A Chapter 42 General chronological recapitulation

'The world's incessant ebb and flow'. *Therargatha X.*

To study scientifically, we define and isolate. We part species from species, rock from rock, subdivide beds into narrow zones, and map out the surface with all the precision of which we are capable. So only, indeed, can we cope with the complexity of Nature. But if delimitations be pressed home, the fluidity of natural process is certain to elude them. Fortunately, geological science is able to transcend its own expedients, and to lead on to a truly philosophical view of the subject with which it deals. Thus regarded, that subject gradually unfolds itself as an unbroken transformation<ref>Science is partially-unified knowledge; Philosophy is completely-unified knowledge'. (Spencer, 'First Principles', ed. 5, p. 134). For the view of Nature as a fluidity, see Spencer, *op. cit.,* p. 277; Bergson (though he seems to be scarcely aware of inorganic evolution), 'Creative Evolution', p. 355, &c.; also the Fragments of Herakleittis; and especially the Pali Pitakas, wherein it is repeatedly emphasised.</ref>. Accordingly, let us conclude the present study of the Geology of Anglesey with an attempt at once to summarise it in small compass,<ref>The reader is requested to bear in mind that, in compressing the whole content of this book into seven pages, it is impossible either to recapitulate evidence or to qualify general statements. Both evidence and qualifications will be found in the body of the work. In view of the peculiar difficulties of the Mona Complex, especial attention is asked to the fact that this condensation thereof is (more than any other portion of the book) to be understood as subject to the cautions and reservations expressed in the Preface and referred to in the footnote to p. 387.</ref> and to contemplate it, not as an assemblage of objects or even as a series of phenomena, but as the expression of an ever-changing continuity.

When light first dawns, it is upon the development of a foliated crystalline complex of extreme antiquity. Not even here, however, in the memorable phrase of Hutton, do we find any trace of a Beginning. For a sedimentary component speaks of derivation from the waste of Something even more remote. which is the utmost phase we are able to discern 'In the dark backward and abysm of time'.

Subsidence and accumulation had come to an end, and basic intrusions were penetrating those ancient sediments, when powerful shearing stresses began to set in, deforming and re-crystallising both sediments and diorites; at a late stage of which process came intimate granitoid permeation, raising the whole to the highest grade of gneissic anamorphism. These disturbances, we can dimly infer, seem to have given birth to lofty land, of whose very existence, however, no more than the faintest possible suggestions have survived. Inevitable erosion ensued, and, in the course of an epoch of unknown duration, this old highland was gradually reduced to what we have termed 'The Ancient Floor'. Upon that floor, as it slowly subsided, the Bedded Succession of the Mona Complex began to be laid down.

The first episodes of the new period are unknown, and it opens, for us, with what seems like the on-coming of marine conditions, accompanied by widespread volcanic eruptions, which have left the felsitic lavas and tuffs of the Fydlyn Group. Sedimentation then greatly increased, and the Gwna conditions are indicated as marine by the presence of annelids, as well as by the nature of the limestone, black shale, and jasper-chert. At this time the spilitic eruptions began. To south ana east was a region of attenuated sedimentation with feeble vulcanicity; to north and west was thick sedimentation with two spilitic episodes, the dust and lapilli mingling with some of the sediments. Then spilitic outflows nearly ceased, but in the Skerries Group we find a great increase of dust-explosion. Marine conditions (again indicated by remains of annelids) continued in (apparently) the north-east, the lapilli mingling with the deposits of the sea; but in the west these gradually gave place to unstratified accumulations of spilitic mingled with rhyolitic dust that seem to have been spread out on dry land. While these eruptions were going on, local elevation took place in the north, exposing to erosion some of the Gwna Beds, as well as hypahyssal acid rocks of unknown age.

General submergence then set in once more, marine conditions being again indicated by the thin beds of chert-like jasper which repeatedly recur in the New Harbour Group. A second series of spilitic lavas was poured out, and fine sprinklings of their dust mingled widely with the sediments. Towards the middle of the series, a gradual substitution of pelitic for psammitie sediment suggests a deepening and widening of the basin of deposit. Hitherto, both the land and the volcanic foci seem to have lain towards the north-west, but signs now appear of a change to south-west or north-east;

and at the same time, with a brief spilitic outbreak, the long-continued vulcanicity of the Mona Complex became extinct.

The change appears to have been connected with a general shoaling of the sea, for, in the South Stack Series, thicker beds of sand began to be laid down. Abundant remains of annelids, with sponge-like organisms, once more demonstrate marine conditions. The grits continued to thicken, until at last a nearly pure siliceous sand was deposited with hardly any interruptions for a long space of time, and with this, now converted into the Holyhead Quartzite, the sedimentary record of the Bedded Succession closes.

Considered as a whole, it seems to give us a picture of a wide though somewhat shallow sea-basin fringed with volcanoes, gradually subsiding some 20,000 feet, and filling up as it subsided.

This gentle vertical movement was then exchanged for a horizontal one of gigantic power. For the next we know of these ancient rocks is a time when they were in process of becoming 'The Mona Complex', when the whole succession was rolling upon itself in recumbent folds, one of which has a horizontal amplitude of some 60 miles. Thrust-planes of corresponding magnitude appeared along them, cutting out the base and driving forward great slices of the underlying Gneissic floor, while originally far-distant facies were brought close together. Three such folds,, produced at three successive stages of the process, are accessible to us, and more must have existed.

There was a characteristic sequel, the Plutonic Intrusions; peridotites, pyroxenites, gabbros, dolerites, diorites, and granites all appearing at intervals which could not have been long after. Upon them followed the major, minor, and minimum folding and thrusting, by which the recumbent folds, with their once horizontal thrust-planes, were thrown into complicated flexures, the lower recumbent folds being driven together while the higher ones were still developing.

To the major, minor, and minimum folding we owe the regional anamorphism, three periods of which, on three successively higher tectonic horizons, can be recognised, and above these were cata-morphic horizons that never underwent mineral reconstruction. Then, with some sporadic mylonising, followed by readjustments of load which found expression in large normal faults, the whole suite of movements, comprising apparently some 16 generations, came to an end, and the Mona Complex was complete.

Disturbances on such a scale could not fail to result in mountain-building, but every trace of those mountains has long ago been swept utterly away, and their very existence is but matter of inference. For during and after its elevation, the once lofty range underwent enormous waste, the highest folds, were destroyed altogether, and the metamorphic rocks of some of the underlying ones were cut into on the crests of the major secondary anticlines, until nothing was left but a low basal wreck, which, when the veil first lifts again, was beginning to subside beneath the waters of a southern sea.

Upon its margins vulcanicity had been resumed, andesitic explosions were taking place and felsitic lavas pouring out. The precise age of these eruptions is still uncertain, but (whether after an interval or not) they were followed by submergence, for there is now little doubt that several thousand feet of Cambrian deposits were laid down upon The Area<ref>We seem to need some concise expression for an area when studied as a *Locus of Geologic Change.* It is absurd, for example, to speak of Ordovician 'Anglesey', for the Ordovician phase was a geographic area, now occupied by Anglesey, but then occupied in a quite different manner. In the earlier parts of this work (now printed off) the need was not keenly felt, but it became apparent on revising the manuscript of this chapter, wherein, accordingly, The 'Area' (printed with capital initials) will be employed to express this idea.</ref>. They too have vanished. So far as Anglesey is concerned, indeed, the great work of the Cambrian period is the destructive erosion of the Complex, and its corresponding monuments of accumulation are now to be sought for in the mountain-land of Wales, where the Complex lies buried beneath its own ruins.

This subsidence was then checked, some differential movement recurred, and The Area rose into a broad anticline. Ordovician time, accordingly, is ushered in by another prolonged period of sub-aerial waste, in the course of which the Cambrian and later Pre-Cambrian rocks were in their turn swept from the crown of the anticline, and the Mona Complex was subjected to a second great erosion. But, the way having been already opened, by the work of its predecessor, this one was able to lay bare wide tracts of the lower tectonic horizons. A glimpse of one phase of it reveals a plateau some 3,000 feet in height, with deep valleys along whose floors a western sea is creeping. Widespread subsidence,

encroaching slowly northward, then set in, and continued for a long time, during' which the whole cycle of graptolitic evolution, from the stage of *Didymograptus extensus* to that of *Dicranograptus clingani* (probably to that of *Dicellograptus anceps* was gone through in the basin of deposit. After the old valleys had been filled in with conglomerate, some 3,000 feet of dark shales were laid down, whose facies, on zone after zone, both lithological and faunal, are closely allied to those of southern Scotland. In comparison with that of the adjacent mountain-land, the facies is one of attenuated sedimentation, devoid of the vulcanicity which was in progress on so great a scale not many miles away. Far to the north, some 20 miles beyond the limits of The Area, we can discern an episode at which the base was on the zone of *Nemagraptus gracilis,* representing, therefore, to us, a third erosion of the Complex, though the process was doubtless uninterrupted along the sinking margins of the sea.

The great subsidence was continued into the Silurian period, as far, at any rate, as the end of the Llandovery; and there is reason to think that it still persisted, but that the rest of the Silurian deposits have been totally swept away by denudation.

The impending change from vertical to horizontal movement was heralded by a reawakening of igneous activity, which failed to reach the surface, but found expression in a series of intrusions ranging in composition from hornblende-picrite to sodium-felsite.

Another period of tangential disturbance then ensued, second in intensity only to that of the Mona Complex. Its dynamical effects resemble in many ways those of the maximum, major, and minor Mona movements, but differ in that they are almost wholly catamorphic, anamorphism, and that of a low grade, being but local. In the south, the impulse was north-westward, but feeble owing to the shelter afforded by the Padarn ridge; in the midst was a zone of compression and approximate equilibrium; while the north was the scene of a very powerful southward impulse. This threw the rocks into isoclinal folds, with many thrusts, and culminated in a gigantic rupture called the Carmel Head thrust-plane, with a horizontal overdrive of some 20 miles. The stratigraphical effects are curious; for it carried the subsidence-stage of the Ordovician sea-basin at which the Nemagraptus zone was at the base on to that at which the Extensus zone was at the base. Affecting at the same time the underlying floor, composed of rocks whose distant facies had already been brought together by the recumbent folding of the Complex, it brought those facies 20 miles still nearer to each other, thus adding to the complexity of the Complex; and carried a slice of the Nappe of Holyhead, already isoclinally folded on the major and minor scale, on to Ordovician rocks that had but lately been similarly folded in the same direction, simulating thus a dynamical unity between isoclinal systems of widely separated ages.

A singular sequel to these phenomena was the development of a good deal of sporadic metasomatism; silicification, micacisation, and pyritisation appearing at many places. At Parys Mountain this occurred on a very large scale, sulphides of copper, zinc and lead being introduced along with those of iron.

That the disturbances of this epoch developed another mountainous region we need not doubt, though its existence also is but matter of inference, for, attacked by inevitable waste, it has vanished, as has its great predecessor. As late, however, as Devonian time, something of it still survived, for we obtain a glimpse of a tract of rugged hills, with a long valley opening eastward, wherein the Mona Complex became exposed to a fourth erosion. Subsidence then recurring, a considerable thickness of sands and loess-like sandy marls belonging to the Lower Old Red Sandstone were deposited. But the persistent horizontal impulse from the north had not died out. Exhausting itself in a third and final outbreak, it threw these beds into isoclinal folds, the largest of which, however, failed to overpass the stage of monocline.

The terrestrial conditions consequent upon these new disturbances appear to have survived until the middle of the Carboniferous period. Most of the surface was composed of Ordovician and Silurian rocks, except where the remains of the Old Red Sandstone still filled its ancient hollow, and where, in the south and west, waste of Ordovician anticlines had laid bare the Mona Complex, which then underwent its fifth erosion. Once more we obtain a glimpse of a plateau, lying, this time, to the west. It seems to have been some 1,400 feet in height, and drained into a broad valley that opened out into an eastern sea. Subsidence had in the meantime set in again, and while coralline and brachiopodic evolution was proceeding, that sea was creeping slowly westward. When it reached The Area, the Dibunophyllum fauna was just about to develop. Over the old slopes, as they sank, the successive stages of the Dibunophyllum limestone were laid down, followed by some siliceous ones of the Posidonomya zone. From time to time there was interruption, local disturbances

giving rise to occasional currents, which washed out parts of the recently-formed limestone and filled the hollows in with pebbly sand. Even when 1,300 feet of limestone had been formed and the Dibunophyllum cycle of evolution was complete, land still emerged on the west and apparently also on the north, but the close of the Posidonomya cycle seems to have seen the submergence of most of this.

Signs then appear of a more serious interruption of subsidence, enough to produce perceptible denudation of the Posidonomya beds and to expose the Mona Complex in the west to a sixth erosion; while the same causes brought about a change in the nature of the sedimentation, which, with the deposit of the thick sands of the Millstone Grit, now began to be mechanical. Subsidence was resumed, though with pauses, the basin filling up as fast as it sank down, thus making it possible, at intervals, for a Coal Measure flora to develop and flourish on the surface. Differential movement then ensued, sufficient to ridge up some of the old land, whereon the Mona Complex was locally subjected to a seventh erosion. This physiographic change brought with it a climatic change, and desert conditions became prevalent. Inside the new barriers, wide tracts went on subsiding, in whose desolate basins the sands and dusts of the Red Measures accumulated to a depth of 700 feet.

The prolonged, though oft-interrupted subsidence of Carboniferous times gave way at length to yet another series of powerful disturbances. This was, however, of a different nature from nearly all its predecessors, for tangential thrust is rare or absent, the rocks now being thrown into broad symmetrical folds of gentle inclination, with amplitudes that approach 3,000 feet; broken by large normal faults, chief of which is the great Berw fault. These movements, moreover, are, to us, a tectonic epoch, for they brought the formations of The Area idato the mutual relations in which (with trifling exceptions) they have ever since remained; thus creating the rock-mosaic out of which have been sculptured the physio-graphies of Tertiary time and of the present day.

Terrestrial conditions, brought about by them, doubtless prevailed at the opening of the Triassic period, but that country went down in the long and gradually deepening submergence of Mesozoic times, by which the whole region was overwhelmed.

The Tertiary period was ushered in by a recurrence of movement, which was comparatively gentle and equable, though slightly differential in that The Area itself was raised into a broad anticline, while, somewhere about the same time, Tertiary volcanic activity made a final contribution to the solid fabric by the intrusion of its basic dykes. But with this exception the work of that epoch seems to have been destructive, the movement having created a very extensive and apparently a lofty land-surface, with its inevitable sequel. The production of the anticline is a physiographic epoch, for it determined the position of the line which later differential erosion was to convert into a coast, as well as the orographic relations of The Area to the much greater anticlinal tract which has since developed into the mountain-land of Wales.

The period of sub-aerial waste which followed these Early Tertiary movements appears to have been a long one. From the crown of the anticline the Mesozoic deposits were first stripped off, leaving a broad core of Palaeozoic and older rocks. This laid bare, the destructive work which had been partly accomplished in Triassic time was carried much further; the Carboniferous anticlines were denuded, the Ordovician ones opened out more widely, and the cores of both classes deeply cut into, so that the Mona Complex underwent an eighth erosion. As a result of this process, the Palaeozoic areas became restricted to something like their present limits. Yet the early Pliocene land would have had wider Palaeozoic outcrops and smaller emergences of the Mona Complex than those we now see; save in the north, where, owing to the low hades of the thrust-planes, the conditions were precisely reversed. Eventually a base-level was reached, which we have called the 'Monadnocks' Platform, but upon its elevation, the work of destruction was resumed, and proceeded (with the interruption of the Tregarth pause) until the Menaian base-level was reached, in cutting down to which the Mona Complex received a ninth erosion. A first result of the waste which recurred upon the elevation of this base-level into. the Menaian Platform was to disengage from its setting of Mesozoic rocks the hard, though planed-off and greatly degraded, core of the Tertiary anticline. This is a second pilysiographic epoch, for it is the birth of what may now for the first time be recognised as 'Anglesey'. The dissection of the plateau by Later Pliocene erosion developed, rugged and angular from sub-aerial waste, the leading features of the scenery which still survives. This added a tenth to the erosions of the Complex; and indeed it may well he that the aggregate erosive work of Tertiary time is second only to that of. the earliest Palaeozoic periods.

Then, by slow degrees, came on the memorable climatic revolution; and an ice-sheet from the sea-basin, deflected by confluence with one from the mountain-land, over-rode Anglesey along a southwesterly resultant. Rounding-off the rugged hills of Pliocene time, deepening and straightening the longitudinal valleys (whereby, in a new manner, the Complex underwent erosion for an eleventh time), and depositing great spreads of boulder-clay, it left us the landscape which we see to-day. Then it shrank back, and just as it had parted from the glaciers of the mountain-land, the Menai channel was completed. Later on, a submergence of some 60 feet ensued, and the outer parts of the Menaian Platform became the Island of Anglesey.

As the ice retreated, and ordinary climatic conditions were resumed, sub-aerial decay and ordinary waste (retarded a little, indeed, by the recent subsidence) once more set in. The glacial drifts are now being swept away, the solid rocks again attacked, and a twelfth erosion of the Mona Complex is beginning.

The long record preserved in the Island, from the ancient fragments in the Mona Complex to the drift of sand before this. morning's wind, cannot but impress the imagination with its picture of unremitting geologic change, ever passing rhythmically through similar though never identical cycles of evolution and dissolution. At no stage is there a moment's pause. While we yet study it, the changing phase to which we give the name of 'Anglesey' is even now in process of transformation into a future and a different phase.