

## **On the denudation of western Brittany / by G.A. Lebour.**

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10

## ON THE DENUDATION OF WESTERN BRITTANY.

By G. A. LEBOUR, F.R.G.S., of the Geological Survey of England and Wales.

1. *Geology.*—STATED roughly, the geology of the Department of Finistère may be said to consist of two masses of granite, one to the north and one to the south, enclosing between them nearly the whole of the sedimentary rocks of the district. These consist of Cambrian slates and gneiss, Lower, Middle, and Upper Silurian slates and grits, and very small and unimportant patches of Upper Carboniferous shales. The entire mass of these deposits has an east and west direction, and occupies the central part of the Department.

All the country to the north of Brest, and extending from Normandy to the Isle of Ouessant, forms part of the northern granitic mass. Between this and the tongue of land to the south of Douarnez, including the very indented peninsula of Crozon, we have the Cambrian and Silurian rocks powerfully undulating and forming the two loftiest chains of hills in the district—the Montagnes d'Arrhée and the Montagnes Noires—which run across the country close to and parallel to each other in an east and west direction. Immediately to the south of this wide band of Palæozoic formations, comes the southern mass of granite. Like the first, this has scattered here and there, over its whole extent, numerous isolated enclosed masses of metamorphic schists, which have, by Dufrénoy and others, been referred to the Cambrian age.

The coal shales mentioned above, as occurring in this district, are to be found in thin elongated patches at Quimper and at Cléden, on the west coast; their extent is utterly insignificant.

About two miles south of Quimper, near the hamlet of Toulven, is to be seen a small series of horizontal beds of Tertiary age (the only instance of the occurrence of such deposits in the Department) of which more will be said presently.

2. *Coastline.*—The coastline of Western Brittany is very irregular. The two great bounding masses of granite forming comparatively even and sweeping lines, interrupted only by the long, narrow, and winding creeks which are to be found at the mouths of all the rivers. These creeks are, however, quite minor features on these coasts, and are many of them hewn out of the micaceous schists which are interspersed among the granites. Where an estuary occurs in the granite itself, it is usually wider, and is bounded by flat sandy shores.

The cliffs along these coasts are low, with rounded and well-weathered tops. They are higher when composed of the metamor-

phic schists, which are much more compact and harder to disintegrate than the granites of these parts, and naturally form bolder and more striking cliffs.

The Cambrian and Silurian beds, on the other hand, which are enclosed between the two above-mentioned bands of granite, are, as a rule, characterized by high, steep cliffs, the faces of which are frequently much eroded into caverns, oftentimes of very considerable magnitude. The general line of this part of the coast is very indented, and forms an endless number of small bays, promontories, and headlands; as may be seen by glancing at the Rade de Brest in any map.

Along the southern granitic coast, the sea is very shallow for some miles, and the numerous small islands with which it is studded have exactly the same geological features as the mainland; thus showing that the southern granitic plateau has a much greater extension than the boundary of the coast alone would indicate. The *Iles de Glénan* are a case in point.

3. *General Surface Characteristics.*—The two great watersheds of the country are formed by the two central chains of hills, the space between them or “swire,”<sup>1</sup> which is very narrow and not much below the average height of the two flanking ranges, being for the most part covered with wet bog-land.

The *Montagnes d’Arrhée* supply the streams running to the north and north-west, and the *Montagnes Noires* those flowing to the south.

Descending from these hills on either side, and proceeding to the south or north, we find ourselves all the way to the sea in what appears at first sight to be an exceedingly hilly and disturbed country. The streams are innumerable, and flow at the bottom of deep narrow rocky ravines, which intersect the country in every direction. Their course is most tortuous, and continues, with scarcely any noticeable difference of width or depth, alike through the hard Silurian grits and their enclosed traps, the vertical or contorted leafy metamorphic schists, and the variously-grained, easily decomposed granites. What slight change there may be, however, is most discernible among the latter rocks, where the valleys are sometimes somewhat wider and less winding than in the former. The jagged appearance, moreover, of the rocky sides of these valleys tends to increase the mountainous and rugged aspect of the scenery. This, however, is only the result of a superficial view of the physical features of this district, and is by no means in accordance with the true facts of the case. These errors are perpetuated by the use of sections across the country drawn on exceedingly exaggerated vertical scales; quite a universal practice abroad.

By drawing horizontal sections on a true scale, cutting the whole breadth of the peninsula, the height and distances being taken from the large government maps of these parts, and by carefully going

<sup>1</sup> I have ventured to use the old north country word “swire” to express the slack between two hills. I think it might be a useful one to adopt in the description of physical features.

over the ground along each line of section, added to a long acquaintance with the country generally, I have been enabled to arrive at the conclusions, the statement of which is the object of the present paper.

Following on paper one of these lines of section (a north and south one) from the base of the Montagnes Noires to the southern sea-shore<sup>1</sup> we are immediately struck by the *absence* of marked features. Even when drawn to a large scale the surface line is a most even one, sloping insensibly towards the sea. The numerous valleys, which give the country its wild appearance, are seen on the section but as a number of little insignificant nicks, breaking for an instant only the continuity of the surface line, and even rendering the evenness of the latter more obvious by their very unimportance. The very slight and gentle undulations to which this surface line is subject are coincident with the changes in the geological conformation of the district across which it runs, and are sufficiently accounted for by the relative hardness and facility of disintegration possessed by the rocks which characterize them.

Looking, then, at the country from this new point of view, we have a long central line of hills standing boldly between two plains, each of which slopes gently to the sea. These plains I look upon as the work of the last great marine submergence of Western Brittany,—as, in fact, being *plains of marine denudation*. The formation of the valleys by which these plains are as it were gouged in every direction, I regard as being due to quite different, and, in part at least, to much more recent causes.

4.—*Date of submergence*.—It has been repeatedly stated, and it is indeed held by many as an established fact, that the whole of Brittany has been dry land since very early geological times.

That this may not be true for the median range of hills of Western Brittany there is no evidence whatever to show; and indeed it is most probable that the old rocks of which they are composed have not been exposed to the action of the sea since very ancient times. They no doubt stood out as a tongue of dry land during the subsidence, and planing down of what I will now term the northern and southern plateaux of Finistère.

Whether this submergence took place several times or only once, and when, I am not aware of any means of determining at present. But I think that there is sufficient evidence to induce us to believe that the last great submergence was a comparatively recent event.

The northern plateau is remarkably deficient in any deposits of later date than the Devonian. At one particular spot on the southern plateau, however, as has been mentioned above, there is an isolated patch of sands and clays which has been referred to the Tertiary age. These beds are lying perfectly flat upon the upturned edges of a mass of micaceous schists; they stand above the general level of the country, and if produced at their present horizon they

<sup>1</sup> The result would be exactly similar were we to follow the northern half of the section from the hills to the north coast.

would spread over a great portion of the southern plain. They are unfortunately quite devoid of any organic remains by which their exact age might be satisfactorily settled. In general appearance, however, in lithological character, as well as in relative position, they agree very closely with some deposits of undoubted Miocene age in the neighbourhoods of Dinan and Rennes. These last-named beds are all marine, and in the total absence of any palæontological evidence to the contrary, it may, I think, fairly be admitted that the patch in question at Toulven, near Quimper is also of marine origin. Indeed the appearance of the beds is such as seems directly opposed to the notion of their freshwater origin.

Now, taking this isolated patch to be the remnant of a large extent of similar beds deposited over the district during its subsidence beneath the Upper (?) Miocene sea; we have, I think, enough to prove that marine action has been at work over a considerable part of Western or Lower Brittany, at least during the middle of the Tertiary epoch—a date of submergence much more recent than has usually been supposed probable for this country.

That the loose sandy deposits formed at the bottom of the Miocene sea should have all but entirely disappeared from the surface is only what one would expect to be the case, considering the vast time which has elapsed since their deposition, and probably also since their emergence and consequent exposure to the denuding power of the various subaërial agents. Indeed this one little patch, which is now the only memento left us of that ancient condition of things, was only saved by its position, and probably consists of merely some of the higher members of the series.

Taking all these things into consideration—the two gently-sloping plains of marine denudation, separated by a high pre-existing water-parting ridge, from whose sides no doubt streams ran into the Miocene sea during its slow advance and recess, as they do now into the Atlantic and the Bay of Biscay,—there seems but a very small effort of the imagination required to suppose that the rivers which are now winding their way across the face of the country are, in their upper part at least, identical with those which were running in a similar manner during and previous to this epoch of submergence. That they have themselves worn and excavated the narrow gorge-like valleys at the bottom of which we now find them, I think no one who has visited this part of Brittany, will doubt for a moment. Many of these river-valleys I have examined minutely, and in no case have I found that they coincided with any marked lines of weakness such as faults, fissures, &c.

One of the principal difficulties connected with these deep and narrow river-valleys, is the extraordinary constancy of their width and depth, which, as I observed before, continues good, quite regardless of the various hardness and capacity for erosion of the different rocks through which they pass.

The assumption that these valleys are the same as those which were scooped out during the retreat of the middle Tertiary sea,

seems however, to afford a sufficient explanation of this curious fact; inasmuch as the hardest rocks (the Silurian grits), being those in the centre of the country (that is—those, a part of which were always dry land, and the rest of which were the first left uncovered by the retiring sea), and the hardness of the different rocks forming the mineral characters of the country *decreasing* regularly from the central chain to the sea, both north and south,—it is plain that the time which has elapsed since they respectively emerged from the sea and became a prey to the action of running water, would have a compensating influence over the erosive power of the latter, the softest rocks having been last under water. This explanation requires the existence of certain conditions; such as, that the scale of hardness of the rocks in question should be exactly counter-balanced by the time taken by the retreat of the sea, the existence of which it would be very difficult to prove. I merely bring it forward for what it may be worth, as an explanation which, if it may not be the true one in the present case, yet may, I doubt not, be applicable to others.

5. *Summary.*—The conclusions I have endeavoured to shadow forth in this paper may be briefly summarized as follows:

1. That with the exception of a central double range of *mountains of elevation*, Western Brittany consists of two great northern and southern *plains of marine denudation*.

2. That the last time these plains were exposed to the action of the sea, was in Upper (?) Miocene times.

3. That the rivers of Finistère are identical with those which flowed from the central dry-land into the Miocene sea.

4. That the valleys at the bottoms of which these rivers run are the result of their erosive action, aided by other subaërial agents.

5. That the uniformity of depth and breadth at present displayed by these valleys is due to the degree of hardness of the rocks in this district, being in an order of succession directly inverse as the time during which they were submerged beneath the middle Tertiary sea, and exactly proportionate to that during which they have been exposed to present subaërial influences.<sup>1</sup>

<sup>1</sup> Read at the British Association Meeting at Exeter, in Section C., on Saturday, the 21st August, 1869.

The history of the United States is a story of growth and expansion. From a small collection of colonies on the eastern coast, it grew into a vast nation that stretched across the continent. The early years were marked by struggle and conflict, as the colonies fought for their independence from British rule. The American Revolution was a turning point in the nation's history, leading to the signing of the Declaration of Independence in 1776. The new nation then faced the challenge of building a government that would unite the diverse states and provide for the common good. The Constitution was drafted in 1787 and put into effect in 1789, establishing a system of checks and balances that has endured to this day. The years following the Revolution were a period of rapid growth and development. The nation expanded westward, settling new lands and building a strong economy. The Industrial Revolution brought about significant changes in the way people lived and worked, leading to the growth of cities and the rise of a new middle class. The Civil War, which began in 1861, was a defining moment in the nation's history, as it fought to preserve the Union and end the practice of slavery. The war resulted in the Emancipation Proclamation and the passage of the 13th and 14th Amendments to the Constitution, which guaranteed the rights of all citizens. The Reconstruction period that followed was a time of great challenge and progress, as the nation sought to rebuild and reunite itself. The late 19th and early 20th centuries were a period of continued growth and innovation. The nation became a world power, with its influence extending across the globe. The Progressive Era brought about significant reforms in government and society, leading to the establishment of a strong federal government and the protection of civil liberties. The 20th century has been a time of great change and achievement, with the United States playing a leading role in the world. The nation has faced many challenges, including the Great Depression, World War II, and the Cold War, but it has always emerged stronger and more united than before. Today, the United States stands as a beacon of freedom and democracy, with its values and principles inspiring people around the world.

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