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MARCH 11th—"On some secular and diurnal motions of the earth's crust, &c. with a reference to a communication from Sir Wm. R. Hamilton, Professor of Astronomy, and Astronomer Royal of Ireland," by Robert Mallet, Esq. Mem .Ins. C.E. M.R.I.A. President of the Society.

THE PRESIDENT said, that on taking the chair for the first time, he could not better mark his sense of the great honour which the Society had conferred on him in electing him their President, than by laying before them a plan which he had for some time conceived for the organization and carrying out of arrangements for a great, combined, and comprehensive movement for the promotion of a particular branch of geological discovery.

Geology might be divided into topographical and physical, both of which require for their study and development, the confluent aid of several distinct branches of natural inductive science, as well as of the exact sciences properly so called. Physical geology, again, might be divided into several distinct branches, for the cultivation of all of which, the application of Physics, Mechanics, and Chemistry, in their largest senses, is indispensable. For a considerable period it had appeared to him that one of the most important directions in which physical geology could be advanced was, in placing it in connexion with a mode of investigation, new as respected geology, although old as regarded other sciences, namely, measurement; by the organization and solution of such questions as were capable, in terrestrial physics, of having an answer in measure, number or weight. The application of measures to geology might be called experimental geology—a branch of the science hitherto, he might say, unexplored. Geologists had hitherto contented themselves with observing what nature had presented to them, and that must, from the nature of geology, at all times form the staple of its investigations; nevertheless, whenever it was possible to use the experimental method, it might be pronounced not only as the most certain, but also the most rapid, means of advancing geological, as it had always been of every other branch of physical science. In order to illustrate what he meant by measurement in geology, and to show its feasibility, and even simplicity of application, and to what important consequences it at once led, he would briefly give an example of the sort of enquiry alluded to. Taking any large island, such as Ireland, let them suppose the following data respecting it to be obtained in measures—the entire amount of water annually discharged into the sea by all its rivers, and the entire amount of soluble and suspended matter carried down to the sea by them, and the chemical constitution of these. From these data they should be able to pronounce on the amount and on the character of deposits annually taking place round the coasts. They should then be in a condition, with the assistance of their tidal and other knowledge to predicate with a considerable degree of accuracy the nature, character, extent, form, and relative locality, of the deposits so taking place; and hence to predict what forms of rock would at a future period be most likely to occur round their shores; to draw direct conclusions from thence as to the changes in progress, or hereafter to occur, to animal and vegetable marine organization on our coasts; to indicate by the most ample and certain data the changes of soundings, of shoals, of harbours, beaches and bars, which concern the Mariner and the Civil Engineer; and to draw conclusions as to the relation and balance between the wear of the land by detrital action, both meteorological and tidal, and its replacement by forces of elevation, whether slowly or convulsively.

He mentioned this as one instance of experimental geology; but the direction in which he was at present anxious to have geology advanced, by obtaining the aid of a co-operative movement in applying this method of investigation, was rather different. It had become certain of late years that the crust of their globe, far from being of that immovable character which was popularly supposed, was, in fact, one of the most unstable and changeable parts of creation, that there was nothing immutable upon it, but the very mutability that marks and agitates it, was subject to almost continual motion in both a vertical and a horizontal direction; the latter resulting, at uncertain intervals, principally from the cause which produced earthquakes, the former occurring at occasional epochs from the same cause; and regularly recurring, in all probability, in the form of annual and daily motions of expansion and contraction in the earth's crust, due to alterations of temperature by changes of season, and of day and night. To measure these motions appeared of the very highest importance, at the present epoch, to the advancement of geology. A communication from Sir William R. Hamilton, which he (Mr. M.) had in his hand related to one of these phenomena; but to take matters in the order of their relative importance, they should first consider these movements which related to the earthquake oscillation of which he had spoken.

It would be necessary, in order that the Society might understand his meaning, and see more clearly the bearing of the motion as to scientific co-operation, which he intended having the honour of laying before Council at a subsequent period, to detain them with a slight sketch of the movements due to forces of elevation and depression which were known to be always taking place in the earth's surface.

That any portion of the earth's crust was absolutely permanent as to level was uncertain; that there were some portions which were neither rising nor falling with respect to an assumed plane, at a fixed distance from the earth's centre, was possible; but that large tracts were slowly rising, and that others were periodically caused to rise; again, that other large tracts were slowly sinking (for instance the great coral region of the South Sea) and some suddenly depressed, (usually at periods of sudden neighbouring elevation,) was certain. The forces which produce these changes of level also give rise to earthquakes. It was necessary for him to refer, very briefly, to some particulars respecting the subject of earthquakes, on which he had recently the honour to lay a paper before the Royal Irish Academy. Every earthquake was in fact a succession, or a combination rather, of waves taking place in the solids forming the crust of the earth, and in the fluids incumbent upon it, and resulting from a rupture or disturbance occurring at some one point of that crust. If they supposed an earthquake taking place under the sea, three sets of waves started at the same moment from the centre of rupture. One of these was the wave of elastic compression, which was propagated in every direction, and was transmitted with a velociety proportioned to the varying elasticity and density of the crust. The passage of this wave constitutes the true earthquake shock. There was also a wave of sound transmitted through both the solid and the liquid portions of the earth's surface, and also a wave of sound transmitted through the air by the impulse communicated to it from the first-mentioned waves; and last of all, the great sea wave, produced by the commotion at the bottom of the sea, which reached the land long after the shock itself had passed it. Here were three classes of motion, which in general were talked of as connected with a very formidable phenomenon, but seldom viewed as movements capable of measurement. It was a fact, that no matter where an earthquake took place, the wave of elastic compression which was produced actuated every portion of the earth's crust, and its occurrence could be detected, by sufficiently accurate instruments, at any part of the globe.

In some of the observatories connected with the great magnetic survey, now in operation at various points over a great portion of the whole world, and in the organization of which our fellow-member, Dr. Lloyd, has had so large a share, there existed a necessity for certain magnetic instruments, which were, in fact, though not intentionally so, ready-made seismometers: and in the magnetic observatory of Dublin, Dr. Lloyd has frequently observed a sudden vertical oscillation communicated at the same instant to all the instruments, and which he believes to be the effect of slight earth tremors, propagated from remote centres of disturbance.

It would be of the highest service, not only to physics in general, but also to geology, if the circumstances of earthquake shocks could be observed and their velocity measured; since, if they could tell the velocity of the wave through the earth's crust, and were at the same time to determine by proper experiments, the elasticity of the superficial rocks of the earth's surface, they should be able to infer, from the two data so obtained, the nature of the geological deposits under the bed of the ocean, concerning which nothing whatever was known at present. Topographical geology as yet extends but to a small portion of the land; future examinations may embrace the whole of this. But of the nature and boundaries of the formations which compose the bed of the ocean, we know absolutely nothing; so that in fact, two thirds of the whole surface of the globe is in this respect a geological blank. The method of investigation here proposed, however, although it may not give us minute information as to the character of the ocean bed, will enable us to gather some general and certain knowledge of the architecture of those fathomless abysses of the ocean, which no eye can ever behold. He would, therefore, hereafter by the aid of Council ask, perhaps through the medium of the General Council of the British Association, that all the observatories in connection with the magnetic survey should, in addition to their magnetic observations, record observations as to the occurrence of earthquake shocks. This might be very readily done, since the magnetic instruments at present in operation in some of the observatories were quite adapted to afford the necessary indications with respect to the shocks, and other instruments required might be easily added, namely, those which it will be necessary to contrive to register the altitude of the crest of the wave of elastic compression, at the moment of its passage—an element in this enquiry of the first importance.

But it happened, that magnetic observatories which were furnished with these sorts of instruments, did not generally exist in places in which earthquakes were frequent. It thus became necessary to establish in some places, at least, observatories specially devoted to geological purposes as their primary object. It would be highly desirable to have such observatories in the volcanic regions of South America—the land of earthquakes; since, in addition to observing the velocity of the shock wave, the elasticity of the neighbouring rocks, through which the shock had passed, could experimentally be determined. He conceived that it would be quite possible to get observatories established there, and he should submit to the Council the means by which such a desirable object could most probably be accomplished. Shocks of earthquake were of greatly more frequent occurrence than was generally supposed, and occurred in every part of the world. Violent ones, producing destructive effects, and which were only experienced at limited distances from the centre of disturbance, were comparatively rare; but minor shocks were of almost daily occurrence; and, indeed, in a district in Scotland, the number of such slight shocks occurring within a certain period had been observed. The proposed observatories, therefore, will be by no means unprovided with work.

There was another class of motion to which the earth's crust was subject, and to which Sir William Hamilton's note related. Before reading it, he (Mr. Mallet) might perhaps mention that as much as four years ago, upon an occasion of his dining in company with Dr. Robinson, Astronomer Royal of Armagh, he mentioned to him, (Mr. Mallet) and others, that the observatory of Armagh had been observed to be subject to very slow and minute annual motions, not only to one which was manifested by the whole observatory being lifted in summer and depressed in winter, but also to one by which it appeared to move in azimuth. Dr. Robinson mentioned the fact as one which had not been explained, and it occurred to him, (Mr. Mallet) and he stated at the moment, his anticipation, that it would be found that the motions were due to expansions of the earth's crust, caused by the alternations of temperature of summer and winter. Very recently, conversing with Sir William Hamilton on the subject, he (Mr. Mallet) perceived that a similar idea in connection with it had independantly presented itself to his mind; and, in fact, Sir William Hamilton was to be considered as the discoverer of this class of motion, since the man who first observed a fact, and at the same time gave a true explanation of it, was entitled to the honor of discovery. Mr. Mallet then read the following note which he had received from Sir William Hamilton, and to which he had referred:—

"Observatory of Trinity College, March 2, 1846.

"My Dear Sir,—The only thing which seemed to me original in what I observed to you and others at the geological dinner last month, was the proposition for instituting in new, and multiplying in old, observatories, observations with a levelling instrument, for the purpose of acquiring accurate data respecting some of the expansions, whether periodical or secular, of the crust of the earth. I thought that by fixing the chief attention on the variations of a long spirit level, very carefully and steadily mounted, and from time to time reversed, as in an astronomical observatory, perhaps with precautions as to original erection and subsequent use, which sidereal checks render not so necessary to the astronomer, and possibly, too, by using two pairs of pillars for two different vertical planes, a gentleman might at a moderate expense of money and trouble make in his own lawn or house observations useful to geology; and if I remember rightly, under this conception I talked of founding geological observatories, on which you remarked, that if your paper on earthquakes had been read to the end at the academy, it would have been found to contain a similar suggestion, though based upon reasons not in all respects the same.

"I also mentioned the fact, that in this observatory, the western end of a transit level, supported on pillars peculiarly favourable for the accurate examination of a point of this kind—(see an account of them by Dr. Ussher, in the first volume of the Transactions of the Royal Irish Academy) —was always a little higher in summer than in winter; and thatin answer to an inquiry of mine, Mr. Cooper's first assistant had by that morning's post informed me that the axis of the instrument at Markree Observatory showed (such as I conjectured that it might) an opposite phenomenon, though this was to be accounted for by mechanical rather than geological consideration. I remember, also, acknowledging that Dr. Robinson had long ago remarked to me that the whole hill on which the Armagh observatory stands is found to have a motion with the seasons, but that I had been in the habit of conceiving Dr. Robinson to deduce this from observations of the azimuth, rather than of the level; and that my own conjecture, perhaps a very wild one, had been, that Ireland as a whole expanded, and thereby rose somewhat more out of the sea in summer than in winter; which expansion, if it were admitted to exist, would account for the western end of the astronomical level rising a little on the east and sinking on the west coast of the Island. Indeed, as a mode of conjecturally accounting for what has been noticed in this observatory, the notion has long been in my mind, and has been put forward by me, though with the necessary diffidence, to some of the astronomical students of the University in one of my lectures last summer, if not at an earlier date. The conversation in which I was engaged with you on this and similar subjects, at the last anniversary dinner of the Geological Society, interested and excited me at the time very much indeed; and if you think the foregoing memorandum, which I have drawn up at your desire, worthy of being incorporated in any communication of your own to the Society, it is perfectly at your service for that purpose.

"I remain, my dear Sir, very truly yours,

"William R. Hamilton."

Mr. Mallet would remind the Society, that the earth's surface was the medium through which two great waves of heat were continually transmitted; one proceeding from the sun, by part of which the atmosphere was heated, and the other coming from the interior of the earth towards the surface. In every climate there was a plane lying between the influences of these two waves, which never changed its temperature, and which varied in its depth below the earth's surface. As there was thus a transmission of heat from the interior of the earth towards its surface, and also from the surface towards the centre, the plane of constant temperature, or isogeothermal plane as it was called, would be found in any given locality at a determinate depth; and if the supplies of external and internal heat were constant, it would always be found at the same depth in the same place. But inasmuch as the earth's surface was exposed to temperatures, varying with the winter and summer seasons, the level of that plane must rise and fall in proportion to the force of the variable wave. The average depth of this plane in their latitudes was about sixty feet, but was far greater in the tropical climates, in some of which the heating power of the sun ranged to a depth of nearly five hundred feet below the earth's surface.

The result of the varying intensity of the external wave of heat must be the contraction and expansion of the earth's crust due to the difference between the temperatures of summer and winter, and hence a certain annual motion in the earth's crust, besides which, from similar causes, acting in shorter periods, and in less degree, there must be a diurnal motion. To measure this systematically, would be, it appeared to him, highly important, not perhaps directly to those more obvious parts of geology which treat of the elevation of mountain ranges and the depression of valleys, and so forth; but inasmuch as it would lead to a region of investigation which was at present absolutely unknown; and by penetrating which it would be probably be found in this, as in so many other parts of terrestrial physics, that forces and motions the most minute, and scarcely to be detected, when taken in aggregate, were essential and potent parts of the universal machine. There had yet been no investigation of the rate of expansion of any rock, the tables of the rate of expansion of the very few solids hitherto published, having reference only to substances which were of value to the astronomer or the engineer. Therefore with respect to the measurement of these motions, the facility with which the observations necessary for that end could be made, and the likelihood of important information being obtained in the pursuit of it, were grounds sufficient to warrant an undertaking of the object. He had now said sufficient to put the Society in possession of the nature of the views he entertained with respect to the opening in a new region of a new campaign in geology, if he might so speak; and which he hoped to do by inducing his fellow-members of the Council to communicate with such members of the great magnetic body as were connected with Dublin—as, for instance, Professor Lloyd—and through them to the Council of the British Association, to enable certain experiments as to the elasticity of the earth's crust to be made, and the velocity of the elastic wave through it determined; to induce hereafter observations to be made in all the magnetic observatories, (and possibly some new geological observatories founded) and observatories continued, both during the continuance of the magnetic survey and after it had terminated, for the use of the geologist, viz., observations of all the motions, whether diurnal, secular, or cataclysmal, that take place in the earth's crust. He believed that such observations would be replete with interest to geology and to physics; and he conceived that the application would be met by the British Association with that ready response which had always been given by it to every project that seemed to be calculated for the benefit of science.

"Brief description of the Coast in the vicinity of Kilkee, Co. of Clare," by George V. Du Noyer, Esq. illustrated by drawings.

The author's communication was principally confined to a description of several drawings and sketches of the coast, which exhibited its structure, and the peculiar mode of degradation which has given rise to the many islands along that shore. To these islands characteristic names have been given in Irish, as Illaunawhilla, or the Island of the gulls; Illaunpoulfouhy, or the Island of the horrible chasm; Illaun-asp-magurtha, or the Island of the niggardly Bishop. On the last of these are the remains of a small stone roofed chapel, and some circular stone roofed, or "bee hive" houses. The island must have been materially altered in form and outline since the erection of these buildings, (probably in the 5th or 6th centuries;) and the author supposes that great slips, partly caused by the shaly character of the rocks, may have chiefly tended to produce this alteration.

Northwards from Kilkee is a promontory, called Gattaphilenatraw, or the Gate of the cavern of the strand; and near it is an isolated rock, called Grain rock, or the rock of the sun, a name which it got from its position, such as always to allow of its catching the rays of the sun, and never being in the shade of the adjoining cliffs. This is pierced at some elevation above the sea.

At the small fishing harbour of Gouleen there is a beautiful example of a synclinal ridge, the rocks on one side of the Bay dipping to the south, and on the other to the north, while the cliffs at the land give a natural section of the contortion. The name Gouleen, in Irish means the little fork of the sea, comparing the rocks which jut out on either side of the harbour, to the outstretched legs of a man.

Many cases may be seen along the coast, in which the rocks have been very much contorted; and in some, as between Doonderilleroe and the puffing holes of Ross, where the forces applied have fractured the softer beds into an acute angle, while the harder and more unyielding have merely been arched.

The rocks along this coast consist of detached portions of grit, resting on black shale, beneath which is a compact silicious sandstone, approaching in many instances to a quartz rock; between which and the shale there occurs a thin bed of impure limestone, containing shells and encrinite remains.