

X.—*Observations on the Theories which have been proposed to explain the Vitrified Forts of Scotland.*

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THE members of this Society are no doubt familiar with what is meant by a Vitrified Fort. By this term is implied an area of ground, often of a round or elliptical form, and evidently selected for some natural defence possessed by it, which is farther protected by one or more inclosing ramparts, formed by stones; these stones showing, to a greater or less extent, marks of vitrification, by which they are cemented together.

None of these vitrified forts exhibit, as from many writers we should be erroneously led to suppose, any regular masonry in their structure. Unhewn fragments of stones, and water-worn boulders, sometimes mingled with smaller gravel, appear in a quantity almost exceeding belief, following the contour of the summit of a mountain, or, as in the instance of a fort which is situated in the Kyles of Bute, following the contour of a small holm or islet, elevated a few yards only above the level of the sea; and in cases where, owing to the more exposed nature of the ground, a stronger defence is demanded, a double or even treble rampart of the same rude materials is added. The vitrification which characterizes these forts is, in some few of them, displayed to an extent that is perfectly astonishing; while in other instances it is with difficulty to be detected. In short, no two forts in their degree of vitrification are in any respect conformable to each other; and it is of importance to add, that throughout Scotland numerous forts appear, only differing from those which form the present object of inquiry in the absence of all marks of vitrification whatever.

These forts first met with scientific attention about half a century ago, when various theories were proposed to account for the origin of their vitrification. At these I shall glance in succession.

1st, *The notion that the vitrification observable in these forts was the result of volcanic agency.*

During the last century it was a very prevalent notion, that the vitrification

of these forts had a volcanic origin; and hence that volcanoes at some remote period had been very common in Scotland. This opinion was embraced by Mr Pennant, the eminent naturalist, who was led to it from an examination of the Hill of Craig Phædrick. A similar view was taken up by Thomas West, Esq. the author of a paper published in the Transactions of the Royal Society of London for the year 1777; and, four years afterwards, by the Hon. Daines Barrington.

The circumstances which led to this opinion have not been ill explained by Dr James Anderson of Monkhill, Aberdeenshire, in a letter dated the 27th November 1777, and read to the Antiquarian Society of London. "It must be owned," says this author, "that the natural appearance of the places where these vitrified masses are usually found, is well calculated to favour the opinion that they have been produced by volcanoes. The vitrifiable matter is usually first discovered by travellers around the bottom and on the sides of steep hills, frequently of a conical shape, terminating in a narrow apex, exactly resembling the hills that have been formed by the eruptions of volcanoes. It is therefore very natural to think that these may have been produced the same way. Let us, for instance, suppose that a traveller strongly impressed with this idea should resolve to examine the top of the mountain more nearly, and for this purpose ascend to the summit:—would not his former conjecture be much confirmed when, at the top, he should find himself in a circular hollow, surrounded on all sides by matter rising gradually higher to the very edge of the precipice, which is there entirely environed with vitrified matter of the same kind with that which he had found at the bottom? Could such a man be called unreasonably credulous if he should be induced by so many concurring circumstances to believe that this had been a real volcano? But would he not be reckoned sceptical in the extreme if he should entertain the smallest doubt of the truth of this opinion, upon seeing the very opening itself in the centre of the hollow, through which the boiling lava had been ejected?"

Such is the liberal excuse assigned by Dr Anderson for the volcanic hypothesis, which is the more generous, as he came prepared to advocate a very different theory. Indeed, from my own experience, I do not hesitate to say, that some few of these forts are not ill calculated to favour the deception. In a hasty survey which I took of the hill of Finhaven (the first vitrified fort I examined), I saw, like Mr Pennant, an apparent crater-formed cavity, filled with fused materials, occurring in such an abundance as to render unsatisfac-

tory any explanation which has been hitherto given of the artificial mode in which vitrification to this immense extent must have been produced. But my illusion was short-lived;—in the examination of a second example it was instantly dispelled.

2dly, *The theory, that vitrification was artificially induced, as a cement for the consolidation of ramparts of loose stones.*

In the year 1777, the validity of the volcanic theory was first opposed in a pamphlet published by Mr John Williams, mineral surveyor and engineer for the forfeited estates of Scotland.

This author, in advocating the artificial origin of vitrified forts, first assured himself, on the authority of a late eminent chemist, that many varieties of the rocks of Scotland were with little difficulty fusible. Dr Black's letter to him on this subject may perhaps be worth quoting: "There are in most parts of Scotland different kinds of stones which can, without much difficulty, be melted or softened by fire, to such a degree as to make them cohere together. Such is the greystone, called whinstone, which for some time past has been carried to London to pave the streets. Such also is the granite or moorstone, which is applied to the same use, and pieces of which are plainly visible in some specimens of those vitrified walls which I received from my friends. There are also many limestones, which, in consequence of their containing certain proportions of sand and clay, are very fusible; and there is no doubt that sandstone and puddingstone, when they happen to contain certain properties of iron mixed with the sand and gravel of which they are composed, must have the same quality. A puddingstone composed of pieces of granite must necessarily have it. There is abundance of one or other of these kinds of stone in many parts of Scotland; and, as the whole country was anciently a forest, and the greater part of it overgrown with wood, it is easy to understand how those who erected these works got the materials necessary for their purpose."

After Mr Williams had thus got over the difficulty of artificial fusion, he promulgated his view, which, as he states with much naiveté in his preface addressed to Lord Kames, appeared so incredible, that no booksellers of London would hazard the publication of it. He supposed that the ancient inhabitants of Scotland derived their earliest notion of vitrification, "first, from melting bog ore, in the process of which they learned how it would, if increased, vitrify stones and earth; secondly, from observations made while roasting oxen. It is evident," adds this choice antiquary, "from the records of the earliest antiquity,

that it was the practice of almost all nations to offer burnt sacrifices. And it was customary, on solemn occasions, to burn a large-sized animal whole, which would require a very strong fire." "After they [the ancient inhabitants of Scotland] became acquainted with this power of heat, I suppose some genius among them to have employed it for forming vitrified walls. The manner, however, in which he employed it is still problematical. I have tried the subject several ways in my own mind, but find difficulty in all the methods I have yet imagined. I shall, however, mention that which satisfies myself the best, and which appears most practicable. I imagine they raised two mounds of earth parallel, and in the direction of their intended wall; and that they filled the ground formed by these parallel mounds with fuel, above which they laid the materials to be vitrified. There is no doubt but a strong fire would fuse these stones, especially if they were of the plum-pudding kind, and not too large; and the frame of earth would prevent them, when in fusion, from exceeding any assigned breadth. I suppose they added layers of fresh fuel and materials alternately, and raised the mounds of earth till the whole was brought to the intended height. I am confident, from the appearance of the ruins, that the materials of them were run down by the fire in some such method as this. For in all the sections which I have seen, whether of the larger or of the smaller fragments of these ruins, I never observed the least appearance of a stone being laid in any particular way. Nor could I in any of them discover a stone, large or small, not affected by the fire, and in some measure vitrified."

In connection with this theory, Mr Williams defines the walls of a vitrified fort, when complete, after the following manner:—"The walls are vitrified or run and compacted together by the force of fire, and that so thoroughly, that most of the stones are melted down, and any part of them not quite run to glass is entirely enveloped in the vitreous matter; sometimes also they appear like vast masses of coarse glass or slag."

But we shall now examine, with some degree of attention, the validity of this theory, particularly as it has recently met with a defence from a writer of no small eminence, who possesses a store of antiquarian and mineralogical knowledge, which eminently qualifies him to enter the lists in the determination of this question. I allude to a memoir published in the Transactions of the Geological Society of London, by Dr Macculloch, and to his views on the subject which are contained in his description of the Highlands and Western Isles of Scotland.

The drift of the theory in question is,—that with the design of strengthening the walls of a fort, the stones have been cemented by a regular process of vitrification.

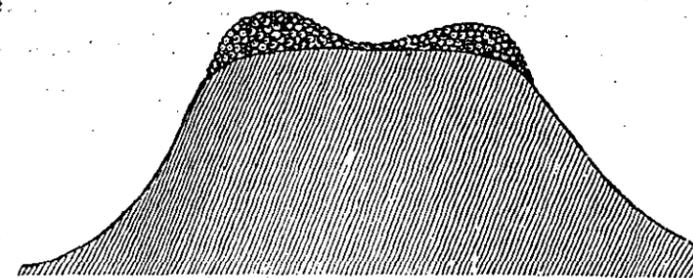
In support of this view Mr Williams has stated, that in none of the vitrified forts which he examined could he discover a stone, large or small, unaffected by the fire, or which was not in some measure vitrified. This assertion, if correct, would certainly go a great way to urge conviction, that the vitrification of these forts was not an accidental or adventitious, but a designed process. Never was there, however, a more unfounded statement. At Dun Evan, where there is an extensive fortified site, the vitrification, so far from having acted upon every stone, is only to be detected in a space the dimensions of which do not exceed two or three yards. I can also avow, without dread of contradiction, that in numerous other sites the vitrification is only to be found in small patches, or that extensive portions of the ramparts which have composed their defence do not show in the slightest degree the effects of fire. Nay, even in the forts which display the greatest extent of vitrification, considerable intervals may be readily traced where no fusion of the stony materials has ever taken place. These circumstances, then, are fatal to the notion that vitrification was the effect of design; they rather show that it was merely incidental to some other view, which the authors of it must have contemplated.

This theory is again as ill supported in its details. Mr Williams has supposed that the builders of these forts raised two mounds parallel to, or in the direction of their intended wall, and that they filled the ground formed by these parallel mounds with fuel, above which they laid the materials intended to be vitrified. Now this supposition is faulty, inasmuch as it proceeds upon an incorrect view which has been taken of the actual construction of these forts. A wall formed in such a manner would present to view a pile of stony materials, with sides which would be vertical, or at least nearly so; and it would inclose the summit of a hill after the manner of a modern park wall. But this is not the character of a vitrified fort. The structure of the least dilapidated example is much more rude, being rather after the model of a filled up or extinct volcanic crater. Upon the summit of an insulated hill, an incredible accumulation of loose stones has been made to rise to the greatest height around its circumference, and to gradually thin off towards the centre of the inclosed site. An original form of this kind could not then have been derived from any parallel mounds. (*See an imaginary section on the following page.*)

These are the chief reasons which induce me to regard the theory of Williams as perfectly untenable.

3dly, *The theory of Dr Anderson,*

*that vitrification was promoted by the employment of a peculiar vitrescible ore.*



The theory of Williams, during the same year in which it was divulged, met with some qualified support from Dr Anderson, in the dissertation by him to which I have already alluded. He observed of the walls of Knockfarril, that “they consisted of stones piled rudely upon one another, and firmly cemented together by a matter that had been vitrified by means of fire, which formed a kind of artificial rock that resisted the vicissitudes of the weather better perhaps than any other artificial cement that had ever yet been discovered.”

Thus, in coinciding with Williams, that vitrification was intended as a cement to strengthen the walls of forts, he only differed from him in the more correct view which he took of the real structure of these defences, or in the theoretical use which he made of an extraneous vitrescible matter. He properly remarked of the vitrified fort of Knockfarril, that its wall was continued quite round the area, being adapted to the form of the hill, so as to stand on the brink of a precipice all round, with the exception of the places of entrance. Such being its construction, he next supposed that vitrification was effected by the aboriginal Britons after the following manner:—

“Through all the northern parts of Scotland, a particular kind of earthy iron ore of a very vitrescible nature much abounds. This ore might have been accidentally mixed with some stones at a place where a great fire was kindled, and being fused by the heat, would cement the stones into one solid mass, and give the first hint of the uses to which it might be applied. A few experiments would satisfy them of the possibility of executing at large what had been accidentally discovered in miniature. This knowledge being thus attained, nothing seems to be more simple and natural than its application to the formation of the walls of their fortified places. Having made choice of a proper place for their fort, they would raise a wall all around the area, building the outside of

it as firm as they could of dry stones piled one above another, the interstices between them being filled full of this vitrescible iron ore; and the whole supported by a banking of loose stones piled carelessly behind it. When the wall was thus far completed, with its facing all round reared to the height they wished for, nothing more was necessary to give it the entire finishing, but to kindle a fire all round it sufficiently intense to melt the vitrescible ore, and thus to cement the whole into one coherent mass, as far as the influence of that heat extended. As the country then abounded with wood, this purpose would be readily effected by building a stack of wood round the whole outside of the wall, and then setting it on fire. It was probably with a view to enable them to build this stack of wood with the greater ease, and to suffer the fire to act more forcibly and equally upon the different parts of the wall as it gradually consumed, that they were induced to incline the walls so far from a perpendicular position. In an after period, when the woods had gradually been destroyed, and before it was well known how to manufacture peat for fuel, it would be such a difficult matter to procure fuel in abundance, that buildings of this kind would come to be disused, and the art in a short period, among a people ignorant of letters, be entirely forgotten."

Such is the explanation of the process of vitrifying, as given by Dr Anderson, with the discovery of which he is so delighted that he patriotically adds, "I am disposed to believe that this has been entirely a British invention, and think it probable that the art was never carried out of this country." He then laboured to prove that so admirable an art was unknown to the Danes, who endeavoured to vitrify some walls round a peninsulated rock off Broughhead; but having blundered by getting hold of some wrong vitrescible ore, the experiment failed.

On this view of Dr Anderson nothing more may be remarked, than that it is in contradiction with the real facts concerned in this vitrification. All later observers have agreed, that the fusible matter does not consist of any peculiar vitrescible iron ore found in Scotland, but that it is derived for the most part from the alkaline ingredients of well-known rocks of granite, gneiss, mica-slate, clay-slate, hornblende schist, sandstone, &c. &c.; these rocks being more or less fusible in proportion to the felspar which they contain.

4thly, *The theory of Lord Woodhouselee, that fire has not been employed in the construction, but towards the demolition of such forts as display the marks of vitrification.*

In a paper published in the year 1787, in the Transactions of the Royal

Society of Edinburgh, Lord Woodhouselee successfully exposed the weakness of the theory first proposed by Williams, and supported to a certain extent by Anderson and other writers.

His Lordship proceeded upon the correct ground, that the vitrification of forts was a very partial occurrence; that three fortified summits which he examined were crowned with stone structures, showing no appearance whatever of the effects of fire; and that the number of such forts as displayed marks of vitrification would be found inconsiderable, when compared with those which have not been at all affected by heat.

The same able writer also questions, with much propriety, the capability of constructing an efficient fortress of vitrified materials. He doubts whether it would be at all possible, even at the present day, by the utmost combination of labour and skill, to surround a large space of ground with a double rampart of stones compacted by fire, of such height and solidity as to serve any purpose of security or defence against a besieging enemy; and concludes that any structure of this kind must have been irregular, low, fragile, easily scaled, and quite insecure.

The hypothesis of Williams having been thus shown to be perfectly unsatisfactory, Lord Woodhouselee next proposed a theory of his own. It was suggested by the observations which he made, that vitrified mounds do not appear to have been ever much higher than they are at present; that even in those sites where the wall was the least elevated, the fragments which have fallen down from it were very inconsiderable. His Lordship was therefore led to suppose, that the ramparts which now remain convey to us a full notion of the original construction of these forts, which was not of stones only, but which depended for their chief defence upon the wood which was employed in their fabric. He supposed that the building was begun by raising a double row of palisades, or strong stakes, in the form of the intended structure, in the same way as in that ancient mode of building, described by Palladio, under the name of *Riempita* or *à Cassa*, coffer-work;—that these stakes were probably warped across by boughs of trees laid very closely together, so as to form two fences, running parallel to each other at the distance of some feet, and so close as to confine all the materials, of whatever size they might be, that were thrown in between them;—and that into this intermediate space were cast boughs and trunks of trees, earth, and stones of all sizes, large or small, as fast as they could be quarried or collected; very little care being necessary in the disposition of these materials, as the outward fence would keep the mound in form.

The learned writer having thus constructed a fortress of his own, or rather one that was borrowed from an Italian architect, proceeded to develop his newer theory of vitrification, which was, that in a structure composed of combustible and fusible materials, the effects of fire would be accidental; that they would be induced, not during the construction, but during the demolition, of a fort.

“The most formidable engine of attack,” remarked his Lordship, “against a structure of this kind, would be fire; and this, no doubt, would be always attempted, and often successfully employed, by a besieging enemy;—and if the besiegers prevailed in gaining an approach to the ramparts, and, surrounding the external wall, set fire to it in several places, the conflagration must speedily have become general, and the effect is easy to be conceived. If there happened to be any wind at the time to increase the intensity of the heat, the stony parts would not fail to come into fusion, and, as the wood burnt away, sinking by their own weight into a solid mass, there would remain a wreck of vitrified matter tracking the spot where the ancient rampart had stood, irregular, and of unequal height, from the fortuitous and unequal distribution of the stony materials of which it had been composed.”

This theory, in its application to a country so well wooded in times of yore as Scotland, merits some notice, though it must be confessed that it is much easier to frame a notion of this kind, which is little more than the offspring of a fertile imagination, than to completely refute it. The chief objection which I have to this hypothesis is, that in many forts which I have examined there is no indication whatever that their structure was at any time different to what they display at the present day; and that the encompassing stone mounds appear to have afforded a sufficient defence to a savage people, without the addition of ramparts of wood. His Lordship must have anticipated the latter objection, by citing the exceptions to his theory, which he explains after the following manner:—“In those parts,” he observes, “where stones would be easily quarried of such size and form as to rear a rampart by themselves of sufficient strength and solidity, there was no occasion to employ wood or turf in its construction, and it was therefore proof against all assault of fire. Such are the ramparts which appear on the hill of Dun Jardel, Dun Evan, &c. But on Craig Phædrick and other hills, where, from the nature of the rock, the stones would be procured only in irregular and generally small fragments, it was necessary to employ some such mode of construction described.”

These are the chief reasons which have induced Lord Woodhouselee to form an opinion differing from that of Mr Williams, and of such as believed these structures to be the proofs of an ancient mode of building, in which fire was employed for the purpose of a cement before our ancestors knew the use of lime. He is rather disposed to conclude that the appearances of vitrification, which a few of these fortified sites evince, are the accidental effects of fire upon a structure composed of combustible and fusible materials, and by no means the consequence of an operation intended to produce that effect.

My own opinion of his Lordship's *demolishing* theory is scarcely a decided one. I cannot think it likely that in all cases structures of wood were called in aid to give additional security to mounds of stone. The probability, however, of rude wood-work being *occasionally* employed for this purpose must be admitted; and perhaps it may be illustrated in forts of very small dimensions. But that vitrification was induced by their being set on fire by a besieging enemy, is a distinct proposition, which in most instances will, I am persuaded, meet with no countenance whatever.

5thly, *The opinion that the vitrification of these forts was the result of beacon-fires.*

A fifth and last opinion, said to be the most plausible one that has yet been broached, is, that the vitrification of these forts was the result of beacon-fires. This theory has met with many supporters, particularly among the contributors to Sir John Sinclair's Statistical Account of Scotland. But the most able advocate of this opinion is Sir George Mackenzie of Coul, Bart. in an article on vitrified forts, written by him for Dr Brewster's Encyclopædia, and in his published letter addressed to Sir Walter Scott, on the vitrified fort of Knockfarril. The chief arguments for this opinion are, that the marks of fire are indicative of an accidental rather than of an intentional effect, and that vitrified forts are generally situated on lofty insulated hills, in such a chain or mutual connection as to allow of telegraphic communications to be conveyed from one station to another at a considerable distance.

But even this theory is not without its difficulties. In a dissertation lately printed in a volume of the Transactions of the Royal Society of Edinburgh, by James Smith, Esq. of Jordan Hill, a fort in the Kyles of Bute is described, which occupies the site of an islet or holm not more than twelve or fifteen feet above high water mark. Arguing therefore from this circumstance, as well as from the regularity of its vitrification, the writer comes to the conclusion, that

the effect of signal-fires will not account for the fort in question, because the situation, in a flat surrounded on every side by hills of considerable elevation, does not appear at all calculated for such a purpose; and because, in the next place, the regularity of its form seems still more inconsistent with the effects of an accidental cause.

Many who have supposed that the vitrification of these ancient remains was the result of beacon-fires have offered conjectures on their date. In a communication read to the Philosophical Society of Manchester, by Dr. Milligan, the author is of opinion that they were in use among the earliest inhabitants of Caledonia; and he supposes that, as the invasion of Agricola was attended by a fleet on the coast of Scotland, the fires seen in the interior of the country, which Tacitus describes as the flames of dwellings kindled by the inhabitants, might have been signal-fires communicating from hill to hill, as, for instance, from Stonehaven to Bute, where a line of vitrified forts may be traced; and that this telegraphic communication was the prelude of the battle of the Grampians. Various other writers, however, assign to these forts a much later date, particularly the contributors to Sir John Sinclair's Statistical Reports. They conceive that they were in chief requisition as beacons during the descents of the Northmen, which lasted several centuries.

This last opinion many, if not most, of the vitrified sites which have been examined, tend greatly to support. The coasts of Scotland began to be annoyed by the predatory visits of the Vikingr about the end of the eighth century; but it was not probably until the Scots had obtained a complete ascendancy over the Picts, by which both were united under one government, that systems of beacons were formed to provide against the sudden descents of the Scandinavians, who invaded them from the Danish or Norwegian shores, or from countries which they subsequently colonized, namely from Shetland, Orkney, Caithness, Sutherland, the Hebrides, Ireland, or the Isle of Man. The Murray Frith, as we learn from ancient Sagas, was one of the most convenient landing places for the Northmen; and hence we must look to this locality for the greatest proportion of vitrified sites. The number of such as have been traced within sight of each other, in a direction east to west from Banff to Dingwall, and in a direction north to south from Cromarty to Fort Augustus, may be estimated at twenty; but it is probable that their actual amount will be eventually found to be much more. Two vitrified eminences appear near Huntly, connected apparently with the line of coast extending from Kinnaird's Head to

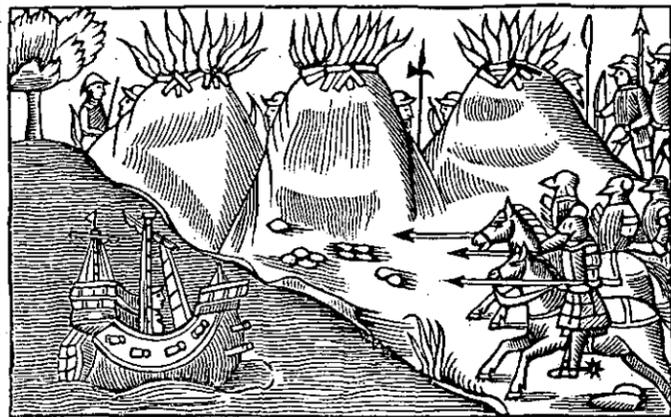
the mouth of the Dee. More south, a chain of vitrified sites, nine or ten in number, appears to have conveyed signals from the line of coast which stretches from Kincardine to the Tay, being prolonged from Stonehaven or Dundee to the neighbourhood of Dunkeld or Crieff. On the west coast, again, we find similar vitrified sites at Bute, Cantire, Isla, Loch Etive, Loch Sunart, Fort William, or at Arisaig. The number which subsists on the west yet remains to be ascertained; about twelve have been enumerated. Lastly, at Galloway, three occur, apparently as signals against the marauding colonists of Ireland.

But it must be kept in view, that it is highly improbable that the original intent of the whole of these vitrified sites was that of affording convenient localities for beacon-fires. There is no necessity whatever, *cæteris paribus*, that signal lights, merely giving notice of the approach of an enemy from the sea, should be situated on fortified stations. It is not improbable, therefore, that the rude ramparts themselves might, at a still more remote period, have been erected by the oldest inhabitants of Albyn, namely by the Caledonians and Picts; and hence their occasional or very partial vitrification would merely indicate the later use to which the eminences upon which they were situated had been applied, when the Scots, who succeeded to far earlier inhabitants, were called upon to repel new invaders from the sea.

Again, it may be remarked, that after the Northmen had gradually acquired a permanent settlement in Scotland and elsewhere, they themselves became liable to sudden piratical descents from their own countrymen; to guard against which, ancient Sagas inform us, they instituted, in every country where their arms prevailed, still more perfect systems of beacon-fires, the wardenship of which was enforced by the most rigorous laws. Edicts on this subject appear in many early codes of the north of Europe, particularly in the *Leges Gula-Thingenses* of King Magnus of Norway, where, in the *Landvarnar-Bólkr*, we find that the bonds were plighted during time of war to be prepared with watch-fires in places where the same had been lighted up from old time. (Magnus Konongs Laga-Bæters Gula-things-Laug. Havnix, edition A. D. 1817, page 85.) Martin also states of the ancient beacons of the isle of Harris, which the Norwegians colonized, that "there are several heaps of stones, commonly called *karnes*, on the tops of hills and rising grounds on the coast, upon which they used to burn heath as a signal of an approaching enemy. There was always a sentinel at each *karne* to observe the sea-coast; the steward of the isle made frequent rounds to take notice of the sentinels, and if he found any of

them asleep, he stripped them of their clothes and deferred their personal punishments to the proprietor of the place." Still more information on this subject, yet of a general

kind, may be found in the "Historia de Gentibus Septentrionalibus," by Olaus Magnus, whose narrative, "De Ignibus Montanis Tempore Hostili," is accompanied with a rude drawing of mountain-fires, which, on ac-



count of the admirable illustration conveyed by it of a frequent cause of vitrification, may with much propriety be introduced in this memoir.

The explanation which Olaus Magnus gives of this drawing is as follows: Ex hac imagine duo veniunt consideranda: quorum alterum in vertice montium, fumi scilicet congestis lignorum struibus ad classicos insultus accedentium inimicorum arcendos excitati: alterum verò in littoralibus angustiis, et scopulis, ne hostes insiliant, diligens equestrium custodia intuenda: qui montana inhabitant loca tempore hostili, veluti celerrimi speculatores, signa fumo faciunt: quibus visis, alii reliquos montes incolentes, itidem a longè positis ignita pyramide demonstrant, ut quilibet armatus juxta numerum principis, et patriæ lege decretum, ex campestribus locis pro littorum custodia sine mora descendat. Inter quos velites equestres celerrimi adsunt, ut hostibus portuum, vel riparum accessum præclusuri, sagittariis plebeïæ multitudinis locum statuunt, ubi commodius excipiant, ac conficiant hostem, omnino aggredi contententem: ut scilicet in vallibus, aut cavernis expectent, vel ad iniqua et ignota hostibus loca, quasi fugitivi declinent, ne fortè eos taliter insequentes educere valeant in agmina robustiora: quæ urgente necessitate, usque ad infinitam multitudinem augeri solent. Nec desunt exploratores quoque versum emissi, qui renuntiant, qua ex parte adhuc immineant hostes, ut his celerius, et copiosius occurrentes vel consilio, vel virtute, vel insidiis, vel necessitate, vel desperatione, vel loci securitate nutantibus, ne dum victoriam adimant, sed et victos, ut imperata perficiant, militari lege constringant." (*De Gentibus Septentrionalibus*, &c. edition, *Romæ*, 1555, p. 228.)

Such is the account of these ancient mountain-fires which I have collected from Olaus Magnus. By another writer, it has been related of the Norwegian Monarch, Haco the Good, that he caused large trees to be formed into piles, and to be so placed as to be visible from mountain to mountain, with the view that intelligence of a hostile invasion might in seven days travel from one end of his kingdom to the other. "Ut in montibus excelsis ex ingentibus arboribus pyræ ita struerentur (s. angari) ut ab una pyræ ad alteram facilis et liber esset prospectus. Excitatus hoc pacto hostilis irruptionis nuntius, a prima in extremo regni ad meridiem angulo extracta pyræ, ad remotissimum boream versus publicorum comitorum in Halogalandia locum septem dierum spatio volitasse fertur." (Snorre Haconar Goda, cxxi. p. 146. The quotation is to be found in Mr Turner's *Anglo-Saxons*, vol. ii. p. 285, 4th edition.)

From this information of Snorro, we are entitled to expect that vitrified sites should be found on the mountain tops of Norwegian provinces. But I am not aware that Scandinavian antiquaries have yet pointed out their existence.

Independently, however, of this historical testimony, most of the vitrified forts which I have examined show internal evidence of their having been in use for such incidental purposes as beacon-signals. Where the stones which have received the full force of the fires appear of inconsiderable depth, a complete fusion of the part has taken place; but, in other examples, the fused matter has run among the stones in small streams. In almost every case vitrification appears in patches; the cementing process not being a continuous, but a very limited effect.

For the extent of fusion, we must look to the comparative degree of frequency with which a beacon-fort would become in requisition; while the part of the fort which would be fused must depend upon the direction of the wind at the time a beacon was lighted.

It is also not improbable, that such a portion of a beacon-hill would be fired, as might convey the earliest information of the direction in which an enemy was approaching, or of any other events suggesting effectual plans of resistance. Thus, at the hill of Cowdenknows, on the borders of Berwickshire, although its summit has been fortified, it is on the flank of this eminence, where little or no defence appears, but which commands the view of a considerable tract of country to the north and north-east, that a small cairn of vitrified stones is to be detected. In many other places, also, vitrification is rather to be observed on the unprotected side than upon the defended summit of a hill;

which circumstance might lead us to suppose, that signals of alarm were often intended to be concealed from an invading enemy, with the design that a readier chance of success might be afforded to stratagems of repulsion or surprise. That this view is not altogether theoretical, may be collected from the very ancient armorial bearing worn by Macleod, Lord of Lewis, where, in a rude representation given by Sir David Lyndsay, Lyon King at Arms, in 1542, fires are made to blaze from many diversified points of a beacon-hill. But the authority of Wallace, who wrote in the year 1700, is more direct to the point. He has stated, that even at this late period "the people [of Orkney] had in every isle a wart-hill or ward-hill, which is the most conspicuous and elevated part of the isle, on which, in time of war, they keep ward; and when they see the enemies ships approaching, they put a fire, thereby to give notice to the adjacent isles of the nearness of the enemy, and to advertise them to be on their guard, or to come to their help; this they distinguish by the *number* of fires."



6thly, *Are there any other very ancient observances or customs, not hitherto cited by authors, which may have contributed to this vitrification?*

As it remains yet to be proved that marks of vitrification are uniformly limited to fortified sites, or even to beacon-hills, a natural question arises, "Are there any other ancient observances or customs which might have contributed to this vitrification?"

For such information we must consult the earliest and most obscure records of Scottish history. One of these which may be noticed, is the public festival said to have followed the labours of the chase, in the commemoration of which all the early Scottish traditions and songs agree. That this feast was accompanied by a sacrifice of fuel derived from the ancient forests of Scotland, to an amount which at the present day is almost incredible, might be inferred from the testimony of Ossian, if we could only depend upon the correctness of the translation: "Night is around the hero and his thousands spread upon the heath; a hundred oaks burn in the midst; the feast of shells is smoking wide." But upon this cause of vitrification it would be imprudent to insist, as I should be disposed to attribute to it very few effects in comparison with that of beacon-fires. I shall merely mention, that in a section which was made by Sir George Mackenzie of the very small vitrified fort of Dun Fion, near Inverness,

the quantity of burnt bones of animals, and of charcoal, found on the site, would rather indicate the sequel of a feast than the effect of signal-fires. But perhaps a combination of events might have occurred to produce this appearance.

Nor is it quite impossible, that some few occasional instances of vitrification in particular sites might have been rather indicative of the forest-trees which blazed during the immense feasts which the Vikings were accustomed to enjoy upon each occasion of a *strand slaughter*; that is, when they assembled near some strand or shore to slaughter the cattle which they had captured, for the purpose of transporting the salted carcasses to their winter haunts.

Another ancient observance connected with the lighting up of immense fires, was the festival in honour of Baal, which was renewed upon each return of the summer solstice. This was the greatest feast of the ancient inhabitants of Scotland, which even long outlived the introduction of Christianity; no ceremony belonging to it being subsequently omitted, except the sacrificial effusion of human blood. Indeed, the custom of the Baaltein is perpetuated in some few districts to the present time; and at the parish of Galstone in Ayrshire a similar pagan honour characterizes the feast of a Christian Saint, the ancient custom being still retained of kindling fires on all the neighbouring heights upon the evening before a celebrated fair is held in honour of Saint Peter. (*Statistical Account of Scotland*, vol. ii. p. 82.)

In short, we have only to conceive of an annual hunter's feast, a Baaltein, or indeed a periodical bonfire upon any public occasion whatever, continued for many centuries in an accustomed site, and during a state of country in which it was deemed patriotic to reduce the luxuriance of extensive forests, and we have a cause perfectly adequate to explain many instances of vitrification, which, I expect, upon inquiry, will be found to be of far greater frequency throughout Scotland than has hitherto been suspected.

7thly, *The probability that many of the sites in which vitrified remains occur, were places of rendezvous for tribes or clans, upon all public occasions of peace or warfare.*

Should this supposition be admissible, it might possibly explain the circumstance of some vitrified sites boasting little or no defence.

In fact, places of rendezvous for tribes and clans upon any public occasion, alike incidental to a state of peace or warfare, must have been suggested by many circumstances, as, for instance, by the custom of holding judiciary courts upon them, or even by religious veneration; the first of which motives recom-

mended a cairn in the holm of Dalmorton as the rendezvous of some Ayrshire tenants (*Statistical Account of Scotland*, vol. iii. p. 594), while superstition taught the Buchanans to gather in the island of Clareinnis in Loch Lomond. Keeping this circumstance in view, we need not be surprised that vitrification, which was as likely to result from festive or religious bonfires as from beacon-signals, should appear in a holm or islet of the Kyles of Bute, not elevated many feet above the level of the sea, or upon some inconsiderable eminence of the easiest access to an assailing enemy, which is the distinguishing site of Dun Fion.

Most places of rendezvous, however, were suggested by defensive motives. Thus, the ancient war-cry of the Campbells, in allusion to their assembling place, was the famous mountain in Argyleshire of Bencruachan; while, among the borderers, that of the Logans was Lesterich Law. And, in the use which we would make of these analogies, we may cite the vitrified fort of Dunardile, near the Fall of Fyres, where, according to the etymology given of the name by a statistical writer, *Dun* signifies a hill; *Ard*, high; and *Dyil*, Carnochs or followers of a tribe. (*Statistical Account of Scotland*, vol. xx. p. 38.) In short, the sites of many forts, vitrified or unvitrified, instruct us, that, while they were intended as places of rendezvous for tribes, their ramparts afforded no less a defence for cattle than for human inhabitants; and upon many of these Duns, or strengths, of inappreciable age, the fire of the Beltein, or the beacon of war, has been in turns the symbol for the gathering of ancient clans.

At the same time it must be remembered, that in some instances a Clan has had one site for its rendezvous, and another for its beacon-hill. Thus, in comparatively modern times, the Seaforths mustered at the Castle of Donan, while the signal-fires were lighted on the summit of Tulloch-ard.<sup>1</sup>

Sthly, *The ancient densely wooded state of Scotland, of which the number of vitrified sites, and the occasional intensity and extent of their vitrification, serve as indications.*<sup>2</sup>

<sup>1</sup> Remains of similar observances may be traced in England even so late as the 18th century. It is asked, in "the Surveiors Dialogue" (edition A. D. 1738, p. 187), "To what place are you that are the tenants of this maner usually called to do your services, to muster, and to show your armour; and what beacons are you appointed to watch and ward at?"

<sup>2</sup> Some few additions have been made to this section since this Paper was read at the Society, in consequence of the information of which I have lately availed myself relative to the ancient forests of Caledonia, from a chapter in Mr Fraser Tytler's excellent history of Scotland. For some additions to my list of the earliest Scottish forest trees, I have to thank my friend Mr Neill.

The forests of Scotland, from the fifth to the fourteenth century, far exceeded in abundance or magnitude those of South Britain. Among the produce of them are enumerated the oak, the pine (*pinus silvestris* or Scots fir), the birch, the hazel, the broad leaved or Wych elm, the roan tree (or mountain ash), the common ash, the yew, the alder, the trembling poplar (*populus tremula*), the bird cherry (*prunus padus*), and the saugh or sallow.

Mr Fraser Tytler has collected from the *Rotuli Scotiæ* the following list of ancient forests:—

The forests of Spey, the forests of Alnete, Tarnaway, Awne, Kilblene, Langmorgan, Elgin, Forres, Lochindorb, and Inverness.

In Aberdeenshire, the forests of Kintore, Cardenache, Drum or Drome, Stocket, Killanal, Sanquhar, Tulloch, Gasgow, Darrus, Collyn, and the new forest of Innerpeffer.

In Banff, the forest of Boyne.

In Perthshire, a forest which, in David I.'s reign, occupied the lands between Scone and Cargill.

In Kincardine and Forfar, the forests of Alyth, Drymie, and Plater.

In Fife, the forests of Cardenie and Uweth.

In Stirling and Clackmannan, extensive forests.

In Ayrshire, the forest of Senecastre.

In the Lowlands, the forests of Drumselch near Edinburgh; of Jedburgh, of Selkirk, of Cottenshope, of Maldesley, of Ettrick, of Peebles, of Dollar, of Traquhair, and of Melrose. A forest, likewise, in David the First's reign, covered the district between the Leader and the Gala.

Such is the list of the ancient forests of Scotland, within the limits of which vitrified sites appear; and it is in vain to look for them where luxuriant woods have not subsisted. In the Orkneying Saga, for instance, we read of numerous beacon-signals having been lighted up in Orkney and Shetland; but as these islands from remote historic times have been destitute of forests, no fire has been raised of sufficient intensity to leave any marks of vitrification upon the mounds of stone on which the inflammable materials rested. The same remark may apply to some of the Western Islands. Vitrification only appears where such mountain-fires have blazed as Olaus Magnus has described.

This very wooded state of Scotland, which was its peculiar character during the period when its shores were the most annoyed by the predatory excursions of the Northmen, will also, I trust, explain why vitrified sites should be so common in this country, to the exclusion of England, where, owing to the more

early civilization of Saxon colonists, forest lands were beginning to be thinned, and where, from motives of necessity as well as convenience, the habit had commenced of using for beacon-fires vessels filled with pitch, instead of unwieldy piles of wood.

Keeping, then, this ancient wooded state of Scotland steadily in view, it is by no means illogical to extend rather than to limit the causes which would induce our ancestors, in a country overspread with trees, where arable land was also much wanted, to allow the spoils of dense woods and thickets to be kindled upon every occasion of rejoicing, of religious sacrifice, or of alarm upon the approach of an invading enemy. All the ancient histories and traditions accordingly agree, that the most extravagant use was made of forest trees on every occasion to which their burning could be applied. Until the thirteenth or fourteenth centuries, Scotland was in the exact state of Wales, which called for the particular law of Howel Dha. "There are," says this legislator, "three causes of progression for salutation; land brought into cultivation, festal games, and the burning of forests; and no person must obstruct such salutation."

In fact, the effects indicative of immense piles of blazing forest trees, the vitrifying action of which would be heightened by favouring currents of wind, as by a blast furnace of surpassing intensity, are most truly marvellous, oft-times appearing to vie with the result of volcanic incandescence. But the phenomenon will admit of explanation. The stones which are vitrified generally consist of such materials as granite, gneiss, mica slate, clay slate, or the older sandstones and porphyries; and these are rendered more or less fusible, in proportion to the felspar which they contain in their composition;—potash being an ingredient of felspar, occasionally to the amount of 14 per cent. The stony fragments which have been subjected to this vitrifying process often exhibit effects which are of particular value to the geologist, as they illustrate various circumstances connected with the agency of heat, in reference to rocks of much theoretical interest, which all ordinary experiments of the laboratory would fail in achieving. Thus I might mention among the most interesting specimens which I collected from vitrified sites, those which show that heat has the power of causing strata of sandstone to assume the precise character of the more crystalline laminae of gneiss, or of rendering gneiss itself prismatic.<sup>3</sup>

<sup>3</sup> The most beautiful and perfect specimens of prismatic gneiss I found some years ago among the vitrified ramparts of an islet (named the Burnt Island) in the Kyles of Bute. They

The thirteenth or fourteenth centuries form the closing period to which we must limit the data of vitrified sites. The English, in their expedition against Scotland, endeavoured to clear the soil from its encumbering woods; and it is recorded that, in an expedition of the Duke of Lancaster, eighty thousand hatchets were heard resounding through the forests, which at the same moment were consumed by spreading fires. Lastly, as Mr Tytler has added, many districts were soon afterwards brought into cultivation, and converted into fields and meadow-lands.

After the period of the destruction of Scottish forests, it would be futile to expect that any records would indicate the continuance of vitrifying causes. The hill which, as a signal of war, once proudly blazed with the lavish conflagration of stately trees, is now illumined with little more than a paltry tar-barrel! *Sic transit gloria mundi.*

#### *Recapitulation.*

But these investigations I shall now close by stating the conclusions to which I have thus far arrived. They are as follows:—

1st, That the notion that vitrification is the effect of volcanic agency, as well as the hypothesis which would consider vitrification as the result of a regular fabrication for the purpose of cementing stone walls, are conjectures equally chimerical.

2dly, That the theory of Lord Woodhouselee, that the conflagration of wooden ramparts by an assailing enemy might have produced the vitrification in question, is not established in any single instance; notwithstanding the probability that such a cause might have occasionally subsisted.

3dly, That the number of vitrified sites in Scotland is referable to the fuel extravagantly consumed during its ancient densely wooded state.

4thly, That if we are entitled to suppose, that in a period of the history of Scotland when wood was most luxuriant, more than one ancient observance

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were small, being about 4 inches in length, and about  $\frac{1}{2}$  an inch in diameter, being formed at nearly right angles to the laminar planes of the rock.

Since reading this paper, I had the pleasure of observing, in the cabinet of M. Von Leonhard, the celebrated Professor of Mineralogy in the University of Heidelberg, several specimens from the vitrified sites of Scotland, which he had collected for the geological information that they conveyed to him of the effects of heat upon certain rocks.

might have induced the vitrification in question, we are authorized in the expectation, that the character of the sites in which vitrification occurs will be found as diversified as the multifarious national causes to which the effect may possibly be ascribed.

5thly, That some of the sites where vitrification is found were ancient places of rendezvous for tribes or clans upon any public occasion whatever of peace or warfare.

6thly, That many vitrified sites may from historical and internal evidence be shown to have resulted from beacon-fires formed by piles of wood, after the manner described by Olaus Magnus, Snorro, and other northern writers.

7thly, That other public occasions, festive or religious, might have given rise to the same effect of vitrification.

8thly, That it would be as easy to show, from numerous examples, that most of the oldest defences or Duns of Scotland exhibit no vitrification whatever, as that when vitrification does occur, it is not restricted to the precise limits of an area characterized by rude ramparts of stone.

9thly, That in some instances the vitrification of stony materials is of so small an extent, as to nearly elude the search after it; while in others it is of a continuity and intensity which almost surpasses credence.

10thly, That as it cannot be proved that the vitrification in question is in every instance confined to fortified sites, the term VITRIFIED FORT is too frequently the language of error. And,

Lastly, That as nothing can be more satisfactorily established, than that vitrification is an incidental, not a designed effect, the name of VITRIFIED FORT may with much advantage be exchanged for the more comprehensive and untheoretical one of VITRIFIED SITE.

## APPENDIX.

THESE are the conclusions which I have adopted, after a laborious examination of most of the vitrified sites of Scotland, to which I was encouraged by the recommendation of a gentleman, who has himself the most successfully toiled in the same difficult investigation;—I allude to Sir George Mackenzie.

It was my intention to have deferred any general remarks on this subject until I was fully entitled to hazard them by a completion of my researches. But having from several unforeseen events been defeated in this object, the present Dissertation has been written more for the hints which it may supply to future observers, than from the conviction that the tenets upon which I have insisted are wholly free from objection. Being perfectly heedless of the ultimate fate of any hypothesis whatever, I have no wish but for the disclosure of new facts, in the pursuit after which it is possible that I may again enter the field of active inquiry.

In the mean time, I would recommend that the Members of this Society be encouraged to continue the investigation which has thus been revived, to which my Essay is intended to render practical rather than theoretical assistance.

Most of the examples of vitrification which have fallen under my personal inspection appear to me to have been so hypothetically described, as to well merit being resurveyed by individuals who have yet a theory to support. For the information of this class of observers, I subjoin the names of all the known vitrified sites of which I have been able to collect information, with the persuasion, at the same time, that considerable additions might be made to the catalogue. I will not, however, answer for its perfect accuracy, although it is given on apparently authentic information.

### LIST OF VITRIFIED SITES.

- |                      |                                |                                |                  |
|----------------------|--------------------------------|--------------------------------|------------------|
| 1. Dunsinnan,        | } Perthshire.                  | 9. Dun-o-Deer,                 | } Aberdeenshire. |
| 2. Barra Hill,       |                                | 10. Top o' Noath,              |                  |
| 3. Monefieth,        | } Forfar.                      | 11. Promontory of Troup,       | } Banff.         |
| 4. Drumsturdy,       |                                | 12. Near Cullen,               |                  |
| 5. Dundee Law,       |                                | 13. Brugh Head,                | } Morayshire.    |
| 6. Findhaven,        |                                | 14. Clunie Hill, near Forres,  |                  |
| 7. Finella's Castle, | 15. The Doune Hill of Relugas, |                                |                  |
| 8. Stonehaven?       | } Kincardine.                  | 16. Castle Finlay, Nairnshire. |                  |

17. Dun Evan, north-east of Inverness,	} Inverness-shire.	30. Sutors of Cromarty; (2 vitrified sites said to be in Cromarty,)	} Cromarty.
18. Dun Daviot, south-east of Inverness,		31. Dun Creich, Sutherland.	
19. Dun le Chatti, near Church of Dunlichty,		32. Island in Loch Sunart.	} Argyleshire.
20. Dun Arduil, near General's Hut,		33. Island in Loch Teachus ( <i>This Loch is connected with Loch Sunart</i> ),	
21. Tor Duin, 3 miles south from Fort Augustus,		34. Dun Mac Sniochain (Berigonium),	
22. Dun Dhairgall, near Ben Nevis,		35. Thurot's Bay, Islay,	
23. Arasaik,		36. Near Killean,	} Mull of Caithre,
24. Dun Fion, west of Inverness,		37. Dunskeig Hill, parish of Kilkalmonell,	
25. Castle Spynie, do.		38. Bay of Carradale,	} Bute.
26. Craig Phaidrick, do.		39. Dun Gall,	
27. Dun-an-Avor, near Dingwall,	40. Kyles of Bute,	} Galloway.	
28. Knockfarril, do.	41. Cowdenknows, Berwickshire.		
29. Ord of Kessock, north of Murray Firth,	42. Anworth,		
	43. The Moat of the Mark, River Urr,		
	44. Castle Gower, in Buittle Parish,		

It was not before this sheet was in a corrected state, ready for the press, that I received the Heidelberg new journal entitled the "Jahrbuch fur Mineralogie, Geognosie," &c. conducted by Messrs Von Leonhard and Bronn, in the first number of which is an essay by the first-named gentleman upon the vitrified forts of Scotland. The scientific professor has reposed upon the theory of Williams, as revived by Dr Macculloch, which is, I believe, the only one known to continental geologists. I am sorry that I am precluded, by the greatest part of my Dissertation being already printed off, from noticing the curious observations of the writer on the effects of the artificial heat thus induced, when compared with the result of volcanic energy upon rocks of similar character. The resemblance, to which I have myself many years since adverted in various papers which I have read on vitrified forts, is often very striking; and when I proceed to explain some of my illustrations in detail, a suitable opportunity will recur to me to notice the valuable remarks of M. Von Leonhard.