

1. Barium Paper

On an
~~Ancient~~ Permian Moraine in
Prince Edward Island.

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The Groat River, which is the eastern branch of the Mill River, New London, P. E. Island, flows in a deep and picturesque valley, cut right through the horizontal Triassic strata, which cap the rock formations of this part of the country. On either side of the stream the fertile rounded hills of fertile red sandstone rise two hundred feet, clothed with bright deciduous groves or golden with the ripened fields of autumn. At the foot of these hills, at a place called Black-man's Island, a conspicuous ridge, or mound, ten to twenty feet in height, fifty yards broad, and five hundred yards in length, runs along the left-bank of the river, assuming

much the appearance of a Quaternary glacial moraine. On examination, however, we find that it is formed by a hard mass of sandstone conglomerate, which has resisted denudation, while the surrounding softer strata have been carried away. A stratified portion at its base shows it to possess the same general dip as the Permian rocks of the district, viz: $S. 22^{\circ} E. \sim 2^{\circ}$. General direction of the conglomerate ridge, $S. 35^{\circ} E.$ The superior beds, which once overlaid it, as seen in adjacent sections, ~~were~~ ^{are} horizontal.

This ~~mass~~ ^{ridge} of ancient conglomerate is composed of rounded masses of red sandstone, sometimes two feet in diameter, gravel, sand, and clay, with some fragments of primary drift, all intimately wrought up together, without any trace of stratification, except in the lower member

mentioned. The whole is now consolidated into ~~hard~~^{firm} rock, hardened in part by carbonate of lime. It contains no organic remains, except that some of the included masses of sandstone show the usual traces of Permian conifers. It appears to me evidently to have been a glacial moraine of the close of the Permian.

The large, rounded masses of stone intimately wrought-up with clay, sand, and gravel, without stratification or other indication of sedimentary origin, I do not think can be referred to any other cause than that of ice operation. The angular fragments of primary rocks, - quartzites and felsites, - sometimes more than six inches in diameter, which it contains, show that the usual agents of a drift-period were in operation, conveying material from great distances.

The rounded blocks of sandstone

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contained in this deposit~~s~~ prove that at the time of its formation the underlying Permian strata had been consolidated into firm rock, and that a great lapse of time must have intervened between their deposition and its formation.

The deposits immediately succeeding this, and forming the base of the Trias, are of clay shale or shaly sandstone and are nearly destitute of organisms. As we mount in the formation, however, more traces of life gradually come in, till at its summit; 200 or 300 feet above the horizon of the moraine, the dark-coloured sandstones bear evidence of an abundance of life, ^{among which were tree ferns, stony corals, and} On the other hand, the deposits ^{gigantic reptiles,} immediately underlying the moraine, and forming the summit of the Permian, are very devoid of organized remains; but as we descend in the system life becomes more abund-

dant, until in the lower Permian we find the brown and grey rocks filled with the remains of a luxuriant vegetation of which tree ferns and ^{Campylo trees of the Permian} great ~~Dadoxylon~~ ~~pine~~ trees formed an important feature.

The middle portion of this system of deposits, so devoid of organisms, forms a broad belt of red rocks widely distributed over the Island, forming its most characteristic red-sandstone scenery, and appears to represent a period of depressed temperature in the past, which found its climax in a glacial period at the ^{time of the formation} line of the ancient moraine. This line is especially interesting as being also the line of division between the Permian and Trias, where such a marked change in life is known to have taken place. Our ancient moraine, then, standing grim and sphinx-like by the glassy flow of the quiet Mill River

probably contains in its dark bosom the secret of that great change in life, viz, an era of glacial cold.

The Permian in England and ⁱⁿ India bears evidence of extensive ice action, and it is exceedingly interesting to find the same in ~~eastern~~ Canada the Permian of Eastern Canada. In Europe the lower Permian shows generally a warm climate, though at its base is a line of drift material. The same line of drift material occurs at the base of the Permian in P. E. Island, followed by the same evidence of long continued warm climate. The upper Permian in Europe indicates, by the absence of corals and the character of ~~the~~ ^{its} molusca, a cool climate. In P. E. Island we have seen that there is evidence of the same depression of temperature, which culminated in an era of ice and drift. Y. Bain