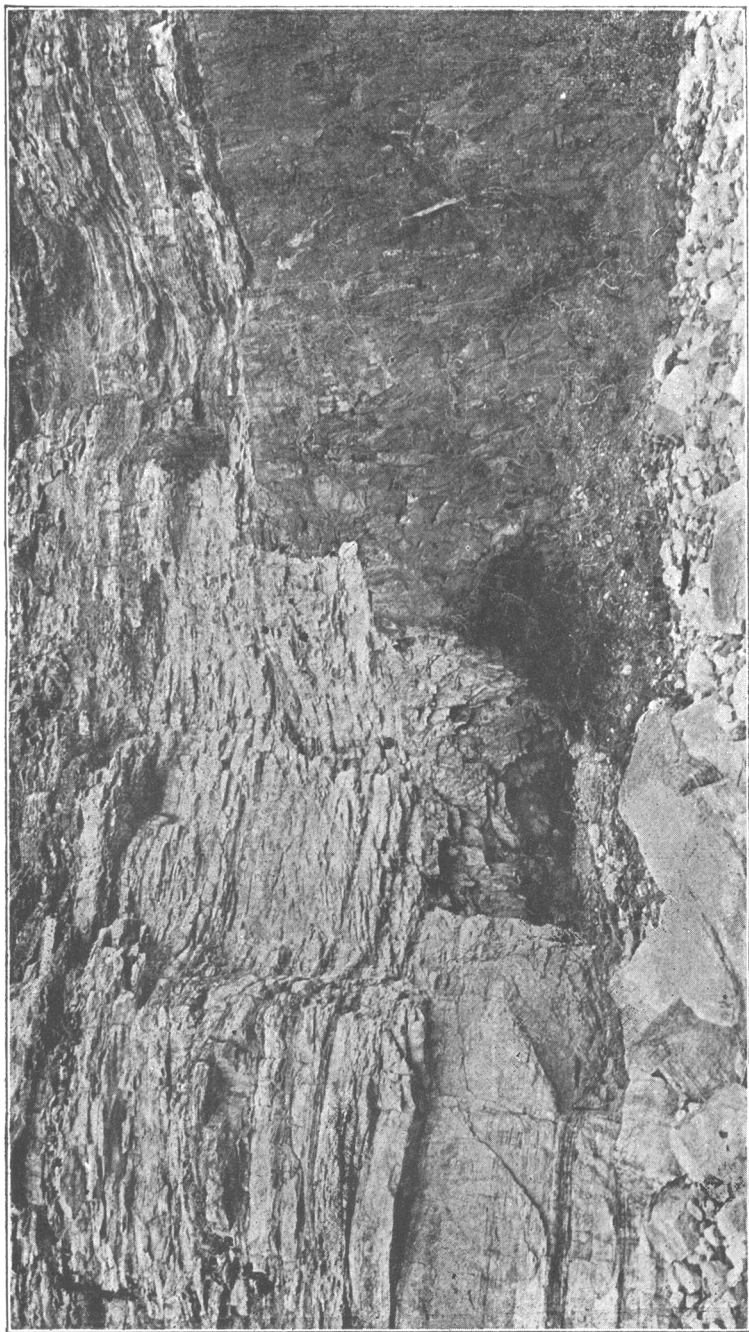
The other section mentioned by Jukes is on the face of a lofty precipitous cliff to the east of the entrance of Port Arthur. The place is reported to be inaccessible for any purpose of close examination; but on the other side of the estuary I have noted many interesting sections in which the diabase occurs as an unmistakable sill, with altered sandstone immediately overlying it.

How are these two conflicting accounts to be reconciled? It is unnecessary to point out that a report by so competent an observer as Jukes, on a formation which he had personally examined, could not be lightly set aside, and the explanation is not far to seek. Between 1842 and 1845, H.M.S. *Fly* was engaged in surveying the eastern coast of Australia and Tasmania, and Jukes held the position of naturalist to the expedition. During the progress of the survey, he appears to have made a trip from Hobart to Port Arthur, at the southern extremity of Tasman's Peninsula, where his ship was temporarily stationed. The only direct means of conveyance at that time was the boat which carried mails, etc. to the peninsula, and no deviation from its regular course would be practicable. The first part of the route was by way of Ralph's Bay to Frederick Henry Bay. The Neck would be crossed by means of a tramway, which has long been disused, and the traveller would pass the section which is the subject of this paper at a distance of about  $\frac{1}{4}$  mile, but he would have no opportunity of landing. Jukes mentions several places which he personally visited, including quarries from which fossils were obtained; the nearest of these, however, is distant about 18 miles from the Frederick-Henry Bay section, and most of them are on the other side of the Derwent estuary. The paper appears to have been written three or four years after the visit to Tasmania, and this might account for a slight want of continuity and clearness in the reference to distinct localities. The sketch, fig. 1, *op. cit.* p. 247 (there is no fig. 2), which immediately follows the account of the Frederick-Henry Bay section, represents the cliff-section mentioned in the next two lines, which is cited as a parallel instance. The latter is more fully described in the second part of Jukes's paper, and was probably seen by him from the deck of the *Fly*.

#### PLATE XXII.

Section showing the junction of diabase and altered sedimentary rocks in Frederick Henry Bay (Tasmania). Reproduced from a photograph.

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**JUNCTION OF DIABASE AND ALTERED SEDIMENTARY ROCKS IN FREDERICK HENRY BAY (TASMANIA).**