

### VIII. *Remarks on the Vitrified Forts of Scotland.*

By J. MAC CULLOCH, M.D. F.L.S. Chemist to the Ordnance, and Lecturer  
on Chemistry at the Royal Military Academy at Woolwich.

V. Pr. Geol. Soc.

**T**HE contest about the vitrified forts of Scotland having for some time ceased from an apparent want of new matter, it may be deemed superfluous to revive it by the description of any more of these extraordinary structures. But some appearances which seemed to have been overlooked having occurred to me in examining these works, I thought it might yet be interesting to those who took a part in the former discussion, to receive any additional remarks which might assist in clearing up the points in dispute.

As far as archæology is concerned in the question, I deem it useless to enquire to what æra they are to be referred. That they belong to a people who had not learned the Roman arts is probable, since they contain no calcareous cement. But that this is a certain conclusion I am not inclined to admit, as the knowledge of a simple fact among a savage people does not necessarily imply the power to direct it to use. The ability to detect calcareous stones, the means of quarrying them in certain situations, and the power of transporting them from great distances to places where they do not naturally exist, must have been possessed by these people before they could have directed to any useful purpose this naked truth derived from their conquerors. To instance only those vitrified forts which are found in Galloway. There is no limestone to be pro-

256 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

cured in that country but by a very distant land carriage, or a very circuitous route by sea. It is evident that a commercial system of some sort must have been established before the inhabitants of these countries could have cemented their buildings with lime, however they might have been acquainted with its properties. It is equally a matter beyond the power of modern investigation to discover whether they were the works of the aboriginal Caledonians or of their Danish invaders. Neither analogy nor examination of the remains throws the least light on the subject, a subject which as it is beyond the reach of historical or traditional evidence, seems equally divested of all those circumstances from which truth is sometimes elicited. It is nevertheless a general opinion that they are remains of the earliest works of ancient inhabitants. This too is a proposition which appears to rest on a very vague sort of reasoning. The same Antiquaries suppose that the well known circular Pictish towers were built before the use of iron, but admit that they are of more modern date than the vitrified forts, from the greater artifice apparent in them. It will however be clear to any one who shall examine the vitrified fort near Amwoth in Galloway, that the ditch which has been excavated for the purpose of giving the fort a scarp all round, has been cut down by iron, or at least by a tool of metal. It is from the greater accumulation of soil on the ruins of the vitrified walls, an accumulation often sufficient to conceal them entirely from the view, that we are (if from any thing) entitled to consider them as erections of a date more ancient than the towers of Glen Elg or Dun Dornadilla, or than any of the works as yet examined in which unvitrified masonry has been used. But it is superfluous to pursue these archæological difficulties further.

The question on which the two contending parties have been most at issue, was, whether the vitrification was the result of design

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 257

or accident. While one party asserted that a regular process had been carried on for the purpose of making a solid wall, the other supposed that these walls might have been originally constructed of stone and wood united, and that accidental fire, or the attack of an enemy, had destroyed the compound structure, producing in consequence the vitrification now to be traced in them. Mr. Williams and Mr. Fraser Tytler are the most conspicuous leaders on each side.

It seemed to me that light might be thrown on the question, by examining with mineralogical accuracy the substances of which these structures were composed, and noting the changes which each had undergone from the operation of the fire, and also by observing whence the stones had been derived which were used in them; and that the question of accident or design might be illustrated by examining in the laboratory the degree of heat necessary to produce the requisite appearances in the stones which actually exist in these structures.

In the present more diffused state of mineralogical and geological knowledge, it is unnecessary to refute the notion of their volcanic origin in a paper addressed to a Society like this. For the purpose of the ordinary spectator, that refutation may be trusted to the increasing progress of natural knowledge.

The hill of Dun Mac Sniochain, which lies in the plain, now supposed by some to be the site of the ancient Beregonium, has been long noticed as the seat of one of these extinguished volcanoes. Having seen specimens of pumice and lava (as they were called) collected from it, I was glad to have an opportunity of investigating a very accessible specimen of what I concluded to be a vitrified fort. Such it proved.

The drawing, pl. 2. fig. 1, which accompanies this paper, contains

258 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

a ground plan of the work, as well as I could determine it by pacing, and without tools to clear away the sod. Those who have seen similar works know how completely they are sometimes covered with the soil; a circumstance which, as I have just noticed, perhaps more decidedly than any other, marks their high antiquity. Imperfect however as their traces generally are, the drawing will serve to show a very peculiar form in that which is the subject of the present paper, and a plan differing much from the uniformity of structure and rudeness of design which have been supposed to distinguish these works.

The long narrow hill on which it stands is nearly precipitous along three quarters of its circumference; at the other end it rises from the plain with a very accessible acclivity. By inspecting the plan, it will be seen that a series of parallelogramic works have been constructed so as nearly to cover the principal and precipitous part of it to the very edge. The greater portion of the hill being thus occupied by two of these works, the strongest part was cut off by a wall from the more accessible end, thus forming a sort of citadel or place of retreat at the last extremity, a practice very common in the ancient peninsular fortifications of Cornwall, in Castle Trereen for example, and in a similar castle at Zenor. To occupy and defend the vulnerable side of this position, the outer work appears to have been placed without the principal area, that from it the enemy might be seen and opposed in every part of his ascent. This disposition bears incontrovertible marks of military design and experience. Were a modern engineer to defend Dun Mac Sniochain, he could do little more than build a fort to occupy the ground and contain his men, erecting an out-work to command the approach.

I have thus particularly detailed the military relations of this

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 259

work, to show that these forts very probably belong to an age of some talent and improvement, a notion adverse to the suppositions of those who have conceived them to be the efforts of the rudest barbarians. But the ignorance and rudeness attributed to nations of mere warriors and hunters is falsely assigned.

The history of infant society shows on the contrary instances of acute reasoning, of ready invention, of perseverance and prowess, which would be in vain sought among the enlightened populace of modern times, nay even among those who are far removed above that rank. But this ability and vigour of mind have been necessarily directed to those objects only, which were useful or honourable, or were then in fashion. The abilities of infant nations require to be compared with their necessities, and to be measured by their best works, not by their worst.

The whole length of ground enclosed beyond the cross wall is about 200 yards, and its breadth is about 60. Within this space are two works, the one containing a perimeter of 153 yards, and the other one of 110. These, according to the modern military computation for the defence of a redoubt, are capable of holding more than 500 men. The perimeter of the external work is 96 yards, a space nearly capable of disposing of a hundred more. We are unable, from ignorance of their weapons and modes of warfare, to determine in what way these works were occupied or defended, but on any supposition it appears that this must have been a military fort of some magnitude and consequence.

I have entered into the details of the magnitude, and figure, and military importance of this work, for the purpose of setting aside another hypothesis with regard to the vitrified forts. They have been supposed by some to be merely beacons, and that the vitrification has been the result of the combustion of those heaps of wood

260 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

which were used for signals. The supporters of this opinion have asserted that they always occupy the highest elevation, and that many of them are so placed as to be visible from each other. This is not true. The fort at Amworth is not on the highest ground it might have occupied, nor is the fort of Dun Mac Sniochain so situated: but they are both on the strongest ground. Where the strongest and highest ground coincide, a case very common in hilly countries, (I speak of military strength of ground as connected with ancient modes of warfare) there, as at Craig Phadric, they naturally occupy the summit. I may add, that no fort has hitherto been discovered between this and Craig Phadric, except that at Dun Dheairduihl, nor have any been observed in its neighbourhood in other directions. I might strengthen this argument by referring to the descriptions of other similar works, but I prefer arguing from those which I have seen.

It now remains to enquire, if by any examination of the walls of Dun Mac Sniochain, light can be thrown on the causes of its vitrified appearance, and whether it was the result of design or of accident.

The remains of walls in the other vitrified forts, noticed by different observers, have been so well described, as far as relates to their general appearance, that little can be added on this head. It may be sufficient to say, that they appear in the present work to be about twelve feet in thickness, and are now nearly buried under the soil.

One circumstance however requires attention, as some false speculations have been founded on it. Both the outside and inside of the walls near the ground are rendered much thicker than their true measurement shows, by a heap of loose stones accumulated against them, and this renders it difficult in the present state of things to ascertain their real dimensions. It has been supposed that this

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 261

was done with a view to strengthen the work, or else that it was an effect of the rude manner in which they were supposed to be erected. It would have been an extraordinary system of defence which should have heaped up a pile of loose stones on the outside of a wall. Modern warfare is satisfied when its ordnance has produced such an addition to the face of an enemy's bastion. A little attention also to the angle which loose stones assume when they are at liberty, might have shown that such a system would not only have prevented the defenders from approaching their own walls, but would in fact in small works, such as those of this fort, have occupied a very considerable portion of the included area.

It is the dilapidation of the unconsolidated parts of the building which has produced this appearance. The thickness of the walls of this fort, as nearly as it can be appretiated, is, as I have already stated, twelve feet. They bear the marks of vitrification throughout their whole extent, but in some places it is more complete than in others. In no case does it seem to have extended more than a foot or two from the foundation, and the most perfect slags are found at the bottom of the wall. As we proceed upwards, we find a mixture of porous slag with stones which having been but partially fused have adhered together in a mass. Higher still we meet with stones which though unvitrified are roasted by the action of the heat, and at length the marks of fire diminish until they almost entirely disappear, leaving only a heap of loose and unconnected stones. The loose part of the wall having fallen through time, has caused that accumulation of rubbish which we find about the vitrified parts. On account of this mixed construction, we have no means of ascertaining the original height of these works; but if a judgment may be formed from the quantity of loose stones which are found at the base of the walls, it was



262 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

probably not considerable. Nor indeed would a work which was intended for defence from within admit of a greater height of wall than five feet, or that over which a man might look, a height which is equal to that of the ancient British field works, if this may be determined from some of the perfect fragments which remain in Cornwall.

Of one of the most remarkable of these, I have given an account to the Antiquarian Society. It is the fort known by the name of Castle an Dinas, in the parish of Ludgvan, in that county. Here the altitude of the work is determined by the perfect finish of part of the remaining wall, which consists of well-fitted dry masonry, the strength and solidity of which show that it was not a temporary enclosure, but a sort of citadel, or work of permanent defence. The wall is here only five feet high, and from this I am inclined to conjecture that the vitrified forts did not exceed this height. Nor indeed are the accumulated ruins about them sufficient to give reason for suspecting that they ever were of a greater elevation. It is deserving of remark, that the vitrification of the outer work is not so complete as that of the inner ones.

Before examining the materials of which the wall is composed, it is necessary to mention the mineralogical nature of the rock on which it stands, and that of the immediate vicinity. The hill of Dun Mac Sniochain is formed of limestone, lying in schistus, similar to that which constitutes the neighbouring island of Lismore. The schistus and the limestone alternate, but the latter is the predominant rock. The hill itself is perfectly insulated in a great alluvial plain. To the west this plain is bounded by the mountains of Benediraloch, which descend abruptly into it, approaching at their nearest point within half a mile or less of the fort. These mountains are formed of the old rocks common to this country, granite, gneiss, mica-slate,



Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 263

quartz rock, and porphyry. A long mountain of trap rising at the borders of Loch Etive, skirts the edges of these hills for a considerable space, terminating on the plain of Connel by a trap breccia, that pudding-stone well known to tourists as occurring in various places from Connel to Oban. This breccia, where nearest the fort, is at least half a mile distant from it. As the geological site of the rock does not concern the present inquiry, I will limit myself to its mineralogical description.

It consists of rounded pebbles of different magnitudes, cemented by a paste of a mixed white and brown colour. The pebbles are generally small, and are much more numerous under the size of an orange than above it. There are very few of considerable magnitude. They exhibit for the most part different varieties of trap, or greenstone, all of which have been rounded previously to their entanglement. Of these there are purple, red, gray, and dark blue specimens, varying as much in solidity of texture as they do in colour, and more or less homogeneous in their appearance. Many of them are of an amygdaloidal structure, containing imbedded grains of calcareous spar, zeolites, and green earth, and some are perfectly cavernous and scoriform. Besides these pebbles of trap, there are rounded pieces of quartz of different colours, white, gray, and red, cemented in the common ground. In the specimens which I examined I could not trace any other kind of rock. The paste by which the whole is cemented is of a peculiar quality. It is either dark purple, or brown, or mottled, or gray, or a dirty mixture of brown, white, and dull green. It may be scratched with the knife, has an earthy smell when breathed on, and effervesces with nitrous acid. Its fracture is not properly granular, but rather of the small splintery. Before the blow-pipe it is fused into a dark glass.

On a minute examination it appears to consist chiefly of frag-

264 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

ments of trap cemented by a whitish substance, which proves to be the hard variety of calcareous spar, mixed with a sand of trap. This trap sand is generally of a dark purple colour, resembling many of the imbedded pebbles. Although this sand is the predominant ingredient in the paste, there are also found in it grains of quartz, minute zeolites, garnets, crystals of calcareous spar, and here and there prehnite, diallage, and chlorite slate, as far as it is possible to speak decidedly of objects so very minute. The spar which cements this sand into a common paste surrounds every grain so as to form them into a perfect breccia, and enable the whole to break with the splintery fracture above noticed, instead of a granular one. Here and there the paste occupies large interstices which have been formed by the approximation of two convex surfaces of considerable extent, and from these it may be traced insinuating itself through all the grains of the mass. It is evident that the calcareous spar has been introduced while in a state of fluidity among the sand and gravel, as the larger pieces of paste may be observed to envelope the grains of trap. Generally therefore we may consider the pudding-stone of Lorn as a congeries of trap sand and trap pebbles, cemented by calcareous spar, a rock often designated by the improper name of trap tufo. This however is not the place to enquire into the means by which the mass was consolidated. That it is a case of an agglutinated rock differing greatly from the ordinary sandstone breccia, or the ferruginous and argillaceous pudding-stone, is very apparent. It resembles them indeed only superficially and in its mechanical texture, and it will be worthy the labour of geologists to direct their attention to the pudding-stones of this coast with more care than they have hitherto done. The other rocks are too well known to need any description.

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 265

The walls of the fort are found on examination to consist partly of the old rocks before enumerated, and partly of that which I have now mentioned. Gneiss, quartz, granite, mica-slate, clay-slate, pudding-stone and pyritical slate are seen entangled together, with a very small proportion of the particular rock on which the fort itself is founded. The source whence these rocks were derived is evident, with the exception of the pyritical slate, which I could not trace in the neighbourhood.

I have now to enquire what motive could induce the builders of this work to reject the stone which lay at their feet, and to fetch from such a distance the large quantities required to raise their walls. It is particularly remarkable, that although the plain and shore are covered with fragments, yet these are almost entirely fragments of the primary rocks. I state this for the purpose of obviating a supposition that may be adduced to nullify the argument which I am about to derive of a previous intention in the builders to vitrify their work, from their having neglected to use that rock on which the building was erected, and which was not adapted for the purposes of vitrification. It might otherwise be suggested that they collected the loose rolled stones of the plain, as being ready broken to their hands. But besides that the pudding-stone is rare among these fragments, the pieces of the wall which have not felt the fire are angular and not rolled stones, showing pretty clearly that they were not collected on an alluvial plain, but broken from the rocks where they were formed.

Now, in the walls, the pudding-stone which we shall presently find to be the only vitrifiable ingredient, predominates to such a degree as to occupy the greater part of it. Hence it appears at least a probable conclusion, that the builders were acquainted with the effect of fire in destroying limestone, and that intending to erect a

266 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

vitrified wall, they rejected that which was unfit for their purposes, however conveniently placed. Had the object been to erect a dry wall of stone and wood the limestone would have equally answered their intentions. This notion of a design to vitrify seems to receive additional strength from the apparent solicitude and labour employed in introducing so much pudding-stone into the work. It is very likely that accident had taught them the vitrifiable nature of this ingredient; a piece of knowledge the more probable, if, as there seems little reason to doubt, they were acquainted with the art of making iron, an art which we need not deny to them when it is known to many of the inhabitants of Africa who are in a very low state of civilization.

Such are the consequences I would try to deduce from the mineralogical considerations belonging to this question.

It is now proper to examine the changes which the several substances have undergone, that we may, if possible, form some rational conjecture on the degree of heat to which they have been subjected, and on the probable means by which that heat was produced.

Where the quartz has been most exposed to the fire it has become brittle and easily pulverizable. The granite too is brittle and crumbles to pieces. The gneiss and mica-slate are also rotten where they have contained much iron, in consequence of the oxidation of that metal. Where purer they have remained unchanged, as we might expect from the well known properties of some of the varieties of mica-slate. Often where their flat surfaces have been in contact they are agglutinated from the superficial vitrification of the quartz which they contain when united to the potash produced by the fuel. This is also the cause of the glazed surface which covers the clay-slate and which has frequently occasioned numerous small pieces to adhere in one lump. In many places the mica-slate has been so softened by

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 267

the application of heat as to have bent and conformed itself to the neighbouring protuberances, undergoing at the same time no great change of texture, unless when much impregnated with iron ; an appearance perhaps assisting to confirm that explanation of the contortions of the gneiss beds which attributes this effect to the action of heat.

Very little change appears in the specimens of common slate which I have taken from it. If any limestone has found its way into the wall, it has probably been calcined, and subsequently assisted to bring into fusion the refractory earths. It is to the pudding-stone however, that the main part of the vitrification is to be attributed. Without this it would have been only a mass of burnt rocks, and specimens of it may be taken from the wall in every state, from that of a black glass, to a spongy scoria capable of floating in water. There are also many pieces, which having been exposed to a lower heat, exhibit a gradual succession of changes, from incipient calcination to complete fusion. This therefore is the cement of the building ; and it has been so mixed through the whole, that there is scarcely a part (I speak of the foundation) which has not been united into a continuous mass by the fusion of this substance. The last stone of which the changes are worth noticing, is the pyritical slate. In general it has become disintegrated in consequence of the sublimation of the sulphur contained in the pyrites. But many specimens may be taken from the wall, where the pyrites has felt no change, proving evidently that it has scarcely undergone the action of heat. In the vitrification therefore of the pudding-stone, and the integrity of the pyrites, we are furnished with the two extreme points of temperature under which this work has been raised. How these are to be reconciled is a new difficulty. It is unnecessary to examine the highest temperature at which pyrites can maintain its

268 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

integrity, as it is known to be low. It is equally useless to examine into the powers of the granite and quartz rocks to resist heat, as they also are well known.

The fusibility of the pudding-stone arises partly from the fusible nature of the substance which I have described as forming its proper paste, but in some measure also from that of the amygdaloids and greenstones imbedded in it. It is in consequence of the carbonic acid contained in the calcareous crystals which these amygdaloid pebbles exhibit, that the inflated scoria are produced; for it may be easily traced to them through a regular gradation. To pursue this subject experimentally, I thought it necessary to submit various parts of this rock to the furnace, that I might ascertain the degree of heat necessary to effect the corresponding changes in it, and the fragments were accompanied by one of Mr. Wedgwood's pyrometer pieces.

The spongy scoria remained unchanged, and the natural amygdaloid was sometimes unaltered, and sometimes disintegrated by the calcination of its lime, without undergoing any mark of fusion in a heat of  $20^{\circ}$ ; a heat at which brass is melted. From  $20^{\circ}$  to  $30^{\circ}$  the amygdaloid underwent no change except a slight vitrification on the surface; at  $40^{\circ}$  it was much affected, and was fused into a glass at  $60^{\circ}$ .

Having excited the fire to  $100^{\circ}$  I exposed to it various parts of the pudding-stone, which had not been affected in the heat at which the amygdaloid was changed. Some of these were vitrified, and became precisely similar to many of the specimens taken from the wall, whilst others continued to resist, for a long time, even this intense heat; a heat at which many varieties of earthenware are baked. It is unnecessary to relate all the experiments which I performed on the different substances, as it is not my object to state these matters for the purposes of chemistry. Those which have been

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 269

adduced are sufficient to prove that some of the fused substances must have been brought to that condition in a heat not less than 60 degrees or upwards of Wedgwood's scale. Such then, at least, is one temperature at which the walls of this fort have been fused. It may have been much greater. It is perfectly evident that if a temperature of 60° existed in one part of the wall, pyrites lying near it must have been decomposed. There could be no such discordancy of temperature existing simultaneously, and so near, in a mass of this construction. Hence then it follows, that the wall could not have put on its present appearance by one heating, if it were all actually built previously to the application of the heat. This precludes the possibility of the supposition contained in Mr. Tytler's hypothesis. Had the fire, which he supposes the cause of vitrification, been produced by the burning down of the wooden part of the compound wall which he has imagined, it could not have happened that a vitrification requiring a temperature of 60° should have taken place in one part, while in another such a substance as pyrites remained unchanged. The great heat requisite to effect the vitrification of the pudding-stone, is an additional argument against this hypothesis, as it could not have been produced by any quantity of wood capable of entering into such a wall, unless the wood had predominated to an extent incompatible with any idea we can form of its architecture. It is not indeed easy to conceive a plan capable of producing these effects, and certainly none more feasible than the suggestion of Mr. Williams. With him I should rather be inclined to suppose that a sort of furnace was constructed of a double earthen wall, in which the materials were placed, with such a quantity of wood as was sufficient to excite a strong heat, and that this operation was repeated till the wall had gained its wished for elevation. The earthen furnace in which the Africans fuse their ores, seems to countenance this supposition. The imperfect fusion of the upper parts may be



270 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

easily conceived to have arisen from a partial neglect of the fire after the wall had nearly attained its requisite height ; nor is there any reason why it should not have been increased in height by the addition of cold stones after a firm foundation had been obtained.

One other circumstance in the appearance of the burnt stones is deserving of notice before quitting this subject. The changes which the mica slate has undergone, appear to be such as could not have been produced but by long torrefaction, or by such a repetition of the heat as I have supposed to be the result of design. The transient effects which would follow from burning down a wooden wall, would scarcely have been sensible on stones of so refractory a nature, which exhibit changes in many instances as great as if they had been exposed for a long time to the heat of an ardent furnace.

Such are the observations to which a consideration of the fort of Dun Mac Sniochain has given rise.

As this was the only one of these mysterious fabrics which I had seen when the above remarks suggested themselves to me, I was afterwards glad to have an opportunity of examining the fort on Craig Phadric, it being that one on which most labour had been bestowed, and that which I thought might possibly either confirm or refute my notions on the subject.

Its general appearance and military structure having been fully and carefully described, I shall only indulge in a very few remarks on its physical composition.

The hill of Craig Phadric, on which it stands, is one of a numerous set of pudding-stone rocks, which may be traced from Fyers, and for aught I know, beyond it. At Fyers they lie above the primary rocks, which they doubtless separate as usual from the secondary strata, as they may be seen near Inverness, succeeded by sandstone-breccia and common sandstone. On the top of the rock there is a deep deposit of rounded stones, consisting of fragments of the older

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 271

rocks. The pudding-stone of Craig Phadric differs completely from that of Lorn. It contains no fragments of the greenstone amygdaloid, there being no greenstone beds in its vicinity, as there are on the Oban coast. The pebbles which it does contain are of quartz, gneiss, granite, and the other associated rocks. The paste which cements them is of a granular texture, entirely and essentially different from that of the Lorn pudding-stone, and belonging to a very different class of substances. It is agglutinated by adhesion, as the sandstones are, without a common binding paste; and consists of fragments of the same rocks which form the nodules, exhibiting generally a gritty mixture of horn-blende, mica, felspar and quartz, with a considerable portion of ferruginous felspar clay. The difference in the vitrification of the wall arising from this cause is obvious, since the scoria of Craig Phadric contain none of that very light and spongy sort capable of floating in water, and which I have shown to arise from the fusion of the calcareous amygdaloid. It differs also in these respects, that it contains no pyritical slate, and that it contains fragments of sandstone. The heat has operated on these stones so as to roast and crack the quartz, granite, gneiss, mica-slate, common slate, and sandstone, producing appearances similar to those of the specimens in Dun Mac Sniochain. The gneiss only which contains much hornblende, and passes into hornblende-slate, is partially fused. The mica-slate, containing also in some instances layers of hornblende, has been split in sunder by the vitrification of these laminæ, and in other cases it is bent and contorted in a very amusing and instructive manner. But the cementation of the wall is produced by the vitrification of the paste which forms the pudding-stone. By this, not only its own pebbles are united, but the neighbouring stones have been entangled in the general mass.

It is plain that no additional argument to support the notion of

272 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

a design to vitrify can be deduced from this specimen, except that of the great heat required to fuse it, which applies as well to this case as to that of Dun Mac Sniochain.

Having in these two instances detected the existence of a vitrifiable substance in the rocks from which the walls were constructed, I was in hopes that all the other vitrified forts would be found to occur in the vicinity of vitrifiable rocks. No mineralogical notice has accompanied the accounts of those which have been observed in Aberdeenshire, in Ross-shire, and other situations, nor had I an opportunity of inspecting them. But I have since learnt that three or four exist in Arisaik, a country consisting of gneiss and granite rocks only. The refractory nature of these substances would almost lead us to doubt that the buildings are actually vitrified, unless hornblende or other unnoticed vitrifiable matters abound in them.

It is but of late that similar structures have been detected in the southern parts of Scotland. Three of them are found in Galloway; but I had an opportunity of examining only that which lies in the parish of Amworth. It is a rectangular and simple wall, occupying the summit of a steep and strong but low hill, and exhibiting the usual general appearances.

As the whole of this part of the country consists of common grauwacke and grauwacke-slate, I was I confess incredulous about the reported vitrification, on account of the refractory nature of those substances.

On examining the wall, it appeared that although it bore very generally the marks of fire, the vitrification had occurred in very few places and in distant patches. I was at a loss to account for this circumstance, till on accurate examination of the surrounding rocks, I found some places where the grauwacke assumed a peculiar character, exhibiting distinct grains of imbedded carbonate of lime.

Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.* 273

This variety is fusible, and from this unquestionably the vitrified portions had originated. It is here that a part of the rock has been cut down, very certainly by sharp tools, for the purpose of scarping one side of the fort. There is no bed of foreign fragments on the top of the grauwacke, and no covering but the common soil. I know not what conjectures we can form about this fort, except that the same attempt has been made, but has failed from the deficiency of proper materials. I confess that the consideration of the requisite heat inclines me as much in this case as in the former to the original supposition, and confirms in my mind the notion that the vitrified forts of Scotland are the effects of design.

Since the above account was written, two circumstances have occurred to me which seem to afford additional evidence of the truth of the opinions I have held respecting the vitrification of these buildings.

The first is an article in the 12th vol. of Nicholson's Journal, p. 313, quoted from the report of a French engineer (M. Legoux de Flaix), describing a method of building practised in Hindustan. In this process a wall of brick earth is erected, which is then surrounded by a coffer filled with combustibles. As the combustion proceeds fresh fuel is added, until the whole wall is baked into one solid brick. The coincidence of the effects of this actually existing process with those of one long since forgotten, seems to prove almost to demonstration, that similar means have been practised in the ancient military works of Scotland to produce structures so analogous to those now commonly used in India, and that the "baking" of buildings in this country must be considered in the light of a lost art.

The other is to be found in the history of Gatacre-house in Shropshire, (now unfortunately pulled down) of which a slight and

274 Dr. MAC CULLOCH *on the Vitrified Forts of Scotland.*

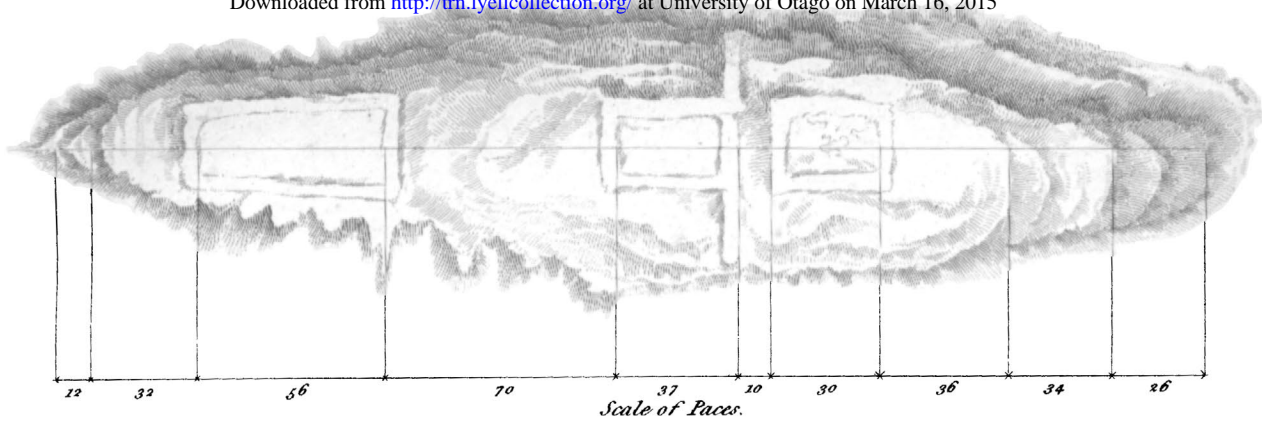
not perfectly correct account is given by Owen Salisbury Brereton Esq. in the third volume of the *Archæologia*. On applying to the present most respectable octagenarian proprietor, (descendant of this ancient family,) to whose regard for the superior comforts of a modern house we are indebted for the destruction of this singular and venerable remain, I was informed that the west end alone had been vitrified. The vitrification was so entire and continuous, as to form one uniform glassy surface over the whole of the wall, and thus to conceal even the joints of the masonry. The wall itself was of grey mottled sandstone, about 18 inches thick. I have examined the vitrified crust in a specimen transmitted to me. It is scarcely the twentieth part of an inch in thickness, and consists of a green transparent glass, perfectly superficial. Its appearance would lead me to conclude that it had been produced by the application of alkali or salt to the surface of the wall, previously to the process of firing by which the vitrification was effected. The proprietor is inclined to think that the vitrified wall was of greater antiquity than the rest of the building, but offers no conjecture relative to the time of its erection. It is only known that the family can be traced on the same spot to a period as far back as that of Edward the Confessor.

We have here then additional accessory evidence to prove that the art of vitrifying buildings after their erection, was an art practised in Britain. In this case it was evidently intended for the purpose of excluding the weather, and certainly a more effectual expedient could not have been devised. The vitrified forts of Scotland, more solid and less exposed to the ravages of art, have but partially yielded to the universal enemy, time. The more slender structures intended for habitation, have disappeared in the lapse of years, or have suffered from the taste of other improvers.

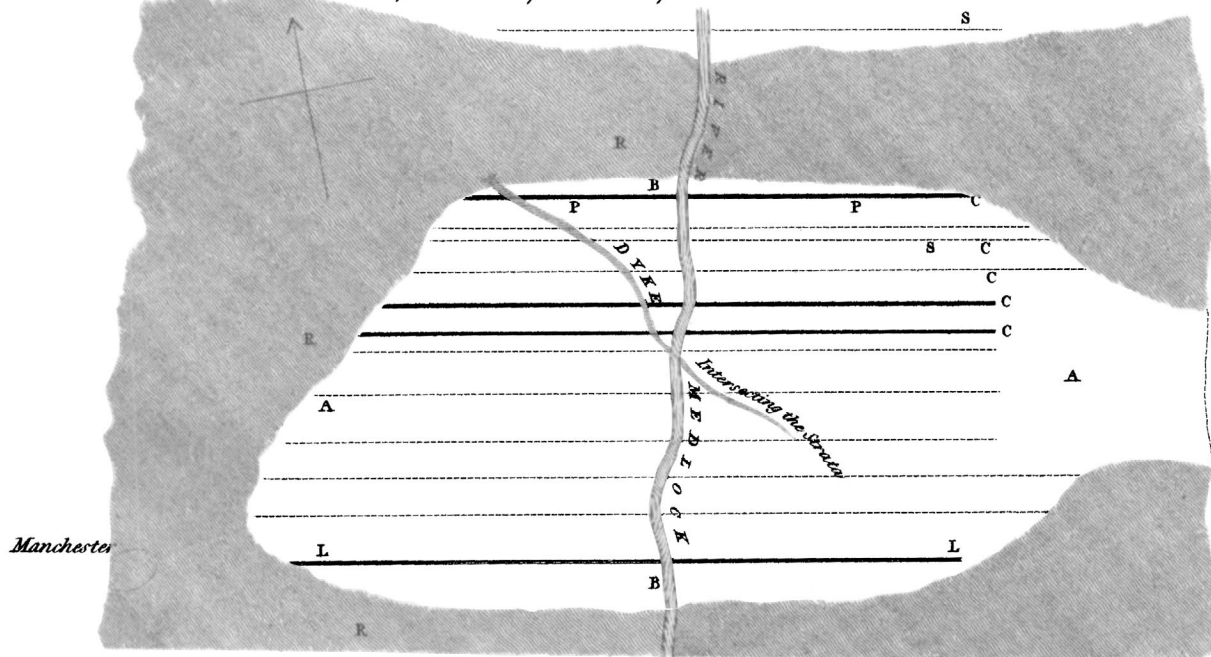


*Plan of the vitrified fort on Dun Mac Iniochan*

Downloaded from <http://trn.lyellcollection.org/> at University of Otago on March 16, 2015



*Plan of the Bradford Coal field, near Manchester.*



*Section of the Strata at Bradford near Manchester*

