

## III.

NOTES ON THE ANCIENT IRON INDUSTRY OF SCOTLAND. BY W.  
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The earliest historical notices of the British Isles agree in representing the inhabitants as well acquainted with the manufacture and use of iron; and the testimony of early documents and charters is conclusive as to the continuance of that knowledge and use of the metal throughout the Middle Ages.

In later times the manufacture of iron with wood charcoal had so far exhausted the forests of England that various Acts of Parliament were passed for their protection. This action of the English legislature was destined to have an important effect upon the Scottish industry. In 1607 Sir George Hay started his large ironwork at Letterewe, in Rosshire. In 1609 an Act of the Scottish Parliament was passed for the protection of the forests. In 1610 a gift of the manufacture of iron and glass in Scotland for thirty-one years was obtained by Sir George Hay, and at the same time Archibald Primrose, clerk of the mines, had his licence for the making of iron in the sheriffdom of Perth ratified. In 1613 the Privy Council restricted the export of iron ore; and in 1621 Sir George Hay of Kinfauns had liberty to transport the iron he manufactured to any port or harbour of any burgh. Sir Robert Gordon's notice of the abundance of iron ore in Sutherlandshire, "of which the inhabitants make good iron," shows that the industry was general over the north of Scotland in the seventeenth century. After the Rebellion of 1715 the Highlands were placed under military regulation, and an opening was presented for English enterprise. No scruples were then expressed as to the waste of timber, and the Scottish forests were extensively used for the conversion of English ore. The ore, being heavy and compact, was more easily transported to the wood than the timber to the ore. Thus the following furnaces sprang into existence:—Bunawe, on Taynult, in 1730; Invergarry in the same year; Abernethy, in Strathspey, also in 1730; Furnace in 1750; Goatfield, Loch Fyne, in

1754; and Carron in 1760. These large works rapidly consumed the wood, and Invergarry and Abernethy soon ceased to be worked; Carron, having changed its fuel to coal, still exists; Goatfield and Bunawe are only a few years blown out; and there is now not a single ironwork in Scotland using charcoal as fuel, and only two remain in England.

The few notices obtained from historical sources are not sufficient to account for the numerous heaps of slag which are found all over Scotland, England, and Ireland.<sup>1</sup>

How far back we must go for the discovery of the process it is impossible to tell. It has been said erroneously, as I shall show further on, that the manufacture of iron implies a higher degree of civilisation than that of bronze. It must be borne in mind that we are not in a copper country, nor in a tin district, so that either the ores or the metal would require to be brought from a distance. On the other hand, we have the materials for the manufacture of iron at nearly every man's door, and the process of conversion is most simple.

The slag heaps are widely distributed throughout Scotland, and their positions various, but they may be roughly classified as—

1. On elevated positions on hill-sides.
2. In valleys without water.
3. On the sides of streams.
4. Near the sea.

Let us glance at the kind of cinders obtained from these various sites.

1. *The works situated on the higher and more exposed points* yield a cinder which is poorly fused, is much mixed with pieces of undecomposed ore and stones, and which shows by its whole appearance and character that it has never been thoroughly in a state of fusion. In other words, the heat employed has been comparatively low.
2. *The sites in valleys without water* may be found to give a slag of either of two qualities,—(a) open, porous and in all ways like

<sup>1</sup> G. H. Kinahan, *Proc. Roy. Dublin Soc.*, 1886.

No. 1 ; (b) a more close and somewhat brown slag, more heavy and better fused than the former. The heat has in this case been sufficient to liquefy the mass more thoroughly.

3. *Sites on the sides of streams.*—These positions are much more carefully selected ; they are frequently under a high bank, and they invariably have indications in their vicinity of a cut having been made to conduct water from the higher reaches of the stream to a point immediately above the furnace. Water has evidently been used, the slags are more dense and compact, and the heat of the furnace has been greater.
4. *Sites by the shore* are generally much larger than any of the foregoing. The slag is more completely fused and glassy, the proportion of iron much less, and the work is on the side of a stream.

The deductions I draw from these facts are that in the case of the works on the hill-sides, the fuel and ore were roasted without the aid of an artificial blast. In support of this theory it is found that such sites are more numerous on such spots as are exposed to the influence of the prevailing winds. In the works situated in hollows the rush of wind through the confined space was made use of, or in the second variety of slag from this class of situation bellows were used. The third class were undoubtedly constructed to use an artificial blast of air obtained by the aid of water, and the fourth class most possibly employed a water-wheel, such as was in use in early times in the Forest of Dean and as is now in work at Newlands and Backbarrow.

The Indians have long been noted for their manufacture of iron.<sup>1</sup>

<sup>1</sup> In an article in the *Graphic* of 6th November 1886, by Mr H. H. Johnston, an illustration is given of an African forge. "The bellows are made of leather—usually a goat's skin, but in this case they are ingeniously manufactured from the broad pliable leaves of the banana. A man sits astride on a sloping wooden block behind the bellows, and works up and down their upright handles, thus driving a current of air through the hollow cone of wood and the double-barrelled iron pipes (fitted with a stone muzzle) into the furnace, which is a glowing mass of charcoal between two huge slabs of stone." The inhabitants of Madagascar melt iron, their blowing apparatus consisting of hollow trunks of trees, with loosely fitting pistons worked by hand. Mungo Park also describes the method employed by Central

The process is described in Ure's *Dictionary of the Arts, Manufactures, and Mines*, and is as follows :—

The furnace or *bloomery* in which the ore is smelted is from four to five feet high, somewhat pear-shaped, being about five feet wide at bottom and one foot at top. It is built entirely of clay, so that a couple of men may finish its erection in a few hours and have it ready for use the next day. There is an opening in front about a foot or more in height, which is built up with clay at the commencement, and broken down at the end of each smelting operation. The bellows are usually made of goat's skin, which has been stripped from the animal without ripping open the part covering the belly. The apertures at the legs are tied up, and a nozzle of bamboo is fastened into the opening forming the neck. The orifice of the tail is enlarged and distended by two slips of bamboo ; these are grasped in the hand, and kept close together in making the stroke for the blast ; in the returning stroke they are separated to admit the air. By working a bellows of this kind with each hand, making alternate strokes, a tolerably uniform blast is produced. The bamboo nozzles of the bellows are inserted into tubes of clay, which pass into the furnace ; at the bottom comes off the temporary wall in front. The furnace is filled with charcoal, and a lighted coal being introduced before the nozzles, the mass in the interior is soon kindled. As soon as this is accomplished a small portion of the ore, previously moistened with water to prevent it from running through the charcoal, but without any flux whatever, is laid on the top of the coals, and covered with charcoal, to fill up the furnace. In this manner ore and fuel are supplied, and the bellows are urged for three or four hours. When the process is stopped and the temporary wall in front broken down, the bloom is removed with a pair of tongs from the bottom of the furnace.

The process which most closely agrees with the third series, or those works which have evidently employed water, is the Catalan forge. The apparatus (fig. 1) consists of a pipe down which water is compelled to pass. The pipe is perforated with a few holes at the upper part, and the water during its descent draws in air by these apertures. The water and air pass into a box which has two openings, one for the water to pass out, and which is at the lower part, and one to allow the air to

African natives :—“The furnace was a circular tower of clay, about 10 feet high and 3 feet in diameter. Round the lower part, on a level with the ground, were placed seven openings, into every one of which were placed three tubes of clay, and the openings again plastered up in such a way that no air could enter the furnace except through the tubes. . . . The fire was applied through one of the tubes, and blown for some time with bellows made of goat's skin.”

be forced out into the furnace hearth. The drawing will explain the apparatus.

The slags obtained by these processes agree with those found in Scotland. In fact, so closely is this the case that Mr Topp, of Elgin, stated, at a meeting of the Elgin Literary and Scientific Association,

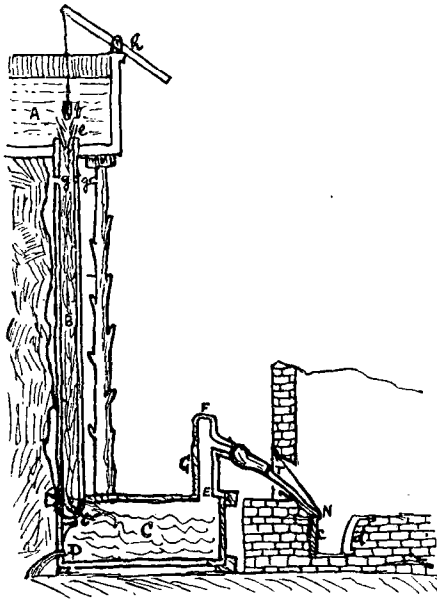


Fig. 1. Diagram of Catalan Forge.

A, water cistern; B, connecting pipe between A and C; C, receiving box; D, opening to allow water to escape; E, F, G, air conduit; T, tuyere; N, nose of tuyere; c and d, iron plate sides of crucible; e, funnel down which water flows to keep it off the sides of the tubes B; f, regulating valve; h, lever for valve f; g, g, openings in pipe B through which the descending water current sucks in the air; i, shelf on which descending current of water and air is broken.

that he had been struck by the resemblance of the Scottish specimens to those he had seen on the Gold Coast.

A very careful examination of the slag heaps in various parts of the country have in most cases led to the discovery of more or less bog iron ore mixed with the slag, and not unfrequently pieces of that substance have been obtained in a half-fused state from the interior part of slag masses. The chemical analysis of bog-ore slags agrees with those made from nearly all of the older slags, and it is only when we come to the historic furnaces that the character of the slag tends to vary.

There are very few instances of iron mines known to have been worked in Scotland; in fact, the only probable exceptions are—the furnace at Edderton, which Mr Ross considers was worked with local ore; the mines at Letterewe, Loch Maree, stated to have been worked by a colony of Englishmen; an iron mine at the Well of Spa, at the west side of the Woman-hill, near Gilkomstoun Mill, a quarter of a mile west from Aberdeen;<sup>1</sup> and the mines at Lecht, Tomintoul, Aberdeenshire, employed for the Abernethy works. In some cases the ore was imported, and I shall refer more fully to this point when speaking of the special works.

The fuel used seems to have been either wood charcoal or peat charcoal. The process for the manufacture of these substances was well known. Up to the beginning of the present century a great many people in the Highlands made peat and wood charcoal in their kitchens. A flag with a hole in the centre was placed over a deep circular pit sunk in the earthen floor, and into this pit the embers of the evening fire and any superfluous wood were thrown. A plug was fitted over the hole in the covering flag, and thus the contents of the pit were converted into good charcoal for smithy work, &c. These domestic charcoal pits have been filled up long ago, but the covering flags may still be observed in some of the old houses in Strathdearn, &c., where the flags form a part of the kitchen pavement. They measure about 3 feet diameter, and the hole in the centre of each flag about 3 inches diameter. When the charcoal was required in larger quantity, as for smelting purposes, the preparation was carried on in the vicinity of special peat mosses. The peats were cut from the more dense and

<sup>1</sup> *Early Records relating to Mining in Scotland*, by R. W. Cochran-Patrick. *Memorandum of the Minerals in Scotland*, by Colonel Borthwick, 1683.

compact part of the moss, and were hard, black, and free from light porous matter. The peats were charred in a deep narrow pit, the mouth of which was nearly covered with wood; an opening was left at the lower part to let in a small amount of air.

This peat charcoal was used in some localities within the memory of living man. A smith in Strathnairn remembers his father using such charcoal in the smithy, and of making it himself. The slag produced was heavier than that now formed through the agency of coal.

Coal was early known in Scotland, for in 1291 a charter was granted to the Abbot and convent of Dunfermline, giving them the privilege of digging coal in the lands of Pittenerieff, but the first workers of the mineral are supposed to have been the monks of Newbattle Abbey. The material was used as fuel, for in an account, given by Eneas Sylvius, of Scotland in the fourteenth century, it is stated that the people who begged at the church doors received for alms "pieces of stone, with which they went away contented. This species of stone, whether with sulphur or whatever inflammable substance it may be impregnated, they burn in place of wood."

In the beginning of the fourteenth century the London brewers and smiths, finding the high price of wood pressing hard on their returns, resolved to try experiments with coal, which led to a law making it a capital offence to burn coal within London, and one man at least was executed for non-observance of the Act.

A description of Scotland written in the beginning of the sixteenth century says:—"There are black stones also digged out of the ground, which are very good firing, *and such is their intolerable heat that they resolve and melt iron, and are therefore very profitable for smiths and such artificers as deal with other metals;*" and it is reported that at the close of the sixteenth century "the use of coal beginneth to grow *from the forge to the kitchen and halle.*"

The use of coal, however, does not seem to have been common, and we have no evidence that it was ever used in Scotland for iron manufacture until the Carron Works took it up somewhere after 1760.

The mineral must, however, have been used at these works only to a very slight extent, for Campbell, writing in 1774, expresses the

hope that pit coal, "often proposed and promised, may become general."<sup>1</sup>

In England coal was first used for iron-smelting by Simon Sturtevant who obtained a patent in 1611 for the use of "sea coale or pit coale" in various metallurgic processes including iron. In 1619 Lord Dudley obtained a patent for a similar purpose, and he would appear to have been successful, but was compelled to discontinue the use of the mineral through the opposition of the other iron makers, who objected because Lord Dudley could undersell them by from £3 to £6 per ton of pigs. In 1785 Abraham Darby permanently succeeded in the use of coal, which, however, he first coked.

#### SITES.

The sites of these old ironworks are very numerous. No claim is made that the following catalogue is complete, and where blanks occur they are due either to a want of observers, to local knowledge not having become public, or to the effects of the plough or the builder. Road-making also has been in many cases the cause of obliteration, for the slag, being hard and often easily available, has been employed in many instances for forming an open solid bottom.

The list is arranged in counties for more ready reference.

#### ABERDEENSHIRE.

*Quarryhead, Parish of Glass.*—The heap, which is of the usual black slag, has been a large one. A great part of it has now been removed, a road having been cut through it some years ago. There is a local tradition that there was a smithy near this heap.

*Bin of Cairnie, Parish of Cairnie.*—The heap is a large one, and contains much black peat charcoal refuse. Locally it is known as the "Smithy Hillock."

#### ARGYLLSHIRE.

*Skipness, Mull of Cantyre.*—On the hill-side above Skipness Castle, and about one mile from the shore. The slag is of the black and oldest series. Extent of mound, from 8 to 10 feet in diameter. Not connected with water, and stands high on side of open ridge.

*Benmore, Cowal.*—On the hill-side above Blairmore.

<sup>1</sup> *Political Survey of Great Britain, 1774, vol. ii. p. 43*



*Easarchan, Stralachlan.*

*Garvalhill, Stralachlan.*

*Strachurbeg, Strachur.*

*Drimdarroch, Stralachlan.*—Midway between Feorline and Drimdarrach, and in the depression between Barr-nan-Damh and Barr-nan-dais. Discovered by Mr Taylor, farmer, Feorline. There is no burn near the bloomery, which is situated at a height of about 400 feet. Large charcoal burnings surround the slag. The district is now almost bare of wood. The furnace was built directly against the prevailing winds.

*Leanach, Stralachlan.*—Situated on the hill-side, 400 feet above sea-level. Not near water, but in the line of the prevailing winds.

*Leak, Stralachlan.*—Within a few hundred yards of the preceding. It lies close to the burn, but there is no evidence of water having been used.

*Esmore, Stralachlan,* is one of the largest bloomeries I have met with. The site, which is at the mouth of the Stucreach burn, about 2½ miles south-west of Strachur, covers some acres, and includes hearths for charcoal burning of large extent. There is still in the locality some small-sized natural wood, much of which is regularly cut for charcoal for gunpowder manufacture. It is used at the Kames Powder Works and until lately at the Furnace Gunpowder Works. The varieties of wood which I have been enabled to identify amongst the refuse are silver birch, oak, holly, ash, elm, and beech. The slag is of two varieties, being partly of the open porous nature of bog-ore scoriæ, and partly compact, hard, and very infusible, as obtained from red iron ore. These works must have done an extensive business for a long period.

*Phuill, Strachur.*—An extensive deposit of slag, with large charcoal hearths, covering a great extent of ground, on the north side of the burn. The Airidh a' Ghobhainn (or shieling of the smith) is represented by a ruin on the side of the hill overlooking the burn, whilst the cottages and houses are still known as Ardnagown (the smith's houses). The slag is mostly heavy, but a mixture of the lighter bog-ore-like slag also exists. The charcoal contains pieces of the same woods as that at Esmore.

*Feorline, Stralachlan.*—On the hill behind the farm-house of the same name. This has been a very large work. Bog iron ore is abundant in mixture with the slag and in the district.

*Stonefield House.*—About one mile from Whitehouse. The deposit is immediately behind the site of the old house.

*Loch Goil.*<sup>1</sup>—Near the shore at the base of the mountain known as Argyll's Bowling Green.

*Glean Heilean and Glen More.*—At the junction of the roads passing through these glens on the higher side of the road, and looking down on Loch Goil.

<sup>1</sup> *Brit. Assoc. Report, 1857.*

*Bunawe, Taynwilt* (described).

*Glendaruel* (several sites).

*Strath Curr* (several sites).

#### BANFFSHIRE.

*Phones*.—On the river terrace of the Spey, and in the parish of Inveraven. The oldest variety of slag.

*Croix Well, Parish of Grange*.—The heap, which was large, has now been removed and used for road-making. Samples of slag can only be obtained after the ground has been ploughed. The mosses in the district are extensive, and contain many tree roots.

*Curlusk, Parish of Boharm*.—A very fine and large heap of slag.

#### BUTE—ARRAN.

*Glenkill, Lamlash* (three sites).—Found by Mr James Tod, of Glenkill Farm. Largest site about 20 yards broad and to the south-west of the farm buildings; No. 2 bloomery to the south-east, and No. 3 to the north-west of the farm-house. The soil is much mixed with charcoal. The slag belongs to the first period; is dense and black. A silver coin of James VI., and date 1580, was obtained in the same field. Bog iron ore was found adhering to the slag.

*Kilpatrick, Sheskin*.—The slag, which exists in considerable quantities, is of the dense black variety or oldest period. On the top of a ridge or mound there is a rude stone building with a circular hollow about 9 or 10 feet in diameter. The slag has been thrown down the slope.

*Glenclay*.—Two sites were found to the south-south-west of Glenrickard Cottage, and situated on separate burns. The work nearest to the Glenrickard Cottage is on the side of the burn, and a trench from the burn, which passed the work and rejoined the burn at a lower level, is still visible. The slags from both works are black and of the early period.

*Coillemohr (Great Wood), Loch Ranza*.—This heap of slag is situated on the side of a hill, about 100 feet above sea-level. Lower down there is a flat piece of ground which is covered with charcoal, and is evidently the site of the charcoal burnings. There is no water near the slag or charcoal, but the position of the former is such that it would be exposed to winds from the south-east, east, north, north-east, north-west, and west. A knoll to the south-east of this heap of slag is known as the "hammer head," and a second as the "smith's hill." The slag is of the usual black type of the older works.

*Cnoc Dubh*.—On the side of the road half-way between Lamlash and Brodick. The slag has been removed for road-making.

*Cnoc Dubh*.—Immediately above the last site, but about 300 feet higher up the hill. Slag of the oldest type.

*Auch-na-Cheardach* (Field of the Smithy).—On the farm of Gortanalister, south side of Lamlash Bay. It is on the right hand of the road to Whiting Bay, at the side of a small stream, and almost at the highest point to which the road rises. The slag is much scattered.

*Largiebeg*.—On the upper side of the road between Whiting Bay and Lagg. About ten carts of slag from this site were used for drains.

## DUMBARTONSHIRE.

*Tarbert, Loch Lomond*.—In a wood near the shore of the loch and half a mile north of Tarbert. The older black infusible slag.

## DUMFRIESSHIRE.

*Ecclefechan*.—There are said to be numerous sites in this locality, but unfortunately I have not been able to obtain any definite information as to the exact positions.

## ELGIN.

*Meftwhi*.—Slag is abundant, and the surrounding ground has many circular pits of from 3 to 4 feet deep in which charcoal is found. The woods used were of the hard varieties, principally oak and beech. Timber is still plentiful in the neighbourhood. The locality is about 4 miles from the sea, and is 80 feet above high-water mark.

*Urquhart*.—On the side of the public road, half-way between Fochabers and Elgin, the remains of a very large bloomery have been discovered. The quantity of slag was so great that it was used for road metal. For a mile round the place the ground is covered with saucer-shaped depressions which contain wood charcoal. Besides oak and other hard woods, fir is found. A neighbouring bog has yielded the trunks of many fine trees, and great numbers of tree stumps show that large forests once existed in the district. The present timber growing has been planted during the present century. The slag is six miles due south of the coast line.

*Fochabers*.—Close to the railway station there is a deposit of slag. The monks of Pluscarden Priory had the whole right to the iron dug in the forests of Pluscarden. The Priory is about 12 miles from the site now referred to, and is still nearer the two previous sites.

*Edinkillie*.—Opposite the house of Relugas and about a mile above the junction of the Divie with the Findhorn there is a large deposit of slag. The site is on the top of a very high bank overlooking the Divie, and is not connected with the river or other stream. The parish of Edinkillie has many extensive mosses, which are crowded with the roots and trunks of what must have been splendid firs.

*Gedlock, Parish of Birnie.*—The heap has been entirely removed, but small pieces can be obtained when the soil is turned over.

*Glen Latterach, Parish of Birnie.*

*Shoggle, Parish of Birnie.*

*Rishtown, Parish of Birnie.*

*Achenroth, Parish of Rothes.*

*Culbin, Parish of Dyke.*

*Delavorar* ("Montrose's Forge").—According to tradition, this is a site on which Montrose's army encamped, and the slag is said to be due to the army forges. The material, however, is dense and black, and is not a forge slag but a bloomery slag, or, in other words, a slag obtained from an ore of iron and not from the metal itself.

*Redavie, Pluscarden.*

#### INVERNESS-SHIRE.

*Corriemony, Glen Urquhart.*—Slag of the oldest type.

*Lochan-a-Chailleach.*<sup>1</sup>—Near Aigas Ferry and on the road leading to Urchany. Slag and charcoal are found in large quantity.

*Farley.*<sup>2</sup>—To the east of the gamekeeper's cottage.

*Loch-nan-Eun.*<sup>3</sup>—At the east end of the loch and behind Farley Wood.

*Loch Bunachton, Drummoissie Muir.*—This work has been a very large one, and the quantity of slag is great. The water in the locality is much impregnated with iron. The condition and constituents of the slag show that bog iron ore was used.

*Aberarder, Strathnairn.*—Heaps of iron, slag, and charcoal refuse.

*Daviot.*—Several heaps of slag have been removed from the fields in the farm of Mains of Daviot.

*Clunes.*—Above Cawdor Castle, on the side of the road.

*Guisachan.*—At the head of Strathglass. The slag is close and heavy.

*Leek Roy.*—At the head of Glen Roy, on the lowest of the parallel roads, and just above the keeper's house.

*Dores.*

*Croy.*

*Rudhana Cheardach* (The Smithy Point).—On the hill south of Aberarder.

*Buntait, Glen Urquhart.*

*Soa Island.*—West coast of Skye.

#### NAIRN.

*Daltullich.*—The site is about  $2\frac{1}{2}$  miles south of Clava, and is situated on a knoll about 700 feet above the Nairn river. The slag is of the older variety, and

<sup>1</sup> *Proc. Soc. of Antiq. Scot.*, vol. xx. p. 353.

<sup>2</sup> *Ibid.*

<sup>3</sup> *Ibid.*

is accompanied by quantities of peat charcoal. A burn called the Alt Ruadh or Red Burn flows past the side of the mound. As its name implies, the water deposits much red iron ochre, such as is found in districts where bog ore is produced. Portions of the slag have undoubtedly been produced from the bog iron ore. The mound is about 24 feet by 18 feet.

*Thom-na-Hann* (Mound of the Furnace).—To the east of Clava.

*Lochan Choarun, Moy.*

*Loch Moy.*—On the side of the hill to the east of the loch.

*Drumbiry.*—Near Dunlichity Church.

#### PERTHSHIRE.

*Tom-na-Cheardach, Grenich, Strathtummel.*—The usual black refuse is obtained here. The charcoal used was from peat, and the smith's stone, with a round hole in the centre, still exists.

*Meall Douglas, Glengarry.*—About ten miles from Blair and midway between the shooting lodges of Clunes and Glaschorrie.

*Dalreich Burn.*—The heap of slag, which is from 30 to 40 yards broad, caps the top of a moraine heap.

*Iron Man's Corrie, Glen Almond.*

*Glen Quaich.*

*Pitlochrie.*

*Glenlochie, Killin.*—The heap lies about ten miles above the farm of the Braes of Glenlochie. The limestone rock of the district yields some iron, but it is not likely that it was ever worked for the metal it contained.

*Gleann-Meuran, Glen Lyon.*—Mounds of the usual black slag of the early period.

*Lochs, Glen Lyon.*—A mound of slag has been found, and the district yields much iron water.

*Tom-a-Crochaire.*—Ten miles west of Killin. At a burn called Allt-na-Cheardach (Burn of the Forge) the people of the locality have a tradition that there was a sword manufactory in the neighbourhood.

*Glenlochay.*—Heaps of iron slag and wood charcoal refuse.

*Strannich.*—Slag of the early period, and wood charcoal.

#### STIRLINGSHIRE.

*Rowardennan, Loch Lomond.*—The bloomery is about 300 yards east by north of the pier of Rowardennan, 100 yards west by north of the game-keeper's house, and within the edge of the wood, south side of the burn, on the left side of the road to the Parmigan Hill. Not many yards from this burn this road cuts the edge of the bloomery, but it is otherwise untouched. The slag and charcoal may be seen at this point. It is about 10 feet above the level of the loch.

## ROSS-SHIRE.

*Fearn*.—Belongs to the oldest type. Peat charcoal was used.

*Blackpark, Craigroy Burn, Edderton*.—The slag is of the older black form, and is mixed with clay, &c. It is found much mixed with bog iron ore, of which there are large local deposits. The charcoal was from wood. There is a vein of hæmatite at the side of this work, and a deep hole, through which the burn now flows, is considered by Mr Ross, of Alness, as the position of the quarry from which the iron was extracted.

*Alt-Minah-Blair*.—On the banks of the burn about  $\frac{1}{4}$  mile down the stream from Setnaruain Inn, and about 14 miles from Alness.

*Glen Docherty, Head of Loch Maree*.—Near the upper part of the glen and on the 1000-foot contour. The slag is black and of the oldest variety; one piece has adhering to it a portion of bog iron ore. Not connected with water.

*Glen Docherty*.—Immediately below the above, and on the 100-foot contour, there is at the side of a burn a very large accumulation of iron slag of the oldest variety. It is mixed with pieces of stone, with much mica interspersed, and there is also some calcareous slag and burned stones which closely resemble the limestone of Glen Logan hard by. Pieces of the stones of which the building was composed were also obtained with slag attached. Portions of bog iron ore were found.

*Loch-a-Chroisg, Auchnasheen*.—A large accumulation of the usual black slag. The furnace was on a hillock and not connected with water.

*Kenlocheve*.—On the top of one of the terraces at the upper part of Loch Maree, and unconnected with water.

*Tollie, Loch Maree*.—For a long time I was very doubtful if this site should be considered as that of an iron-work, and in Mr J. H. Dixon's book, "Gairloch," it was, at my suggestion, not included. Since the publication of that work however, I have visited the furnaces at Backbarrow and Newlands, near Ulverstone, and have found at these works pieces of slag which so closely agree with those found at Tollie that I am now inclined to the belief that the site is entitled to be recorded as that of an iron-work. The calcareous character of the slag leads me to the belief that the works situated here have been in operation at the same time as those at the Red Smiddy.

*Garavaig, Loch Maree*.—Slag of the oldest type, but light coloured, and with limey portions adhering.

*Gairloch Church Yard*.—A calcareous slag of doubtful origin.

*Fasagh, Loch Maree* (see description).

*Letterewe, Loch Maree* (described).

*A Cheardach Ruadh (Red Smiddy), Poolewe* (described).

*Talladale*.—Slag has been buried in drains.

## SUTHERLANDSHIRE.

*Loch Yues, or Unes (Lochan Aonias).*—The slag here is partly heavy and partly light. Portions are obtained with clay attached, and in some cases flints are found amongst the slag (Dr Joass' Golspie).

*Lairg.*—Black slag of the older series.

*Golspie Links.*—With clay attached and mixed with fashioned stones, &c.

*Suisgill Burn, Kildonan.*

*Loch Merkland.*

*Durcha.*—Mentioned by Mr D. W. Kemp in a paper to the Royal Scottish Society of Arts, Edinburgh, session 1886.

*Altasbeg,* two miles from *Durcha* (also mentioned by Mr Kemp).

The slags obtained from all of the older classes are black and heavy, and in no way resemble the slags made at our present blast furnaces. They contain large proportions of iron as oxide, very little, if any calcium (lime) compounds, practically no magnesia, and a variable proportion of silica as silicate of iron. The uniformity of ingredients, as well as the chemical conditions of the slags, are very marked, a fact which points most decidedly to a similarity in the process of manufacture as adopted all over Scotland, England, and Ireland, as well as over a considerable part of the continent of Europe.

Recently, during a visit to the Ulverston district, I obtained samples of slag, made within the memory of living man, which so closely resemble in properties and chemical composition those slags found all over the country as to leave no doubt that the process adopted in the older days (and which, so far as British metallurgy is concerned, is prehistoric), was practically identical with that employed at the Newlands Forge, near Ulverston. This process was essentially a bloomery process. As described to me by the present manager at Newlands Ironworks, the furnaces consisted of clay erections of a temporary character, worked first with wood-charcoal, and latterly with coke; the air being supplied by water-power. These furnaces have only been out of existence for a few years.

The extremely wasteful character of the process can readily be understood when I state that the proportion of iron in the slag, partly present as silicate, but also partly as finely divided metal, is not unfrequently found to amount to over 67 per cent. of the whole, whilst the present charcoal furnaces yield a slag containing from less than 0·5 per cent. to 14 per cent. of metallic iron.

## LOCHMAREE FURNACES.

The district round Loch Maree was the seat of very early iron-works; probably originated to supply local wants, but gradually, through the force of circumstances (which I propose to discuss), the district became a veritable iron forge for the whole of Britain. The reason for so great a development of this trade, at so distant a point of the kingdom, may be presumed to have been due to some special resource of the locality. The earlier works, as we have already shown, required bog iron ore, which, being open and porous, was the more readily reduced to the metallic form. The fuel was either wood charcoal or peat charcoal. Now, all of those substances abounded in the district.

*Bog Iron Ore.*—This ore is found abundantly, and is still being formed in many of the bogs. Mr J. H. Dixon conducted me over the ground, and we located eleven deposits, some of them very large.

First in point of size is that of South Erradale, where the inhabitants have built a wall, known as the Garadh Iaruim (iron dyke), out of the masses. Some of the pieces are from 9 inches to a foot in thickness, and from 18 inches to 3 feet square. This wall was the result of the establishment of crofts in 1845. The ore is of good quality, and would be readily smelted. Several of these deposits were sampled and analysed, with the following results:—

*Bog Iron Ores from Gairloch Parish, North-west Ross-shire.*

	Ferric Oxide.	Equal to Metallic Iron.	Silica.
1. Cove, . . . . .	(a) 72·54	50·77	3·56
	(b) 5·48	3·83	85·92
5. North Erradale, . . . . .	(a) 69·84	48·88	2·61
	(b) 55·42	38·79	12·64
6. Little Sand, . . . . .	73·68	51·57	4·72
7. Lonmor, . . . . .	73·16	51·21	3·84
8. Strath of Gairloch, . . . . .	30·48	21·33	60·56
9. South Erradale, . . . . .	(a) 70·88	49·61	7·48
	(b) 66·68	46·67	8·24
10. Point Gairloch, . . . . .	(a) 71·04	49·72	10·61
	(b) 20·84	14·58	61·08

It will be seen from these figures that the ore to be worked upon



was by no means poor, being in fact quite equal to many of the red iron ores now used for smelting, and superior to not a few of the blackband ores even after calcination.

There are certain traditions which may be read to infer that other local iron ores besides the bog iron were employed at these furnaces. The Bennetsfield MS. says, "Letterewe, where there was an iron-mine, which they wrought by English miners, casting guns and other implements, till the fuel was exhausted and their lease expired;" and in the letterpress of Blaeu's Map of the North of Scotland there is a statement regarding an inner Loch Ewe, "surrounded by thick woods, where in past years there had been iron mines." "It will be noticed, however, that both statements are based upon traditions relating to iron-works having been in the locality, and the passage from "works" to "mines" is more possibly a mere change of language, rather than an assertion as to actual mining operations. We have not been able to trace any grant which could be supposed to refer to iron-mining in this district.

Local tradition says that the ore was obtained from quarries on the side of Slioch, and the positions of these workings are shown in a great ferruginous band, which may be traced on the side of the hills for miles, and can be seen from the opposite side of the loch. I have gone over the various sites and have collected samples of the so-called ore. These have been analysed and shown to contain very little iron, and what little there is being present as iron pyrites,—a condition which would not be useful for iron manufacture, and which could not possibly have yielded the masses of iron which have been obtained from the various works. The total amount of iron in these local "ores," calculated as metal, varies from a little over 3 per cent. to about 8 per cent. An argument is based on the finding of portions of these rocks on the sites of the iron-works, and from the fact that the edges appear to have been intentionally broken. After very careful examination of the various sites and of the pieces of "ore," I have been led to the belief that there is no evidence to connect these stones with the manufacture of the iron. Possibly some of the fragments round and about Letterewe and Fasagh may be due to an after attempt to find silver in the locality, and which proved a failure. It is probable that the

belief in the presence of silver was due to the shining particles of white iron pyrites which are dispersed throughout the rock.

The second point necessary would be fuel for the manufacture of peat charcoal or wood charcoal. There are many historical notices referring to the forests which at one time abounded north of the Tay, but there are also special statements, some of which may be interesting.

In Munro's description of the Western Isles of Scotland, written in 1549 A.D., there are two notices:—"177, Ellan Ew.—Upon the shore of Lochebrune lyes Ellan Ew, haffe myle in length, *full of woods*, guid for thieves to wait upon uther men's gaire;" and "178, Gruynorde.—Northwarte frae this ile lyes the ile of Gruynorde, maire nore ane myle lange, *full of wood*, guid for fostering of thieves and rebellis." Both islands are stated to belong to "M'Enzie"; and again, in 1610 A.D., Mackenzie of Kintail gave Mr George Hay "the woods of Letterewe." If any doubt existed as to the vast extent of the forests, it would be set at rest at once by an examination of the locality, which is still covered by numberless tree roots now overlaid by peat.

The three principal sites of these more recent iron-works were at Fasagh, Letterewe, and Red Smiddy. Of these the second is purely historical, and it is very probable that the last was a branch or improved work belonging to the same parties. So far as I am aware, there is no statement on which to found an opinion as to the ownership of the Fasagh. I propose to describe these three works separately, as they are undoubtedly the most perfect remains at present known.

#### FASAGH.

This work was of great extent, and covered acres of ground. There is no direct evidence to connect it with the other two large works further down Loch Maree, but there can be little doubt that the period of its existence was one much more advanced in the metallurgic arts than that during which the slag heaps at Loch-a-Chroisg, Glen Docherty, and the Kenlochewe terrace were laid down.

The position of the works was on the south bank of the *Abhuinn an Fhasaigh* or Fasagh Burn, which flows from Loch Fada to Loch Maree. The works were situated close to the shore of Loch Maree. At Loch

Fada there are evidences of a sluice and dam, as if to retain the water at certain seasons. A reference to the rough plan of this work (fig. 2) will aid the explanation. The work was evidently built on the "island" principle, and was surrounded by a water-course constructed of stones. On

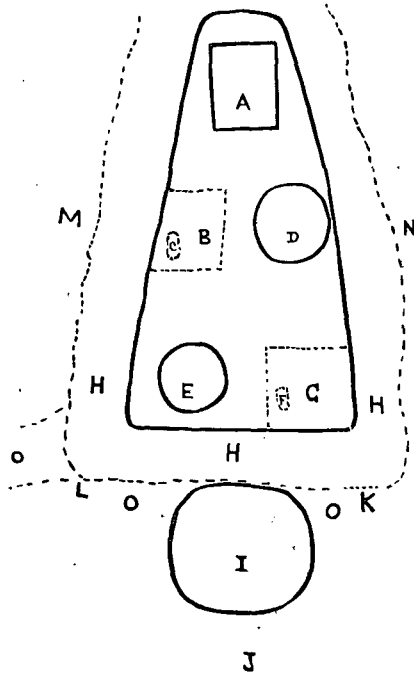


Fig. 2. Plan of Fasagh Ironworks.

A, building made of rough stones without lime; B G, hearths for casting; D and E, furnace beds, about 6 feet in diameter; C and F, tree roots embedded in slag; H, water-course defended on inner side by a built stone wall; I, large furnace site, 12 feet diameter; J, casting hearth for furnace I; K, depression, evidently for escape of water; L, similar to K; M, N and O, high banks of slag.

the island there was a roughly built house (A); two furnaces D and E with attached hearths B and G. The "island" most probably represented the forge where the manufacture of implements was carried on. A large

furnace stood at I, and had in front of it a bed of sand at J, to permit of castings being made. The whole site is surrounded by immense heaps of iron slag of the oldest black type. The only ore found in these works consisted of fragments of bog ore, which were obtained in the slags. Both hearths (B and G) have been made over the stumps of trees, which still remain. At hearth G, the roots of the tree have been surrounded by molten matter, which has cracked the wood and flowed into the cavities, filling them up. I removed some of the material and analysed it, with the result that it was shown to contain 66 per cent. of metallic iron, 1·48 per cent. of insoluble siliceous matter, and about 12 per cent. of carbon. It is undoubtedly much weathered, and is unlike any of the slags obtained from other localities. A bolt-like mass of a similar appearance was also found, and gave on analysis 62·5 per cent. of metal, 6 per cent. of silica, and over 10 per cent. of carbon. On the same hearth we obtained some heavy metallic-looking portions, which on analysis gave oxide of iron equal to 72·7 per cent. of metal, accompanied by 0·88 per cent. of silica (sand) and  $2\frac{1}{2}$  per cent. of carbon. When exposed to the air for some time, this material splits up and falls to a coarse powder. A piece of metallic iron obtained from the roots of one of these embedded trees gave 98 per cent. of metal and  $1\frac{1}{2}$  per cent. of carbon, with nearly  $\frac{1}{2}$  per cent. of silicon. The black slags contain over 60 per cent. of metallic iron. A heavy casting, evidently the "tuyere" of the bellows, was found some years ago at this works, and it is now in the museum of this Society. A cast metal ring with attached tongue, also obtained from Fasagh, is in the possession of Mr. J. H. Dixon of Inveran; it appears to have been part of the forge hammer. The hammer head is said to have been removed to the smiddy at Kenlockewe, and I was shown a mass of metal said to have been the one half, the other portion having been used to make an anvil. The anvil and mass are practically cast steel, and would accord with the class of iron made at the Fasagh. Whilst there is no direct evidence as to a connection with the other large works on Loch Maree, tradition points to the workers having been English, or at least English-speaking, for a spot of ground a little further down the loch is known as "Cladh nan Sasunnach," or the burying-ground of the English, and a pool in

the centre of a marsh, called *Lochan-Cul-na-Cathrach*, is pointed out as the place where the workers deposited their tools on leaving the district.

This Fasagh furnace was evidently one of the last works in existence at which bog iron ore was smelted with charcoal direct. There is no evidence, so far as can now be gathered, of any great improvement in the actual processes employed over those previously in existence in earlier days, although undoubtedly the works were much more extensive than was usual in other parts of the country. The process was a wasteful one at the best (as I have already shown by analysis), and left so much iron in the cinders that the bloomeries in the Forest of Dean "furnished the chief supply of ore to twenty furnaces for between 200 and 300 years."<sup>1</sup>

#### FURNACE, LETTEREWE.

This furnace is of great interest, as the earliest historic iron-work in the country.

It is situated on the north bank of the *Aimhainn na Fuirneis*, or Furnace Burn, which flows into Loch Maree about one mile to the south of Letterewe House. The foundations of the furnace are still to be seen, although by no means perfect. They stand on the top of the bank of the burn, which must have materially altered its course since the works were in existence. The furnace was built of Torridon sandstone and brick, masses of which, much vitrified, are still visible in large quantities.

The first mention of these works was in 1610, when Sir George Hay obtained the woods of Letterewe for use in his iron-works. This Sir George Hay probably obtained his knowledge of the manufacture of iron in Perthshire, for in 1598 he obtained from James VI. the Carthusian Priory of Perth and the ecclesiastical lands of Errol. Now this county was an early seat of iron manufacture. In 1612 the Parliament granted ratification of a licence given some time prior to "Archibald Prymroise, clerk of his maiesties mynis, ffor making of yrne within the boundis of the Schirefdome of Perth."

The reason why Sir George Hay (a native of Perthshire) found his way to the extreme north-west of Scotland may be found in a grant

<sup>1</sup> Rev. T. Ellwood, in *Trans. Cumber. and Westmorl. Antiq. and Archæ. Soc.*, vol. viii. pt. 1, 1885.

(1598) to the "Fife adventurers," who obtained from the crown the right to colonize the Lews, which at that time was in a state of internal feud.<sup>1</sup> These gentlemen were not successful, and in 1607 a further grant was made to Lord Balmerino, Sir George Hay, and Sir James Spens, who a year later made another unsuccessful attempt to obtain possession of the country. The road to the Lews lay in those days to Poolewe *via* Loch Maree, and thence per boat. Probably Fasagh was then in work, and Sir George Hay would at once see that with the great abundance of ore and wood on the spot a lucrative business could readily be established. Accordingly we find that "Lord Balmerino, Sir George Hay, and Sir James Spens, finding they were not able to manage the affair (of the Lews), and could not gett men to follow them, they sent for my Lord Kintaile, sold to him their own right and title yrof, with the forfeitry of Trotternish and Waternish, for a sum of money gin they took the woods of Letterewe in part of payment."<sup>2</sup> The purpose to which these woods were to be put is more fully brought out in the "Letterfearn MS.," which says, "Mackenzie did entertain the notion (to buy), and in end give them a sum of money and the woods of Letterewe, where the said George Hay kept a colony and manufactory of Englishmen making iron and casting great guns, untill the woods of it was spent and the lease of it expired."

In Speed's map of "The Kingdome of Scotland" (1610) there is an indication of "mines of iron" on the north-east of what is evidently intended for Loch Maree, although it is called "Loch Hew." This would of necessity show that the so-called "mines" had been established for some time previous to 1610.

Pennant notices "the remains of a very ancient iron furnace," and adds that "Mr Dounie has seen the back of a grate marked S. G. Hay, or Sir George Hay, who was head of a company here in the time of the Queen Regent."<sup>3</sup>

<sup>1</sup> For further information as to the cause of these internal wars the reader is directed to "Gairloch," by J. H. Dixon, Esq. of Inveran.

<sup>2</sup> From an old MS. in the possession of Alexander Mackenzie, Esq., of Inverness, to whom I am indebted for much valuable information.

<sup>3</sup> Pennant's *A Tour in Scotland*, 1772, pp. 383, 384.

This would place the commencement of the works between 1542 and 1560, but there is evidently a mistake, for Sir George Hay was not born until 1572. At the same time there is direct evidence that the works were in existence before the sale of the Lews and purchase of Letterewe woods, because in 1608 "Farquhar M'Cra, second son of Christopher M'C. born at Island-donan in 1580," was "selected by the Bishop of Ross as the best fitted to serve a colony of Englishmen at Letterewe, engaged in making iron and casting cannon, but was sent on a mission to the Lewis in 1610 with Kenneth, Lord Kintail, and afterwards settled at Kintail."<sup>1</sup>

From this it would appear that the works were a going concern in 1608, and the probable date of foundation would therefore be somewhere about the period at which the second charter of the Lews was granted, although it may have been even earlier, as Sir James Spens at least knew the locality as early as 1598, the date of the first grant to the "Fife adventurers" of the Lews.<sup>2</sup>

Iron working must have been extensively proposed at this time, for on the 27th January 1609 there was an Act entitled "Act anent the making of Yrne with Wode," in which it is stated that "being informit that some personis vpoun advantage of the present generall obedience in those partis (the heylandis) wald erect yrne milnis in the same pairtis, to the vtter waisting and consumeing of the saidis wodes. . . . . Thairfore . . . commandis, chairgeis, and inhibitis all and sindrie his maiesties leigis and subjectis that nane of thame presome nor tak vpoun hand to woork and mak ony irne with wod or tymmer under the pane of confiscatioun of the hail yrne. . . ." <sup>3</sup>

This Act, however, does not seem to have materially influenced Sir George Hay, for he shortly afterwards (Dec. 24, 1610) obtained a gift (which was ratified in 1612) of the "privilege of making of yron and glas workis within the kingdome of Scotland."<sup>4</sup> The glass manufacture was

<sup>1</sup> "MS. Hist. of the M'Ras," quoted in *Fasti Ecclesie Scoticanæ*, by Hew Scot, D.D., vol. iii. pt. 1, p. 99.

<sup>2</sup> The works are also referred to in the New Statistical Account of Scotland.

<sup>3</sup> *Scots Acts*, vol. iv. p. 408.

<sup>4</sup> *Scots Acts*, 1612.

not carried on at Loch Maree, so far as we know. Sir George took advantage of a peculiarly formed cave at Wemyss, on the Fife coast, and therein set up a furnace; but the concern did not pay, and was soon abandoned, the glass-house being allowed to go to ruin. The place it occupied is still known as the "glass cove."<sup>1</sup>

A year after the ratification of the above gift there was a proclamation made to restrain the export of iron ore from Scotland,<sup>2</sup> which states that certain of his Majesty's subjects have, after great expense, brought the manufacture of iron to reasonable perfection, and they being hampered by "the frequent transport of the irne vr furth of this realme," orders that "nane of thame presume nor tak vpoun hand at ony tyme after the publicatioun heirof to carye or transport furth of this realme ony irne or." How long the iron-works continued it is impossible to say, but the concern must have been in a thriving condition in 1621, for on the 4th of August that year Sir George Hay obtained a licence to sell his iron in any royal burgh and to any person, and that notwithstanding any privileges or liberties previously granted to the said royal burgh.<sup>3</sup>

Sir George Hay, afterwards Earl of Kinnoull, died at London in 1634. How far the works at Letterewe were carried on after the death of the founder I have not been able to determine. At any rate it is not likely that the Hay family had much connection with Loch Maree after that period, for Sir George Hay's son, who was a captain of the Guards under Charles I., and was an active royalist, was defeated by the powers in Scotland, and made prisoner in 1654.

There is a tombstone in Gairloch Churchyard to one of the Hay family, on which there is inscribed

..... R · LYIS · IOHNE · HAY · SON · ..... HAY · OF · KIRKLAND ·  
WHO · DIED · AT · LOCH · .....

In 1660 Blaeu, in his map, speaks of the "iron mines" as having

<sup>1</sup> *The Industries of Scotland*, Bremner, p. 376.

<sup>2</sup> *Regist. Secreti Concilii Acta*, folio 166, 7th April 1613.

<sup>3</sup> *Scots Acts*, 4th August 1621.



been worked in past years, thus leading to the belief that they had been out of work for a considerable period.

The slag found round the Letterewe furnace is very heavy and compact, and has the appearance of having been obtained at a high temperature as a somewhat thick mass, very difficult to flow. It has all the characteristics of a slag obtained from rich ores without the use of a sufficient quantity of flux. Other portions are more light and frothy, but none of the samples can be compared with the slags now obtained from blast furnaces where limestone is used to flux the minerals. An examination of the débris shows that the ore used at these furnaces was very different, at least at one period of their existence, from that employed at the Fasagh or at any other of the works we have yet considered. A part of the soil of the field at the side of which the furnace stood is composed of red iron ore or hæmatite; whilst in the wall and distributed over the ground are large pieces of a carboniferous rock, partly in nodular masses and partly fragments of a bedded rock. Now, neither of these ores are found in the neighbourhood, and they must therefore have been imported. That they came by sea there can be little doubt, for, leaving out of consideration the fact that there was no such thing as a road over which wheeled conveyances could travel, there is evidence to show not only the port but the exact place at which the ore was landed. At the landing stage at Poolewe large quantities of the ore and rock may still be obtained on the spot where they were landed from the boats. During the summer of 1885 the foundations for a new store were dug, and the material cut out may be said to have been practically the carboniferous rock.

A few hundred yards further south we find heaps of red iron ore, in a position which makes it very probable that the substance had been lifted directly from the boats by a windlass. These ores are identical with those found at the Letterewe furnace.

The reason why the boats did not proceed direct to the iron-works is not far to seek, for the River Ewe, which runs from Loch Maree to the sea at Poolewe (a distance of little over a mile), is not navigable, owing to a few hundred yards of rapids. The landing-place and stores at Poolewe were on the opposite side of the river from the iron-works at

Letterewe, and the road from Poolewe only seems to have been carried up the Ewe so far as was necessary to pass the rapids, after which water carriage would appear to have been again resorted to. This method of locomotion was, moreover, rendered necessary by the fact that the character of the country precluded the possibility of making a cart road or even a pony track, unless, indeed, such had been quarried out of the flanks of the mountains. To this day there is no carriage road to Letterewe.

The carboniferous stone has been described by Mr John E. Marr, C.E., who examined the district along with Mr J. H. Dixon of Inveran (to whom I am indebted for Mr Marr's report), as being composed of "septarian nodules with radiating crystals along the cracks, the others being bedded and containing numerous plants and fish remains, but no shells. These fossils show them to belong to the Carboniferous system." Professor James Geikie, who kindly looked over the samples I gathered, says, "The specimens must all have come from the Carboniferous of central Scotland. Nothing like them is known north of Fife." We have already seen that Sir George Hay had a glass-works in Fife, and the presumption is that the carboniferous rock would be obtained from that county.

I have made a series of analyses, so as to compare the chemical composition of these imported ores obtained at Letterewe and Poolewe with the native ores of Fife. The following is a summary of the results:—

	Furnace, Letterewe.	Pool, Poolewe.
* Ferrous oxide, . . . . .	8.388	5.286
Aluminic ,, . . . . .	1.241	1.313
† Calcic ,, . . . . .	35.511	12.074
‡ Magnesian ,, . . . . .	2.281	3.052
Insoluble matter, . . . . .	7.362	54.976
Carbonic anhydride, . . . . .	35.606	16.913
Moisture, . . . . .	4.246	2.816
Organic matter, . . . . .	5.223	3.412
	<hr/>	<hr/>
	99.858	99.842
* = Metallic iron, . . . . .	6.524	4.107
= Ferrous carbonate, . . . . .	13.510	8.526
† Calcium carbonate, . . . . .	63.414	21.562
‡ Magnesium ,, . . . . .	4.876	6.413

These results prove that the ore is a limestone with a small proportion (as is usual) of carbonate of iron. It weathers red, and when so oxidised looks exactly like a red iron ore. This appearance is greatly exaggerated owing to the solubility of the carbonate of lime, which, becoming dissolved, has left a thick coating of oxide of iron. In all probability the limestone was added as a flux, so enabling the furnaces to be worked with the imported red iron ore.

The hæmatite bears a striking resemblance to that obtained in the Ulverston district, and so far as general appearance and physical characters are concerned is identical. The substance varies much in chemical composition, as the two analyses given below will show :—

RED IRON ORE.		
* Ferric oxide, . . . . .	86·027	42·516
Aluminous oxide, . . . . .	0·214	1·418
Calcic „ . . . . .	0·106	0·494
Magnesian „ . . . . .	0·324	0·315
Insoluble matter, . . . . .	9·260	49·902
Carbonic anhydride, . . . . .	0·206	0·465
Moisture, . . . . .	1·212	1·246
Soluble silica, . . . . .	2·081	3·496
	99·430	99·852
*=Metallic iron, . . . . .	60·218	29·761
Sulphur, . . . . .	0·101	0·206

Samples of the red iron ore presently smelted in the Ulverston district gave :—

* Ferric oxide, . . . . .	85·6	89·4	54·2
Insoluble matter, . . . . .	14·0	8·3	40·6
* Metallic iron, . . . . .	59·92	62·58	37·94

The ores therefore are practically alike.

Let us now try to connect the Ulverston district with Loch Maree.

It is shown in the Scotch crown accounts that about the time of the starting of the works at Letterewe the king was bringing men from England to work in his mines. Sir George Hay was in constant

communication with the sovereign, being in fact a gentleman of the bed-chamber. He must therefore have known of these Englishmen being brought to the north, and also that they were learned in ironwork. That he availed himself of this information, and brought men from the south, is evident from the fact that their descendants are found in the Poolewe district to this day as Kemps and Crosses. The art of casting guns was well known in England, the works by Elizabeth's time having grown so large as to cause the Queen to pass an Act putting a stop to the felling of wood for the use of the bloomeries in Sussex. This Act evidently caused increased activity in other counties, for seven years after the first Act we have a similar Act passed regarding the Ulverston district.

The latter Act is interesting from the amount of light it throws on the manner of the manufacture of iron at that period. It would appear that it was passed as the result of a petition from the inhabitants, for Pennant says, "In Queen Elizabeth's time the inhabitants of Colton and Hawkshead Fells remonstrated against the number of bloomeries then in the country, because they consumed all the loppings and crop-pings, the sole winter food for their cattle. The people agreed to pay to the queen the rent she received from these works, on condition they were suppressed. These rents, now called *bloom-smithy*, are paid to the crown to this day, notwithstanding the improved state of the country has rendered the use of the former indulgence needless."<sup>1</sup>

"A Decree for the abolishing of Bloomeries in High Furnes, the Origine of the Bloomsmithies Rent and Confirmation of the Customes of High Furnes" (7th year of Elizabeth, 1563).<sup>2</sup>

. . . . that the queen's majestie's woods within the said lordships be sore decayed and dayly more and more are like to fall into great decay ; *not only by reason of certain iron smithies lately erected and demised* . . . . the queen's majestie . . . . are like after the expiration of the said lease not only to loose the yearly rent of twenty pounds now answered for by the said smithie's and whereas also the tenants and occupiers of the saidis lordships . . . . doth claim . . . . have always used to take and have comodity and profit of the said woods . . . . and thereupon have made their humble suit and

<sup>1</sup> Pennant's *A Tour in Scotland*, 1772, p. 33.

<sup>2</sup> *Antiquities of Furness, or an account of the Royal Abbey of St Mary, &c.*, by Thomas West, 1774, Appendix ix.

Petition . . . . that their customs of premises . . . . may be allowed, ratified and confirmed. . . . Whereupon the chancellor and counsel have fully heard all their allegations and reasons for the maintenance of the said customs . . . . ordered and finally decreed . . . . for all the residue of the said terme of years yet to come in the said iron smithies, that from the feast of St Michael the Archangel last past the said indentures, demise and lease of the said iron smithies . . . . and every thing therein contained shall cease, determin and be utterly void and frustrate . . . . and it is also ordered . . . . in consideration that the said customary tenants . . . . after such decay of the said iron smithies, shall have great necessity for iron for their necessary uses shall hardly come by the same *by reason that seldom any iron is brought from the partes beyond the seas* into any of the coasts adjoining to the said lordships and when any iron shall happen to be brought from beyond the seas . . . . yet the same cannot scarce by any probable means be carried into any of the said lordships . . . . because that the ways . . . . be so strait and dangerous and do ly over such high mountains and stoney rocks . . . . that all and every of the said customary tenants . . . . which shall happen to have wood remaining over and besides his or their necessary houseboot . . . . shall or may . . . . at all and every time . . . . of the same dispose and of the said shreadings . . . . make coales, shall and may burn and make iron . . . . at or in any iron smithies or other convenient place *at or upon any water, pool, stream, or beck.*"

Whilst this Act is not one applying to Scotland, yet it gives us much information as to the manners of a part of the mainland in constant communication with Scotland.

From the contents of the Act, it would appear as if the iron smithies were "lately erected and demised," but this was scarcely the fact, for "the mines, by the date of the passing of the Act, had been worked above four hundred years," as appears by a grant of William of Lancaster, lord of Kendal, to the priory of Conished in this neighbourhood, of the mine of Plumpton, probably part of the present vein. "The vestiges of the ancient workings are very frequent, and apparent enough, from the vast hollows in the earth wherever sunk in."<sup>1</sup> This extract would put the working of iron in the Ulverston district as far back as about 1370 A.D.

Formerly the abbot of Furness had the sole management and profit of the iron mines, and the exclusive power of making iron for the use

<sup>1</sup> Pennant's *A Tour in Scotland*, pp. 30, 31.

of his tenants and for exportation.<sup>1</sup> This latter point is more fully shown in "The Interrogatories on the cause betwixt John Brograve, Esq., Attorney-General for the Duchy of Lancaster, and the Tenants of Low Furness<sup>2</sup> [25 Eliz. 1582]: "3<sup>o</sup> item, Whether do you know of any allowance of bread, ale, or beare, or of iron that the late abbot did yield or allow to the said tenants," &c. The "depositions of certain witnesses on the behalfe of John Brograve" reply, "that he hath by credible report that iron was yearly delivered forth of the said monastery unto the said tenants;" "that certain clott iron was delivered and allowed yearly."

The Act further shows that iron was not made at certain large centres and afterwards distributed, for we are told that the government fear that, after the decay of the iron smithies consequent on the passing of the Act previously quoted, the people will be in want of iron for their necessary uses, because the metal is seldom imported; and further that even if it were obtainable, the roads would not allow of its being carried far inland. These statements show that the metal was made locally as required; hence the number of remains now visible, and also the comparatively small extent of such heaps of slag. The sites do not represent centres of industry, but mere local works to supply the wants of the peasants in the neighbourhood. The reason given for the necessity of local manufactories applies equally or with even greater effect to Scotland, where the ways were also "so strait and dangerous and do ly over such high mountains and stoney rocks." Moreover the Act distinctly states the positions of the works, for it says that the tenants may make iron "at or upon any water, pool, stream, or beck," thus giving us another connecting link in the history of the old iron manufacture, for the situations in Scotland are very frequently on the sides of running water.

The effect of this Act of Elizabeth was to cause the smithies to look for charcoal elsewhere, and this would naturally lead to the exportation of ore, as a larger quantity could be carried in the boat than of the lighter and more bulky charcoal or wood. But this point can be carried past mere supposition, for in a paper on the bloomeries of

<sup>1</sup> *Antiquities of Furness*, p. xxxvii.

<sup>2</sup> *Antiquities of Furness*, Appendix viii.

Rossendale in east Lancashire, Mr James Kerr has shown that, on the abolition of the High Furness bloomeries in 1565, the ore was carried to the forest of Rossendale and there smelted, and also that the Coniston slag is identical with the Rossendale scorix.<sup>1</sup>

In Pennant's time there was regular communication with Scotland, for he says that "the ore is carried on board the ships for 12s. per tun, each tun 21 hundred, and the adventurers pay 1s. 6d. per tun farm for liberty of raising it. It is entirely smelted with wood charcoal, but is got in such quantities that wood in these parts is sometimes wanting; so that charcoal is sometimes procured from the poor woods of Mull, and other of the Hebrides."<sup>2</sup> As to the class of work done at the Furnace Letterewe we are told that it consisted of "casting cannon and making great guns."

The only fragment of metal I have been able to find at Furnace Letterewe is of a crystalline nature, and contains over 97 per cent. of iron, fully 2 per cent. of carbon, and a little silicon. It is extremely tough and difficult to break, and is of excellent quality.

#### A CHEARDACH RUADH, OR THE RED SMIDDY.

This very extensive work was situated on the River Ewe, exactly at the spot where the navigable part of the river from Loch Maree ceases. It is close to the place where, we may presume, the ore brought to Poolewe was reshipped for transit *via* Loch Maree to the Letterewe Furnace, at a point 150 yards nearer the sea than the present wharf. Why this position was chosen can only be conjectured, but we may suppose that it had to do with the rafting of wood down Loch Maree from the extensive forests. A further reason would undoubtedly lie in the splendid natural situation for an iron-work of that day. There was on the side of the river a bed of gravel on which to build the work, and the river flowing past supplied motive power. It was at the end of the navigable waters of Loch Maree, and within reasonable distance of the ore supplies brought by sea to Poolewe, distant only half a mile, by a road still visible. At the east side a cut or channel (B) was made to

<sup>1</sup> *Trans. Historic Soc. of Lancashire and Cheshire*, 1872.

<sup>2</sup> Pennant's *Tour in Scotland*, p. 30.

supply power for the blast and hammers, and a dam was run across the river to ensure a sufficient quantity of water, and also it is said to act as a causeway for the transmission of ore to the work from the road on the opposite side of the river.

A glance at the accompanying diagram (fig. 3) will explain the details of the work.

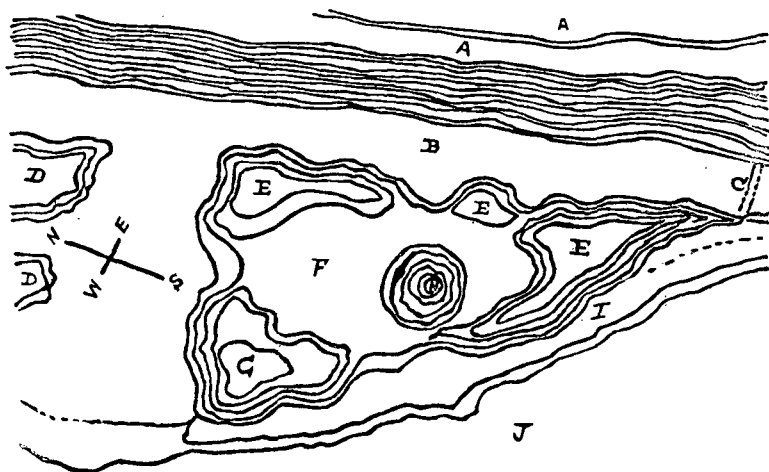


Fig. 3. Plan of the Red Smiddy, Poolewe.

A represents the old bank of the River Ewe standing high above the ground E F on which the Red Smiddy stands. All along this bank there is evidence of deposits of charcoal; B, the artificial water-course already referred to; C, an obstruction recently placed to block up the old water-course; D and E are mounds partly artificial, and possibly formed of the material removed when the water-course was being made; F, flat sandy space representing the casting floor; G, slag mound; H, position of the furnace; I, protecting bank of stones; J, bed of the River Ewe.

The chimney of the furnace is said to have been standing in the year 1852, and was then about 10 feet high. The furnace appears to have been built on the top of a heap of stones and rubbish, but it is more likely that the mass represents the débris of that construction.



It was built of sandstone and brick, and the heat to which these were subjected was sufficient to melt them at parts, and convert them into a glass which has filled in the cracks and cavities in the blocks.

The slag found at this work is quite different from that of any other work I have yet visited. It is purely calcareous, and shows that the character of the manufacture was entirely different from that of the other works round Loch Maree. It is open and porous, comparatively light in gravity, of a yellowish colour, and contains oxide of iron representing about 20 per cent. of the metal. It, moreover, contains a large proportion of lime, equal to nearly 25 per cent. of carbonate of calcium; is perfectly soluble in acids, the whole of the silica present, amounting to over 50 per cent., being in a soluble condition. It also contains a proportion of magnesia, and the sulphur is much higher than was the case in the Letterewe samples, being equal to 0·569 per cent.

The ores found at the work are hæmatite and a clayband ironstone. The former corresponds to that found at Letterewe and Poolewe, and has been obtained from the same or a similar source. Of the clayband ore, Mr Marr, C.E., says that the nodules are "mostly blue inside, and weathering red and yellow. Many of these were septarian, and when fossils occurred they were of shells, and there was no trace of plant or fish remains." The ore belongs to the Carboniferous system. Its analysis gave:—

	Red Smiddy.	Red Smiddy.	Pool, Poolewe.
* Ferrous oxide, . . . . .	42·227	31·589	48·591
Aluminic „ . . . . .	0·166	1·185	0·242
† Calcic „ . . . . .	1·210	17·519	2·396
‡ Magnesian „ . . . . .	5·963	2·644	2·918
Insoluble matter, . . . . .	14·322	7·483	7·863
Carbonic anhydride, . . . . .	33·398	37·017	34·867
Moisture, . . . . .	1·021	1·136	1·541
Organic matter, . . . . .	1·414	1·201	1·317
	<hr/>	<hr/>	<hr/>
	99·721	99·774	99·735
* = Metallic iron, . . . . .	32·810	24·544	37·755
= Carbonate of iron, . . . . .	68·108	50·950	78·358
† Carbonate of calcium, . . . . .	2·161	31·284	4·282
‡ Carbonate of magnesia, . . . . .	12·529	5·555	6·132

It is unusual to find carbonate of iron used as an ore at the direct-process bloomeries, the only other instance which I can bring to recollection being in Borneo, where the ore receives a preliminary roasting by being placed on the top of the previous charge of metal. At the Red Smiddy there is distinct evidence that the clayband ore was first roasted, for on the banks, marked A on the plan, pieces of the roasted ore with a beautiful columnar structure may readily be obtained. Agricola (1561) mentions the process of roasting iron ore before smelting it; and Campbell says, in his *Political Survey*, that some ore is roasted before it can be smelted. This last operation is performed in a large open furnace, the fuel and ore being mixed, and the fire kept to the greatest height by two pairs of large bellows moved by a wheel driven by water.<sup>1</sup>

At Red Smiddy the red iron ore seems to have been mixed with the clayband, and the two smelted together. The result of such an operation would be the production of a larger proportion of metal than could be obtained from either ore separately, accompanied by a more fusible slag. Campbell speaks of the advantage of mixing ores, and says that in the old times they scarce made within their footblasts or bloomeries one hundredweight in a day, and left as much more metal in their slags, whereas they now make two or three tons of iron in the same space, and leave a mere cinder behind. It is said that about a century ago there were eight hundred forges in England.<sup>2</sup>

The metal made at the Red Smiddy was of superior quality, containing about  $1\frac{1}{2}$  per cent. of carbon and about 0.25 per cent. of silicon.

The work conducted was evidently that of casting direct from the furnace. Sir George Stewart Mackenzie of Coul says, in his *General Survey* (1810), that he found the breech of a cannon among the rubbish, which had evidently been spoiled in casting. About 1840 there was at Aultbea an old hammer head which was known to have come

<sup>1</sup> Campbell's *Political Survey of Britain*, 1774, vol. ii. p. 43.

<sup>2</sup> *Ibid.*, p. 41.

from the Red Smiddy. It was very massive, and required two men to lift it, and from its great weight must originally have been worked by mechanical power. To be able to move it from the ground was long considered a test of manly strength. It is said to have been removed from Aultbea by Donald Macdonald, fisher at Lochinver, and appears to have passed out of sight.

In 1859 Dr Arthur Mitchell, C.B., found a small pig of iron, which is now deposited in the Museum of this Society.

In 1883 Mr J. H. Dixon of Inveran found another piece of metal, which he kindly forwarded to me through Mr Fraser, C.E., Inverness, and which is now the property of the Society.

In 1885 Mr Dixon discovered some other portions of metal, which still remain at the Red Smiddy.

In 1786 Mr Alexander Mackenzie of Lochend informed Knox that his grandfather had got from these works "an old grate and some hammers."

It is very difficult to form any opinion as to who started or worked these furnaces. Sir George Hay is never referred to as belonging to any other furnace than that at Letterewe, and the only link of connection between him and the Red Smiddy lies in a statement made by Pennant that he was told by the Rev. Mr Dounie that he (Mr Dounie) had seen the back of a grate marked S. G. Hay, for Sir George Hay.

This furnace is not mentioned in Speed's or Blaeu's maps. The latter, being of date 1662, speaks of the iron mines as a thing of the past; whilst Knox, in his tour, states that he was informed by Mr Alexander Mackenzie of Lochend that cannons were still made at Poolewe in 1668. If these authorities are correct, Sir George Hay could not be connected with the Red Smiddy, as he died in 1634. The date 1668 may be considered to be approximately that of the closing of the works, for Mr Mackenzie told Knox that his grandfather had "lent ten thousand merks to the person or persons who carried on the works, for which he got in return the back of an old grate and some hammers." Local tradition says that the work was in existence for a much longer period.

## INVERGARRY.

Burt, in his 14th letter, refers to a Liverpool company, who smelted ore at Invergarry about 1730.<sup>1</sup> The ore was imported, but a native hæmatite is also said to have been used.

At Gairlochy locks, on the Caledonian Canal, there is an old disused burying-ground, in which, twenty-five years ago, Dr Joass, of Golspie, found some pigs of iron doing service for headstones. These masses of metal were about three feet long, and were inscribed "1732."

The manager of these works was called Thomas Rawlinson. He gets the credit of having invented the modern form of kilt, by causing his workmen to detach the upper portion of the plaid from the lower, so as to leave their arms free for work.

Several heavy beams of iron are still in the neighbourhood.<sup>2</sup>

BUNAWE WORKS—*The Lorn Furnace Company, Taynuilt.*

These works were originally started by an Irish company in the year 1730. This company worked with imported ore, and for fuel they bought the woods of Glenkinglass. The company tried peat as fuel, but failed.

When the York Buildings Company took up the Strontian mines they sent to Glenkinglass for certain castings.

The Bunawe Works were taken over by Messrs Richard and William Ford, James Blackhouse, and Michael Knot. The lease ran for 110 years from 1752, and on the expiry of that period the tack was retaken by Messrs Harrison, Ainslie, & Company, who also possess large iron mines in the Ulverston district and the only two surviving charcoal furnaces in the country. The second lease was for 21 years, and fell out in 1883.

Through the kindness of Mr Hossack, solicitor, Oban, I have read the original leases, which are very full and complete.

The last lease was not finished, the works ceasing in 1866. The machinery was removed to England in 1878. The ore was imported from Ulverston.

<sup>1</sup> Burt's *Letters from the Highlands*, 5th ed., 1818, pp. 259-264.

<sup>2</sup> *The Culloeden Papers*, edited by Major Duff, of Muirtown, 1625-1748.

I have lately visited the Messrs Ainslie's furnaces at Newlands and Backbarrow, near Ulverston, and through the kindness of the managers obtained details of the working. The Backbarrow furnace is the older of the two (Mr Bellman, manager). It has in front of it an iron plate inscribed "I.M.W.R.S.C. 1711 \* H. A. + AND CO. 1870." At the time of my visit this furnace was blown out for repairs, and I had therefore full opportunity of examining it. It is about 30 feet high and conical. The top has lately been fitted with a bell to save fuel. The make is 4 tons of pig iron per day of twenty-four hours, or 28 tons per week. The charge for the 4 tons consists of

Charcoal, . . . . .	8 tons.
Red iron ore, . . . . .	6½ tons.
Limestone, . . . . .	8 cwts.
Lithomarge, . . . . .	4 cwts.

The substances are broken fine and thoroughly mixed, divided into 32 parts, and the furnace charged every 45 minutes.

The lithomarge is a bauxite from Ireland, and consists of

Alumina, . . . . .	53.62
Oxide of iron, . . . . .	42.26
Silica, . . . . .	4.12

100.00

This is the very same erection that Pennant saw during his tour in Scotland. The furnace was in existence long before 1711, as testified by the slags. The iron ore is rich, and the yield is about 60 per cent. To make 1 ton of charcoal 2½ tons of wood are required, so that for a ton of pig iron 5 tons of wood are needed, or the furnace burns 20 tons of wood in 24 hours, or 168 tons of wood per week.

The furnace is blown out once in three years for repairs, and it is kept out of blast during one year, so as to allow of an accumulation of charcoal. The company make some of their own charcoal and buy the remainder. The woods take sixteen years to grow, and the price paid for the timber varies from £3 to £18 per acre.

The slags now made are glasses variously tinged with colour, and are unlike any other variety of scorizæ. The iron is of the very finest quality, and fetches a high price.

The blast is cold and the air is obtained from upright cylinders fitted with leather valves. The piston rods act directly on the shaft, and the air is conducted into a cylinder, from which it is passed into the furnace direct.

The charge for the furnace has varied from time to time, that used at Backbarrow in 1738 being, for one week's work,—

Charcoal,	. . . . .	28 tons.
Red iron ore,	. . . . .	32 tons.
Ironstone,	. . . . .	10 cwts.
Limestone,	. . . . .	2 tons.

And the weekly yield of iron was 16 tons of pigs.

The present Newlands Furnace was built in 1747. The charges and general working are similar to those at Backbarrow. These are the only two charcoal furnaces now in existence in Britain.

Within a very few years there was at Newlands a forge for the manufacture of steel and wrought iron from the charcoal pigs made in the larger furnace. As described to me these furnaces were of a temporary character, and built of brick and clay by the workmen themselves. They required to be partially taken down before the charge was removed, and the amount of iron converted was about half a ton per day per furnace. The material after being fused was put below the hammer direct, as in the old bloomery process; and in fact the description given by Mungo Park of the methods used at the time of his journey in Central Africa very much agree with the account I obtained of the work carried on till recently at Newlands Forge.

The whole operations conducted within recent years and now in active work at Newlands may be said to be those by which iron was made in pre-historic times, with the one exception that the actual output has been enormously increased and the results improved.

#### ABERNETHY—STRATHSPEY, 1730 A.D.

These works would seem to have had their origin in the year 1728, when the York Buildings Company, of London, purchased £7000 worth of timber (60,000 trees) from the laird of Grant out of his Strathspey forest. Originally this purchase would seem to have been made with

the object of supplying masts to the navy, but the material turned out so small as to be worthless for such purposes. Colonel Horsey therefore in 1730 entered into a contract with Sir James Grant,<sup>1</sup> "for a supply of wood for charring purposes." The company set up iron furnaces in the neighbourhood of Abernethy, under the charge of one Benjamin Lund, where were produced "Glengarry" and "Strathdown" pigs, and they also had four furnaces for making bar iron. The terms "Strathdown" and "Glengarry" are difficult to understand, as neither name would seem to be local. The terms, however, appear in a pointing by John Grant in 1734-1735, which included "2½ tons of Glengarry pigs"; and he further removed from the furnace doors, where they lay, "52 tons of Strathdown pigs." Mr Murray suggests that Strathdown should in reality be Strathdovern, which is a local name.

I am not aware that there is any reason to suppose that the "Glengarry" referred to had anything whatever to do with the Invergarry, unless, indeed, the Invergarry pigs had established a name for their metal in the market which caused the York Buildings Company to adopt a similar title. The initial letter **I** also appears on two iron beams still in the neighbourhood, with the date 1730. Besides supplying their own wants, the York Buildings Company made large shipments of charcoal to Holland,<sup>2</sup> England, and other places.

The name of the manager of the company, Benjamin Lund, appears on several cast-iron pillars as "Benj. Lund, 1730." Two other members of the Company are known in connection with this undertaking, viz., Aaron Hill, the poet, who devised the rafting of wood down the Spey, and John Crowley, who fitted up a spring of water which is still known by his name.

Mr Caddell, of Grange, in 1883, found two square beams of about 2 hundredweight each. They were 18 feet long, 9½ by 7½ inches thick, and had a half-bearing cast at each end.

The iron ore was brought from Tomintoul, in Banffshire, a distance of

<sup>1</sup> *The York Buildings Company*. By Dd. Murray, M.A., 1883, p. 64.

<sup>2</sup> A curious point in regard to this export of charcoal lies in the fact that the brass workers of Edinburgh at this very time were buying their charcoal in Holland, and most probably receiving the material obtained by the Dutch from Strathspey.

nearly 20 miles, on pony back. It was a brown hæmatite, containing from 45 to 50 per cent. of metal, accompanied by from  $1\frac{1}{2}$  to 4 per cent. of manganese.

The Old Statistical Account says :—"In the year 1736 an iron mine was opened in the hill 'Leach-mhic-gothin,' which separates this parish (Kirkmichael) from Strath Don, by a branch of the York Buildings Company then residing in Strathspey. It was continued to be wrought till 1739, when by a derangement in their affairs they left the country. Since that period it has been totally abandoned. This mine is the property of the Duke of Richmond."

The adventure was unsuccessful, and in two years a loss was incurred of £6935, 6s. 11 $\frac{1}{2}$ d.

Beyond what has been stated, little is known as to the doings of this company, but Sir Thos. Dick Lauder has the following suggestive notice:--

A hammer-head, 21 inches high by 11 and 12 at the base, which must have been moved by machinery for pounding the ore, still lies on the top of a high bank, on the right side of the Nethey, immediately over the Iron Mill Croft. But the Croft itself bore no traces of any such work having been there, and was all cultivated, except a part of it at the lower end covered by a grove of tall alders, standing between the arable ground and the river running to the west. Such was the state of things when the flood of the 3rd and 4th of August scooped out a new and very broad channel for the river, right through the arable croft and a part of the alder grove, excavating it to the depth of 6 or 8 feet. Under this and in the middle of its new channel, to the astonishment of every one who has seen it, appear the lying beams or framework of a gangway across the water. A platform on the left of the sketch, which is nicely jointed and morticed together, seems to have been the foundation of the mill-house. There seem to have been upright posts in some of the beams, probably to support a platform above; the sluices for conveying the water to the works, and for the escape of flow-water, appear to have been between these upright posts. The whole timber is perfectly fresh, and the mortice ends of the beams are all carefully numbered with the axe. The haugh above must have formed a reservoir for supplying the machinery with water. On the brow of the high right bank of the Nethey the flood has exposed a bed of charcoal 18 inches thick, probably deposited there for the use of smelting works."<sup>1</sup>

<sup>1</sup> Sir Thomas Dick Lauder's *Account of the Great Floods in the Province of Moray and adjoining Districts*, pp. 197-200.



## CARRON, 1751.

Pennant, in his *Tour* (1759), p. 224, says, "Carron iron-works, about a mile from Falkirk, . . . . were founded about eight years ago."

The work was conducted at first entirely with charcoal, which was brought from great distances. Walker<sup>1</sup> mentions that many years ago this company purchased a wood on the estate of Glenmoriston, on the north side of Loch Ness, for the purpose of making charcoal. For this they paid £900, though it was distant 8 computed miles of very bad road from water carriage on Loch Ness, and had to be transported from thence to Carron.

The company was the first in Scotland to employ pit coal in place of charcoal, with the result that the works exist as a going concern to this day.

It is not my intention to follow the concern further. We have to deal only with charcoal furnaces, and as such they have ceased to exist.

## CRALECKAN (GOATFIELD) FURNACE, LOCH FYNE, 1754.

This furnace has given rise to much speculation and discussion. Wilkie, in his *Manufacture of Iron*, seems to have been one of the first to fall into the difficulty, for he seems to have come to the conclusion that "Goatfield" being the old name for Goatfell, in Arran, it must have been there that the furnace stood, and he accordingly added the words "in Arran" to the name of this work. One writer after another blindly follows, and the error appears regularly from that period. At my request His Grace the Duke of Hamilton kindly caused his agents at Hamilton and elsewhere to search for any document which would throw light on the subject, and Mr Stewart, His Grace's factor, kindly conducted the search at Brodick, but in neither case with success.

When it is stated that in 1788 the Goatfield furnace turned out, along with Bunawe, 1400 tons of metal, and that not a tradition even of such iron-works is known in the Island of Arran, the difficulty was increased. A careful search of the flanks of the Fell and of the surrounding country led to the discovery of several bloomeries, which are mentioned in their

<sup>1</sup> *An Economical History of the Hebrides and Highlands of Scotland*, by John Walker, D.D., 1812, vol. ii. p. 209.

proper places, but not the least information could be obtained as to a large furnace capable of turning out 700 tons of pigs per year. The solution of the difficulty undoubtedly lies in the fact that the local name for the farm on which Craleckan furnace stands is "Goatfield," and that therefore the works of that name were situated on Loch Fyne-side and not in Arran.

The importance of these works can be gathered from the fact that the name of the village has been changed from Inverleckan to Furnace. Being about eight miles distant from Inveraray, the works are sometimes spoken of as the "Inveraray" furnaces.

The works were erected in 1754 by a Lancashire company, who brought the ore from England. The buildings are now much broken down, except a large store which is used as a drill shed for the local volunteers. The aqueduct and forge also remain. The former ran along the bank of the river Leckan to a large water-wheel which gave the necessary power for the forge-hammer.

The furnace bears the date "1775 C.F." (Craleckan Furnace), and stands in front of its casting floor composed of sand. There was a large wharf, remains of which can still be seen. The older inhabitants in the district still remember seeing the string of from 30 to 40 ponies laden with charcoal coming over the hill road from Lochawe, which is distant about 10 miles. The material was contained in bags which were placed on a large cradle saddle to protect the sides of the animal. The work ceased in 1813, and was succeeded by a gunpowder work, which was wrecked by an explosion some two years ago, and has not been in operation since.

The cause of the decay of the charcoal iron-works is not far to seek. Scotland was far removed from ore, and, whilst Elizabeth's Act forced the industry out of the Ulverston district for a time, the people, who were the cause of the stoppage, soon discovered that they had in reality hurt themselves, and that much of the money that previously came to them through the iron-smelting works was not now available. They seem to have taken full advantage of the privilege of making charcoal with the excess of their wood, and gradually, as the progress of agriculture proceeded, they found better and more nourishing fodder for their cattle than

tree twigs and chippings. West, speaking of the land as he saw it in 1774, says:<sup>1</sup>—

“The land about Hawkhead is fitter for pasture, sheep walks, and wood than for agriculture. The last article is become a great object since the beginning of this century (18th) by the *reintroduction* of furnaces and forges for the making and working of iron.”

This reintroduction rendered it unnecessary to carry so much ore to the north to be smelted. Roads also were made, with the result that the older local or “customer” forges disappeared before the larger companies. But there was a greater foe to meet. Coal, which had been often tried, was successfully introduced for iron-working, and gradually one by one the charcoal furnaces had to succumb to the less costly coal-using works.

Little is known as to the actual cost of the metal in early days, the only actual figures that I know of being in the following extract, which also shows the method of calculating the weight, &c., of the metal:<sup>2</sup>—

“Interrogatories to be ministered to certain witnesses to be produced on the part and behalfe of the Queen’s Majestie’s Tennant’s of Low Furneis or Plain Furneiss. 5° item. How many loads of iron did the same tenants yearly have and receive out of the said monastery for the maintenance of their ploughs and husbandry, and what weight did every band containe, and what was every band worth to your knowledge?”

In the replies the following occurs:—

Robert Wayles, aged about 78, says, 5° item to the fifth interrogatory, “this deponent deposeth and saith, that he hath seen divers of the tenants of the said mannor come to the smithy of his father’s-in-law in Kirkby . . . bringing with them certain clott iron which they said was of their livery iron received out of the said monastery for maintenance of their ploughs and husbandry, and that he had divers times heard that the tenants of the said abbey received yearly amongst them out of the said monastery of the said livery iron to the value of eleven or twelve bands, ever band weighing fourteen ston and every ston fourteen pound, which at that time was worth eight pence a stone.”

I am well aware that the subject has not been treated nearly so fully as it might have been. It has been my endeavour to cut down the great mass of information received to the smallest possible bulk.

<sup>1</sup> *Antiquities of Furness*, p. xxxvii.

<sup>2</sup> *Ibid.*, Appendix viii.