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JOURNAL OF

THE TRANSACTIONS

OF

The Victoria Institute,

OR,

Philosophical Society of Great Britain.

EDITED BY THE SECRETARY

VOL. XXXVI.

LONDON:

(Published by the Institute, 8, Adelphi Terrace, Charing Cross, W.C.)

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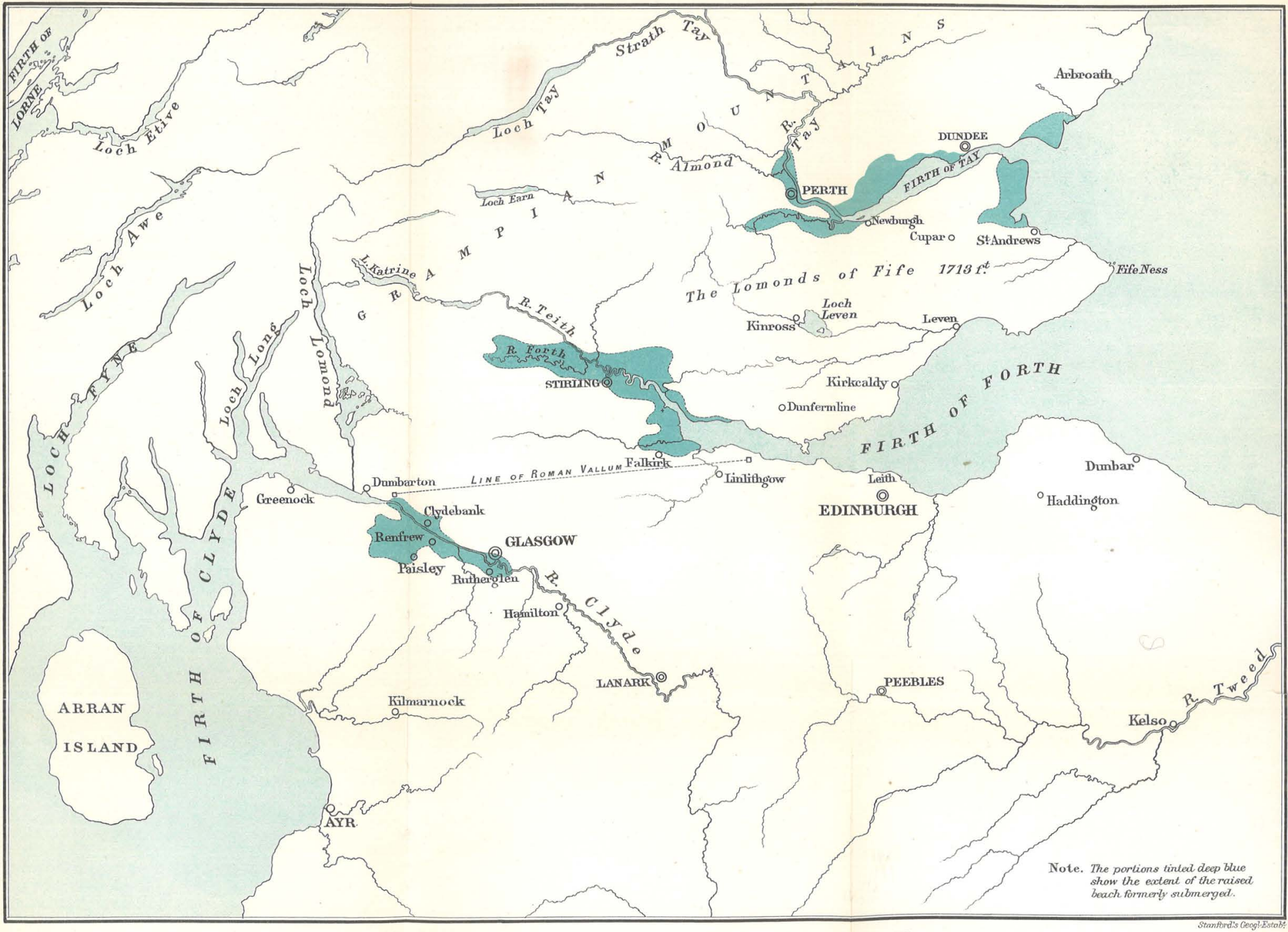
1904.



Stanford's Geogl Estabt

MAP TO SHOW EXTENT OF SUBMERGENCE OF THE CENTRAL PART OF SCOTLAND.

(TO ILLUSTRATE PROFESSOR HULL'S PAPER.)

ORDINARY MEETING.*

REV. JOHN TUCKWELL, M.R.A.S., IN THE CHAIR.

The Minutes of the previous Meeting were read and confirmed.

The following candidates were put forward by the Council :—

MEMBER :—George Benson Clough, Esq., Barrister-at-Law.

ASSOCIATE :—Harry Bonny, Esq.

The following paper was read by the Author :—

ON THE AGE OF THE LAST UPRISE OF THE BRITISH ISLES. (With Map.) By Professor EDWARD HULL, M.A., LL.D., F.R.S. (Secretary).

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* Monday, March 7th, 1904.

5. Indications of the partial submergence of Scotland during the Roman occupation. Evidence derived from the Roman Wall (*Vallum*). Views of Sir Archibald Geikie. Statement of Gildas.

PART III. DATE OF EMERGENCE OF THE LAND.

6. Inferential date; that the final elevation took place well within the Christian Era.

PART IV. CONCLUSION.

Introduction.—Whatever may have been the length of time between the Pliocene Tertiary and the historic periods,—generally included in the term "Post-Tertiary"—it cannot be denied that it included several remarkable oscillations of the land of Western Europe—indeed we might say, of the Atlantic sea-board on both sides. Oscillations which have left their impress upon the physical features of the lands, and in this way have powerfully influenced the social character of the present inhabitants. We begin with the first of these terrestrial movements of Post-Pliocene times—namely, that of the first glacial elevation—to which Professor James Geikie has given the generally accepted name of "The Great Ice Age." We here recognise a movement of elevation of land reaching a height of several thousand feet above the present surface of the ocean, during which the Continental platform now covered by the waters of the sea was upraised, its surface abraded, and traversed by channels (or cañons) of the existing rivers, to their outlets on the floor of the abyssal ocean at depths of 6,000 to 7,000 feet below the present surface. Having already described in the pages of the Journal of the Institute the position and character of these "drowned river channels," I need not further allude to them here, except to reassert my conviction that in the great elevation of the continental lands of Europe and Africa of which these submerged river-valleys are evidence, we have a sufficient cause for that vast extension of extreme arctic conditions shown by the glacial phenomena of a past time in Scandinavia, the Alps, Pyrenees and Atlas mountains, extending far beyond the limits of existing glaciers, as also in the British Isles from which the glaciers have altogether passed away.*

Succeeding to the epoch of the great Ice Age came that of the "Interglacial stage," in which the British Isles were depressed beneath the ocean to varying depths, of which the maximum was 1,200 feet in Central England, North Wales, and central

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* *Trans. Vict. Inst.*, vols. xxx, xxxi, and xxxii.

Ireland. This level being indicated by raised beaches with sea shells of existing species in Denbighshire, Carnarvonshire (Moel Tryfaen), and the Wicklow Mountains.* From this maximum level of depression the amount diminished both to the north and south. In Lancashire these gravels rise along the banks of the Irwell to about 600 feet, in Scotland to about the same. On the other hand, in Gloucestershire, the level of submergence was determined by myself many years ago to be 600 feet in the Cotteswold Hills, being that to which rolled quartzite pebbles are to be found scattered over the tableland formed of Jurassic limestone, these pebbles having been derived from the New Red conglomerate of the Midland Counties and drifted to their places by marine currents. This determination was fully confirmed by the late Professor Phillips in his *Geology of Oxford*.† Extending our observations still further south, we find the gravels of this period forming plateaus resting on the Bagshot Sands at Englefield Green and Windsor Forest southwards, and finally, in the Isle of Wight, forming the terraces of St. George's Down and Headon Hill, at a level of 400 feet above the sea. Such, in brief, are some of the localities at which the interglacial gravels may be observed. They are everywhere later than the newest Tertiary strata, and the deposits are consequently referable to the Great Ice Age.

The rudely stratified clays with glaciated pebbles and erratic blocks to be observed along the valleys of the Irwell and Ribble and other parts of Lancashire resting on the interglacial sand and gravel indicate a recurrence of sub-glacial conditions, when the waters of the sea were clouded with glacial mud, and floats of ice carrying blocks from the glaciers entered the sea. This epoch need not detain us, as it was probably of short duration; and the deposits resulting from it do not appear to have extended into the centre and southern parts of England. We, therefore, pass on to the consideration of the subject which more immediately concerns us, and to

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* The fact of these beaches occurring at *nearly the same* level along a west to east tract of about 100 miles is clear evidence of their marine origin, although attempts have been made to prove they owe their formation to "the great ice-sheet" which filled the Irish Sea. An ice-sheet never could have produced beds of stratified sand and gravel with shells, some of which are but little injured; an ice-carriage would have ground them to powder.

† Page 457. The gravels were first described by Dr. Kidd and Dean Buckland. Phillips gives the extent of submergence as 1,500 feet—somewhat excessive.

which the preceding observations seemed a necessary introduction. All the deposits above described belong to the prehistoric, probably the prehuman period.

I have thought it necessary for the sake of perspective to pass in review these deposits of Post-Tertiary age and the oscillations of land, before entering upon the description of those which more immediately concern us, in order that the reader may gather how considerable have been these oscillations during the period immediately preceding that of the human race in our islands; and having done so we are now in a position to consider the deposits and terrestrial movements of a time during which man himself has been a witness of the scene.

Part II.

Raised beaches.—The general uprise of the land at the close of the Post-Pliocene or glacial period appears to have been accompanied by pauses giving rise to the formation of marginal terraces at several successive levels. These terraces are of frequent occurrence along the Norwegian fjords, rising to a maximum level of 700 feet in the latitude of Mölde.

To what extent these higher terraces of Scandinavia represent (if at all) the "Interglacial gravel" of the British area it is impossible to say; but we are safe in considering that the lower terraces of the former are representative of those in Scotland, England, and Ireland. And as regards these latter, there are at least two in Scotland, the higher having a general level of about 70 feet, the lower, of 25 to 30 feet above the present surface of the sea. At both these levels there were prolonged pauses in the process of elevation; but owing to the longer period at which the upper terrace has been exposed to atmospheric erosion, and also to the fact that during the elevatory process the terrace itself was subject to attack from the sea waves, it is not so clearly defined and continuous as is the case with the 25-feet terrace which lies at much lower level. This terrace is therefore of more recent origin, nor (as far as my information extends) does the upper terrace present us with those works of human art which are so abundant in the strata of the lower level. If this view be correct then it would appear that, between the formation of the upper terrace and of the lower, there was a considerable lapse of time.

The 25-feet beach of Scotland.—This is the most conspicuous and latest of all the terraces of Central Scotland, and is sometimes called "the 30-feet beach," as its margin occasionally

approaches to, or touches, that level above the high-water line. It has been described in more or less detail by several writers; by Robert Chambers in his *Ancient Sea-Margins*; by Smith of Jordan Hill; by Sir Archibald Geikie in the *Journal of the Geological Society*,* and more recently in his *Scenery and Geology of Scotland*.† I have myself had numerous opportunities of examining this terrace along the western coast and isles as well as in the interior of the country.

The 25-feet beach forms a fringe along the western coast of Scotland, and is especially conspicuous along the coast of Cantyre and the Firth of Clyde where it affords the most convenient sites for roads, houses and churches. On the one side we have the rocky sea-coast; on the other the cliff of rock or steeply shelving bank, which formed the old coast-line before the uprising of the land (Fig. 1). On Cantyre the inner cliff is

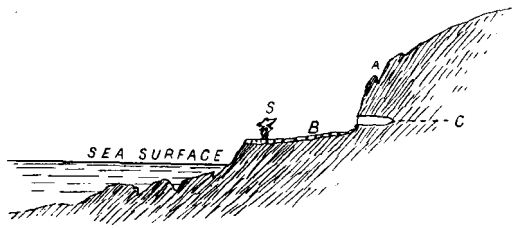

FIG. 1.—GENERAL SECTION OF COAST OF CANTYRE.

A.—Old coast cliff.
B.—Raised Beach.
C.—Cave.
S.—Sea-stack.

sometimes perforated by tunnel-shaped caves, the floors of which are strewn with rounded pebbles of hard stone which the waves made use of for breaking into the schistose rock. The resemblance to a sea-beach goes still further in the existence of old sea-stacks rising from the surface of the terrace, monuments of wave-action during the uprise of the coast.

The terrace is likewise well-developed on the eastern coast of Scotland and along the margin of the Firths of Forth and Tay. But physically its most important features are those of the interior parts of this country; for here it gives rise to the broad plains or "carses," which border the valleys of the Clyde, Forth and Tay, with their branches. To this category belong

* *Quart. Journ. Geol. Soc.*, 1862.
† Published 1865.

the Carses of Gowry, Falkirk and Stirling, and they have been largely taken advantage of for the sites of towns and cities, such as those of Leith, Burntisland, Dundee, Arbroath, Greenock and the lower part of Glasgow. These towns are built either partly, or altogether, on the upraised terraces which have their representatives along the coast. At Glasgow, which is partly built on the same platform, the silt and sand of which it is composed have yielded no fewer than eighteen canoes, some of them under the very streets and houses, together with stone hatchets, boat-hooks, anchors, pottery and other works of art. The boat-hooks and anchors are of iron, and indicate an age on the verge of what may be called that of "Roman Civilization" for Great Britain. Most of the Clyde canoes were formed out of single oak stems, but two of them were built of planks. Of these the more elaborate was discovered on the property of Bankton in 1853. The description of this clinker-built boat, with keel, cutwater and planks fastened by means of oaken pins, is given in much detail by Sir R. Geikie,* as indicating the use of iron implements; to which may be added a plug of cork indicating some communication with more southern and civilized people. It is clear that this boat is of later age than either "the stone," or "the bronze" periods. The occurrence of skeletons of whales, one at Airthrey near Stirling in silt fully a mile from the present river, and at a height of about 25 feet above high-water of spring tides; another at Dunmore in stiff clay at a height of about 24 feet; and a third at Blair-Drummond, which lies seven miles higher up the valley than Airthrey, show that pretty deep sea-water spread into the centre of Scotland at this period.

But more impressive still, as showing the presence of men capable of working in iron, is the occurrence of an iron anchor, dug up near the spot where the Dunmore whale was found. It appears to have been about 20 feet above high-water mark, and consisted of a beam and ring in tolerably perfect condition; the flanges, however, were much decayed. Other anchors have been found below Larbert Bridge, and near Camelon in Stirlingshire, as also an iron boat-hook on the farm of Inchmichael imbedded under 8 feet of stratified gravel at a distance of a mile from the margin of the Firth of Tay. The surface of the ground was about 3 feet higher than that of the surrounding carse or about 28 feet above high-water mark. This boat-hook, which has

* *Supra cit.*, p. 222 *et seq.*

been described by the late Mr. Robert Chambers, is preserved in the Museum of Scottish Antiquaries in Edinburgh. Enough has probably now been stated to show that, at a period when iron was in general use in North Britain amongst the lowland inhabitants, the sea had occupied the land up to a level of about 30 feet above the present surface of the ocean, sufficiently deep to allow the ingress of whales; in other words, when the land was submerged to that extent: and when the arms of the sea stretching into the interior of the country, both from the eastern and western coasts were navigated by men far removed in the arts from the savages who only used stone weapons and implements. Consequently the whole region has been elevated into land since that period, and these firths have been converted into the river-valleys of the Clyde, the Firth and the Tay, while the marginal tracts form the wide plains or "carses" on either side of these rivers. We have now to consider the question at what period did the rise of the land take place owing to which this remarkable change in the physical geography of the country was brought about. But before entering upon this subject we must glance at the coast of Ireland in order to determine whether, and if so to what extent, that country was affected by the terrestrial movement here contemplated.*

Effect of the submergence on the land.—I have been able to define, with a great approach to accuracy, the submerged areas on the 1-inch ordnance map of Scotland by means of the contour lines along the valleys of the Clyde, Forth and Tay, inasmuch as the 50-feet contour closely coincides with the margin of the 30-feet terrace. This is owing to the fact that the 50-feet contour represents the height above the mean level of the sea at Liverpool—not above that of high-water—which is the datum for the terrace itself. When tracing this contour on the map, one could not but observe that it coincided with an abrupt rise in ground above the nearly level plain formed by the raised beach. As regards the change effected in the topography of the country itself, the prolongation of the present estuary of the Forth into the heart of the country above Kippen and Thornhill in the valley of the Forth, had the result of almost dividing Scotland into two parts. The distance of land from the

* The occurrence of several places in the valley of the Tay and beginning with the word "Inch" (Celtic for Island) is very suggestive of former conditions; thus we find Inchture, Inchmartine, Megginch Castle, Inchyra and Inchcoonans. These are all remote from the present sea-margin.

western end of the estuary to the shore of L. Lomond at Balmaha, being only eleven miles. During the submergence L. Lomond must have been a salt-water firth or sea loch. (See Map, p. 175.)

Raised beach of the Irish Coast.—The northern coast of Antrim is at so short a distance from that of Cantyre that it is natural to suppose that whatever changes of level affected the latter must also have been, to a greater or less extent, extended to the former, and such is unquestionably the case. The "25-feet raised beach" of the west coast of Scotland is represented also on the coast of Antrim by "the 15-feet beach" which may be traced at intervals all round the coast of Donegal, Londonderry, Antrim, Down, and southwards to that of Wicklow, wherever protected from the direct action of the waves. Its highest limit is about 15 feet above high-water mark at Portrush, Larne, and Belfast Lough; but, with the exception of a diminution of level as compared with the raised beach of Scotland, it presents all the features which I have described as characterising the Scottish terrace. At Larne Harbour, for example, the terrace rises from 15 to 20 feet high, composed of stratified sand and gravel, with numerous blanched marine shells of existing species. At Kilroot on the north shore of Belfast Lough, the beach contains numerous arrow-heads or spearheads of worked flint rudely sculptured. These are the only works of human art which have been found in this Irish beach.* The level of the beach itself gradually falls as we trace it southwards by the coast of Louth and Dublin bay till at co. Wicklow it almost descends to the level of high-water of spring tides.† All along the inland border of the terrace in the north of Ireland we find similar features to those of Cantyre, namely, the old coast cliff, sometimes perforated by caves in which bones of deer, sheep, goats, otters, badgers and birds were found by the late Dr. Bryce and Dr. McDonnell some years ago. Remarkable sea-stacks occur at Ballycastle and Island Magee rising above the terrace and now out of reach of the waves. From the above account it will be seen that the

* The gold "Celtic" ornaments, etc., recently discovered lying on the surface of the raised beach, and covered over by the soil, have been determined by the Court of Chancery not to have been directly connected with the raised beach itself, but to have been hidden for safety under the soil after the elevation of the land. This does not uphold the view of Mr. Arthur Evans as to the deposition of the ornaments as described by him in *Archæologia*, vol. lv (1897).

† I have described this beach in some detail in my *Physical Geology of Ireland*, 2nd edit., p. 138.

terraces on each side of the Irish Sea are representative of each other; and the inference is that whatever terrestrial changes in recent times affected the Scottish area, also affected that of Ireland to a greater or less degree. With regard to the northern parts of England south of the Scottish border they doubtless partook of similar changes; but I do not propose to extend our survey farther than is necessary for our immediate object.

PART III.

Date of Emergence.—We have now to endeavour to determine approximately the period at which the rise of the land took place, and the evidence on this head is partly circumstantial, partly inferential. There has existed a feeling for a long time past that this uprise was at such a distant period that there was no use in attempting to investigate the subject at all. But we have seen that it is certainly within the human period and not only so, but within a period comparatively recent, and in which works of art were not uncommon. If we accept as generally true that the "Stone Age" was succeeded by that of the Bronze, and the "Bronze Age" by that of Iron, we have clear evidence that this last had prevailed for a considerable time when portions of Scotland and Ireland were below the waters of the sea; and this brings us down to the epoch of modern art. We have therefore to inquire within what limits of time we may infer the introduction of iron into North Britain—and we may add into the North of Europe—for use in the arts. That iron came into use in Northern Europe and Britain some centuries before the Christian era seems pretty clear; though the exact time cannot be determined. When the armies of Rome brought the civilization of the south into contact with that of the north they found the value of iron already well known to their enemies;* and the description given by Tacitus of the Caledonian weapons shows that bronze swords were no longer in use in Scotland.† That iron was in use in the arts of Norway as far back as the third century of our era is shown by the discovery of a boat by M. Engelhardt

* Sir J. Lubbock (now Lord Avebury) *Prehistoric Times*, p. 7.

† The question occurs, were bronze swords ever in general use amongst the Caledonian warriors; it does not follow that everywhere bronze succeeded stone in the manufacture of weapons in North Britain. In fact in the case of Scotland, it is probable that iron succeeded to stone directly, without the intermediate stage of bronze.

in the moss at Nydam in 1862, in which iron was used for the bolts, and in close proximity to numerous Roman coins ranging in date from A.D. 67 to 217; while at Thorsbjerg other articles of iron were found with Roman coins ranging from A.D. 60 to 197.

Now it is highly probable that Scotland and Norway were in intercommunication during the Roman occupation of the former country, and we might even hazard the view that the clinker-built boats together with the boat-hooks, anchors and other objects of iron were of Roman manufacture. Between the clinker-built boat of Bankton, above described, and the canoe hollowed out of the trunk of a tree, there is so great a distinction in the stage of art that we might well be justified in recognizing the former as the work of Roman art and the latter as that of the savage; and the Norwegian discoveries lend to this view additional force from the presence of the coins of definite date lying in proximity to objects and works of art made of iron. In a word we find ourselves in presence of works of art of a civilized race and those of the savage, one the Roman, the other the Caledonian highlander.

The "Roman Wall," or Vallum.—But however strong the evidence afforded by the remains above described that the "25-feet terrace" was under the sea at no very distant date; in fact, during the period of Roman occupation, that afforded by the position of the "Roman wall" is still more confirmatory if the account I am about to give of this rampart be correct. For this account we are indebted to Sir Archibald Geikie, who has in much detail collected the evidence which I shall now briefly capitulate, referring the reader to this author's original memoir for fuller information.*

The mainland of Great Britain twice contracts into narrow width, of which the Romans in their early occupation took advantage by constructing two lines of ramparts from sea to sea for security against the hostile tribes to the northward respectively. The first is known as "Hadrian's wall," from the Tyne to the Solway Firth, wholly in England, constructed about A.D. 120; the second from the Forth to the Clyde, about A.D. 142, and known as "the wall of Antoninus." (See Map.)

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* *Quart. Journ. Geol. Soc.*, vol. xviii, p. 229. Sir A. Geikie's conclusions have been called in question, but it is scarcely credible that so able an observer could have been mistaken in his facts of observation, and with the conclusions deduced from them I can see no reason to disagree; in fact, it seems to the writer that he has made out his case.

This wall was constructed to repel the attacks of the Caledonian tribes from the north, and was abandoned about 45 years afterwards, which would bring us down to about A.D. 187, or the close of the second century of our era.

Dealing with the eastern end of the northern wall, Sir A. Geikie states that west of Borrowstounness (or Bo'ness), the ground rises from the old coast line as a steep bank the summit of which is 50 to 100 feet above the sea. Between the bottom of this abrupt declivity and the present margin of the Firth of Forth there is a narrow strip of flat ground on which Bo'ness is built, and which nowhere rises more than 20 feet above high-water. It is in fact a prolongation of the Carse of Falkirk and of the raised beach of central Scotland, which was submerged when the waves beat against the steep bank which here formed the old coast margin. But the important point for us is, that the Roman wall appears to have terminated at the top of the steep declivity. The flat terrace below, over which, if it had been land as at the present time, the rampart would have naturally been carried to the sea margin, presents no traces of this "wall or foss." In the words of Sir A. Geikie, "if the land were here depressed 25 feet, no part of the wall would be submerged."* Again, the western extremity of the wall stood on a little eminence called Chapel Hill on the north bank of the Clyde near West Kilpatrick, and the conditions are somewhat similar to those of the east end of the wall. Between the rising ground and the margin of the river is the nearly flat terrace about 20 feet above high-water mark, and the base of the hill is 5 to 6 feet higher; over this terrace the wall does not appear to have been carried, and it is now traversed by a railway and canal. In making the latter a number of Roman antiquities were found: the terrace is a portion of the raised sea beach. The inference seems clear that the *vallum* terminated at the promontory of Chapel Hill, because at the foot of the descent the sea itself formed a sufficient protection against the Caledonian highlanders as far at least as an advance by land was concerned, and the same remark applies to the eastern extremity at Bo'ness. The strategetic reasons for terminating the walls are self-evident on the hypothesis that they were carried from sea to sea. To leave wide spaces at either end incomplete while the rampart was carried over the intervening land would have been an act of folly for which we cannot credit such skilful engineers as were the Roman settlers. Hence in the words of

* *Ibid.*, p. 230.

Sir Archibald Geikie, "the Antonine wall, therefore, yields no evidence in favour of the view that the land has remained stationary since the time of the Romans," a favourite article of faith with some persons.

Ancient Harbours.—It may be mentioned in corroboration that there are the remains of old Roman harbours along the east coast of Scotland at Inverest and Cranund which show that the land has been raised since Roman times; and of another at Camelon in the valley of the Carron, at which an anchor was dug up. Lastly, there is the tradition of a Roman harbour in Falkirk Carse, below Larbert Bridge, where pieces of broken anchor have been discovered;—from all of which the late learned Dr. Nimmo, writing in 1777, inferred that the Firth stood considerably higher in former ages than at present.

Historical evidence.—I have only one more point of evidence to add to the above in support of the view that the land of North Britain has been considerably elevated since the Roman occupation, and that is of an historical kind. The historian Gildas, who lived in the early part of the seventh century, describes the "Picts" or Ancient Caledonians as a "*transmarine*" people, who, emerging from their forests, attacked the Roman garrisons from the north-east, crossing the intervening water in their coracles.* The interpretation which I would venture to place on this interesting passage is as follows:—

At the time of the Roman occupation of Scotland an arm of the sea occupied the valley of the Forth, a prolongation in fact of the present Firth, separating the land in occupation of the Romans on the south, from the Grampian Mountains on the north, the slopes of which were covered by forests affording shelter to the highlanders who, emerging from time to time, and crossing the intervening estuary in their coracles, attacked the Roman entrenchments, doubtless making it very unpleasant for the soldiers, who in sheer disgust abandoned the inhospitable country, leaving Britain to its fate about the year A.D. 187. The term "transmarine" used by Gildas is specially worthy of note, and would scarcely be applicable to the Caledonians had they been separated at this time from their foes only by the waters of the river Forth, as at the present day; but with the sea stretching inland nearly twelve miles beyond Stirling, as shown by the map, the expression becomes quite intelligible.

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* Quoted by Professor Rhys in *Celtic Britain*, 2nd edit., p. 167.

PART IV.—CONCLUSION.

It now only remains for us to gather up in a few words the evidence we have been considering bearing on the question, when the last emergence of the northern portion of the British Isles took place. We have seen that there is abundant evidence of a higher civilization in a country the natives of which were in a condition not much removed from that of the savage; certainly uncivilized. In the one case, we find axes, anchors, and boat-hooks of iron, clinker-built boats; in the other, canoes hollowed out of the trunks of trees, and we may suppose men using for weapons, bows and arrows, and spears armed with heads of stone or horn. This, however, is hypothetical. That the objects of iron, etc., representing the higher civilization were brought in by the Romans, there can scarcely be a doubt. We know as a fact that these invaders entered the country and constructed a rampart across the land of Scotland about the year A.D. 142, and we may be sure they did not rest content with boats constructed after the manner of the Caledonian canoes. Finally, we have the statement of the old historian Gildas, regarding the mode by which the Caledonian highlanders attacked the Roman settlements, paddling their canoes across the arm of the sea which separated their habitation from those of their enemies; and lastly, the evidence afforded by the form of the Roman Vallum at either end, terminating at a height overlooking the terraces which were once the sea-bed. All this evidence is cumulative, and confirmatory of the view that at the period of the Roman occupation of Scotland in the latter part of the second century of our era, the sea occupied considerable tracts of the present land, not only along the coasts, but running far up into the interior along the valleys of the Tay, the Forth, and the Clyde.

Having established this point, the only question remaining for us to discuss is, at what period did the land emerge to its present level above the surface of the adjoining sea? The answer to this question can only be conjectural. It is probable that the movement was slow at the commencement, and towards the end; and if we suppose that the upward movement begun at the commencement of the third century, it may not have concluded till two or three centuries more had elapsed. The only evidence that might have been educed on this subject would be that of the very oldest ecclesiastical buildings, and the position of their sites, in reference to that of the terrace

and the sea margin ; but as these only reach back to the tenth century in this part of the British Isles, though to a much earlier period in England and Wales,* there is too wide an interval to allow of exact determination. At that time the rise of the land had probably reached the stage at which it seems to have remained till the present day.

Explanation of Map.—The extent of the land submerged beyond the margin of the present river banks, namely, those of the Tay, the Forth and the Clyde, is shown by the darker shade of blue ; the lighter shade being that of existing sea and firths. The upper margins of the formerly submerged terrace have been traced from the 50-feet contour line on the Ordnance Survey Maps, corresponding very nearly to the 30-feet level above high-water of spring tides.

Discussion.

The Chairman.—There is a good deal in this paper that is very suggestive, though, perhaps, few of us feel ourselves competent to discuss a matter that is so particularly and specially the province of geologists. Yet I think everything that touches on the history and condition of man is a matter of genuine interest to members of such a society as this.

On hearing such a paper as this, it occurs to one that geologists, like many other scientists, appear to be reducing the very long period which was supposed, years ago, to have existed since man first appeared on this globe. The fact that these geological changes, elevations, and depressions, have been going on in such recent times may serve, perhaps, to correct needless exaggeration in the other direction. Then I think the fact that these various implements are found in those raised beaches is also a matter of interest to us. If I understand correctly, the researches of modern geologists show that there have been, really, two Human Periods.

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* In fact, it is considered on very good evidence that St. Mary's church in Dover Castle, and St. Martin's at Canterbury were built by Roman soldiers about the middle of the second century. See *Dover, the Ancient Cinque Port*, by an Ancient Freeman (1904, Marshall and Son).

I do not know whether it is possible to establish that with regard to the Stone, the Bronze, and the Iron Ages. In some countries the different Ages, no doubt, are shown by the remains that are found; but I do not think we need suppose that those different periods were contemporaneous throughout the whole world. Dealing with our own times, certain tribes in America are now using flint implements, so that we have flint implements contemporaneous with the highest civilization yet obtained by man.

Another thing that interests me in this paper is the reference that Professor Hull makes to the early period preceding these more modern oscillations and elevations. There seems to have been a break, if I understand it, in the history of man shown in this way. In certain of the caves in different parts of the country, as for instance even in the Brixham Giant's Cavern, you have deposits in which what are known as "palæolithic" implements are found. Then over that you have a layer of stalagmite, and over that layer of stalagmite you have a more recent deposit in which what are known as "neolithic" implements are found, made of bones and so forth; practically indicating that there are two eras in the history of this and other caves, and that the men who wrought the palæolithic implements had not attained to, or at any rate practised, the art of smoothing and polishing them as the men of a later period had done. Now it may interest us to inquire whether anything is known in the history of the human race that would at all agree with these breaks in its history. Well, we have, I think, something that may possibly correlate with this change. Take, for instance, the change of temperature in the northern parts of Europe. I believe the mammoth is not necessarily an Arctic animal, but it is of the elephant species, and probably therefore preferred a temperate or even a tropical climate to the Arctic conditions; and, as we are aware, for many years thousands of tons of mammoth ivory were brought year by year into this country, indicating, apparently, as Professor Hull has told us, that these many remarkable elevations of the land were accompanied by (if not producing) a very low temperature. Then there appears to have been a return of something like temperate conditions at all events, as these creatures have been found in these regions. Then there was a gradual elevation of the land when they were suddenly frozen, and they have been found almost intact in our own time. Such changes as these,

occurring within the human period, not unnaturally cause us to think of what was brought before us some years ago at this Institute by Professor Prestwich, who found in some of these cases indications of a deluge that had swept over the whole of the earth, washing away every living creature, and accumulating large quantities of the bones of various animals on the northern shores of the Mediterranean Sea. Then you have other changes following, showing how the history of man has gone on through the later geological periods right up to the present time.

I just throw out these suggestions as matters that may, perhaps, deserve a little consideration and may help to make this paper more interesting and instructive to us.

The subject is now open for discussion.

Mr. MARTIN ROUSE.—I think that Professor Hull in his admirable paper has thoroughly proved his case. It is a paper teeming with historic interests whether to the geologist or to the antiquarian.

I should like to ask regarding that part which the Chairman dwelt upon, whether the lofty beaches that have been found up to 1,200 feet in North Wales and the Wicklow Mountains are thinner. or more scanty, than the beaches with which the paper mainly deals at the height of 30 feet; because that would help us, would it not, to determine those questions which are matters of eyesight, of which the last speaker spoke—whether the former submergence and re-emergence was a very sudden one, whereas the latter was, as we know, a very gradual one. If the submergence which led to these lofty beaches was a very rapid one, or the uprise that followed it was rapid, then, of course, these beaches would be very thin and scanty, and would correspond in that regard with the thin beaches found at 25 or 30 feet level.

Then I should like Professor Hull kindly to explain a little more fully how the 50 feet contour line corresponds very nearly with the 30 feet beaches, because on the face of it I do not quite understand how 50 feet above the mean sea level at Liverpool would be the same as 30 feet above high water mark. If it is 50 feet above the mean level, of course the mean level at that rate would be 20 feet above the lowest level, or 20 feet below the highest level, *i.e.*, there would be a difference of 40 feet between high and low water mark, which I should have thought too great.

The AUTHOR explained.—The rise and fall of the spring tides at Liverpool is 26 feet, of which the mean level is 13 feet. This is the "ordnance datum"; add to this 30 feet for the upper level of the terrace and the result is 43 feet, not much below the 50 feet contour and sufficiently near for the purpose in view.

Mr. MARTIN ROUSE.—Then is not there a slight mistake in the paper? Referring to Norway, you say in the paper at pages 183 and 184, "When the armies of Rome brought the civilisation of the south into contact with that of the north they found the value of iron already known to their enemies," and it goes on to speak of Roman coins being found along with a boat well made, as proving the Roman occupation of Norway, or as pointing to the Roman occupation. Is not that a slight slip, inasmuch as the Romans never did occupy Norway?

The SECRETARY.—Are you sure of that?

Mr. MARTIN ROUSE.—Perfectly, sir.

The SECRETARY.—How do you account for the coins being found?

Mr. MARTIN ROUSE.—I think they came by trade. The Romans, I assume, occupied a good piece of Germany and they were driven back.

The SECRETARY.—They never went across the Baltic, you mean?

Mr. MARTIN ROUSE.—No. There is no proof that they went across the Baltic.

The SECRETARY.—Very well, I thank you.

Professor LOGAN LOBLEY.—As you have been good enough, Mr. Chairman, to ask me to speak on this paper, I have great pleasure in rising to say a few words, as I am greatly interested in it as a geologist and greatly interested in it as a lover of archæology and a lover of the history of my country.

Very seldom do we hear a geological paper read which has reference to such modern times as that given by Professor Hull to-day. This brings us quite into an historical period, the second, or third century of our era, and that is quite unusual in geological papers.

It seems to me from the evidence brought forward in this paper, that the case, as Mr. Martin Rouse has said, has been very well proved, especially by the fact of the Roman wall not having extended quite to the present margin; that seems very strong evidence

indeed that this uprise has occurred in very recent periods. But the other uprisings, mentioned in the former part of the paper, belongs to quite a different era. The great uprise represented by shelves at a height of 1,200 feet to 1,300 feet above the level of the sea was at a long preceding period, and has no connection whatever with the uprise more especially spoken of in this paper. But we must not think, late though this period has been, that this was the last oscillation of the land in these islands. Professor Hull does not speak of it as the last oscillation or movement of the land but as the last uprise of the land. Now there has been a fall of the land since that period, evidently; because we have submerged or sunken forests round our coasts and on the coast of Cheshire, at low water, you may see the stumps of trees. This shows the depression that has taken place since that uprise, and that these elevations and depressions have taken place in all geological epochs of the world's history down, one may say, to the present time; and we have evidence that they are going on even at the present day, for the movement of the land in the Scandinavian Peninsula, in the last century, has been measured to amount to about 3 feet in 100 years, and that is going on as we know.

Then we have distinct evidence that in the last century the whole of the western coast of South America rose very considerably and at one time it rose 9 feet in 24 hours, which is a permanent uprise; but there has been a very considerable uprise along the whole of the west coast of South America in recent times. These are facts in geology which show us very clearly that the present state of things has been due to the various movements of the terrestrial sphere through a vast number of ages.

This paper has brought before us a controversy very recently raised, viz., as to whether the elevation of the relative levels between land and sea is due to the movements of the land, or of the sea. It has been accepted as a commonplace in geological teaching that the level of the sea is a permanent level.

The SECRETARY.—Since Lyell's time.

Professor LOBLEY.—Yes; that the water, being mobile, any change of level in one place will be distributed over the whole of the sea of the globe; and seeing that the seas occupy three times the amount of the surface of the globe that the land does, the small alteration of level would be quickly distributed and lost; so we may

take it for granted that the sea level is a permanent and fixed level and that any alteration of level must be due to the movement of the land. But now some continental geologists have been raising the question whether this is to be accepted as definite, or not, and have even thought that it may be from a shrinkage of the crust of the globe, a diminution of radial extent of the globe, the distance of the centre of the globe to its mean surface, which might so take down the level of the surface of the sea. It seems to me that the paper of Professor Hull has a very direct bearing on that question and entirely disproves it, and I may say corroborates the theory of Lyell; for if this alteration of level, of say 25 feet and so on, takes place in a very short time, that cannot possibly be due to any diminution of the general level of the sea, for no shrinkage of the globe could give such a diminution of the general level of the sea in so short a time. The shrinkage of the globe, if it goes on (and Lord Kelvin advocates that, and I have the temerity to oppose it and I say there is no evidence of that or of the cooling of the globe) is entirely based on *a priori* reasoning. At Oxford, some years ago, I brought forward very strong evidence to show that there has been no cooling of the globe and no alteration in the general temperature of the globe since the Cambrian period. So I consider this paper of Professor Hull's is an exceedingly interesting and important one, and I hope it will draw attention to this controversy and tend to establish the position I have, as a geologist, always held, that the mean level of the sea is constant, and that it is the land that rises and falls, and not the sea.

Professor ORCHARD.—Our thanks are due to the learned author of this able paper for the interesting subject he has brought forward.

Some of us may have been a little surprised, and even startled, by the idea that since the time of the Roman occupation there has been an uprise in these British Islands. It is really but another illustration of the fact that there is nothing stable underneath the sun.

Reference has been made to the antiquity of man and to the universal deluge. With regard to the antiquity of man, the scientific world generally, I believe, now credits the view that there is no evidence of the existence of man on the earth earlier than after the close of the glacial period. That has been put, I think, pretty

well beyond the question, as from seven thousand to ten thousand years ago. The paper which we have had the pleasure of listening to, would not, I apprehend, be regarded by its author as entirely conclusive. The evidence cannot be called demonstrative. At the same time there is a great deal of probability about it. He has brought forward witnesses of very good character and unimpeachable honesty. The Roman wall strengthens his argument, and what the author says on page 180 of the paper shows there is a great deal to be said for this interesting theory. What he says in the last paragraph of page 180 with regard to the iron anchors and iron boat hook seems to be of very great interest indeed.

I should like to ask Professor Hull whether he can draw any date of demarcation between what is called the Stone Age and what we know as the Iron Age?

I would also like to ask him his opinion as to the cause of these supposed uprises in the British Islands.

The CHAIRMAN.—I would like to say one word concerning what Professor Lobley said about the cooling of the earth. If I have correctly understood Lord Kelvin in his remarks on the thermal conductivity of the earth, it seems to me that the earth is giving off its heat, but it does not necessarily follow that the earth is becoming actually lower in temperature.

I think there can hardly be any doubt that the earth must be giving off its heat through volcanos, and all sorts of ways. The sun itself is giving off heat constantly, and yet we are told that the sun is not becoming cooler, because it is contracting constantly, the contraction causing the temperature to be maintained while the heat is being given off, as we know, in enormous quantities. That may possibly be a reconciliation between what Professor Lobley said and Lord Kelvin's writings as I have understood them.

I am sure we are all very grateful to Professor Hull for bringing such an interesting subject as this to our notice.

The SECRETARY.—I have listened with great pleasure to our chairman's remarks. which indicate that he has grasped subjects connected with geology and with physical history as well as those of a higher and different kind.

But to pass on to Professor Lobley's questions, I would ask him whether he is perfectly sure that those cases of submergence on the shores of Cheshire and, as I have seen them, on the shores of

Waterford in Ireland, were not contemporaneous with the rise of the land in Scotland and the north of Ireland?

Mr. Rouse asked if the high beaches, indicating a submergence of some 1,200 feet, were scanty. I presume he means that since then they have only been of rare occurrence here and there.

Mr. MARTIN ROUSE.—No, sir, I meant thinner. My line of thought was that if there were a submergence and a rapid fresh rise, then there would be little time for deposit. The deposit would be much thinner in the centre.

The SECRETARY.—No, the beach in Moel Trefaen, North Wales, is of considerable thickness. I have not examined it myself, but I believe some of those beaches have been illustrated in the *Journal of the Geological Society*, and I think the thickness of some is 15 feet or 20 feet of gravel with marine shells of still existing species.

I accept Mr. Rouse's statement that the Romans never did occupy Norway, and I am much obliged to him for the correction. A young lady with whom I am acquainted made the same statement to me, and I asked her how she knew it; she said it was very well known that they did not. However, I do not think that invalidates what I have said as regards intercommunication with Scotland.

Professor Lobley referred to the sunken forest in Cheshire, with which he is acquainted. I know of one in the West of Ireland, in county Mayo, and another in county Waterford (Tramore Bay), a most remarkable instance, in which the process of subsidence may have been going on *pari passu* with that of elevation. I do not think the one is antecedent or subsequent to the other. I recollect making that very statement to Professor Phillips at a meeting of the British Association, and I remember his illustrating the process by a movement of his arm—one part of his arm going up and the other going down.

I doubt very much if there has been any movement of the least importance to the British Islands since the movements to which my paper refers.

Professor ORCHARD.—I asked Professor Hull if he could give a definite line of demarcation between the Stone Age and the Iron Age, and whether he could attribute it to any particular cause.

The SECRETARY.—Yes, I had forgotten that. Do you mean a date in years?

Professor ORCHARD.—Within a hundred years.

The SECRETARY.—B.C. or A.D. ? That is quite impossible, and it does not follow. It is not like the case of the introduction of different kinds of architecture in our ecclesiastical buildings in England or Europe which is most remarkable and seems to have taken place over very wide areas. We know when we pass from the Early English to the Decorative, and from the Decorative to the Perpendicular styles. We know within a few years when those buildings were erected; but we cannot use an argument of that kind with regard to the Stone Age and the Iron Age.

Professor ORCHARD.—I thought not. Thank you.

The SECRETARY.—They were not contemporaneous all over the earth and in the British Islands. As to the cause, the whole crust of the globe, if we could see it, is no doubt in motion, but it may be very slow in some parts and comparatively rapid in others.

I thank you for the kind manner in which you have received my paper.

The Meeting then terminated.