

GEOLOGY AND THE MOUNTAINEER.

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Unlike the hymn-writer, the rock-climber does not turn to the mountains when looking for a simile to suggest permanence. He remembers a rock fall because it perhaps turned one pitch of a climb from difficult to severe; he sees his favourite handholds flake away, his essential footholds worn smoother and the disappearance of vital jammed stones; moreover, he notes how the little fan of scree at the foot of a gully grows larger after very heavy rains.

These changes are easily visible and, though small, will level a mountain to the ground if they go on for long enough; but the mind finds it difficult to see the enormous spans of time involved and the best we can do is to draw a parallel with some familiar scale. If we picture the solid world as having existed for 24 hours, then life has been on the earth for 5 hours and man for perhaps 5 seconds, while the life of man, on the same scale, is about 1/5000th second. In the flick of a camera shutter a fast moving train seems to stand still and to the rapid glance that one lifetime gives, the melting mountains appear fixed. But Ice and Water, those great chisels which carved out the Snowdon mountains and valleys, are still at work.

Disturbances in the deep-seated plastic rocks of the earth—the origin of which is still obscure—give rise to folds on the surface and often, as in the Alps and Himalayas, the folds so produced form mountain chains. Although such folds may be seen in Wales on a magnificent scale, they have little connection with the direction of the mountain chains and the crests of such folds rarely coincide with the mountain summits.

A trough between two such folds is well seen in the cliffs at the head of Cwm Idwal. The two rakes on either side of the Devils Kitchen are the two limbs of the folds rising on either side, the Kitchen itself being the lowest point of the trough. If these two folds, of which we see only the roots, were still complete, we should find that the crest of the south-east fold lay over Cwm Tryfan and of the north-west fold over Bethesda—two depressed areas.

The summit of Snowdon itself is the lowest point of a trough between two great folds of rock with crests which once

centred over the Rhinogs and Anglesey. The Snowdon Summits are certainly not the crests of rock folds.

In spite of editorial warnings to the contrary, I am going to use a technical term and say that Snowdonia is a "dissected plateau," a high tableland cut and grooved into cwms and valleys by ice and water. The mountains that we see to-day are simply those parts of the plateau that have not yet been carved away. Nature here seems to prefer the methods of a sculptor who chisels away a block of marble rather than the building-up technique of modelling in clay.

When water and ice act upon a fairly homogeneous mass of rock, the result is fairly uniform and not very exciting. Smooth rounded hills with grass right up to the summits, very few outcrops of rocks and no cliffs at all are produced. The Berwyns and Plynlimon are good examples and very different from the dramatic scenery of the Snowdon district or Cader Idris. The difference is due to the heterogeneity of the raw material from which the latter mountains are carved.

The broadest classification divides rocks into two classes—sedimentary and igneous.

Sedimentary rocks were laid down on the bottom of the sea and have as their raw material gravel, sand and mud deposited on the ocean bed by rivers or lime, silica and iron actually dissolved in the water. Pressure exerted by subsequent layers, heat from the centre of the earth or the infiltration of water laden with soluble matter binds together the mud sand or gravel into solid rock. Sedimentary rocks are laid down in layers known as strata and these are originally horizontal though subsequent folding may tilt them up to any angle. Sedimentary rocks almost invariably contain fossils.

Igneous rocks are fire-formed and derive from the hot plastic rocks below the crust of the earth. They may take the form of volcanic ash, of melted lava that has flowed out from some fissure in a great sheet, of melted lava that has filled up some crack in rocks already formed or of great masses of molten rock that have solidified below the surface and are only revealed by later denudation.

Igneous rocks are not stratified nor do they contain fossils. In North Wales igneous rocks are pre-eminently the the climbers' playground.

You will now be wanting a technical term with which to

impress your friends. The word is "Ordovician." You may safely pick up almost any piece of rock in the Snowdon area and say "this belongs to the Ordovician Series," or simply, "Ordovician deposits" for that is the name which geologists give to the age in which the rocks were laid down from which Snowdonia is carved.

You might imagine that this work was done in the Cambrian age but it is not so. Cambrian rocks are older than Ordovician; they underlie the Snowdon group and crop out on the north between Caernarvon and Bethesda; along the line of Cwellyn—Llyn Peris they disappear under the Snowdon massif to reappear in the vale of Ffestiniog and around Portmadoc. Cambrian rocks yield fine slates (Bethesda, Penrhyn, Blaenau) also gold (Dolgelly) but they yield little of interest to the climber. Those who would like to try climbing on Cambrian rock can visit the Sentries' Ridge on Mynydd Mawr or Hywel Ridge on Rhinog Fach. The rock on both these climbs is rotten and insecure.

On this Cambrian foundation were laid down the Ordovician rocks. Wales was submerged at that time so that we might expect these rocks to be entirely sedimentary, and so they would have been had there not been a simultaneous outburst of volcanic activity, mostly submarine, in the area we now know as Caernarvonshire and Merionethshire.

Volcanic activity did not, in this case, imply volcanoes. Fissures would appear in the sea bed out of which flowed molten lava or, in some cases, lumps of rock and ash were ejected with explosive violence. After the indescribable turmoil which such an eruption must have produced, the sea became calm once more and sediments were again deposited in the normal way.

This process was repeated many times and, as a consequence, the Ordovician rocks in Caernarvon and Merioneth are alternately igneous and sedimentary. A side of streaky bacon, the lean meat representing igneous rock, might be taken to give a rough picture of the final result.

Slowly this mass of rock was raised up above sea level, raised up to form a great plateau (becoming rather crumpled in the process), raised up and exposed to ice and water, raised up only for the grinding down process to begin at once.

This grinding down is not uniform. The sedimentary rocks tend to wear away more quickly so that valleys are cut into

them while the more resistant igneous rocks are often found forming the upper cliffs and the summits of mountains. A fine example of this is Tryfan where the Heather Terrace marks the boundary between the sedimentary rocks which form the floor of Cwm Tryfan and the lower slopes of the mountain and the magnificent igneous buttresses and cliffs of the upper mountain. These cliffs of the East face are the stub end of a broken arch of igneous rock that once spanned Cwm Tryfan; look across the Cwm and you will see the other end of the arch in the cliffs of Gallt yr Ogof.

The same fine solid igneous rock curves round to form the cliffs of Glyder Fach but the Gribin Ridge, although of igneous rock, is composed of newer, less resistant stuff, while Foel Goch with its characteristic pink colour, is of granite, igneous it is true, but, in Wales at least, not a climber's rock.

Lliwedd is utterly different from Tryfan in character; the holds are smaller and rarer; the rock is softer and tends to weather into vertical ribs. Indeed Lliwedd (and with it most of Snowdon) although igneous, is not a solidified lava that was once melted but a consolidated volcanic ash. At least three outpourings of ash have gone to build up Snowdon and between these outpourings came normal sedimentary periods giving rocks rich in fossils; you can find plenty of fossils in the rocks of which the summit cairn itself is built.

Quartz is a characteristic of Lliwedd so a note might be made of it here. Quartz is an intrusive rock, intruding its way into cracks that have developed in rocks already formed and hardened. It is therefore much newer than the rock in which it is imbedded and from its formation it only occurs in narrow veins. Under heat and pressure water will dissolve quartz and it is such a solution of quartz formed deep in the earth that seeps into cracks and fissures to form that beautiful, white, brittle rock that climbers use but distrust.

First cousin to glass, quartz is brittle, and its adhesion to the base rock is uncertain; it is stuck on rather than welded in place by heat from abysmal fires.

It is astonishing to think how recent the scenery of Snowdon is. The plan of North Wales was apparent before the Great Ice Age (this includes at least four minor ice ages) with the mountain groups of Cader, Arenig, Rhinog and Snowdon and the major valleys such as Llanberis and Nant Ffrancon already

indicated. On the other hand, the profile of North Wales would have been utterly unfamiliar; valleys would have been V-shaped instead of U-shaped as now, and the floor of the valley would have risen at a constant angle nearly to the top of the mountains; there would have been no lakes, no cwms, no moraines.

Then came the ice. Every valley had its glacier and at the coldest period the ice stood 1,000 feet thick above Glan Dena flowing down Nant Ffrancon to join the ice streams from the Lake District and Scotland. Such a flow of ice flattened the sharp bottoms of the valleys and gave the U-profile which we know so well. In the successive stages of retreat moraines were left behind which dammed up valleys to form shallow lakes such as Ogwen, Dinas and Gwynant; in other cases ice actually ground out and deepened a rock basin and lakes so formed are exceptionally deep, Glaslyn, Llydaw, Dulyn and Cwellyn for example.

In the last phase of the Ice Age ice evacuated the main valleys but persisted in the high cwms, deepening them and leaving mounds of moraine so well seen around Llydaw and Idwal; one of these moraines is pointed out as the burial place of the giant Idwal.

About 25,000 years ago the ice finally disappeared leaving Wales much as we know it to-day but bare and desolate. Since then, trees, grass and heather have added warmth and colour to the scene, contours have become rounded, scree has climbed higher up the cliff face and lakes have shrunk. Nevertheless, you would not have lost your bearings if you had visited Wales in 25,000 B.C.

The average duration of a minor Ice Age was about 50,000 years with interglacial periods of about the same duration; it is, therefore, quite possible that we are living in one of those milder, warmer interludes and that the Great Ice Age has not yet come to a close.

Thou shalt thresh the mountains, and make them small, and shalt beat the hills as chaff.

—THE PROPHET ISAIAH.