

Excavation of Bloomeries in Rannoch, Perthshire, and elsewhere

by W. G. Aitken

It is some considerable time since any attempt has been made to investigate the ancient iron industry in Scotland. This in part has been caused by the difficulty in finding and identifying slag heaps and hearths, and in part to the fact that these can be found now only in the more remote and uncultivated areas.

Undernoted is a report on various excavations of bloomeries carried out over the past six years, and of work which is still being undertaken in certain areas.

DESCRIPTION OF THE RANNOCH AREA

The limits of the wild and desolate area known as the Moor of Rannoch are difficult to define but might fairly be said to enclose an area stretching from Mamore Forest to the north, to Glencoe in the west, Strathfillan to the south and Loch Rannoch in the east. The surface is varied with streams and even rivers draining it, mountains enclosing it, lochans, moraine mounds and peat bogs spreading over the flatter stretches. The most striking feature, one which draws attention to itself, is the immense quantity of glacial drift boulders, nearly all granite, which lies in disordered masses almost everywhere the eye can reach. These rocks can reach the dimensions of a small cottage and there are many perched on top of each other, tribute to the slow melting ice which brought them to their resting place. Moss, grass, heath, heather and stunted bushes clothe the ground. Up to about 10 years ago trees were few but the work of the Forestry Commission is rapidly changing the face of the Moor. In twenty years time the Moor of Rannoch will again appear to the onlooker much as it must have done to the ironworkers at their hearths. The proof that trees once grew abundantly lies just under the present surface. The Forestry ploughs tear up and expose the roots and stumps of earlier forests – the *raison d'être* of the iron industry in the area. The large proportion of pine charcoal in the slag heaps is supported by the fact that the majority of these roots are of pine trees. That the Moor was not always the desolate and deserted place it is now is proved by the ruins of ancient 'clachans' which are to be found in many secluded and lonely spots in the heart of this amazing place. I am quite certain – as far as the bloomeries are concerned in Rannoch – there are many more to be uncovered, and that, in the fifteenth century at least, the area was a 'good going concern'.

THE SITES

No. 1. Bridge of Gaur, Rannoch

My attention was first directed to a dispersed slag heap at Bridge of Gaur at the western end of Loch Rannoch in Perthshire, by Miss Alison Cameron. (No. 1 on Table 1 and fig 2.)

The site is on a flat-topped knoll with a large stream flowing past into the Loch which lies about $\frac{3}{4}$ ml to the E. On the N face of the knoll and very close to the right bank of the stream, I uncovered a large well-built kiln. This structure is later than the bloomery as slag from the site above it was found at the base of the kiln among the infill, and a quantity of the same material had been used to fill the 'backing' around the sides of it. This kiln was made the subject of a separate report.

The actual hearth was difficult to find, but greatly assisted by advice from Dr Tylecote I eventually uncovered the bowl and the surrounding stones. It is an extremely good example of its kind with a considerable amount of slag adhering to the sides and base of the hearth, particularly thick at the western end where two large stones marked the position of the tuyere, and where the heat would be greatest. The hearth or 'bowl' is rectangular rather than circular and, by the position of the stones surrounding it and the shape of the slag adhesions, had been cut out originally in that shape. A double line of stones extended west of the hearth, opening out in a fan or funnel shape and having a rough paving or cobbling of small stones within the area thus enclosed (fig 1).

Although the whole top of the mound was covered with a thin layer of slag, disintegrated

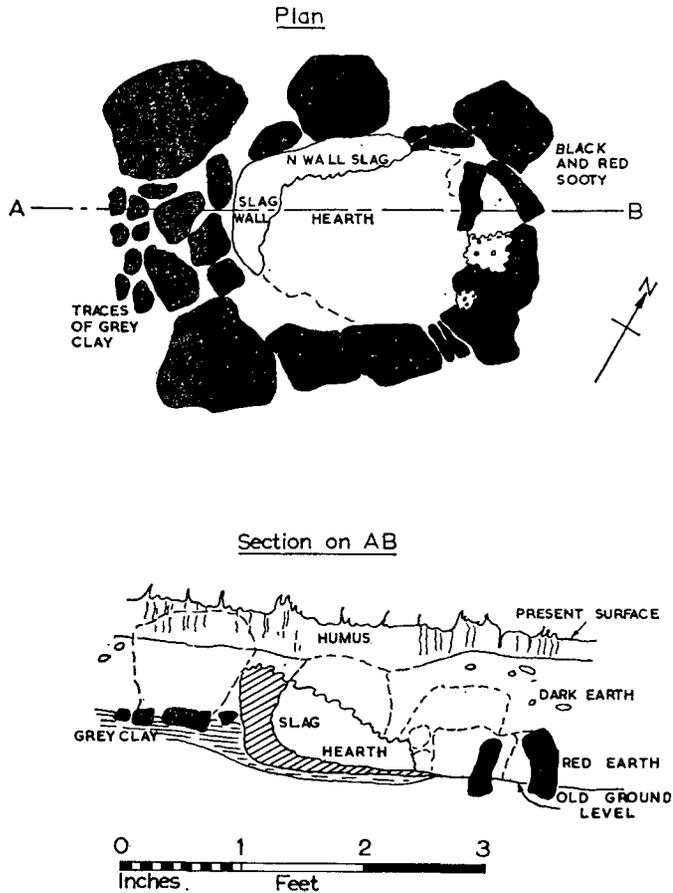


FIG 1 Smelting hearth at Bridge of Gaur, no. 1

charcoal and patches of dark red earth, no sign remained of the usual heap of slag. It could be assumed that the kiln builders had used the material and had probably scattered the rest in order to flatten the top of the mound for ease of walking.

No. 2. The Dunans, Bridge of Gaur

The Staff of the Forestry Commission, on whose ground many of the sites lie, having seen site no. 1 uncovered, recollected certain areas where the large Forestry ploughs had passed over heaps of slag. As far as was possible I examined and excavated the sites indicated. Many were

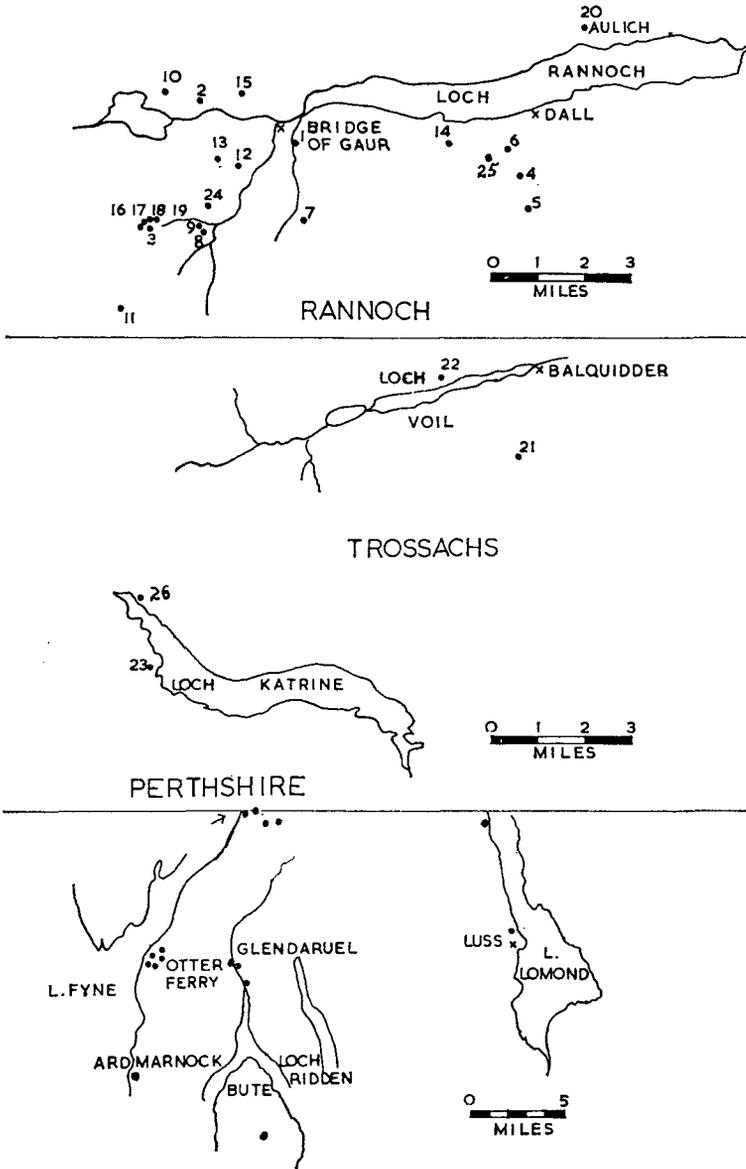


FIG 2 Distribution maps of some sites mentioned in Tables I and II

irretrievably damaged by the great ploughs, and only finds of stones with slag adhering provided proof that a furnace had been in the vicinity. Site no. 2 was a case in point. Between two streams in a small sheltered valley some 300 yards to the N of the road to Rannoch Station and 1½ mls from Bridge of Gaur, the plough had torn right through the long axis of a very large slag heap. This heap, some 32 ft long and 22 ft wide, was the largest found in the Rannoch area. Composed of a vast quantity of reduced charcoal and slag, I had hoped that it would produce a good example of a hearth, but in spite of careful digging only an area of tap slag and some large stones were found, the plough having gone right through the hearth itself.

No. 3. The Barracks

The Forestry Commission, in the course of opening up the Moor of Rannoch, have driven several roads into the 'wilderness' and at the end of one of these some four miles west of Gaur a complex of five heaps close together was found. Again the ploughs had scattered and broken up the mounds but part of a hearth was found intact at one point, while a fine piece of adhesion – slag on granite – was found among the 'scatter' of another heap. It might be fair to assume that there had been at least five hearths in this area. The part-hearth had a flat 'slabbed' area formed by two large flat stones with a wall of large boulders at the east end. Behind this wall was an area of solid tap slag. A quantity of charcoal was found nearby and some pieces were sent away for identification. The west end of the hearth had been cut across by the plough.

No. 4. Upper Dall (fig 3)

Dall lies some five miles E of Gaur, down Loch Rannoch and on its S bank. To date five slag heaps have been found in the area and of these five no. 4 Upper Dall proved to be of great interest. The main feature was a platform of four large flat stones roughly 3 ft wide and 6½ ft long, ending in a rough semicircle of boulders, double banked at the southern end. Beyond this wall lay areas of almost unbroken tap slag. No less than seven different layers could be distinguished. A number of large stones at both sides of the platform – disturbed by the plough – might indicate that the wall had been continued for a short distance northward. At the northern end two large stones were sunk into the earth with a smaller oblong stone a little way from the

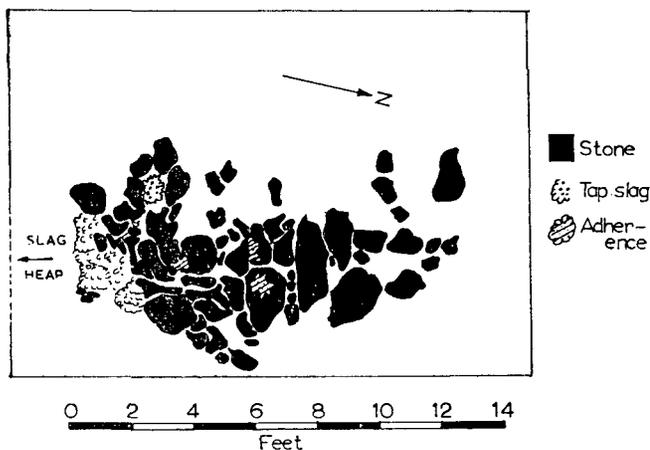


FIG 3 Smelting hearth at Upper Dall, Rannoch, no. 4

gap between the two but on the centre line. At the S end of the 'platform' there was a depression walled in on one side by the semicircle of large stones. There was an area of adhesion within the depression. Several patches of slag adhesion were noted on the surface of two of the large flat platform-stones. The tap slag had been poured southwards around the base of the wall, and a number of the wall stones were enclosed at their base by the slag. There was no great heap of slag as most of it had found its way into a small valley beyond. To the W of the site, at a distance of some twenty yards, a number of large stones marked the possible position of a rectangular hut.

No. 5. Outer Dall

Unfortunately this site had been so cut about by the plough that no excavation could be attempted. Samples of slag were recovered.

No. 6. Lower Dall

This site, situated in a planting of some age, was difficult to examine. A 2 ft thick layer of sand covered the slag heap which was of no great size. An area of tap slag was recovered in reasonable condition, but when this was followed back, an old tree was found to be growing on top of the position assumed to be that of the hearth. The nearest stream to the site is some fifty yards away, therefore it may be taken that the sand had been washed down from the hillside over a long period of time and before the area had been covered with trees.

No. 7. Leagag

A mile due S of Site no. 1, on the W ridge of a hill (Leagag, 1,909 ft) another slag heap was found.

It lies in a most difficult, if picturesque position, situated on a narrow ledge with a steep slope in front. Down this forward slope lies a large quantity of slag. Access is really only possible from behind the ledge on which the hearth stands – and that with difficulty. A very turbulent stream with a series of falls is some 15 ft to the W of the site which is located roughly on the 1450 ft contour. A very puzzling site on which to find a hearth.

Nos. 8 and 9. The Red Stable, Glen Comrie

Glen Comrie is a comparatively narrow valley leading W from Bridge of Gaur to the more open Moor of Rannoch. The high ground on the N side of the valley is dominated by the hill of Meall Chomraidh (1,522 ft), while the S side is a line of hills rising to over 2,000 ft. The valley floor is flat, marshy and drained by the Chomraidh Burn flowing E into Loch Rannoch. Three miles up this valley from the Loch, and on the lower slopes of the hill, there is a succession of natural platforms or small plateaux. One slag heap was discovered on one of these on the 1,000 ft contour. The heap was circular, roughly 15 ft in diameter. The hearth is still to be found.

The second slag heap was located within a planting about 300 yards to the N and almost on the valley floor. The site had been too badly damaged to expect any results from excavation. (No. 24 lies directly N across the valley from these sites.)

No. 10. Station Road. Rannoch

This site on private ground, lies on the top of moraine mound on the right hand side of the road leading to Rannoch Station. It has not been disturbed as far as can be seen. The slag heap is fairly large and has spilled down over the W and N sides of the moraine.

No. 11. The Greens. Moor of Rannoch

The Forestry road running W through Glen Comrie ends about 5½ mls out into the Moor. About 400 yards still further W and beside a large stream a 'box' type bowl-hearth was uncovered. It is similar to no. 1 with a southern protrusion of slag about seven inches high. The plough had just missed the bowl but had scattered a number of large stones, one or two of which bore visible signs of having been in close proximity to heat. An interesting point regarding this hearth, was the fact that the interior had been deliberately filled with a number of thin small stones set on end. I first examined this site in 1965 then left it to be excavated the following year. However, I was not able to return until 1970, only to discover that the young trees had grown so high as to lose for me all landmarks. A close search failed to refind it, but the Forestry Superintendent, Mr P Garrow, has kindly indicated that as the occasion arises a full scale search will be made.

Nos 12, 13, 14, and 15. Comrie Hill, West Camghouran Farm and Coille Bhienie

These are reported sites and at least one – Camghouran – will be excavated.

Nos 16, 17, 18 and 19. Barracks

These were discovered while working on no. 3. All the heaps are large, and are within yards of each other. A stream had run close by the site, but when the Forestry road had been constructed its course had been diverted. The actual position is at the termination of a branch road which turns off northwards from the Glen Comrie Forestry road at a point three miles from Gaur.

No. 20. Aulich, N shore of Loch Rannoch

This site was reported to me by Mr Dickson of the OS. It is on the ground of Viscount Wimborne of Craiganour, about ¾ ml from the Loch shore and on the 1,000 ft contour. The situation is open and the slag heap easily distinguished by an almost circular mound covered with short green grass, in sharp contrast with the heather-covered ground around it. The mound measured approximately 27–28 ft in diameter and was 4 ft thick at the centre. It did not appear to have been disturbed. This point is important, since when the mound was opened by trenching a well-laid structure of large stones was exposed – more than half of it under the slag of the mound. No doubt, of course, a great deal of this overlay could be caused by slip from the upper part of the mound. In shape the structure is a broad arrowhead, the arms forming an angle of roughly 90 degrees. The point of the 'arrow' is to the S, the longest arm (12 ft 6 in) points approximately NE. The other NW arm is much broken at the farthest point from the tip of the arrow and is only some 8 ft long. The width of both arms is a fairly constant 3 ft. There is only one layer of stones forming each arm. Dr Tylecote suggests that the structure is probably the foundation of some form of shelter, and if it were higher it would certainly give protection against the prevailing wet SW wind. The site is very exposed on a bare hillside and indeed, I would have welcomed some form of shelter several times. With regard to the fact that so much of the structure lay under slag, my latest experience on no. 24 Darachan (see below) would indicate the amount of movement of slag, from the higher part of the mound to around the edges, is quite considerable. Although a quarter of the heap was removed, i.e. the quarter covering the stones, no trace of the hearth was found, but there are three quarters of the mound left to examine still. The site was covered in but will be re-examined later. If the ore used was bog iron, it is likely that two large depressions in the hillside, quite close by (now filled with water), could be the places where the bog iron was obtained; Mr Wilson, the farmer, indicated that once, under conditions of

severe drought, the bottom and sides were covered with a reddish brown deposit, left when the water had evaporated.

No. 21. Balimore. Balquhidder

Examination of this site showed that a part of the farmstead had been built on top of the area. The slag heap apparently had been where the garden now is and the occupiers over the years had continually turned up slag when digging the ground.

No. 22. Loch Voil. Balquhidder

This site was reported to me by Mr Dickson of the OS. It is on the banks of a stream close to the Lochside. It is on private ground, and is still to be excavated.

No. 23. Stronachlachar. Loch Katrine

This was an interesting site, but a difficult one to examine. It is beside a large stream, 300 yards NW of the house occupied by the manager of the Glasgow Corporation Water Works. A few yards away are the ruins of a very old cottage which is enclosed by a turf dyke. From this dyke the remains of 'lazy beds' can be traced, running downhill. There was, apparently, no slag heap and pieces of this material seemed to be scattered over a wide area but in no great quantity. On examining the foundations of both the cottage and the dyke, I found that slag had been used as 'bottoming' for both. Close search discovered the hearth. Although it had been badly damaged it still retained a half sphere of slag within the bowl. This had been scooped out of fine sand and where it could be measured undamaged, was 17 in in diameter. The half sphere of slag measured $7\frac{1}{2}$ in across the undamaged diameter and 5 in from the circumference to the broken centre. Some large stones were found around the edge of the bowl. An interesting point arises regarding a site such as this in the Loch Katrine area. G Turner in an article printed in vol I (1907) of *Scotia*, the journal of the St Andrew's Society, indicates that in 1456 the Laird of Buchanan obtained the licence to manufacture iron, and to pay the Crown rent of Duchray and Drummond in that material. The works were situated in SW Perthshire, NE Dunbartonshire and the NW part of Stirlingshire on the banks of small streams and rivulets flowing into Loch Katrine and the Forth. It does not follow, of course, that this site is one of these mentioned, but until larger and more sophisticated sites are discovered in the area which can be clearly shown to belong to the fifteenth century, it is at least a hard date for basing the working of iron in the neighbourhood.

No. 24. Grundd nan Darachan, Rannoch (Table 1; fig 4)

The name is that of an old ruin about 200 yards W of this site, which is on a flat-topped knoll 40 yards off the Barracks Forestry road on the left going west. This is the first site of all those examined in the Rannoch area which was easily accessible and allowed a complete and careful archaeological search. The slag mound had been circular, but slip to the west down a slight slope gave it now a rather pear shape, the 'bulb' being on the higher side. I marked off an area 20 by 20 ft which included a large part of the slag heap. When the turf and heather was removed, followed by a 6 in layer of soil, several large stones appeared. One was quite flat-topped with a slightly sunken area about 18×12 in which seemed to have an artificial appearance of chip marks or peckings. Lying beside this boulder was a large granite pebble which had one flat face. It fitted the hand perfectly with the flat face downwards. Without proof it cannot be stated that this was used as a rough and ready anvil, but it is at least possible. As the various layers of soil were removed the original surface became obvious, with the various gradations of colour from brown, red brown to the usual charcoal black.

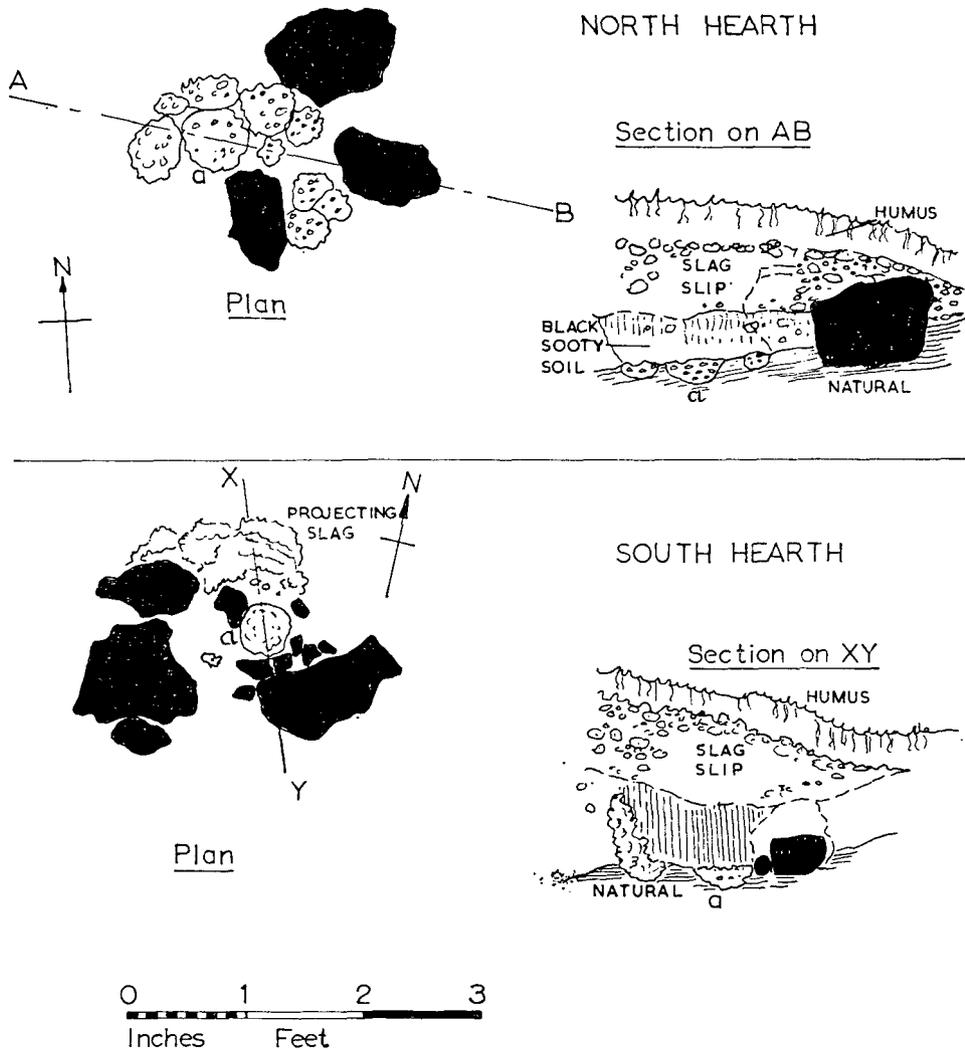


FIG 4 Smelting hearths at Grundd nan Darachan, no. 24. The two hearths were 7 ft apart on the east and higher side of the slag heap; 'a' indicates the position of the hearth bases

When the slag heap was skinned of turf, it was obvious that the overspill was between 3 and 4 ft all round. Work was now concentrated on moving the slag from the east or slightly higher side on a segment of the circumference measuring some 18 ft. The first hearth was found about 3 ft within the slip of slag from the mound. It is a bowl type with a quantity of slag adherence standing up about 8 to 9 in above the level of the base bowl. This projection of slag was on the NW side of the bowl and nearest to the heap. Almost a half sphere of slag remained within the bowl.

Moving N and following the curve of the slag heap, a second hearth was uncovered. The median line drawn between the usual two stones on the E side, and through the centre of the bowl ran due E to W, the western end being nearest to the slag heap. Whereas the first hearth retained its bowl-like character, this second hearth was different in all respects but one. Beginning

with two moderate-sized stones at the west end, a space, quite flat, was lined or paved with lumps of heavy rust coloured slag. This formed a flat surface about 10 × 10 in. This was immediately followed by what appeared to be a flat circular piece of slag 5½ in in diameter. When this was removed it proved to be a 'half sphere' 3 in thick at the centre point, and was obviously the *bottom of a bowl hearth*. Another lump of slag of some 6 × 5 in completed the hearth. There were no stones enclosing this end. The thickness of the filling (of reduced charcoal and earth) was on average 6 in thick, while the top covering of slag which had slipped over all varied from 8 in at the eastern to 18 in at the west end.

This is the first time I have come across more than one hearth associated with a slag heap in this area, but since most of the slag heap sites are in very difficult ground, it is possible that some of the others might still contain a second or even a third hearth. For example the very large slag heap at the no. 2 Dunans site, which is about four times the size of this one at Darachan, is very likely to have had more than one hearth. My experience on the latter site would lead me to suggest that close attention (where the condition of the site allows) should be paid to the slag slip around the perimeter of the heap. Careful examination of the slag heap led to the recovery of many bowl-bases, indicating that, after a few firings, the base of the 'bowl' had been cleaned out in readiness for the next firing.

Ardmarnock Forest, Argyll (Table II)

This site, on Forestry land, was visited in company with members of the Cowal Natural History Society. Lying on top of debris flung up by the Forestry plough was a flint blade, both edges being carefully sharpened by a series of pressure chips (the blade has been retained by the Society for further examination). Under the circumstances of the find I do not think that it can be connected with the ironworkers. However, another two finds can be more definitely attributed to them. A piece of pottery protruding from the edge of the trench made by the plough, and a foot or so from the spill of the slag heap, led to a careful examination of the immediate area. This resulted in finding sufficient fragments to identify them as having formed (a) a cooking pot, (b) a jug.

These have been identified as (a) cooking pot, Leuchars ware late thirteenth-early fourteenth century; (b) jug, probably of the same period and type. The Cowal Society undertook further excavation of the site but to date have not found the hearth. The slag mound is circular.

Cairndhu, Cairnbaan, Crinan, Argyll (Table (Roman) II)

This site is on Forestry ground and was reported to me by G Davis, Forestry Estate Officer. It is situated on the southern flank of high ground above the Forestry Offices and overlooking the Crinan Canal. It had been the object of previous curiosity and some slag lay scattered over the mound which was small and circular. With the assistance of members of the Mid-Argyll Nat. Hist. Soc. the site was excavated and a hearth uncovered.

THE FINDS

Appearance of the slag

The appearance of the slag varies in the heap from small to fairly large rough cindery masses, sometimes containing small particles of charcoal. Closer to the hearths themselves, the slag has the usual appearance of having had a 'toffee'-like consistency, with the top surface showing the ripples of flow. Within the bowls the slag takes on a rough craggy appearance and there would seem to be a rustiness in colour lacking in the slag discharged on to the heap.

A few fragments of the same heavy compressed sandy material, found in association with some of the other sites, were found lying on the original surface. This must be poor grade bog iron ore. No iron nodules were detected. As further examination of the terrain was carried out, many 'pockets' of bog ore were discovered ranging from light sandy material to quite solid masses, usually these were discovered not far from hearth sites.

The fuel

Random samples of charcoal found on the various sites were identified as: Scots Pine, Ash (not mountain ash), Oak, Birch. I am informed that, in the Rannoch area now, Ash and Oak are uncommon especially on the Moor.

Observations

Where it was possible to recover the actual hearth, the type-pattern was as follows:

Circular 'bowl'	Stronachlachar, Loch Katrine No. 24. South hearth, Darachan No. 4. Upper Dall (probable)
Rectangular	No. 1. Bridge of Gaur No. 24. North hearth, Darachan No. 11. Outer Barracks
With stone flagged area	No. 4. Upper Dall No. 3. Barracks
Arrow shaped construction partly under slag heap	No. 20. Aulich
Clay observed either in furnace, i.e. as 'bedding' or in close proximity to it	No. 1. Bridge of Gaur No. 8. Glen Comrie No. 4. Upper Dall No. 6. Lower Dall Ardmarnock Otter Ferry
Streams in vicinity, i.e. not further away than 40 yds	In every case with the exception of nos 10 and 20, and Cairndhu. There had been a stream very close to the Barracks group of five -- nos 3, 16, 17, 18 and 19, but a new Forestry road has diverted it into a new bed.

Slag heaps

There are two types of slag heaps. Those I would describe as of the 'crag and tail' type, and those which are circular. The hearth associated with the first type is usually found at the 'crag' end, while the hearths associated with the circular type can be anywhere on the perimeter of the mound. The largest 'crag' type was no. 2 The Dunans. Some 35 ft long by 22 ft wide, it also contained the greatest amount of charcoal dust and debris.

The circular mounds were at no. 20 Aulich, no. 8 Glen Comrie, no. 24 Darachan, Cairndhu, no. 14. West Camghouran, no. 22 Loch Voil. Many of the others must have been circular also, but had been so badly damaged by the ploughs that actual identification was difficult.

No. 7 Leagag. Here the slag had been tipped down the steep hill-slope. No. 4 Upper Dall. The slag, apart from the flat area of Tap slag, had been allowed to fall into a small valley. At Stronachlachar the slag heap had been dispersed. This had happened also at no. 1 Gaur.

It was impossible to be quite sure about the shapes of nos 3, 16, 17, 18 and 19 as, again, the ploughs had torn up the whole area.

The direction of the hearth openings

I found that there was no settled direction in which one might say that the entrances backed onto – to receive the draught as it were.

Taking the two stones which seem to point to the position of the tuyère as being the opening into the hearth, the directions, where identifiable, were as follows: three hearths opened towards the N, three to the S, three to the W, one to the E, one to the SW, one to the NW, one to the SE and one to the NE.

The prevailing wind in the area is from the SW, and therefore, if natural draught had been the method used to increase the temperature within the furnace, one would have expected the hearth entrances to open to the SW. Macadam (1887) put forward the theory that sites on hill-tops and in narrow valleys had used natural draught to assist in raising the temperature within the burning mass of slag and charcoal. Modern investigation has proved that to obtain and sustain the necessary temperature to smelt the ore (1100-1200 degrees C), forced draught from a pair of bellows must be obtained. It is not necessary to place the hearth in such a way as to

TABLE I

HEARTHES AND SLAG HEAPS EITHER EXCAVATED OR EXAMINED BY THE AUTHOR IN PERTHSHIRE

Sites are identified by name, either descriptive or given locally to the immediate area. The numbers correspond to those shown on the sketch maps. The map reference is also given.

<i>Sketch map No.</i>	<i>Descriptive name</i>	<i>Nat. Grid. Ref.</i>
1	Bridge of Gaur	NN 503562
2	Dunans	NN 485576
3	The Barracks	NN 457542
4	Upper Dall	NN 590542
5	Outer Dall	NN 597525
6	Lower Dall	NN 594554
7	Leagag	NN 504543
8	Red Stable, Glen Comrie	NN 465533
9	400 yds north of no. 8	Approx. same
10	Station Rd, Rannoch	NN 462574
11	The Greens, Outer Barracks	NN 445504
12	Comrie Hill	NN 482559 approx.
13	Comrie Hill	NN 482553 "
14	West Camghouran farm	NN 559555
15	Coille Bhiennie	NN 488576
16-19	Part of same complex as Barracks above	NN 457542
20	Aulich, N side of L. Rannoch	NN 606599
21	Ballimore farm, Balquhidder	NN 530170
22	N shore of Loch Voil	NN 48941984
23	Stronachlachar, L. Katrine	NN 399104
24	Grundd nan Darachan, Rannoch	NN 470540
25	Black Wood, Rannoch	NN 586549
26	Head of Loch Katrine	?
	Additional sites still to be examined at Easter Bohespic, 3 or more	NN 756603

TABLE II
LIST OF SLAG HEAPS AND FURNACES

Based on personal observation or from information supplied by the Forestry Commission and other sources. They are additional to those shown and numbered on the site maps and described in the text.

<i>Number of slag heaps</i>	<i>Area</i>	<i>County</i>	<i>Nat. Grid. Ref.</i>	<i>Remarks</i>
1	Top of West Lomond	Fife	NO 197068	Under Indicator
1	Blackmount Estate	N Argyll	NM 670590	
13	Sunart Forest and on L. Sunart side	N Argyll		No detailed ref.
1	Carradale	Argyll		100 yds from Pier
1	Cairndhu, Crinan	Argyll	NR 828903	Excavated, circular hill site
1	Isle of Jura	Argyll	NR 604804	Checked
1	Otter Forest	Argyll	NR 946797	Excavated
1	Otter Forest	Argyll	NR 946799	Checked
1	Otter Forest	Argyll	NR 947798	Checked
1	Otter Forest	Argyll	NR 950797	Checked
1	Lindsaig Fm, Kilfinan	Argyll	NR 961808	Checked
1	Ardmarnock Forest near Kames	Argyll		Pottery sherds found
20	Lochgoilhead area (4 checked)	Argyll	NN 218018 NN 174001 NN 177004 NN 193054	
1	Glengarry Forest	Inverness	NH 205005	
1	Naver Forest above Rossal Township	Sutherland		
1	Glendaruel	Argyll	NS 003850	
21	N shore of L. Maree Col. Whitbread's Estate	Ross-shire		
25	Glendochart Forest (Strome section)	Perthshire	NN 378238	1 heap checked
1	Glendaruel Forest	Argyll	NS 016822	
1	Above Glendaruel Hotel			
1	Loch Lomond, N of Luss	Dunbarton	NN 348968	Checked
1	Loch Lomond	Dunbarton	NS 355945	
1	Loch Ridden	Argyll	NS 016822	Checked
1	Shandon	Dunbarton	NS 259879	Checked
1	High Balernock	Dunbarton	NS 257887	Checked
1	Otter Forest	Argyll	NR 948796	Checked
1	Kilfinan	Argyll	NR 931723	Checked
2	Strathlachlan	Argyll	NS 032972	Checked
			NS 034969	Checked
3	Strachur	Argyll	NN 092030	Checked
			NS 132965	Checked
				Also 1 near the 14th milestone to Dunoon
3	Dunoon	Argyll	NS 163791 NS 166779 NS 166787	500 yds W of Dunloskin Fm 200 yds S of Chapel Burn
1	Toward	Argyll		Behind Knock Dow House
1	Junction of Whistlefield Rd and Loch Eck Rd			
1	Achnabreck above the small Telephone Exchange			
1	Carie Burn, Rannoch	Perthshire	615565	OS 1 in sheet 48; part of hearth found

have the assistance of the prevailing wind. That only two hearths out of fifteen excavated had the 'entrance' opening to the SW would seem to argue that the ironworkers had no need to depend on the natural wind.

If further proof were required, then the experiment of O'Kelly (1958) in reconstructing a bowl furnace would seem to be conclusive; using the evidence from Chelms Coombe in Somerset (Balch 1925; 1947) and from Round Pound, Kestor in Devon (Fox 1954), O'Kelly succeeded in producing iron and slag, comparable to that found on ancient sites, with the use of double bellows. The bowl-type of furnace found at Kestor may be compared with those found at Gaur (no. 1) and Darachan (no. 24).

Macadam (1887) mentioned a number of sites where slag heaps were to be found, identifying them by district rather than by any map reference, but he does not appear to have excavated any of them. He recorded 12 sites in Perthshire, none of which coincides with any of the 26 sites listed in Table 1 below.

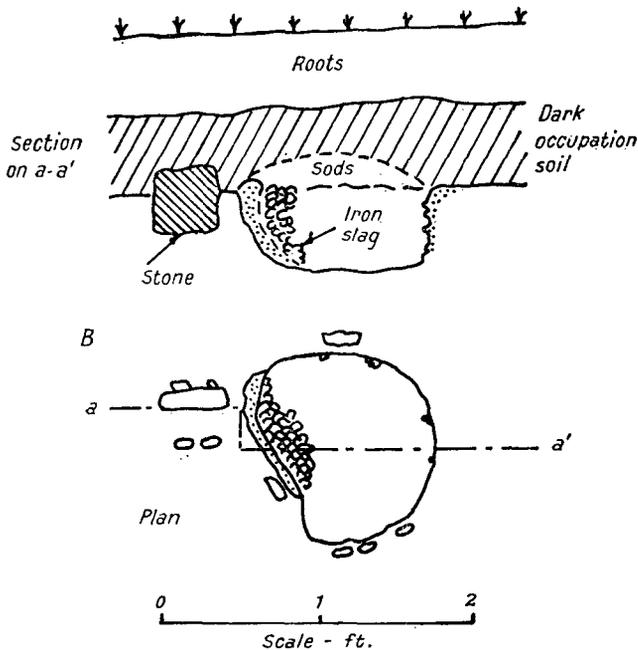


FIG 5 Plan and section of the iron smelting hearth found at Round Pound, Kestor. (Reproduced by kind permission of Lady Fox and the Devonshire Association for the Advancement of Science)

CONCLUSION

The evidence, and conclusions to be drawn therefrom, supplied by the various sites described would point to the use of the 'bowl' type of hearth by the ironworkers.

This system required a depression to be excavated in a suitable spot within easy reach of bog iron ore, trees and generally a stream. The 'hole in the ground' did not in most cases exceed 16 in in diameter if circular and if rectangular 21 x 14 in wide. Depths varied between 9 and

11 in. The excavation was enclosed by a 'box' of stones about 12 in high and, judging by the amount of stones now scattered around, no more than two layers high. Two small openings were left in the surrounding stonework, one on the downhill slope of the gentle incline usually chosen for the site and the other between two larger stones on the opposite or higher side. The latter opening worked out at 2-4 in between the stones. From traces of clay found beside and around the stones at some of the sites, it is likely that the spaces between the stones were filled with the clay thus making an enclosed box to contain the heat and the charge. The interior may have been coated also but in only one instance – at Otter Ferry – was clay actually found within the hearth. There is some debate as to whether or not a dome of clay was built over the box. If this was the case an opening would have to be left to act as a chimney to allow the escape of gases. In only one case – Ardmarnock – was there found sufficient evidence of clay to support the dome theory.

It is practically certain that some form of forced draught was required and employed and this points to the use of bellows; a pair would be needed to keep up a constant flow of air; these would be made of sheepskin or goatskin. To protect the nozzles of the bellows a tuyère was employed. This would be made on the spot from local clay and would be in the form of a tube about 8-12 in long, one end being about 1 in in diameter and the other about 6 in in diameter. A hole would be pierced lengthwise, narrow at the small end and wide at the other. The tuyère was then laid between the two large stones with the narrow end inserted at a slight downward angle into the heart of the furnace. The larger end would be supported by a stone to give the tube the required angle – (fig 3) Site no. 4 perhaps shows the support stone in position for the first hearth on that site. The nozzles of the bellows would be inserted into the wide end of the tuyère and the furnace now ready to operate. The fuel was charcoal and I found two charcoal making sites in close proximity to two furnaces – the Dunans and the Barracks sites – these were about 2-3 ft below the present surface.

The sequence of firing would probably be as follows. First a fire of dried grass and twigs followed by small branches and when well alight some of the charcoal added around the edges. As the fire grew in strength more charcoal would be added until all would be a red glowing mass; the bellows would now be brought into play and small pieces of washed ore added to the centre of the fire. More charcoal, more ore and a stronger and continuous draught directed to the burning mass would gradually reduce the ore to a pasty consistency. After a time estimated at up to 5 or 6 hours a temperature of some 1,100 degrees Centigrade to 1,200 degrees would be attained. Floating on top would be a mass of impurities: sand, small stones, charcoal and 'undigested' ore. This would be allowed to run out of the lower opening in the furnace 'wall' as tap slag and if the hearth was an open one this debris might be skimmed off and thrown forward to form a heap. The tap slag which would gather around the lower opening would have to be removed and added to the heap. This heap would naturally grow in size as firing followed firing.

When the smelt was completed the clay dome if present and the surrounding stones would be thrown aside to allow the bloom of iron to be removed. This might be difficult as it could happen that it might be adhering to the base or sides of the hearth, even to the tuyère. It is almost certain that it would be sticking to lumps of slag from which it would have to be broken. The tuyère would be smashed and thrown away to lie and disintegrate over the years; only the small end might remain as a glassified ring of fired pottery of which some examples have been found. Inevitably a certain quantity of slag gathered at the bottom of the hearth taking on the semi-spherical shape of the bowl and these castings are to be found in numbers in the slag heaps. They have one use – the size of the bowl itself can be calculated from them and any measurement of an existing hearth confirmed.

The bloom of iron would be inevitably of poor quality and only by repeated heatings and hammering would the impurities contained in it be driven out. Only then could the smith work on it to make any articles of iron required.

Dating of these furnaces is difficult and only with 'finds' which are in obvious association with a given hearth *and* datable can a reasonable safe date be attempted. Such finds as the Leuchar Ware of Ardmarnock can give a date of the late thirteenth century to the early fourteenth, while the Loch Katrine sites *might* be assigned to the late fifteenth century. I think that for the moment it would be wiser to put the Rannoch sites in that area of time and to continue searching. What we do know is that bowl furnaces were in use from the first century BC until the middle of the sixteenth century AD and even a little later in some areas.

There is little evidence of the human element to be found. I did discover two huts close to two furnaces – a rectangular one at no. 4 Upper Dall and a circular one at no. 10 Rannoch Station Road but no finds of any sort were made. No doubt they were very crude efforts and would have a very short period of occupation.

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Over the period which this investigation covers, I have been indebted to many people who have assisted me in a multitude of ways. I should like them to know that I appreciate and value that assistance. My thanks go to Dr R F Tylecote, who has patiently guided me at all points; Mr N McCallum; Mr Henry Cleere; the four Conservators of the Forestry Commission: Mr D W Benoy, Mr E J M Davies, Mr W D Fraser, Mr D Furneaux; Mr R B Stewart; Mr P Garrow, who assisted me in every way and kept a watchful eye on my activities; Mr N Proudfoot; Mr R A Innes; Mr G Francey; Mr J D Menzies; Mr A Polwart.

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APPENDIX

Notes on the composition of the Slags and Ores

Mr Archibald MacIntyre of Lindsaig Farm, Kilfinan, Argyll, was responsible for the discovery of several sites near Otter Ferry, Loch Fyne. The material gathered from these is of some interest, and when submitted to Dr Tylecote, Newcastle University, he reported on them as follows:

Otter Forest	NR 950797 – Ore. Iron Hydrate.		
		This specimen lost 21.6 per cent of its weight on ignition. Its black colour shows that it has a high Manganese content.	
”	NR 947798 – Sandy bog iron ore; low grade.		
”	NR 946799 – Heavy iron tap slag		
”	NR 946797 –	”	”
Lindsaig Farm	NR 961808 –	”	”

Mr MacIntyre kindly took me over the ground mentioned above in the Kilfinan area. Much of this had been ploughed for tree planting and very large deposits of the rich black ore were easily noticed. A very pertinent question arises. But for the tearing up of the ground by the modern ploughs it would be almost impossible to find the spots where the ore is lying. It is at a depth of 10–15 in below the present surface and in pockets of 2–3 ft in width and up to 10 ft in length. There are no indications on the surface which might show what lies beneath. The thought which at once springs to mind is – how did the ancient smelters know it was there and in sufficient quantity to justify a small industry?

Time permitted only the excavation of one of the slag heaps, but a hearth was found with slag adherence both to the sides and projecting. A quantity of red clay was found around the sides with some large stones embedded in it.

The material used in the Rannoch hearths has been identified as a light coloured sandy form of bog ore which is rather friable. Although in appearance and texture quite different from the dark solid ore of Kilfinan, Dr Tylecote reports that it has much the same iron content.

The Cowal Natural History Society were good enough to supply me with details of other bloomeries in their area (Dunoon etc) as indicated in Table II. These have been examined by Mr MacIntyre.

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ANALYSES OF ARCHAEOLOGICAL SPECIMENS (SLAG, ETC)

Sample A - Bridge of Gaur, Site no. 1	Sample G - Lower Dall, Site no. 6
" B - Dunans, Site no. 2	" H - Glen Comrie, Site no. 8
" C - Upper Dall, Site no. 4	" I - Rannoch Station Road, Site no. 10
" D - Bog Iron, near no. 4	" J - Leagag, Site no. 7
" E - Outer Dall, Site no. 5	" K - Slag from Hearth, Site no. 3
" F - Sample of sand with iron or slag fragments in top of slag flow	" L - Piece from Hearth showing red clay in which K was embedded

Samples B, C, E, G, H, J, K and L, all contain magnetic material suggesting the presence of Magnetite and/or Metallic Iron

	A	B	C	D	E	F	G	H	I	J	K	L
Water	ND	.4%	2.6%	9.8%	.8%	15.0%	.7%	1.1%	.3%	.8%	.2%	.5%
Silica	25.3	17.9	28.2	17.9	12.5	31.3	17.3	10.1	23.9	15.7	18.6	64.1
Alumina	15.8	5.1	7.6	4.1	3.9	4.3	1.5	4.3	8.3	8.4	3.5	15.5
Ferric Oxide	3.4	9.4	20.8	41.5	12.3	32.0	12.2	13.8	4.9	9.6	8.6	4.0
Ferrous Iron	51.1	42.8	19.7	.5	45.0	.5	43.1	50.2	35.5	45.2	42.5	5.0
Lime	1.7	1.4	.7	.5	1.3	.4	1.6	1.3	1.5	.7	1.8	1.6
Magnesia	ND	.4	.4	.2	.5	.3	.7	.5	.4	.4	.8	1.4
Manganese Oxide	2.8	3.9	4.3	7.9	4.8	2.5	3.3	.6	11.9	3.4	6.1	.6
Sulphur Trioxide	ND	.3	.4	.2	.3	.2	.2	.3	.3	.2	.2	.3
Phosphorus Pentoxide	ND	.5	.5	ND	ND	ND	.3	ND	.3	ND	ND	ND
Carbon Dioxide and Organic Matter	ND	2.2	5.8	15.3	2.0	11.1	2.4	2.4	1.4	1.8	1.0	1.8
TOTAL IRON CONTENT	42.0	49.4	34.3	29.6	53.6	23.0	51.6	59.9	38.9	52.0	48.5	7.8

The analysis of D indicates an iron ore.

That of B, C, E, G, H, I, J and K - Iron ore also but in various stages of reduction to metal.
Analyses F and L confirm the description given.



a Furnace bowl at Stronachlachar, no. 24



b Half a bowl-base from Stronachlachar, no. 24



c Slag adhering to granite from Barracks, Moor of Rannoch, no. 3, with examples of 'tap' slag