

mile E. of the Nith to about two miles W. thereof. In this section the lowest strata, well seen at Craig's Quarry, are red sandstones with the same footprints as those of Corncockle, upon which, after passing through false-bedded sandstone, the thick mass of breccia forming a trough through which the Nith flows, and which extends to the Silurian hill W. of Dumfries, is seen.

The sections of Annandale and Nithsdale collectively furnish the following groups which compose the Permians of this part of Scotland:—first and lowest, breccias; second, a thick series of sandstones, some of the strata of which are somewhat incoherent, and some flaggy, with footprints; and third and highest, a thick mass of breccias. This sequence shows such an analogy to the inferior sandstones of Westmoreland as to justify the conclusion that in Scotland, so far as is yet known, the Rothliegende portion only of the Permians is exhibited.

Another important circumstance connected with the Scottish Permians is the position of the footprints. Like those occurring in the neighbourhood of Penrith, which consist of *Chelichnus Duncani*, these impressions appear to mark the *middle* portion of the Rothliegende—a position probably below that portion of the inferior sandstone represented in the East of England, but which has very likely its equivalent in the well-developed Rothliegende of Saxony.

No allusion has been made to the geological age of the upper sandstones of the N.W. of England and the S.E. of Dumfriesshire. Like similar strata in the S.E. of Durham, they succeed the Zechstein representatives of the Eden valley, and might therefore be regarded as Triassic.

As Mr. Binney has noticed the occurrence of Liassic strata in North Cumberland, near the margins of the Solway Firth, which exhibit themselves in such a position as to lead to the conclusion that they repose in the trough formed by the upper sandstones, the Triassic age of these arenaceous deposits, with clay-beds, becomes highly probable*.

Note.—In a memoir published in the 6th vol. of the Quart. Journ. of the Geol. Soc., having reference to the sandstones of the Vale of the Nith, I allude to them as appertaining to the same age as those of the Cumberland area, referring the whole to the Trias. This opinion I adopted in consequence of its being then a generally received one among geologists. Subsequently, in another memoir (vol. xii. p. 266), I stated the reasons which induced me to alter this opinion, and to regard these deposits as belonging, for the most part, to the Permian age.

2. *On the DATE of the LAST ELEVATION of CENTRAL SCOTLAND.* By ARCHIBALD GEIKIE, Esq., F.R.S.E., F.G.S., of the Geological Survey of Great Britain.

THAT the central districts of Scotland, together with the greater part of the British Islands, have undergone a movement of upheaval within

* Quart. Journ. Geol. Soc. vol. xv. p. 549.

a comparatively recent geological period is a fact which has long been familiar to the geologist. A line of raised beach, with shells of living species still in a perfect state of preservation, fringes many parts of the coast, at a height of from 15 or 20 to upwards of 40 feet above the present sea-level. This difference of elevation may point either to different periods of upheaval or to one great upward movement which varied in intensity in different parts of the island. For facts so well known it is only necessary to refer here to the papers of Mr. Smith of Jordan Hill, Mr. Maclaren, Mr. Chambers, and others who have described the evidence which different parts of the Scottish coast-line furnish as to a recent rise. The object of the present communication is to inquire how far we have data for ascertaining the time at which at least the later stages of this rise took place.

Ever since the publication, in 1838, of Mr. Smith's great paper on the last changes of level in the British Islands*, the belief has been universal that no alteration of the relative position of sea and land has taken place within the last two thousand years, the coast-line being the same now as it was at the time of the Roman invasion. I shall have occasion, in a subsequent part of this paper, to examine the evidence on which such a belief is founded. With regard to the centuries prior to the Christian era, Mr. Smith remarks that probably no change of level has taken place within the human period†. For this statement, however, he adduces no other foundation than that mounds known as British tumuli, along with vitrified forts, exist close to the margin of the present high-water mark. The discovery of canoes in an elevated part of the old alluvium of the Clyde, and of other antiquities in that of the Forth, tended to throw some doubt on Mr. Smith's assertion. Mr. Chambers, in his volume on 'Ancient Sea Margins' (pp. 18–22), published in 1848, refers with hesitation to the possibility of these canoes having been in use prior to the last shift of the land, and the same view was entertained by other geologists; but in October 1850 he published an account of some antiquities found in the Carse of Gowrie which he conceived to have been brought by an abnormal inundation within the historical period, and he then acknowledged his belief that those of Glasgow had been similarly imbedded, and that consequently they afforded no evidence in favour of a change of level since Scotland had been tenanted by man‡.

Such was the state of the question when, in the spring of last year (1861), I obtained evidence which seemed to show that a portion of the coast of the Firth of Forth had been elevated not only within the human period, but even since the first years of the Roman occupation§. This observation involved so wide a departure from

* Edin. New Phil. Journ. xxv. p. 385; and Mem. Wern. Soc. vol. viii. part i.

† Mem. Wern. Soc. vol. viii. p. 58.

‡ See Edin. New Phil. Journ. vol. xlix. p. 233.

§ Edin. New Phil. Journ., new series, vol. xiv. p. 107. Since this paper was written, more recent excavations have shown the existence of mediæval

preconceived opinions, and bore so closely on questions of the deepest moment regarding the antiquity of man, that I felt the necessity of examining other parts of the coast with the view of ascertaining how far the movement may have been general over the central districts of Scotland. It seemed to me advisable also to make a search through such archæological volumes as treat of our maritime antiquities, in order to see whether any antiquary had detected proofs of physical changes. The results of these inquiries are now communicated to the Society.

The Firths of Clyde, Forth, and Tay are each bordered with a strip of flat land, varying in breadth from a few yards to several miles, and having a pretty uniform height of 20 or 25 feet above high-water-mark. This level terrace is the latest* and on the whole the most marked of the raised beaches. It must have been formed when the land was from 20 to 30 feet lower than at present, and evinces an upheaval which was nearly uniform over the whole of the central valley of Scotland. What, then, was the date of this upheaval?

The discovery of human remains in the sands and clays of the raised beach affords the only ground for an answer to this question. From these strata canoes, stone hatchets, boat-hooks, anchors, pottery, and other works of art have been from time to time exhumed on both sides of the island. These remains are usually claimed by the antiquary. He arranges them in his museum according as they belong to the Age of Stone, of Bronze, or of Iron. He speculates from them as to the character of the early races, and from the indications which they may afford he compiles his prehistoric annals. But the geologist, too, has an interest in them. To him they are true fossils, as much as the footprint of a Reptile, the track of a Crustacean, or the tube of an Annelide. He deals with them as he deals with other evidence of the former presence of animal life. The circumstance of their occurrence, the nature of the material in which they lie imbedded, the indications which they may afford of former diversities of surface, whether of lake or river, land or sea, their association with the bones of animals now rare or extinct, and then

pottery in the sands and silt of the section described by me as occurring at Leith. Attempts have been made to show that the deposit in which these fragments occur is merely artificial ground. Since this idea was suggested I have several times visited the sand-pit, both alone and in company with observers of greater experience than myself, and have been unable to alter the opinion I originally formed as to the true aqueous origin of the upper silt and sand. A hasty inspection might lead one to confound these beds with an unconformable artificial earth which overlaps them, and to class together the contents of two very different formations. The occurrence, however, of pottery, to which Mr. Franks of the British Museum can hardly assign a higher antiquity than 700 years, seems to show that the upper parts of this series of strata have been re-assorted in more recent times than I had supposed. But the subject requires further investigation, and until this is given, I am unwilling to depart from my original conclusion.—July 18, 1862.

* There are occasional traces of a later terrace, as along the Clyde at Glasgow, but these may for the present be disregarded.

their intrinsic character as illustrations of various stages in the onward march of human progress,—all these are points of view from which the geologist claims to study such remains. The antiquities of man have thus a geological as well as an archæological interest. The day, indeed, is perhaps not far distant when archæology will form well-nigh as integral a part of geological science as palæontology does now. This conviction must, at least, be my apology for bringing before you some parts of a subject which is not usually held to come within the scope of the Geological Society.

Along the margin of the Clyde at Glasgow, the raised beach extends as a level terrace of varying width, its surface lying about 26 feet above high-water-mark. This plain, when sections are cut through it, is found to consist of alluvial clay, silt, and sand, with layers of shells—the deposits of an ancient estuary. Its presence so high above the limits of even the extremest spring-tides or the highest recorded river-floods can only be accounted for by an actual upheaval of the land. No transient flood, of what magnitude soever, could deposit well-stratified laminae of fine silt and mud in regular succession to a height of 26 feet above the ordinary level of the estuary. The bed of the river, along with the surrounding country, must therefore have been raised; and hence any remains which may occur contemporaneously imbedded in these alluvial deposits must have been involved in the same upheaval. If it can be shown that human works of art lie beneath some of the undisturbed silt-beds, it will follow that the elevation has been witnessed by man.

Human remains have been especially abundant in the alluvium of the Clyde. There is comparatively little variety, however, in their character, inasmuch as they have been almost entirely connected with the primitive navigation of the river. Within the last 80 or 90 years the hulls of no fewer than eighteen canoes have been exhumed, some of them even from under the very streets of the city*. The most important discoveries took place during the progress of those great excavations by which the harbour of Glasgow was widened and deepened. Twelve canoes were then obtained, the whole of which came under the notice of the antiquary, who in 1856, under the signature of J. B., communicated an account of them in the third volume of the work entitled ‘Glasgow, Past and Present.’ With only one exception, they were all formed of single oak-trees. Two had evidently been scooped out by the action of fire; others had been hollowed with a rough implement, such as a stone axe; while several were cut beautifully smooth, evidently with metal tools. Hence a gradation could be traced, from a pattern of extreme rudeness to one showing considerable mechanical ingenuity. The average depth beneath the surface of the ground at which the whole were found was about 19 feet, or about 7 feet above the level of high water†. They all lay

* For the details of the Glasgow canoes I am indebted to an interesting paper in ‘Glasgow, Past and Present,’ vol. ii., written, I believe, by that zealous antiquary, Mr. Buchanan.

† The canoe found at an earlier date, on the site of the Tontine Hotel, lay about 21 or 22 feet above high-water-mark in the river.

at a distance of more than 100 yards back from the margin of the Clyde as it existed before the alterations began, and were chiefly imbedded in a thick bed of finely laminated sand.

Most of the Clyde canoes were formed out of single oak-stems; but two of them were built of planks. Of these the more elaborately constructed was discovered on the property of Bankton, in 1853. A large oak had been cut longitudinally into a mere strip, as the back-bone of the boat, from which a long keel was formed underneath by being simply *left standing out*, while the back-bone was pared away, so that the keel appeared a mere longitudinal projection from the lower plane of the same strip. Strong transverse ribs were inserted for the skeleton of the back. These were clothed outside with deals about 8 inches broad, and they overlapped each other precisely as in modern clinker-work. The stern was formed of a thick triangular-shaped piece of oak, fitted-in exactly like those of our day. Again, the prow had a neat cutwater, rising about a foot above the gunwale, and giving it rather an imposing effect, not unlike, on a very small scale, the beak of an antique galley. The length of this curious vessel was 18 feet; width at the waist 5 feet, and at the stem $3\frac{1}{2}$ feet. When discovered, it was lying *keel uppermost*, with the prow pointing straight up the river. It had probably been capsized in a storm. The planks were fastened to the ribs, partly by singularly shaped oaken pins, and partly by what must have been nails of some kind of metal. The perforations where nails had been were uniformly square, and the marks of their broad heads driven home by smart blows deeply into the wood were very perceptible. None of the nails themselves were, however, to be seen; but several of the oaken pins were left. They were round, thicker than a man's thumb, and ingeniously formed. The pin, after being rounded, had been sliced in two, and a triangular-shaped tongue inserted; so that, when driven into the deal, the pin would firmly hold its place*.

In addition to these canoes, a polished celt of greenstone, a thin piece of lead perforated with nail-holes, and a plug of cork in the bottom of one of the vessels have also been discovered. Such are the remains of human workmanship which have been found in the elevated silt-beds of the Clyde. Do they of themselves afford any indication of the probable period during which this elevation was effected?

At the outset it must be borne in mind, that the occurrence of these canoes in the same upraised silt by no means proves them to be synchronous, nor even to have belonged to the same archæological period. The relative position in the silt from which they were exhumed could help us little in any attempt to ascertain their relative ages, unless they had been found vertically above each other. The varying depths of an estuary, its banks of silt and sand, the set of its currents and the influence of its tides in scouring out alluvium from some parts of its bottom and redepositing it in others are circumstances which require to be taken into account in all calculations as to the relative position of different parts of the bed of the stream in any

* Glasgow, Past and Present, pp. 565-6.

former period. Hence mere coincidence of depth from the present surface of the ground, which is tolerably uniform in level, by no means necessarily proves contemporaneous deposition. Nor would such an inference follow even from the occurrence of the remains in distant parts of the very same stratum. A canoe might be capsized and sent to the bottom just beneath low-water-mark; another might experience a similar fate on the following day, but in the middle of the channel. Both would become silted up on the floor of the estuary; but as that floor would be perhaps 20 feet deeper in the centre than towards the margin of the river, the one canoe might actually be 20 feet deeper in the alluvium than the other; and on the upheaval of the alluvial deposits, if we were to argue merely from the depth at which the remains were imbedded, we should pronounce the canoe found at the one locality to be immensely older than the other, seeing that the fine mud of the estuary is deposited very slowly, and that it must therefore have taken a long period to form so great a thickness as 20 feet. Again, the tides and currents of the estuary, by changing their direction, might sweep away a considerable mass of alluvium from the bottom, laying bare a canoe that may have foundered many centuries before. After the lapse of so long an interval, another vessel might go to the bottom in the same locality, and be there covered up with the older one, on the same general plane. These two vessels, found in such a position, would naturally be classed together as of the same age, and yet it is demonstrable that a very long period may have elapsed between the date of the one and that of the other. Such an association of these canoes, therefore, cannot be regarded as proving synchronous deposition; nor, on the other hand, can we affirm any difference of age from mere relative position, unless we see one canoe actually buried beneath another.

Hence the only evidence that remains is that which may be afforded by the character of the antiquities. It is usual to speak of the canoes which have been from time to time exhumed in Scotland as of an extremely rude construction, and as the relics of a very barbarous people. They are described along with the stone implements of the Stone Period, standing thus as far back in the past as the antiquary can place them*. But it is manifest that most of the Glasgow canoes cannot be spoken of as works of extreme rudeness. One or two of them, indeed, were certainly primitive enough in their construction; but the Bankton boat could not have been built by a race of savages. It is, indeed, impossible to avoid the conviction that the rough-hewn, fire-burnt oak-trunks must have belonged to an earlier time than that of the smoothly cut canoes, and that these again date further back than the regularly built boat of Bankton. The first class may be a relic of the Stone, the two latter of the Bronze Period, if, indeed, the boat came not within the Period of Iron. We seem to see, in the various stages of mechanical skill shown in these primitive vessels, a record of the gradual progress of

* See Dr. Wilson's 'Prehistoric Annals of Scotland,' chap. ii.

advancement from a state of comparative barbarism to a kind of semi-civilization.

It is plain that the islanders who built this primitive fleet were not only acquainted with the use of metal, but that before they could have cut out the more highly finished canoes they must have been long familiar with its use. They must have had serviceable metal tools wherewith they could saw an oak through cleanly and sharply at its thickest part, make thin oaken boards and planks, and plane down a large tree into a smoothly cut and polished canoe. They had advanced, too, to a high degree of mechanical ingenuity. We are told, for instance, by the antiquary whose account of the discovery of these canoes has been cited, that one of them had its open stern so broad that the builder seems to have been unable to procure a board large enough to fill it. In this dilemma he took two boards, fitted them into the usual grooves, and inserted between them, along their vertical line of junction, a thin lath of oak, which dovetailed them together and made them water-tight.

What may have been the nature of the metal out of which these aboriginal tools were fashioned has not yet been ascertained. The square metal nails too, although the marks of their heads were still visible, had themselves wholly disappeared. If they were made of bronze, we cannot assign to the canoes in which they were used a date older than some part, it may have been a very late part, of the Bronze Period. If it can be shown that the metal employed was iron, the age of the antiquities must, in accordance with the received archaeological chronology, be brought still further down towards the present time.

Two of the canoes were built, not out of a single oak-stem, but of planks. That of Bankton, already described, had its deals fastened to strong ribs, like a modern boat; its prow was turned up "like the beak of an antique galley," and its whole build suggests that the islander who constructed it may have taken his model, not from the vessels of his countrymen, but from some real galley that had come from a foreign country to his secluded shores. Nor is this the sole ground for inferring that, at least at the time indicated by some of these canoes, the natives of the west of Scotland had some communication with a more southern and civilized race. How otherwise are we to account for the plug of cork? It could only have come from the latitudes of Spain, Southern France, or Italy. By whom, then, was it brought? Shall I venture to suggest that the old Briton who used it was not so ignorant of Roman customs as antiquaries have represented him, and that the prototype of the galley-like war-boat may have come from the Tiber to the Clyde?

But whether such a suggestion be accepted or not, it is abundantly evident that the elevation of the bed of the estuary, by which the canoes have attained an altitude of sometimes 22 feet above high-water-mark, cannot be assigned to the rude ages of the Stone Period, but must have taken place long after the islanders had become expert in the use of metal tools*.

* To the conclusion stated in the text, the only objection with which I am

If now we cross the island to its eastern coast, we shall find the shores of the Firth of Forth bordered with a belt of upraised alluvial deposits similar to those of the estuary of the Clyde. This belt reaches its greatest extent on the south side of the Firth, where it expands into a broad plain, known as the Carse of Falkirk, the surface of which appears almost a dead flat, with a general height of about 20 or 25 feet above high-water-mark. From Stirling the same plain extends westward along both sides of the sinuous river for a distance of 16 or 18 miles. This upper part is called the Carse of Stirling. When these carse-lands are cut through by drains, they are found to consist of fine dark silt, with layers of sand, and of shells belonging to species that still live in the adjoining estuary. Layers of peat, with great numbers of oak-stems, occur in the silt; and many parts of the plain, especially above Stirling, are at this moment covered with a thick stratum of peat-moss. The occurrence of finely laminated silt, and layers of marine shells, at a height of 20 or 25 feet above the present high-water, and over many square miles of ground, implies a rise of the land to about the same extent as that indicated by the silt-beds of the Clyde*.

That this elevation has taken place within the Human period is proved by the existence of human remains at various localities, imbedded in the upraised alluvium. In the year 1819, on the carse-land of Airthrey, near Stirling, the skeleton of a whale was found imbedded in the silt fully a mile back from the river-bank, and at a height of nearly 25 feet above the high-water-mark of spring-tides. At Dunmore, on the south bank of the estuary, a few years later, a second whale was disinterred from a stiff clay at a height of 23 or 24 feet above high-water-level. Again, in 1824, a third whale-skeleton was exhumed from under a covering of peat-moss and clay at Blair-Drummond, which lies seven miles higher up the valley than Airthrey. Beside the bones, both at Blair-Drummond and at Airthrey, lay a piece of perforated deer's horn, unmistakeably a work of human fashioning†. They were, in short, two harpoons, one of them having still partially attached to it the fragments of the wooden handle by which it had been wielded. The circumstances under

acquainted is a casual remark by Mr. Smith, of Jordan-hill, in his paper on the "Last Changes of Level in the British Islands," *Mem. Wern. Soc.* vol. viii. p. 58, to the effect that some British tumuli and vitrified forts have been formed with a regard to the present level of sea and land. Now, in the first place, we know absolutely nothing of the age of the vitrified forts. Dr. Wilson, indeed, in his '*Prehistoric Annals of Scotland*,' p. 413, discusses them along with the strongholds of the *Iron Period*. Again, the date of tumuli, I imagine, must be fixed, to a large extent, if not entirely, by the nature of the antiquities found within them. A mere mound of earth or stones may surely belong to any conceivable period of human history. The custom of raising cairns over dead bodies or on the scenes of suicide and murder is still prevalent in some parts of Scotland.

* For an account of the alluvium of the Forth, see Blackadder, *Mem. Wern. Soc.* vol. v. p. 424; also, Chambers's *Ancient Sea Margins*, p. 131; *New Statistical Account of Scotland* (Stirlingshire).

† For accounts of these whales, see *Edin. Phil. Journ.* i. 393; *Mem. Wern. Soc.* iii. 327; *Edin. Phil. Journ.* xi. 220, 415; *Mem. Wern. Soc.* v. 437, 440. See also Wilson's *Prehistoric Ann. of Scot.* p. 33; Owen, *Brit. Foss. Mamm.* p. 542.

which these remains were found leave no possibility of doubt that the land here has been upraised at least 24 feet, and that this upheaval has been witnessed by man. The horn weapons do not indeed indicate an advanced state of civilization; yet they unquestionably prove the presence of a human population perhaps contemporary with that which built the ruder canoes of the primitive fleet of Glasgow.

In the elevated alluvial plains of the Forth, canoes similar to some of those of the Clyde have also been found. One was dug up on the Carse, not far from Falkirk, from a depth of 30 feet. Early in the last century, too, a flood of the River Carron, which flows through the carse, undermined a part of the alluvial plain, and laid bare what was pronounced at the time to be an antediluvian boat. It lay 15 feet below the surface, and was covered over with layers of clay, moss, shells, sand, and gravel. Its dimensions were greater than those of any other canoe yet found in Scotland; for it reached a length of 36 feet, with a breadth of 4 feet. "It was described by a contemporary newspaper as finely polished and perfectly smooth, both inside and outside, formed from a single oak-tree, with the usual pointed stem and square stern*."

These features seem to harmonize well with those of the more perfect of the Clyde canoes, and to justify the inference that they were produced by the employment, not of stone, but of metal tools.

But in the Carse of the Forth an implement of metal has actually been found, and one formed not of bronze, but of iron. It was an iron anchor, dug up a little to the south-east of the place from whence the Dunmore whale was obtained. The exact depth at which it lay is not given; it was probably about 20 feet above high-water. "The flanks were much decayed; but the beam, which was of a rude square form, with an iron ring, was tolerably perfect. It hung many years in the old tower near Dunmore, but was at length stolen†." Pieces of broken anchors have also been found below Larbert Bridge and near Camelon‡.

Putting together, therefore, the archæological evidence to be gathered from the contents of the elevated silt of the Forth, the inference, I think, can hardly be avoided, that not only was the upheaval effected subsequent to the first human immigration, but that it did not take place until the natives along the banks of the Forth had learnt to work in metal, and until vessels sailing over that broad estuary had come to be moored with anchors of iron. There is some additional evidence, however, from another class of works of art, which will more appropriately be discussed in a subsequent part of this paper.

The Firth of Tay, like the estuaries already described, is bordered with a flat plain, which on the north side expands into the broad tract of country known as the Carse of Gowrie. Its general

* Prehistoric Ann. of Scot. p. 32.

† Edin. Phil. Journ. xi. p. 416.

‡ Nimmo's 'History of Stirlingshire,' 2nd edit. p. 74; Chambers's 'Ancient Sea Margins,' p. 160.

elevation above the level of high water is about the same as that of the raised beaches of the Forth and Clyde. Like these also, it consists of clay, sand, gravel, and layers of shells, and proves an upheaval of from 20 to 30 feet. The analogy holds still further; for the old alluvial deposits of the Tay furnish evidences that the rise has been effected within the Human period.

Mr. Robert Chambers* has pointed out that along the Carse of Gowrie many of the hillocks and eminences which rise above the general level of the plain bear names in which the Celtic word *inch* (island) occurs; such are Inchyra, Megginch, Inchmichael, Inchmartin, Inchsture,—“as if a primitive people had originally recognized these as islets in the midst of a shallow firth.” But, besides these names, the Carse is still full of traditions that represent the sea as having once advanced inland a long way from the present margin of the Forth. Time out of mind, it has been a popular belief in this district that the Flaw Craig, a cliff which overlooks the Carse between Kinnaird and Fingask, bore the remains of a ring to which ships were fastened when the sea ran at the base of the hill. Mr. Chambers adds that, a few years before the appearance of his volume on ‘Ancient Sea Margins,’ “there was a man living who alleged that he had seen this ring in his youth, as he climbed bird-nesting along the face of the crag. So also it is told that the rock on which Castle Huntly stands, in the centre of the Carse, once had rings fixed to it, for mooring the boats formerly used in sailing over the surrounding waters†.” These circumstances all conspire to indicate that the rise of the Carse of Gowrie above the limits of the sea is a comparatively recent event. If there were no other evidence, however, such traditional beliefs would hardly be worth the serious attention of the geologist; but they acquire a peculiar significance from the fact that they are fully borne out by the character of the antiquities from time to time exhumed from the clay and sand of this great plain.

Between sixty and seventy years ago a small anchor was dug up, not many feet beneath the surface, on a piece of low ground near Megginch‡. Mr. Chambers refers to another anchor as having been met with in casting a drain below the Flaw Craig§. But the most important and the most carefully investigated relic yet discovered in this district was an iron boat-hook, found in 1837 by some workmen on the farm of Inchmichael||. It lay imbedded under eight

* ‘Ancient Sea Margins,’ p. 18.

† Ibid. pp. 19, 20.

‡ New Stat. Acc. Scotland, Perth, x. p. 378.

§ ‘Ancient Sea Margins,’ p. 19.

|| Mr. Chambers, in the work already cited, briefly alludes to this relic; but he subsequently made it the subject of a very careful investigation, and published the results in a paper (Edin. New Phil. Journ. 1850, p. 233), from which the particulars above given are quoted. From the fact of the implement being iron, he admitted that it must have belonged to no very remote period, and that the rise of the land, if at least this boat-hook were to be taken as evidence, must have been greatly more recent than any one had imagined. To such a conclusion he demurred, and accordingly he endeavoured to account for the position of the boat-hook by some other means than an elevation of the Carse. For this purpose he supposed that the vessel in which it was used may have been swept inland

feet of stratified gravel, at a distance of a mile from the margin of the Firth. The surface of the ground was about 3 feet higher than the level of the surrounding part of the Carse, or about 28 feet above high-water-mark; so that the height of the boat-hook above the upper limit of the tide was fully 20 feet. "The relic itself," says Mr. Chambers, "was in no respect uncommon. It was pronounced by Rear-Admiral Sir Adam Drummond of Megginch to be such an instrument of its kind as would be used in a man-of-war's launch or a mercantile boat of 3 or 4 tons." It is now preserved in the Museum of the Scottish Antiquaries at Edinburgh.

No river-flood or violent inundation will account for the position of this interesting relic. The gravelly ridge in which it occurs is surrounded by the finely stratified silt of the flat Carse, and belongs, like all the other similar mounds of the district, to the ordinary slow deposits of the estuary. The inference therefore appears to me irresistible that, when this boat-hook was in use, the sea was beating upon these islets of gravel, and depositing around them the dark mud on which the fertility of the plain now depends. Hence the elevation of this part of the coast of Scotland must have been effected since the introduction of iron into the country. And thus all the traditions of the district, the names of its rising-grounds, and the character of its antiquities contribute each their independent testimony to the fact that a large accession of land has been gained from the sea within a comparatively recent, if not actually within the historical period. The historical period dates in Scotland from the year 80 of our era, when Agricola first led the Roman legions across the Tweed. Is there, then, any evidence to connect the elevation of the Scottish coast-line with the time of the Roman occupation?

Mr. Smith of Jordan Hill was the first to assert that since the Antonine Wall was built (about A. D. 140) there could have been no change in the relative position of sea and land, inasmuch as the ends of the wall were evidently constructed with reference to the existing level*. This statement has been the foundation of all the

during some of the great floods recorded in history. Such an explanation I believe to be not only unlikely, but even impossible. The effects of a storm must be comparatively slight in so sheltered an estuary as that of the Tay. We can hardly conceive the sea rising upwards of 28 feet above high-water-mark, and flowing for more than a mile inland. Still less can we believe that, if it did so rise, it could deposit 8 feet of sediment over the surface of the Carse. The effect of great floods is not to renovate the land, but to waste it; and the result of a violent inundation of the Tay would be to sweep away the surface-soil and carry it out into the estuary. Lastly, if we could suppose any sediment to have been deposited by such a sea-flood, it would not have been in the form of stratified gravel, but of fine mud and silt; for the rush of water coming from the sea could only carry with it the fine muddy sediment of the estuary, and in crossing the Carse it could get nothing but clay to tear up and re-deposit. No geologist can doubt as to the origin of those gravelly mounds or *inches* of the Carse. Most assuredly they are not the result of violent inundations, but of the mingling currents of the river and the sea, when the bed of the estuary stood at least 25 feet lower than it does now. As they rose, and the channel shallowed, only the finest silt gathered round their margins, forming now the rich alluvial soil of the Carse.

* Mem. Wern. Soc. viii. p. 58, and Edin. New Phil. Journ. vol. xxv. for 1838, p. 385.

subsequent geological arguments as to the long period at which the British Isles have been stationary. If it be true, then we must allow that the upheaval, of which the evidence has been adduced in the present communication, is referable to a period certainly previous to the Roman invasion. If the statement be erroneous, the other alternative remains, that the upward movement may have been wholly or in part effected after the Roman invasion.

After carefully examining both extremities of the wall, and reading the narratives of the various antiquaries who have treated of the Roman remains in Scotland, I have no hesitation in affirming that not only is there no evidence that the wall was constructed with a regard to the present level of the land, but there is every ground for believing that it was built when the land was at least 20 feet lower than it is at present. To begin with the east end,—from the Avon west of Borrowstounness eastward to Carriden the ground rises from the old coast-line as a steep bank, the summit of which is from 50 to 100 feet above the sea; between the bottom of this abrupt declivity and the present margin of the Firth there is a narrow strip of flat ground, about 200 yards broad, on which Borrowstounness is built, and which nowhere rises more than 20 feet above high water. It is a mere prolongation of the Falkirk Carse, already described, and beyond doubt formed the beach when the sea broke against the base of the steep bank. Now the Roman Wall was carried, not along this low land bordering the sea, but along the high ground that rose above it. The extremity at Carriden, therefore, instead of having any reference to the present limit of the tides, actually stood on the summit of a steep bank overhanging the sea, above which it was elevated fully 100 feet. If the land here were depressed 25 feet, no part of the wall would be submerged. The only change on the coast-line would be in the advance of the sea across the narrow flat terrace of Borrowstounness and Grange, as far as the bottom of the abrupt declivity.

The western termination of the Antonine Wall stood on the little eminence called Chapel Hill, near West Kilpatrick, on the north bank of the Clyde. Between this rising-ground and the margin of the river lies the Forth and Clyde Canal, the surface of which is 20 feet above high-water-mark, and the base of the hill at least 5 or 6 feet higher. Hence the wall terminated upon a hill, the base of which is not less than 25 feet above the present level of the sea. In making the canal, a number of Roman antiquities were found at various depths in the alluvium: these seem to have been part of the ruins from the fort above. If we admit that the wall was constructed previous to the last elevation of the land, we see a peculiar fitness in the site of its western termination. The Chapel Hill must in that case have been a promontory jutting out into the stream, and at high water the river must have washed the base of the Kilpatrick Hills—a range of heights that rise steeply from lower grounds, and sweep away to the north-east. Hence, apart altogether from considerations dependent upon the strategic position of the hills which were infested by the barbarians, we obtain an obvious reason why Lollius

Urbicus ended his vallum at Old Kilpatrick. He carried it, in fact, as far westward as he could carry it, and placed its last fort on a promontory which commanded the passage of the Clyde. He thus drove the natives to the necessity of making their incursions by crossing further down in the more open and exposed part of the river below Dumbarton. The Antonine Wall, therefore, yields no evidence in favour of the land having remained stationary since the time of the Romans. On the contrary, it appears to indicate that since its erection the land has actually risen.

I have examined the sites of the Roman harbours along the east coast of Scotland, without obtaining any proof of a stability of level. Inveresk and Cranund, the chief seaports, tend to confirm the opinion that since the Romans left the country the coast of the Forth has not merely been silted up, but has actually been upraised 20 or 25 feet above its previous level. The position of the remains of a harbour mentioned by Sir Robert Sinclair as having existed fully five miles from the present sea-margin, in the valley of the Carron, near Camelon (the old *Statio ad Vallum*), along with an anchor dug up at the same place, likewise go to corroborate this conclusion*. But for this part of the evidence I may be permitted to refer to the paper in which attention was first called to this subject†.

Several antiquaries have referred to the difference between the present aspect of the Scottish coast-line and that which it must have had in some places when seen by the Romans. This evidence is that of men who had no geological bias, but who drew their inferences chiefly from a consideration of the present position of the antiquities which they described. So far as it goes, therefore, it is not without its value, adding as it does another collateral confirmation to the proofs in favour of a recent rise of the land. Thus Horsley, sagaciously observing the disposition of the ground at the western end of the Wall of Severus, and the necessity of defending this point with care, concludes that the Roman engineers could never have allowed so long a space to intervene between the sea-shore and the end of the wall, as that which now separates them. The Solway Firth, he says, "must have reached much higher, both southward and northward, than it does now;" for, as the wall stands at present, a body of men might easily march unperceived round its end. He also states that, although now so far removed from the sea-margin, this rampart of Severus extends further seaward than the earlier one of Hadrian. How far the change may have been due to a silting up of the estuary, or to an actual elevation of the land, can only be determined by a careful examination of the locality.

Horsley's observations along the Solway prepared him for the detection of similar phenomena along the other Scottish estuaries.

* Sibbald, *Hist. Inquir.* pp. 34 and 41. See also Gordon's '*Itinerarium Septentrionale*,' pp. 23, 29; and Stuart's '*Caledonia Romana*,' pp. 177-8. Buchanan wrote that in his time ruins of the Roman Camelon resembled those of a modern city; and that its ditches, walls, and streets were then apparent (*Hist. Scot. lib. i.*).

† *Edin. New Phil. Journ.*, new series, vol. xiv. p. 107.

"There is good reason to think," we find him remarking, "that both the Solway Firth and the Firths of Clyde and Forth were formerly deeper, and that the tide has flowed further up than it does now;" and thus that "the land seems to have gained here*."

General Roy, about the middle of last century, made the Roman antiquities of Scotland the subject of careful study, when they remained much more perfect than they do now, after a hundred years of advancing agriculture. He surveyed with a military eye the sites of the forts, camps, ramparts, and highways which the legionaries had left to mark their presence. "With regard to the position of these forts," he says, "the Romans seem to have been guided by the same general principles which now-a-days would direct in the execution of works of a like nature. A high and commanding situation hath therefore been their choice, from whence the country could be discovered to a considerable distance all round, but especially towards the north—the quarter from which they were to expect the enemy,—contriving, as often as circumstances would permit, that a river, morass, or some difficult ground, by way of obstruction and additional security, should extend at some little way along their front. Thus we find that the forts toward the right occupied the heights which overlook the shores of the Forth, the low carse-lands of Falkirk, and the banks of the Carron." He was convinced that these low lands could not have existed then in their present condition. "If," he remarks, "the Falkirk Carse were not entirely overflowed in the time of the Romans, it is probable at least that they were then salt-marshes, subject in some degree to temporary inundations in high spring tides†."

Nimmo, in his 'History of Stirlingshire,' published in 1777, after alluding to the tradition of a harbour having existed on the inner edge of the Falkirk Carse, below Larbert Bridge, and to the fact that pieces of broken anchors had been found in that neighbourhood within the memory of people then living, contends that there was "reason to believe that the firth flowed considerably higher in former ages than it does at present‡."

Lastly, Mr. Stuart, the most recent writer who has treated specially of the Roman antiquities of Scotland, is still more explicit. He declares his belief that "the whole of this lower district (towards the mouth of the Carron) had in all likelihood been covered by the sea when the Roman forces occupied the Wall of Antonine. It is likewise probable," he adds, "that the entire plain between Inner-avon and Grahamstown (that is, the whole of the Falkirk Carse) was at the same period subject to the influx of the tide, which may even have penetrated the deeper hollows of the Carron as far up as Dunipace§."

* Horsley's 'Britannia,' pp. 157, 160.

† 'Military Antiq.' book iv. chap. iii. sect. 2.

‡ 'Hist. Stirlingshire,' Edinburgh, 1777, p. 63.

§ 'Caledonia Romana,' Edinburgh, 1845, p. 177.

I have not deemed it necessary to increase the length of this communication by controverting the alleged Roman origin of certain roadways and other traces

Putting together all the evidence which the antiquities yet discovered along the Scottish coast-line afford as to the date of the last upheaval of the country, we are led to infer that this upheaval must have taken place long after the first human population settled in the island—long after metal implements had come into use, after even the introduction of iron; and reviewing the position and nature of the relics of the Roman occupation, we see no ground why the movement may not have been effected since the first century of our era; nay, there appear to be several cogent arguments to make that date the limit of its antiquity.

Although lines of raised beach, or marine littoral deposits, may be traced round the greater part of the Scottish coast-line, I am not aware that remains of art have been found imbedded in any of them, except in the districts described in the preceding pages. The elevation of the land appears to have been general over the whole of the central districts of Scotland between the Firth of Clyde and the Firths of Forth and Tay. Whether or not the movement extended northwards into the Highland districts, or southwards into England, must be determined by future observation. In the mean time, we seem at last to have a date for one of the latest, but not least important, changes which have affected a part of the British Isles.

APRIL 2, 1862.

Charles Longman, Esq., Shendish, Hemel Hempstead, and Thomas Wyles, Esq., Allesley Park College, Coventry, were elected Fellows. Baron Sartorius von Waltershausen, Professor at the University of Göttingen, and M. Pierre Merian, late Professor and Rector of the University of Basel, were elected Foreign Members.

The following communications were read:—

of art found along the present coast-line at a height of less than 20 feet above high-water-mark. The causeway of logs, for instance, which crossed a part of the Kincardine Moss, in the Carse of Stirling, is commonly spoken of as Roman; but this is mere conjecture. The bronze vessel found in the same moss, and cited by some writers as a Roman camp-kettle, is most certainly of ancient British workmanship. (See Dr. Wilson's 'Prehistoric Annals,' p. 247.) It is quite possible, indeed, that Roman masonry may be found at a lower level than 20 feet above the present high-water-mark, just as in our own day piers and other pieces of stone-work are constructed which the tide covers twice every twenty-four hours. It does not appear, however, that anything of the kind has yet been described. In short, so far as I am aware, there are no remains of Roman buildings which would be submerged by a depression of the land to the extent of 20 or 25 feet; and there seems, therefore, to be no archaeological evidence to contradict the conclusion that the land has been actually raised to that extent since the beginning of our era, while the evidence which does exist, whether of antiquaries or of antiquities, tends materially to confirm that conclusion.