

METALLURGY IN THE ROMAN FORTS
OF SCOTLAND:
AN ARCHAEOLOGICAL ANALYSIS

By

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OF SCOTLAND:
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An Undergraduate Honors Project Presented

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History Honors Paper

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I. Introduction

This paper presents roughly four months of research on the Roman forts within the current political boundaries of Scotland. The purpose of this inquiry was to collect all available information on the 37 known Roman installations classified as “forts” (per the Royal Commission on Ancient and Historical Monuments in Scotland, or *RCAHMS*) and analyze what information could be gleaned regarding the presence of metalworking on these sites. The primary list of Scottish forts was taken from Lawrence Keppie’s *The Legacy of Rome: Scotland’s Roman Remains* 3rd ed., and checked against the *RCAHMS* database.

The term “metalworking” is used here to include a variety of metallurgical processes indicative of some cultivated, well-established industrial tradition transmittable (and thus archaeologically identifiable) throughout forts in the Roman Empire. This encompasses, but is not limited to: mining, smelting, and smithing of lead, copper, tin, brass, bronze, silver, gold, antimony, and iron. Evidence for the aforementioned processes is varied and complex, although comparatively few archaeological means can be used to identify sites which had metalworking facilities. The three main sources of evidence for mining and metallurgy available to archaeologists have been identified as: literary and epigraphic records, mining sites and associated archaeological remains, and surviving metal objects.¹

The first category, for the purposes of this paper, will only prove useful as a means of assessing the likelihood of locating *fabricae* on Roman forts and confirming the logic of approaching this topic as a vital and present (if archaeologically obscure) facet of Roman military life in Scotland. Ancient sources like Pseudo-Hyginus – who makes mention of the *fabrica* and

¹ J. F. Healy., *Mining and Metallurgy in the Greek and Roman World* (Plymouth: Latimer Trend & Company, 1978), 11.

its placement in his treatise on the castramentation process of the Roman army on campaign,² and the Vindolanda tablets – wooden records found along the Antonine Wall, have helped illuminate the role of the *fabrica* in Roman Scotland.³

There is also epigraphic evidence for a professional group of metalsmiths within the Roman army in Britain. A Belgian weaponsmith specifically dedicated to the XX Legion Valeria Victrix was discovered to have been buried in Bath by a “guild of armourers”.⁴ The XX Legion, it should be noted, constructed the fortress at Inchtuthil sometime in the mid-80’s AD in Scotland before rebuilding Chester, in England.⁵ It is reasonable to assume that the guild and its craftsmen had been with the Legion for quite some time, and that the profession had been institutionalized as a part of the military apparatus as a whole. While this is direct evidence for Legionary armourers (the forts in Scotland were garrisoned by *auxilia*), the presence of *fabricae* and workshops in the forts surveyed in this paper would seem to indicate the practice applied to auxiliary units as well. There is no firm textual or epigraphic evidence for metalworking apart from Vindolanda, however, and as such the category is of little direct importance to this study.

Mining was not represented on the Roman forts analyzed (as it would have taken place at outcroppings), and it is not examined in detail. Numerous copper and iron deposits are known in Scotland,⁶ and though lead sources are present and they appear to have been exploited in Scotland (see Castledykes, Birrens), no direct evidence for the working of silver, gold, antimony, or tin was found in the research for this paper. These metals are accordingly left out of this survey.

² Pseudo-Hyginus. *de munitionibus castrorum*, ed. and trans. M. C. Miller and J. G. DeVoto, (Chicago: Ares, 1994), 69, 83.

³ <<http://vindolanda.csad.ox.ac.uk/index.shtml>>

⁴ S. Ireland, *Roman Britain: A Sourcebook*, (New York: St. Martin’s Press, 1986), 236.

⁵ W. H. Manning, “The Fortresses of Legio XX,” in *Roman Fortresses and Their Legions*, ed. R. J. Brewer, pg. 69-82 (London: The Society of Antiquaries, 2000), 70.

⁶ R. F. Tylecote, *The Prehistory of Metallurgy in the British Isles* (London: The Institute of Metals, 1986), 11, 124.

What we are left with, then, is the purely archaeological data to work with regarding three metals (iron, copper/copper alloys, and lead). The furnace requirements for working iron do not differ drastically from those needed to smelt copper ore,⁷ so most direct evidence of ironworking would be found in the presence of iron slag and other metalliferous remains like hammerscale. Perhaps the most reliable identifiers of copper and copper-based alloy activity are the crucible and casting mold; both typically stone or clay constructs. The well-known Roman lead pigs were also cast in clay molds,⁸ and both crucibles and molds are ideal indicators of metalworking on a given site. While the provenance of individual artifacts can be difficult to establish, on-site evidence of casting materials demonstrates not only the presence of copper and lead smiths and workshops, but also of furnaces able to reach liquification temperatures of up to 1150° C in some cases (Cu).

In light of the limitations and exceptions made above, two main indicators of metalworking were used to determine if activity was present on the sites for this paper: structural evidence (buildings considered workshops or *fabrica* due to their placement within the fort and their shape, size, etc.) and artifactual evidence (remains of crucibles, hearths, slag, burned soil, etc.). It should be noted, though an obvious fact, that the former is a much less reliable means of determining metallurgical activity; and must be somehow corroborated in order to hold scientific weight. The latter, while a more firm indicator of metalworking, is still beset by difficulties. Hearths had multiple uses in Roman forts, and slag (as well as evidence of charcoal and burned soil) can be the result of conflagration rather than smithing and smelting. Caution was used with these problems in mind when interpreting the data.

By researching the topic of metallurgy (or, as the evidence is rather complex in many instances, the term pyrotechnological activity may be more appropriate) in the first three centuries

⁷ Tylecote, *The Prehistory of Metallurgy in the British Isles*, 124.

⁸ Ibid., 68.

AD, this relatively small-scale study in scope can be used to approach the much larger and more daunting concept of “Roman Scotland”. The ways in which the industrial centers were positioned in the forts, the metallic debris uncovered, the kinds of furnaces or forges used, and the scale of operations are just a few examples that can be used to infer a range of attitudes and logistic realities facing Roman garrisons. Some of the decisions evidenced in the archaeo-historical record would have been purely pragmatic. Others could have incorporated much more elusive, social elements; such as religious beliefs (seen in metal and clay figurines of deities) and the hierarchical value of metallurgy within the Roman camp (i.e., whether the smithy was sequestered or relegated in plan, or placed in an important area of the fort). While any conclusions drawn from such evidence are conjectural, they offer an important “mainstream application” counter-balance to the thoroughly esoteric nature of this research.

Roman Resource Management

The mammoth financial and material needs of the Roman army could only be managed by a careful, measured system that left no element of supply to chance.⁹ The sheer amount of food required to sustain the juggernaut was staggering; calculated by Kehne to be roughly 154,395 tons of wheat 108,770 tons of other food per annum (excluding fodder for animals and servants).¹⁰ Weapons and armor would have needed regular repair, and practical implements for construction and maintenance were constantly in demand. Timber needed to be harvested for the 30+ Flavian forts, and stone and turf for the two walls. Roman soldiers at Inchtuthil buried nearly 1 million

⁹ Peter Herz, “Finances and Costs of the Roman Army,” in *A Companion to the Roman Army*, ed. Paul Erdkamp (Oxford: Blackwell, 2007), 319-20.

¹⁰ Peter Kehne, “War- and Peacetime Logistics: Supplying Imperial armies in East and West,” in *A Companion to the Roman Army*, ed. Paul Erdkamp (Oxford: Blackwell, 2007), 325.

nails when the site was abandoned in the late 80's AD alone,¹¹ not to mention how many were used in the construction of the fortress. The logistics of gathering supplies for the army were precise and organized, and there can be no doubt that an element as important as metalworking would have been carefully planned out well before the invasions on Scotland began.

That the Romans possessed great skill in both the fabrication and repair of metal objects is well-documented, most definitively by archaeometric analyses of Roman remains.¹² The interaction between the Roman army and the indigenous population of modern Scotland in the Iron Age is a topic of much study, and the Roman use of native craftsmen to produce metal objects for the army has been demonstrated throughout the empire.¹³ Of interest in this paper, however, is the direct evidence of these complex processes taking place on the frontier itself.

Research Method

Adams library was the prime source of information for this thesis. The Inter-Library Loan service was used to gather what texts were available in America, while *Britannia* and the *Journal of Roman Studies*, the two primary journals dealing with Roman Scotland, were available through JSTOR. Worldcat, Discovery and Excavation in Scotland (*DES*), *RCAHMS*, *Britannia*, and the *JRS* were cross-searched in a regulated fashion with each of the 37 sites listed below. In addition, numerous e-journals were accessed through the University of Edinburgh library's database.

Due to time and resource constraints, sites labeled as "fortlets" (small installations, usually less than one acre square) and "fortresses" (designed to accommodate legions), fort annexes, and marching camps are excluded from this study. Although an in-depth analysis of each of these

¹¹ Lynn Pitts and J.K. St. Joseph, *Inchtuthil: The Roman Legionary Fortress Excavations 1952-1965* (London: The Society for the Promotion of Roman Studies, 1985), 109-13.

¹² See Fulford et al (2005), Williams (1977), Lang (1988).

¹³ Herz, 315.

subjects with regard to metallurgical facilities would greatly enhance the overall understanding of the topic, sufficient time to explore these avenues was not available.

In addition to the exceptions noted above, forts located along the Antonine Wall, stretching from the Firth of Forth in the East to the Clyde in the West, have been omitted as well. The reasoning for this is twofold; firstly, the Antonine Wall and the forts built along it have been subjected to much more careful scrutiny than the sites explored in this paper. In order to avoid treading over old ground, the focus of this study will be directed towards lesser-known forts in Scotland. Secondly, the forts along the wall may be considered as a discrete grouping of installations, separate from free-standing Flavian forts in both function and character.

As such, this paper serves as an introduction to the topic of metallurgy and production facilities within the Roman military apparatus; an area of research I hope to pursue in further studies throughout my academic career.

II. HISTORICAL BACKGROUND

A. Roman military encampments

Gnaeus Julius Agricola, appointed by Vespasian as governor of Britain in 77/78 AD, personally conducted the series of military campaigns in Scotland which resulted in the climactic battle of Mons Graupius in 83/84 AD, which effectively ended native resistance to Roman control.¹⁴ The subsequent withdrawal of Roman forces from the highlands following the battle has puzzled historians for centuries. One of the most widely accepted explanations emphasizes Rome's well-known policy of geographic pragmatism, noting that the Romans only held sway as

¹⁴ Tacitus, *De Vita Agricolae*, ed. R. M. Ogilvie and Ian Richmond (Oxford: Oxford University Press, 1967), 249.

far north as the best agricultural lands along the western Scottish coast.¹⁵ This interpretation seems to be corroborated by the absence of northerly Roman forts in aerial reconnaissance, as well as a dearth in archaeological evidence of Roman structures north of the fort at Stracathro.

Agricola's campaigns are categorized as part of the Flavian period of initial Roman occupation in Scotland; an era defined by the rapid invasion of northern Britain and marking the furthest extent of known military dominion in Scotland. 31 identified forts were founded during this period, as well a complex series of watchtowers along the Gask Ridge. Construction of the first legionary fortress in Scotland, based at Inchtuthil, was begun in the mid-80's AD as well, emphasizing the intended permanent nature of the Roman presence in Northern Britain.

Despite the preponderance of military activity in the central and highland regions of Scotland during the Flavian invasions, as well as the monumental financial, logistical, and political investments made by Rome in the operations, the following decade was defined by the steady removal of troops from the area. Inchtuthil was abandoned in mid-construction,¹⁶ and Roman garrisons were removed from their forts in waves. This process had begun following Roman defeats in Germany in 85-86 AD, as troops were needed to bolster continental forces, and continued until Roman gains in Scotland had been all but abandoned.¹⁷ By the beginning of the second century, the Romans appear to have retreated entirely south of the Scottish Borders.¹⁸

Emulating the Trajanic *limes* of the German frontier, construction was begun around 122 AD by the emperor Hadrian of a large wall along the Tyne-Solway isthmus.¹⁹ This new border was to become the most favored position of Roman defense against Scotland's inhabitants until

¹⁵ Kevin Edwards and Ian Ralston, *Scotland After the Ice Age* (Edinburgh: The University Press, 2005), 198-203.

¹⁶ Pitts, *Inchtuthil* 1.

¹⁷ Andrew Hobley, "The Numismatic Evidence for the Post-Agricolan Abandonment of the Roman Frontier in Northern Scotland," *Britannia*, Vol. 20 (1989) 70.

¹⁸ W. S. Hanson and Gordon Maxwell, *Rome's North West Frontier* (Edinburgh, The University Press, 1983), 48.

¹⁹ Antony Kamm, *The Last Frontier: The Roman Invasions of Scotland* (Stroud: Tempus, 2004), 99-100.

the island was abandoned in ~410 AD; serving as a constant fall-back line for thwarted northern ambitions. Although the wall and its defenses are outside the scope of this paper, topically, the engineering feat played an important role in keeping at least some Roman influence in southern Scotland during times of both peace and conflict.

The Antonine occupation of Scotland, initiated by Antoninus Pius in 138 AD, re-established Roman control over the lowlands of Scotland by constructing numerous forts, re-occupying Flavian sites, as well as ordering the building of the famous Antonine Wall from the Firth of Forth to the River Clyde.²⁰ Antoninus likely initiated the re-conquest of Scotland to consolidate his political position,²¹ and although there is some debate over the chronological nature of Antonine occupation,²² it is generally accepted that the wall and most of its associated forts were abandoned sometime around the accession of Marcus Aurelius in the mid to late 160's BC, in favor of the more tenable frontier along Hadrian's wall.²³ The seemingly spastic twenty year endeavor has left a confusing archaeological legacy, riddled with peculiarities and contradictory evidence of intent.

In 208 AD, the emperor Septimius Severus and his son Caracalla marched into Fife, and for the next two years conducted operations along the East coast of Scotland.²⁴ The only known permanent base past the Forth in this period was located at Carpow, where a legionary fortress was constructed, likely by Severus. The emperor died in 210 AD, and his son quickly abandoned the Scottish campaigns in favor of the defensive line at Hadrian's wall.

²⁰ Hanson and Maxwell, *Rome's North West Frontier*, 59-60.

²¹ D. J. Breeze, "Q Lollius Urbicus and A Claudius Charax, Antonine commanders in Britain," *PSAS* 121 (1991): 229.

²² N. Hodgson, "Were There Two Antonine Occupations of Scotland?" *Britannia*, Vol. 26 (1995) 41-43.

²³ Kamm, *The Last Frontier*, 121.

²⁴ Nicholas Reed, "The Scottish Campaigns of Septimius Severus," *PSAS* 107 (1975-1976): 96.

The Changing Goals of Occupation

The three phases of Roman occupation in Scotland have a number of characteristics both in common and at odds with each other. The salient features of the Flavian invasion, for instance, revolved around the rapid movement of troops and intense fort-building under Agricola's brilliant leadership, culminating in the desired Roman military showdown at Mons Graupius. The implicit goals of the invasion (either total or practical conquest of the whole British island, elimination of adversaries, etc.) seem in keeping with the traditional Roman model of expansion, but differ markedly from the following Antonine operations.

The Antonine *reconquista* has the hallmarks of carefully-planned military and strategic maneuver, focusing on establishment of a newly fortified position along the Forth-Clyde line with a few tactical forts near Fife being retained. The apparent aims of "Romanizing" the Scottish borders, furthering Antoninus Pius' prestige, creating a new defensive barrier to alleviate stress on Hadrian's wall, and reasserting Roman control in the region appear to indicate a new approach to problem of northern Britain. Continuing the tradition started in the reign of Domitian, Antoninus seems to have considered Scotland a somewhat secondary frontier; capable of being utilized in more subtly strategic and political sense, rather than being completely conquered militarily.

The Severan occupation echoes this notion of Scotland as a simultaneously dangerous and yet contained threat, one that an emperor could march into with thousands of troops to aggrandize his position back in Rome without fear of catastrophe. No real military gains appear to have been made in the third century invasion; quite the contrary, significant casualties were reported without a climactic battle to break Caledonian resistance, and plans for further conquest were

abandoned.²⁵ The brief nature of this period essentially diminishes its importance to this study, as most of the operations took place too quickly for new forts to be created.

When looking at the Flavian and Antonine occupations, then, the purpose of the Roman presence in each era needs to be considered before approaching the data. The needs of the Roman army in Scotland under Vespasian and Domitian's reigns differed from their successor counterparts under Antoninus Pius and Marcus Aurelius. While the Flavian troops likely saw semi-regular combat (be it through skirmishing, campaigning, or pacification missions), as they were part of an ever-advancing frontier of forts, the Antonine troops had a physical barrier created between themselves and the indigenous tribesmen of northern Scotland. This by no means implies that the Antonine troops were any less deadly or prepared to fight, but it does stress that life along the Antonine wall was assuredly different from life in a Flavian fort.²⁶ As these occupational models differed, so too would the metallurgical demands of both the Flavian and Antonine soldiers.

Occupational Models and their Metallurgical Needs

Proceeding under this assumption, it would seem more likely to find metalworking facilities inside Flavian forts, which served as independent units along the frontier and had to be markedly more self sufficient than the Antonine troops garrisoned along the wall and in the Borders (which by this time had been under varying levels of Roman control for half a century). The idea is lent some support by Hanel, who argues that military workshops were initially located

²⁵ Reed, "Scottish Campaigns," 99.

²⁶ D. J. Breeze, "Roman forces and native populations," *PSAS* 115 (1985): 223.

within the fort for protection, and in later periods were moved to an annex.²⁷ Once some control had been established in the region around the base, "...the kind of industrial processes that might have been hazardous and disagreeable if conducted within the confines of the main fort"²⁸ could be pursued in *vici* or other extramural settings. If that assumed trend is accurate, the record will show a substantially greater number of *fabricae* in the Flavian forts, fewer in the Antonine, and a mixture of results in the sites from both stages of occupation.

²⁷ Norbert Hanel, "Military Camps, *Canabae*, and *Vici*. The Archaeological Evidence," in *A Companion to the Roman Army*, ed. Paul Erdkamp (Oxford: Blackwell, 2007), 407.

²⁸ Duncan Campbell, *Roman Auxiliary Forts 27 BC-AD 378* (New York: Osprey, 2009), 45.

IV. DATA EXAMINED

A. Determination of Statistical Significance

18 of the Roman forts in Scotland belong distinctly to the Flavian period, 6 exclusively to the Antonine, 12 to both, and one (Cramond) to both as well as the Severan period. Cramond, as it is an unusual outlier, will be primarily considered as a member of the group of both Flavian and Antonine occupation, bringing the total number of sites in that category to 13 (see tables 2, 3, 4 below). In total, 31 known forts were occupied in the Flavian period, 19 in the Antonine, and one in the Severan.

Table 2, 3 & 4:: Excavation Periods at Sites by Period

#2	Exclusively Flavian
1	Barochan
2	Bochastle
3	Broomholm
4	Cardean
5	Cargill
6	Dalswinton
7	Dalginross
8	Doune
9	Drumquhassle
10	Easter Haprew
11	Elginhaugh
12	Fendoch
13	Malling
14	Milton
15	Mollins
16	Oakwood
17	Stracathro
18	Ward Law

#3	Exclusively Antonine
1	Bishopton
2	Bothwellhaugh
3	Carzield
4	Inveresk
5	Lyne
6	Raeburnfoot

#4	Flavian and Antonine
1	Ardoch
2	Bertha
3	Birrens
4	Camelon
5	Cappuck
6	Castledykes
7	Cramond
8	Crawford
9	Drumlanrig
10	Glenlochar
11	Ladyward
12	Loudoun Hill
13	Strageath

#1	Site Name	Flavian	Antonine	Severan
1	Ardoch	√	√	
2	Barochan	√		
3	Bertha	√	√	
4	Birrens	√	√	
5	Bishopton		√	
6	Bochastle	√		
7	Bothwellhaugh		√	
8	Broomholm	√		
9	Camelon	√	√	
10	Cappuck	√	√	
11	Cardean	√		
12	Cargill	√		
13	Carzield		√	
14	Castledykes	√	√	
15	Cramond	√	√	√
16	Crawford	√	√	
17	Dalswinton	√		
18	Dalginross	√		
19	Doune	√		
20	Drumlanrig	√	√	
21	Drumquhassle	√		
22	Easter Happrew	√		
23	Elginhaugh	√		
24	Fendoch	√		
25	Glenlochar	√	√	
26	Inveresk		√	
27	Ladyward	√	√	
28	Loudoun Hill	√	√	
29	Lyne		√	
30	Malling	√		
31	Milton	√		
32	Mollins	√		
33	Oakwood	√		
34	Raeburnfoot		√	
35	Strageath	√	√	
36	Strathcaro	√		
37	Ward Law	√		

**Table 1: Excavation Periods at
Sites (Combined Chart)**

B. Specific Sites Examined

The 37 following analyses represent the collection of available information on the topic at the time of creation. Other sources (especially excavation reports) pertaining to the sites mentioned below were inaccessible due to inter-library loan restrictions, a lack of scanned documents online, and exclusive foreign holdings of some texts.

The sources cited during the research of each fort are not exhaustive. Moreover, they are specifically tailored to the topic of this paper, and are circumscribed by the lack of a number of books, articles, and journals not readily available in the United States.

Following the style of British archaeological reports, I will refer to the orientation of sites and features with the shorthand (N) for North, (S) for South, (E) for East, and (W) for west.

All grid references per RCHAMS

1. Ardoch (NN 839 099, Perth and Kinross, ~10 acres)

Sources consulted:

1. Christison, D and Cunningham, J H, "An Account of the Excavation of the Roman Station at Ardoch, Perthshire," *PSAS* 32 (1898): 399-476.
2. Breeze, D. "Excavations at Ardoch 1970" *PSAS* 102 (1970): 122-128.
3. D. B. Taylor, "Ardoch and Strageath," *DES* 1956, 19.
4. R. E. Jones, "Ardoch Roman Fort," *DES* 1993, 98-99.
5. P. Johnson and R. Cachart, "Ardoch," *DES* 1996, 81.
6. R. P. Wright, "Roman Britain in 1949," *JRS* 40 (1950): 92.
7. D. R. Wilson et al., "Roman Britain in 1970," *Britannia* 2 (1971): 248.
8. B. C. Burnham et al., "Roman Britain in 1993," *Britannia* 25 (1994): 255.
9. B. C. Burnham et al., "Roman Britain in 1994," *Britannia* 26 (1995): 332.
10. B. C. Burnham et al., "Roman Britain in 1996," *Britannia* 28 (1997): 405-06.
11. <<http://canmore.rchams.gov.uk/en/site/25227/details/ardoch/>>

Bronze objects found on the site from 1896-1897 site were almost exclusively ornamental, while iron weapons were the most common form of ferrous metal artifacts (excluding nails).²⁹

²⁹ D. Christison and J. H. Cunningham, "An Account of the Excavation of the Roman Station at

Masses of lead of indeterminate function were also unearthed, but there is no evidence of slag or structures particularly associated with metalworking. Christison noticed the similarities of the interior layout of the fort with that of Birrens (which, as shown below, has fairly conclusive evidence for either a workshop or *fabrica*), and it should be noted that on the W end of the central block at Ardoch, in the exact spot of building IX/X (the workshop) at Birrens, a series flues are present.³⁰ Though this by no means is a strong indicator of metalworking, as flues were used for myriad tasks on Roman sites (i.e. tile-making, glass manufacture, hypocaust heating, etc.), it is an interesting coincidence.

2. Barochan (NS 413 690, Renfrewshire, ~3 acres)

Sources consulted:

1. S. S. Frere et al., "Roman Britain in 1984," *Britannia* 16 (1985): 265-67.
2. D. R. Wilson et al., "Roman Britain in 1972," *Britannia* 4 (1973): 275.
3. S. S. Frere et al., "Roman Britain in 1985," *Britannia* 17 (1986): 371.
4. S. S. Frere et al., "Roman Britain in 1986," *Britannia* 18 (1987): 311-13.
5. <<http://canmore.rcahms.gov.uk/en/site/43107/details/barochan+hill/>>

The only evidence of fabrication facilities at Barochan is burnt clay associated with kiln-ovens, likely used for tile making, near the western entrance to the fort.³¹

3. Bertha (NO 097 269, Perth and Kinross, ~9 acres)

Sources consulted:

1. H. Adamson and D. Gallagher, "The Roman Fort at Bertha, the 1973 Excavation," *PSAS* 116 (1986): 195-204.
2. J. K. St. Joseph, "Air Reconnaissance in Britain, 1961-64," *JRS* 55 (1965): 83.
3. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 63.
4. B. C. Burnham et al., "Roman Britain in 1999," *Britannia* 31 (2000): 380.
5. D. R. Wilson et al., "Roman Britain in 1973," *Britannia* 5 (1974): 402.
6. Callander, J., "Roman Remains at Grassy Walls and Bertha," *PSAS* 53 (1918-1919): 137-152.
7. D.J.Woolliscroft & B.Hoffmann, <<http://www.theromangaskproject.org.uk/Pages/Papers/Bertha.html>>
8. <<http://canmore.rcahms.gov.uk/en/site/138035/details/bertha+roman+fort/>>

Ardoch, Perthshire," *PSAS*, 32 (1898) 460-65.

³⁰ Christison, 447.

³¹ S. S. Frere et al., "Roman Britain in 1986," *Britannia* 18 (1987) 311-313.

The large fort at Bertha has not been fully excavated as of yet, and as such, there is no detailed excavation plan of the interior of the site. An emergency dig was conducted in 1973 by Adamson and Gallagher, though only pottery fragments and glass were recovered.³² Discussion of the site was primarily limited to the subject of its defenses until 2008, when the Roman Gask Project conducted resistivity and magnetometric surveys of the fort.³³ It was then able to produce a rather clear picture of the forts' layout, and it was reported that there were, in the NW section of the fort area, "...a series of rounded features inside a rectangular structure...This might be a set of ovens protected by a timber shed, or a workshop containing furnaces."³⁴ In addition, Wooliscroft raised the possibility that part of the structure of the fort (including where the potential furnaces or ovens are) may in fact be an annex. These findings, however, remain preliminary and are not corroborated by any artifactual discoveries through excavation.

3. Birrens (NY 218752, Dumfries and Galloway, Antonine I Fort: ~ 5 acres)

Sources consulted:

1. Barbour, J., Christison, D., and MacDonald, J., "Account of the Excavation at Birrens, a Roman Station in Annandale, Undertaken by the Society of Antiquaries of Scotland in 1895," *PSAS* 30 (1896): 81-199.
2. Birley, E., "Excavations at Birrens, 1936-1937," *PSAS* 72 (1938): 275-347.
3. Robertson, Anne. *Birrens (Blatobulgium)*. Edinburgh: T. and A. Constable Ltd., 1973.
4. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 57-8.
5. R. G. Collingwood, "Roman Britain in 1935," *JRS* 26 (1936): 237.
6. R. G. Collingwood, "Roman Britain in 1936," *JRS* 27 (1937): 225.
7. R. G. Collingwood, "Roman Britain in 1937," *JRS* 28 (1938): 171-2.
8. R. P. Wright, "Roman Britain in 1939," *JRS* 30 (1940): 160-161.
9. R. P. Wright and D. R. Wilson, "Roman Britain in 1962," *JRS* 53 (1963): 128.
10. D. R. Wilson and R. P. Wright, "Roman Britain in 1963," *JRS* 54 (1964): 155.
11. D. R. Wilson and R. P. Wright, "Roman Britain in 1964," *JRS* 55 (1965): 202.
12. D. R. Wilson and R. P. Wright, "Roman Britain in 1965," *JRS* 56 (1966): 199.
13. D. R. Wilson and R. P. Wright, "Roman Britain in 1966," *JRS* 57 (1967): 177.
14. D. R. Wilson and R. P. Wright, "Roman Britain in 1967," *JRS* 58 (1968): 178-9.
15. D. R. Wilson and R. P. Wright, "Roman Britain in 1969," *Britannia* 1 (1970): 274.
16. B. C. Burnham et al., "Roman Britain in 1996," *Britannia* 28 (1997): 401-11.
17. Anne Robertson, "Birrens," *DES* 1962, 25-6.
18. Anne Robertson, "Birrens," *DES* 1963 27-8.

³² H. Adamson and D. Gallagher, "The Roman Fort at Bertha, the 1973 Excavation," *PSAS*, 116 (1986) 200-202.

³³ <<http://www.theromangaskproject.org.uk/Pages/Papers/Bertha.html>>

³⁴ Ibid.

19. Anne Robertson, "Birrens," *DES* 1964 25.
20. Anne Robertson, "Birrens," *DES* 1965 16-17.
21. Anne Robertson, "Birrens," *DES* 1966 21.
22. Anne Robertson, "Birrens," *DES* 1967 21-22.
23. <<http://canmore.rcahms.gov.uk/en/site/67099/details/birrens/>>

The three main excavations undertaken at Birrens (1895, 1937-1937, 1962-1967) were analyzed. The initial excavation of the interior of the fort was presented by James Barbour in the 1896 PSAS publication, with no direct evidence of metallurgical facilities being found. Typical finds of iron nails, decorative bronze objects and lead weights were recovered, but no indication that any of them had been fabricated on site.³⁵

Eric Birley's 1936-1937 re-examination of Birrens was primarily motivated by the desire to better establish the chronology of the site, and as such did not yield any substantial finds with regard to this paper's topic. Five phases of occupation were identified, and a small assembly of ornamental bronze objects was found.³⁶

The five year effort headed by Anne Robertson in the 1960's is by far the most important excavation with regards to this study. While no buildings of unquestionable metallurgical function were identified, a square building (in plan, 2 rectangular buildings, IX and X respectively, which were attached) identified by Robertson as part of the Antonine I phase (BIX/X, located at the W end of the central block, N of the *via principalis*) was found to have the remains of a heavily vitrified crucible inside its walls.³⁷ The preponderance of metal artifacts located there suggested "...use as an armoury or workshop."³⁸

³⁵ J. Barbour and D. Christison, and MacDonald, J., "Account of the Excavation at Birrens, a Roman Station in Annandale, Undertaken by the Society of Antiquaries of Scotland in 1895," *PSAS* 30 (1896) 192-194.

³⁶ E. Birley, "Excavations at Birrens, 1936-1937," *PSAS* 72 (1938) 335-338.

³⁷ Anne Robertson, *Birrens (Blatobulgium)* (Edinburgh: T. and A. Constable Ltd., 1973), 139.

³⁸ D. R. Wilson and R. P. Wright, "Roman Britain in 1967," *JRS* 58 (1968) 179.

Bronze objects were almost exclusively decorative, whilst stratified and unstratified finds of both iron and lead slag were found.³⁹ Lead slag was unearthed inside BIX/X, and iron slag, as well as fragments of another crucible, was discovered just outside the south entrance to the building.⁴⁰ Outside of BIX/X, two more finds of lead slag were made in the northwestern part of the fort. Along the east rampart, only a few feet away from where a cooking oven was discovered in 1964, a group of indeterminate lumps and fragments of lead were found.⁴¹

It is interesting to note that every stratified find of iron and lead found at Birrens was dated to the first period of Antonine occupation, prior to 158 AD. Also, the collection of slag finds in the NW section of the fort must be mentioned.

4. Bishopton (NS 418 720, Renfrewshire, ~ 5 acres)

Sources consulted:

1. K. A. Steer, "The Roman Fort at Whitemoss, Renfrewshire," *PSAS* 83 (1948-1949): 28-32.
2. J. K. St. Joseph, "Air Reconnaissance in Britain, 1955-7," *JRS* 48 (1958): 90.
3. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 52.
4. K. A. Steer, "Renfrewshire," *DES* 1949, 10.
5. F. Newall "Renfrewshire," *DES* 1952, 12-13.
6. F. Newall, "Whitemoss Farm, Bishopton," *DES* 1953, 14-15.
7. F. Newall, "Whitemoss Farm, Bishopton," *DES* 1954, 12.
8. F. Newall, "Whitemoss Farm, Bishopton," *DES* 1957, 25.
9. R. P. Wright, "Roman Britain in 1949," *JRS* 40 (1950): 93.
10. R. P. Wright, "Roman Britain in 1950," *JRS* 41 (1951): 120.
11. R. P. Wright "Roman Britain in 1951," *JRS* 42 (1952): 87.
12. R. P. Wright, "Roman Britain in 1952," *JRS* 43 (1953): 105.
13. R. P. Wright, "Roman Britain in 1953," *JRS* 44 (1954): 86.
14. R. P. Wright, "Roman Britain in 1954," *JRS* 45 (1955): 123.
15. "Roman Britain in 1957," *JRS* 48 (1958): 133.
16. Lawrence Keppie, "The Antonine Wall 1960-1980," *Britannia* 13 (1982): 111.
17. <<http://canmore.rcahms.gov.uk/en/site/43341/details/bishopton+whitemoss/>>

³⁹ Robertson, *Birrens*, 108-128.

⁴⁰ *Ibid*, 126, 130.

⁴¹ *Ibid*, 130.

All four successive occupations of Bishopton took place during the Antonine period.⁴²

Excavations in the 1950's found, during the third occupation in the E half of the *retentura*,

"Traces of clay flooring..., and numerous traces of small clay "benches" associated with small hearths, all disturbed. Pieces of slag, iron - "both bar and rod - and broken tools suggest workshop activity in this area."⁴³

5. Bochastle (NN 614 079, Stirling, ~5 acres)

Sources consulted:

1. J. K. St Joseph, "Air Reconnaissance in Britain, 1965-68," *JRS* 59 (1969): 109.
2. "Roman Britain in 1948", *JRS* 39 (1949): 96-115.
3. R. P. Wright, "Roman Britain in 1949," *JRS* 40 (1950): 92.
4. R. P. Wright, "Roman Britain in 1950," *JRS* 41 (1951): 120.
5. R. P. Wright, "Roman Britain in 1953," *JRS* 44 (1954): 86.
6. W. Anderson, "Perthshire," *DES* 1949, 10.
7. W. Anderson, "Bochastle," *DES* 1949b, 9-10.
8. W. Anderson, "Bochastle," *DES* 1950, 11.
7. D.J.Woolliscroft & B.Hoffmann, <<http://www.theromangaskproject.org.uk/Pages/Papers/Bochastle.html>>
8. <<http://canmore.rcahms.gov.uk/en/site/24337/details/bochastle/>>

Excavations at Flavian fort of Bochastle, led by W. Anderson in 1949, were limited to establishing the size and date of the site.⁴⁴ Like at Bertha, Bochastle did not receive significant attention until recently (2006) when the Roman Gask Project conducted a geophysical survey of the fort and the surrounding area. Results cleared many issues regarding the site's construction, but have little importance to this study as no definite internal metallurgical structures or artifacts were discovered.⁴⁵

6. Bothwellhaugh (NS 730 577, North Lanarkshire, ~ 4.5 acres)

Sources consulted:

⁴² <<http://canmore.rcahms.gov.uk/en/site/43341/details/bishopton+whitemoss/>>

⁴³ F. Newall, "Whitemoss Farm, Bishopton," *DES* 1954, 12.

⁴⁴ "Roman Britain in 1948", *JRS* 39 (1949) 96-115.

⁴⁵ <<http://www.theromangaskproject.org.uk/Pages/Papers/Bochastle.html>>

1. G. S. Maxwell, "Excavation at the Roman Fort of Bothwellhaugh, Lanarkshire, 1967-8," *Britannia* 6 (1975): 20-35.
2. G. S. Maxwell, "Bothwellhaugh, Lanarkshire," *DES* 1967, 59.
3. G. S. Maxwell, "Bothwellhaugh, Lanarkshire," *DES* 1968, 50-51.
4. L. J. Keppie and J. MacKenzie, "Bothwellhaugh, Lanarkshire," *DES* 1975, 30.
5. "Roman Britain in 1937," *JRS* 28 (1938): 170.
6. R. P. Wright, "Roman Britain in 1940," *JRS* 31 (1941): 128.
7. D. R. Wilson and R. P. Wright, "Roman Britain in 1967," *JRS* 58 (1968): 178.
8. D. R. Wilson and R. P. Wright, "Roman Britain in 1968," *JRS* 59 (1969): 204.
9. R. Goodburn et al., "Roman Britain in 1975," *Britannia* 7 (1976): 291-392, 304.
10. S. S. Frere et al., "Roman Britain in 1976," *Britannia* 8 (1977): 369.
11. B. C. Burnham et al., "Roman Britain in 1994," *Britannia* 26 (1995): 337.
12. I. A. Richmond, "Roman Britain, 1910-1960," *JRS* 50 (1960): 183.
13. Clarke, John et al. *The Roman Occupation of South-Western Scotland*. Glasgow: The University Press, 1952.
14. <<http://canmore.rcahms.gov.uk/en/site/45661/details/bothwellhaugh/>>

Three excavations at the Antonine fort of Bothwellhaugh have failed to reveal any structural or artifactual evidence of metallurgical activity at the site.

7. Broomholm (NY 378 814, Dumfries and Galloway, ~ 4 acres)

Sources consulted:

1. D. R. Wilson and R. P. Wright, "Roman Britain in 1964," *JRS* 55 (1965): 202.
2. R. P. Wright, "Roman Britain in 1956," *JRS* 47 (1957): 200-1.
3. R. P. Wright, "Roman Britain in 1950," *JRS* 41 (1951): 122.
4. R. P. Wright, "Roman Britain in 1961," *JRS* 52 (1962): 162,164.
5. R. P. Wright and D. R. Wilson, "Roman Britain in 1962," *JRS* 53 (1963): 128.
6. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 52.
7. A. Truckell, "Broomholm Knowe," *DES* 1956, 13.
8. M'Cracken and Tolson, "Broomholm," *DES* 1960, 26.
9. C. Daniel, "Broomholmshlel. Lansholm," *DES* 1962, 26.
10. <<http://canmore.rcahms.gov.uk/en/site/67709/details/broomholm/>>

A trench dug in 1956 by A. Truckell across the fort's SW corner defenses to the intervallum road revealed a number of hearths, one of which "... rather larger than the rest, and outlined by a setting of stones, yielded a considerable amount of slag."⁴⁶

8. Camelon (NS 863 809, Falkirk, ~ 8 acres)

Sources consulted:

1. Buchanan, M., "Account of the excavation of the Roman station of Camelon, near Falkirk, undertaken by the Society in 1900," *PSAS* 35 (1901): 350-79.

⁴⁶ A. Truckell, "Broomholm Knowe," *DES* 1956, 13.

2. Joseph Anderson, "Notice Of The Pottery, Bronze, And Other Objects Found At Camelon ," *PSAS* 35 (1901): 397-409.
3. T. W. T. Tatton-Brown, "Camelon, Arthur's O'on and the Main Supply Base for the Antonine Wall," *Britannia* 11 (1980): 340-343.
4. N. McCord, "Annexe Of The Antonine Fort At Camelon, Near Falkirk, Stirlingshire," *DES* 1961, 55.
5. N. McCord, "Camelon," *DES* 1962, 44-45.
6. E. G. and J. G. Price, "Camelon," *DES* 1972, 40.
7. E. G. and J. G. Price, "Camelon," *DES* 1973, 51-2.
8. E. G. and J. G. Price, "Camelon," *DES* 1974, 63-4.
9. V. Maxfield, "Camelon Roman Fort," *DES* 1975, 52-3.
10. V. Maxfield, "Camelon Roman Fort," *DES* 1976, 61.
11. V. Maxfield and E. J. Price "Camelon," *DES* 1977, 34-5.
12. R. P. Wright, "Roman Britain in 1959," *JRS* 50 (1960): 213-14.
13. R. P. Wright, "Roman Britain in 1961," *JRS* 52 (1962): 163.
14. R. P. Wright and D. R. Wilson, "Roman Britain in 1962," *JRS* 53 (1963): 127-8.
15. D. R. Wilson et al., "Roman Britain in 1972," *Britannia* 4 (1973): 273-4.
16. D. R. Wilson et al., "Roman Britain in 1973," *Britannia* 5 (1974): 405.
17. D. R. Wilson et al., "Roman Britain in 1974," *Britannia* 6 (1975): 226.
18. R. Goodburn et al., "Roman Britain in 1975," *Britannia* 7 (1976): 300.
19. S. S. Frere et al., "Roman Britain in 1976," *Britannia* 8 (1977): 362-3.
20. R. Goodburn et al., "Roman Britain in 1977," *Britannia* 9 (1978): 411.
21. R. Goodburn et al., "Roman Britain in 1978," *Britannia* 10 (1979): 275.
22. N. B. Rankov et al., "Roman Britain in 1981," *Britannia* 13 (1982): 337.
23. L. J. F. Keppie et al., "Roman Britain in 1998," *Britannia* 30 (1999): 328.
24. <<http://canmore.rcahms.gov.uk/en/site/46920/details/falkirk+camelon/>>

During the 1900 excavation, a variety of ornamental bronze artifacts were recovered, as well as iron implements, but no evidence of slag of any kind.⁴⁷

In 1975, further rescue work revealed four hearths located in an "industrial" area of the NE section of the southern annex where "... A quantity of slag and scraps of iron in the vicinity suggest that one, at least, of the hearths was used for ironworking."⁴⁸

9. Cappuck (NT 695 212, Borders, ~ 1.5 acres)

Sources consulted:

1. G. H. Stevenson and S. N. Miller, "Report On The Excavations At The Roman Fort Of Cappuck, Roxburghshire," *PSAS* 46 (1911-1912): 446-83.
2. I. A. Richmond, "Exploratory Trenching At The Roman Fort Of Cappuck, Roxburghshire," *PSAS* 85 (1950-1951): 138-45.
3. I. A. Richmond, "Roxburghshire," *DES* 1949, 11.
4. J. K. St. Joseph, "Cappuck," *DES* 1974, 61.

⁴⁷ Joseph Anderson, "Notice Of The Pottery, Bronze, And Other Objects Found At Camelon ," *PSAS* 35 (1901) 397-409.

⁴⁸ Maxfield, V A (1975b) 'Camelon Roman fort', *Discovery Excav Scot*
Page(s): 52.

5. R. P. Wright, "Roman Britain in 1949," *JRS* 40 (1950): 95.
6. J. K. St Joseph, "Air Reconnaissance in Britain, 1969-72," *JRS* 63 (1973): 72.
7. <<http://canmore.rcahms.gov.uk/en/site/57050/details/cappuck/>>

Ornamental bronze and practical iron finds were discovered⁴⁹ at Cappuck, though neither the Flavian nor Antonine occupations revealed any evidence of metallurgical activity.

10. Cardean (NO 289 460, Angus, ~ 9 acres)

Sources consulted:

1. J. K. St. Joseph, "Air Reconnaissance in Britain, 1961-64," *JRS* 55 (1965): 83.
2. Barry C. Burnham, "Sites Explored," *Britannia* 37 (2006): 369-428.
3. J. Robertson, "Cardean," *DES* 1966, 1.
4. J. Robertson, "Cardean," *DES* 1967, 5.
5. A. Robertson, "Cardean Meigle," *DES* 1968, 2.
6. A. Robertson, "Cardean Meigle," *DES* 1970, 4.
7. A. Robertson, "Cardean Meigle," *DES* 1971, 1.
8. A. Robertson, "Cardean Meigle," *DES* 1972, 2.
9. A. Robertson, "Cardean Meigle," *DES* 1973, 6.
10. J. K. St. Joseph, "Cardean," *DES* 1974, 7.
11. A. Robertson, "Cardean Meigle," *DES* 1975, 8.
12. "Cardean Roman Fort," *DES* 1976, 61.
13. B. Hoffman, "Cardean Roman Fort," *DES* 2001, 13.
14. D. R. Wilson and R. P. Wright, "Roman Britain in 1966," *JRS* 57 (1967): 175.
15. D. R. Wilson and R. P. Wright, "Roman Britain in 1967," *JRS* 58 (1968): 177.
16. D. R. Wilson and R. P. Wright, "Roman Britain in 1968," *JRS* 58 (1969): 202, 238.
17. D. R. Wilson et al., "Roman Britain in 1970," *Britannia* 2 (1971): 248.
18. M. W. C. Hassall et al., "Roman Britain in 1971," *Britannia* 3 (1972): 302.
19. D. R. Wilson et al., "Roman Britain in 1972," *Britannia* 4 (1973): 273.
20. D. R. Wilson et al., "Roman Britain in 1973," *Britannia* 5 (1974): 402.
21. D. R. Wilson et al., "Roman Britain in 1974," *Britannia* 6 (1975): 225.
22. Barry C. Burnham et al., "Roman Britain in 2001," *Britannia* 33 (2002): 285.
23. <<http://www.theromangaskproject.org.uk/Pages/Papers/Cardean.html>>
24. <<http://www.theromangaskproject.org.uk/Pages/Papers/Cardeansurvey.html>>
15. <<http://canmore.rcahms.gov.uk/en/site/30689/details/cardean/>>

Excavations at the Flavian fort of Cardean (1966-1975) have yielded little in regard to this paper. The fort's internal structure was not well elaborated during early exploration, and only barracks and a granary are attested to by excavation.⁵⁰ Practical iron implements and decorative

⁴⁹ G. H. Stevenson and S. N. Miller, "Report On The Excavations At The Roman Fort Of Cappuck, Roxburghshire," *PSAS* 46 (1911-1912): 474.

⁵⁰ <<http://canmore.rcahms.gov.uk/en/site/30689/details/cardean/>>

bronze pieces were found,⁵¹ but the only direct evidence of fabrication on site was with regard to the production of glass.⁵²

In 2001, the Roman Gask Project conducted fieldwalking and metal-detector exercises, aerial reconnaissance, and both a floodplain and geophysical resistivity survey of the site.⁵³ As stated by B. Hoffman, “A fieldwalking program was purposefully designed to cover a larger area than the resistivity survey... as well as highlighting any possible areas of industrial activity, by looking for concentrations of charcoal, burnt material and metal slag... In Prof. A.S. Robertson's notes passing reference is made to a *fabrica*/workshop area. This does not appear among the excavated structures but has to be assumed on the basis of high concentrations of metal and possible glass working waste among the backfill of the fort ditches.”⁵⁴ The efforts were rendered nearly useless by the natural magnetic properties of the stones in the soil, and no further evidence of a *fabrica* was found.

11. *Cargill* (NO 13NE 27, Perth and Kinross, ~5 acres)

Sources consulted:

1. I. A. Richmond, “Recent Discoveries in Roman Britain from the Air and in the Field,” *JRS* 33 (1943): 47.
2. N. B. Rankov et al, “Roman Britain in 1981,” *Britannia* 13 (1982): 335-336.
3. F. O. Grew et al., “Roman Britain in 1980,” *Britannia* 12 (1981): 319.
4. G. S. Maxwell and D. R. Wilson, “Air Reconnaissance in Roman Britain 1977-84,” *Britannia* 18 (1987): 16, 17, 21, 22.
5. <<http://canmore.rcahms.gov.uk/en/site/28493/details/cargill/>>

The Flavian fort at Cargill appears to have had a relatively short lifespan, being occupied for less than a decade.⁵⁵ A granary was discovered in 1980, as well as a second, unidentified

⁵¹ A. Robertson, “Cardean Meigle,” *DES* 1971, 1, 1972, 2.

⁵² <<http://www.theromangaskproject.org.uk/Pages/Papers/Cardean.html>>

⁵³ Birgitta Hoffmann, The results of the survey at the Roman fort of Cardean, August 2001, <<http://www.theromangaskproject.org.uk/Pages/Papers/Cardeansurvey.html>>

⁵⁴ <<http://www.theromangaskproject.org.uk/Pages/Papers/Cardeansurvey.html>>

⁵⁵ G. S. Maxwell and D. R. Wilson, “Air Reconnaissance in Roman Britain 1977-84,” *Britannia* 18 (1987): 16.

building of timber.⁵⁶ From the sources available for this paper, there was no evidence for either metalworking or metalworking facilities.

12. Carzield (NX 968 818, Dumfries and Galloway, ~ 6.5 acres)

Sources consulted:

1. A. Truckell, "Carzield Roman Fort," *DES* 1955, 10-11.
2. A. Truckell, "Carzield," *DES* 1956, 14.
3. A. Truckell, "Carzield," *DES* 1959, 23.
3. A. Truckell, "Carzield," *DES* 1973 23.
4. J. Williams, "Roman, Carzield, Kirkmahoe," *DES* 1968, 14.
5. A. McCracken, "Carzield, Roman fort," *DES* 1967, 21.
6. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 58.
7. I. A. Richmond, "Recent Discoveries in Roman Britain from the Air and in the Field," *JRS* 33 (1943): 50.
8. R. P. Wright, "Roman Britain in 1939," *JRS* 30 (1940): 162.
9. "Roman Britain in 1948," *JRS* 39 (1949): 98.
10. R. P. Wright, "Roman Britain in 1955," *JRS* 46 (1956): 123.
11. B. C. Burnham et al., "Roman Britain in 2002," *Britannia* 34 (2003): 306.
12. I. A. Richmond, "Roman Britain, 1910-1960," *JRS* 50 (1960): 183.
13. <<http://canmore.rcahms.gov.uk/en/site/65890/details/carzield/>>

During the site's initial excavation in 1939, one of only two identifiable internal buildings (a barrack in the SE corner of the fort) revealed a furnace in one of the officer's quarters.⁵⁷ Two figurines found within the furnace were reported to be "...ready for fusing into an alloy of iron and bronze."⁵⁸

Excavations just N of the fort in 1955 revealed a rubbish pit filled with ash, pottery sherds, iron, slag, and the remnants of a furnace.⁵⁹ Four years later, lead and iron were found upon further excavation of the feature.⁶⁰ Although indicative of metallurgical activity, the find was both unstratified and outside the fort proper.

13. Castledykes (NS 928 442, South Lanarkshire, ~6.5 acres)

⁵⁶ F. O. Grew et al., "Roman Britain in 1980," *Britannia* 12 (1981): 319.

⁵⁷ R. P. Wright, "Roman Britain in 1939," *JRS* 30 (1940): 162.

⁵⁸ Wright, 162.

⁵⁹ A. Truckell, "Carzield Roman Fort," *DES* 1955, 10-11.

⁶⁰ A. Truckell, "Carzield," *DES* 1959, 23.

Sources consulted:

1. Robertson, Anne. *The Roman Fort at Castledykes*. Edinburgh: Oliver & Boyd, 1964.
2. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 57.
3. A. Robertson, "Castledykes," *DES* 1950, 10-11.
4. A. Robertson, "Castledykes," *DES* 1951, 10-11.
5. A. Robertson, "Castledykes," *DES* 195, 11-12.
6. A. Robertson, "Castledykes," *DES* 1954, 10-11.
7. A. Robertson, "Castledykes," *DES* 1955, 18-19.
8. J. K. St. Joseph, "Castledykes," *DES* 1956, 17.
9. "Roman Britain in 1937," *JRS* 28 (1938): 171.
10. R. P. Wright, "Roman Britain in 1939," *JRS* 30 (1940): 158-160.
11. R. P. Wright, "Roman Britain in 1951," *JRS* 42 (1952): 47-8.
12. R. P. Wright, "Roman Britain in 1953," *JRS* 44 (1954): 86.
13. "Roman Britain in 1954," *JRS* 45 (1955): 123.
14. R. P. Wright, "Roman Britain in 1955," *JRS* 46 (1956): 123.
15. S. S. Frere et al., "Roman Britain in 1989," *Britannia* 21 (1990): 312.
16. B. C. Burnham et al., "Roman Britain in 1992," *Britannia* 24 (1993): 281.
17. L. J. Keppie et al., "Roman Britain in 1998," *Britannia* 30 (1999): 383.
18. B. C. Burnham et al., "Roman Britain in 2002," *Britannia* 34 (2003): 305.
19. B. C. Burnham et al., "Roman Britain in 2003," *Britannia* 35 (2004): 269.
20. B. C. Burnham et al., "Roman Britain in 2004," *Britannia* 36 (2005): 400.
21. <<http://canmore.rcahms.gov.uk/en/site/47721/details/castledykes/>>

Five seasons of sporadic excavation by a team of students and laborers between 1950 and 1955 confirmed the presence of both Flavian and Antonine remains at the site. Due to the presence of numerous trees impeding excavation efforts, only two buildings (the *Principia* and a potential granary) were able to be definitively identified and were assigned to the Antonine period of occupation.⁶¹ Pottery sherds and numismatic evidence were used to contextualize finds within the settlement. Robertson identified four phases of occupation through successive layers of rampart construction; an initial and transient structure was postulated to have been built during Agricola's campaigns, while a later Flavian fort occupation and two separate Antonine phases were described.⁶²

Ornamental bronze pieces and practical iron implements such as nails and chisels were found throughout the excavations, although there was no evidence for on site fabrication of these objects. However, furnace lead, slag, fused glass and burned clay were discovered in the remains

⁶¹ Anne Robertson, *The Roman Fort at Castledykes* (Edinburgh: Oliver & Boyd, 1964), 14.

⁶² Robertson, 96.

of a potential building along the E rampart of the initial Antonine phase, N of the *via principalis*.

“The abundant signs of burning suggested that the structure had either been used for some such purpose as cooking or smelting – possibly lead smelting since the lead slag was unlikely to have been brought from elsewhere...” (Robertson 25). This sentiment was echoed by Dr. J. A.

Smythe of King’s College, who analyzed the lead slag and proposed that the raw material was imported from Leadhills, Lanarkshire for smelting at Castledykes.⁶³

14. Cramond (NT 189 768, Edinburgh, ~ 6 acres)

Sources consulted:

1. Paul Masser, “Cramond Roman Fort: evidence from excavations at Cramond Kirk Hall, 1998 and 2001,” Scottish Archaeological Internet Report 20, 2006. <<http://www.sair.org.uk>>
2. Alan, Viola Rae et al, “The Roman Fort at Cramond, Edinburgh Excavations 1954-1966,” *Britannia* 5 (1974): 163-224.
3. “Roman Britain in 1937,” *JRS* 28 (1938): 170.
4. R. P. Wright, “Roman Britain in 1955,” *JRS* 46 (1956): 122.
5. R. P. Wright, “Roman Britain in 1956,” *JRS* 47 (1957): 200-1.
6. “Roman Britain in 1957,” *JRS* 48 (1958): 133.
7. R. P. Wright, “Roman Britain in 1958,” *JRS* 49 (1959): 104.
8. R. P. Wright, “Roman Britain in 1959,” *JRS* 50 (1960): 214.
9. R. P. Wright, “Roman Britain in 1960,” *JRS* 51 (1961): 161.
10. R. P. Wright, “Roman Britain in 1961,” *JRS* 52 (1962): 163.
11. R. P. Wright, “Roman Britain in 1962,” *JRS* 53 (1963): 128.
12. D. R. Wilson and R. P. Wright, “Roman Britain in 1964,” *JRS* 55 (1965): 202.
13. M. C. Hassall et al., “Roman Britain in 1971,” *Britannia* 3 (1972): 304.
14. R. Goodburn et al., “Roman Britain in 1975,” *Britannia* 7 (1976): 305-6.
15. S. S. Frere et al., “Roman Britain in 1976,” *Britannia* 8 (1977): 368-370.
16. R. Goodburn et al., “Roman Britain in 1977,” *Britannia* 9 (1978): 418.
17. R. Goodburn et al., “Roman Britain in 1978,” *Britannia* 10 (1979): 278-9.
18. F. O. Grew et al., “Roman Britain in 1979,” *Britannia* 11 (1980): 354.
19. F. O. Grew et al., “Roman Britain in 1980,” *Britannia* 12 (1981): 321.
20. N. B. Rankov et al., “Roman Britain in 1981,” *Britannia* 13 (1982): 339.
21. S. S. Frere et al., “Roman Britain in 1982,” *Britannia* 14 (1983): 289.
22. S. S. Frere et al., “Roman Britain in 1987,” *Britannia* 19 (1988): 429.
23. S. S. Frere et al., “Roman Britain in 1991,” *Britannia* 23 (1992): 264.
24. B. C. Burnham et al., “Roman Britain in 1992,” *Britannia* 24 (1993): 280.
25. B. C. Burnham et al., “Roman Britain in 1995,” *Britannia* 27 (1996): 402.
26. B. C. Burnham et al., “Roman Britain in 1996,” *Britannia* 28 (1997): 408.
27. L. J. Keppie, “Roman Britain in 1998,” *Britannia* 30 (1999): 331.
28. L. J. Keppie, “Roman Britain in 2000,” *Britannia* 32 (2001): 321.
29. B. C. Burnham, “Roman Britain in 2001,” *Britannia* 33 (2002): 289.
30. B. C. Burnham, “Roman Britain in 2002,” *Britannia* 34 (2003): 305.
31. B. C. Burnham, “Roman Britain in 2003,” *Britannia* 35 (2004): 269.

⁶³ Ibid, 167-168.

32. B. C. Burnham, "Roman Britain in 2004," *Britannia* 36 (2005): 399.
33. B. C. Burnham, "Sites Explored," *Britannia* 37 (2006): 387.
35. A. Rae, "Cramond," *DES* 1961, 31.
36. A. Rae, "Cramond," *DES* 1962, 30.
37. M. Walker, "Cramond," *DES* 1971, 57.
38. N. M. McQ. Holmes, "Cramond," *DES* 1975, 24.
39. N. M. McQ. Holmes, "Cramond," *DES* 1976, 32.
40. N. M. McQ. Holmes, "Cramond," *DES* 1977, 13.
41. N. M. McQ. Holmes, "Cramond," *DES* 1978, 15.
42. R. Callander and C. Hoy, "Cramond," *DES* 1979, 18.
43. C. Hoy, "Cramond," *DES* 1980, 20.
44. N. M. McQ. Holmes and C. Hoy, "Cramond," *DES* 1981, 22.
45. C. Hoy, "Cramond Roman Fort," *DES* 1982, 16.
46. C. Hoy and N. Holmes, "Cramond Roman Fort," *DES* 1984, 17.
47. N. Holmes, "Cramond Roman Fort," *DES* 1986, 19.
48. V. E. Dean, "Cramond Roman Fort," *DES* 1988, 18.
49. V. E. Dean, "Cramond Roman Fort," *DES* 1989, 51.
50. V. E. Dean, "Cramond Roman Fort," *DES* 1990, 29.
51. V. E. Dean, "Cramond Roman Fort," *DES* 1991, 51.
52. V. E. Dean, "Cramond Roman Fort," *DES* 1992, 52.
53. V. E. Dean, "Cramond Roman Fort," *DES* 1993, 59.
54. V. E. Dean, "Cramond Roman Fort," *DES* 1994, 47.
55. D. Reed, "Cramond Roman Fort," *DES* 1995, 53.
56. V. E. Dean, "Cramond Roman Fort," *DES* 1996, 38.
57. V. E. Dean, "Cramond Roman Fort," *DES* 1997, 32.
58. V. E. Dean, "Cramond Roman Fort," *DES* 1999, 36.
59. H. Jones, "Cramond Roman Fort," *DES* 2000, 33.
60. H. Jones, "Cramond Roman Fort," *DES* 2001, 39.
61. H. Jones, "Cramond Roman Fort," *DES* 2002, 47.
62. H. Jones, "Cramond Roman Fort," *DES* 2003, 68.
63. <<http://canmore.rcahms.gov.uk/en/site/50409/details/cramond/>>

The 1954-1966 excavations yielded evidence of an industrial complex (Block B) in the NE corner of the fort.⁶⁴ A hearth and kiln with small finds of unfinished lead and bronze immediately surrounding the facilities in Block B are postulated to be part of the 1st or 2nd Antonine occupation of the site.⁶⁵

Decorative bronze found, lead pieces, and hundreds of iron nails as well as other practical implements.⁶⁶

Another industrial complex was noted in a large annex to the east of the site in 2003, while Severan metalwork just outside the NE defenses was discovered in 1998/2001 excavations.⁶⁷

⁶⁴ Alan, Viola Rae et al, "The Roman Fort at Cramond, Edinburgh Excavations 1954-1966," *Britannia* 5 (1974): 181-186.

⁶⁵ Rae, 181-2, 195.

⁶⁶ Ibid, 195.

15. Crawford (NS 953 214, South Lanarkshire, ~2 acres (Flavian), ~3 acres (Antonine))

Sources consulted:

1. Gordon Maxwell, "Excavations at the Roman fort of Crawford, Lanarkshire," *PSAS* 104 (1971-1972): 176-7.
2. R. P. Wright and D. R. Wilson, "Roman Britain in 1962," *JRS* 53 (1963): 128.
3. D. R. Wilson and R. P. Wright, "Roman Britain in 1966," *JRS* 57 (1967): 176.
3. D. R. Wilson and R. P. Wright, "Roman Britain in 1969," *Britannia* 1 (1970): 313.
4. Clarke, John et al., *The Roman Occupation of South-Western Scotland*. Glasgow: The University Press, 1952.
5. <<http://canmore.rcahms.gov.uk/en/site/47396/details/crawford/>>

A potential hearth, located in Building IX of the Antonine fort plan, was surrounded by slag and other evidence of metallurgical activity in the NW corner of the site at Crawford.⁶⁸

Ditch-filling also produced considerable quantities of slag.⁶⁹ There is no evidence for Flavian metalworking.

Decorative bronze, iron weapons and nails, and varying lead items were recovered.⁷⁰ XRF analysis of crucible fragments confirmed the presence of brass-working at Crawford.⁷¹ The sophistication of the crucible (tripartite clay form), the ability to attain requisite temperatures needed for processing brass (1100 degrees Celsius) as well as another crucible fragment being discovered near the W granary indicate an established and considerable brass-making workshop at Crawford.⁷² Proximity of the fort to known sources of lead at Leadhills should be noted.

16. Dalginross (NN 773 210, Perth and Kinross, ~ 3.5, ~ 7.5 acres)

Sources consulted:

1. J. K. St Joseph, "Air Reconnaissance in Britain, 1965-68," *JRS* 59 (1969): 110.
2. A. Robertson, "Dalginross," *DES* 1961, 40.
3. "Dalginross," *DES* 1976, 73.
4. D. J. Wooliscroft, "Dalginross," *DES* 1999, 70.

⁶⁷ Paul Masser, "Cramond Roman Fort: evidence from excavations at Cramond Kirk Hall, 1998 and 2001," Scottish Archaeological Internet Report 20, 2006. <<http://www.sair.org.uk>> 6.

⁶⁸ Gordon Maxwell, "Excavations at the Roman fort of Crawford, Lanarkshire," *PSAS* 104 (1971-1972): 176-7.

⁶⁹ Maxwell, "Excavations", 158.

⁷⁰ Ibid, 184-7.

⁷¹ Ibid, 198.

⁷² Ibid, 198.

5. R. P. Wright, "Roman Britain in 1961," *JRS* 52 (1962): 162-3.
6. F. O. Grew et al., "Roman Britain in 1980," *Britannia* 12 (1981): 317.
7. B. C. Burnham et al., "Roman Britain in 1999," *Britannia* 31 (2000): 381.
8. B. C. Burnham, "Roman Britain in 2001," *Britannia* 33 (2002): 285.
9. B. C. Burnham, "Sites Explored," *Britannia* 37 (2006): 386.
10. <http://www.theromangaskproject.org.uk/Pages/Papers/Dalgin_pots.html>
11. <<http://canmore.rcahms.gov.uk/en/site/24832/details/dalginross/>>

No proper excavation has been carried out at this time; a single trench was cut into the outer fort in 1961, but produced no evidence of structural occupation.⁷³ The only metal recovered was an unstratified entrenching tool, a *dolabra*.⁷⁴

17 Dalswinton (NX 933 848, NX 933 841, Dumfries and Galloway, (Flavian) ~ 13, ~9, ~8, ~11 acres)⁷⁵

Sources consulted:

1. J. K. St Joseph, "Air Reconnaissance in Britain, 1969-72," *JRS* 63 (1973): 217.
2. J. K. St Joseph, "Air Reconnaissance in Roman Britain, 1973-76," *JRS* 67 (1977): 131.
3. J. K. St. Joseph, "Dalswinton," *DES* 1974, 31.
4. <<http://canmore.rcahms.gov.uk/en/site/65893/details/dalswinton+bankhead/>> (Bankhead)
5. <<http://canmore.rcahms.gov.uk/en/site/65920/details/dalswinton+bankfoot/>> (Bankfoot)

Available sources did not reveal any indications of workshops or metallurgical activity. However, with this site and the fort at Milton in particular, many articles were published in the Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society (*TDGNHAS*), which the author was unable to obtain.

18. Doune (NN 727 013, Stirling, ~ 5.5 acres)

Sources consulted:

1. G. S. Maxwell and D. R. Wilson, "Air Reconnaissance in Roman Britain 1977-84," *Britannia* 18 (1987): 17.
2. G. S. Maxwell, "Doune," *DES* 1984, 4.
3. C. Moloney, "Doune Primary School, Doune," *DES* 1999, 87.

⁷³ A. Robertson, "Dalginross," *DES* 1961, 40.

⁷⁴ D. J. Wooliscroft, "Dalginross," *DES* 1999, 70.

⁷⁵ J. K. St Joseph, "Air Reconnaissance in Roman Britain, 1973-76," *JRS* 67 (1977): 131. A total of four individual forts, all of presumably Flavian date, have been recognized at Dalswinton. It is important to note that the area measurements are "within the ditches" (that is, within the defensive fortifications) while every other site in this report has been measured approximately "over the ditches". As such, the forts at Dalswinton in fact have even larger measurements than the ones available for this paper, despite their already unusual size.

4. G. S. Maxwell, "New Frontiers: The Roman Fort at Doune and Its Possible Significance," *Britannia* 15 (1984): 217-223.
5. S. S. Frere et al., "Roman Britain in 1983," *Britannia* 15 (1984): 275.
6. S. S. Frere et al., "Roman Britain in 1984," *Britannia* 16 (1985): 264.
7. B. C. Burnham et al., "Roman Britain in 1999," *Britannia* 31 (2000): 381-2.
8. <<http://canmore.rcahms.gov.uk/en/site/24767/details/doune+roman+fort+and+annexe/>>

Excavations of the Flavian fort at Doune have yielded no evidence of metallurgical activity, structural or otherwise.

19. Drumlanrig (NX 854 989, Dumfries and Galloway, ~ 3 acres)

Sources consulted:

1. G. S. Maxwell and D. R. Wilson, "Air Reconnaissance in Roman Britain 1977-84," *Britannia* 18 (1987): 19.
2. S. S. Frere et al., "Roman Britain in 1984," *Britannia* 16 (1985): 267.
3. B. C. Burnham et al., "Roman Britain in 2004," *Britannia* 36 (2005): 401-2.
4. Wessex Archaeology, "Drumlanrig Roman Fort, Drumlanrig Castle, Dumfries and Galloway: Archaeological Evaluation and Assessment of the Results" (2005). <<http://www.wessexarch.co.uk/>>
5. <<http://canmore.rcahms.gov.uk/en/site/65200/details/drumlanrig+roman+fort/>>

The Antonine fort of Drumlanrig, having undergone geophysical and gradiometric surveys, as well as excavation in 2004, has not produced any evidence for either metalworking facilities. Finds are of the typical practical iron, ornamental bronze, and lead weight variety.

20. Drumquhassle (NS 484 872, Stirling, ~ 3 acres)

Sources consulted:

1. G. S. Maxwell, "Recent Aerial Discoveries in Roman Scotland: Drumquhassle, Elginhaugh and Woodhead," *Britannia* 14 (1983): 171.
2. R. Goodburn et al., "Roman Britain in 1978," *Britannia* 10 (1979): 275.
3. S.S. Frere et al., "Roman Britain in 1983," *Britannia* 15 (1984): 167-171, 181.
4. L. J. Keppie et al., "Roman Britain in 1997," *Britannia* 29 (1998): 379.
5. L. J. Keppie et al., "Roman Britain in 1998," *Britannia* 30 (1999): 328.
6. B. C. Burnham et al., "Roman Britain in 1999," *Britannia* 31 (2000): 381.
7. B. C. Burnham et al., "Roman Britain in 2004," *Britannia* 36 (2005): 395.
8. "Drumquhassle," *DES* 1978, 1.
9. J. Rideout, "Drumquhassle," *DES* 1997, 79.
10. L. J. Keppie, "Drumquhassle," *DES* 2000, 89.
11. <<http://canmore.rcahms.gov.uk/en/site/43408/details/drumquhassle/>>

Drumquhassle has not yet been properly excavated. In 1983, the only trench dug within the fort along the NE corner, yielded “some extremely small fragments of what was probably a clay crucible used in metal-working.”⁷⁶

21. Easter Happrew (NT 194 401, Borders, ~ 3 acres)

Sources consulted:

1. “The Roman Fort At Easter Happrew, Peeblesshire”, K. A. Steer, *PSAS* (1956-1957).
2. R. P. Wright, “Roman Britain in 1956,” *JRS* 47 (1957): 200-2.
3. B. C. Burnham et al., “Roman Britain in 1996,” *Britannia* 28 (1997): 412.
3. J. K. St. Joseph, “Air Reconnaissance in Britain, 1955-7,” *JRS* 48 (1958): 88-9.
4. J. K. St. Joseph, “Air Reconnaissance in Britain, 1958-1960,” *JRS* 51 (1961): 121.
5. R. W. Feachem, “East Haprew, Stobo,” *DES* 1955, 21.
6. F. Hunter, “East Happrew,” *DES* 1999, 79-80.
7. <<http://canmore.rcahms.gov.uk/en/site/50032/details/easter+happrew/>>

Excavations in 1956 did not yield any evidence of metalworking facilities within the Flavian fort. Copper alloy artifacts were later recovered outside the fort.⁷⁷

22. Elginhaugh (NT 321 673, Midlothian, ~ 4 acres)

Sources consulted:

1. Hanson, W. S. *Elginhaugh: A Flavian Fort and its Annexe*. London: The Society for the Promotion of Roman Studies, 2007.
2. F. O. Grew et al., “Roman Britain in 1980,” *Britannia* 12 (1981): 321.
3. S. S. Frere et al., “Roman Britain in 1984,” *Britannia* 16 (1985): 264.
4. S. S. Frere et al., “Roman Britain in 1986,” *Britannia*, 18 (1987): 312-3.
5. S. S. Frere et al., “Roman Britain in 1987,” *Britannia*, 19 (1988): 428-9.
6. B. C. Burnham, “Roman Britain in 2001,” *Britannia* 33 (2002): 290.
7. G. S. Maxwell and D. R. Wilson, “Air Reconnaissance in Roman Britain 1977-84,” *Britannia* 18 (1987): 18-19.
8. G. S. Maxwell, “Recent Aerial Discoveries in Roman Scotland: Drumquhassle, Elginhaugh and Woodhead,” *Britannia* 14 (1983): 167-181.
9. W. S. Hanson, “Elginhaugh,” *DES* 1987, 31.
10. <<http://canmore.rcahms.gov.uk/en/site/53492/details/elginhaugh/>>

Evidence for metalworking at Elginhaugh is somewhat complex. Structurally, a *fabrica* was identified by W.S. Hanson in his 1986 excavation of the site, located in the NE corner, set ~ 3

⁷⁶ G. S. Maxwell, “Recent Aerial Discoveries in Roman Scotland: Drumquhassle, Elginhaugh and Woodhead,” *Britannia* 14 (1983): 171.

⁷⁷ B. C. Burnham et al., “Roman Britain in 1996,” *Britannia* 28 (1997): 412.

m into the E rampart wall.⁷⁸ Its curious position is paralleled in the Flavian period at Hod Hill, and at Strageath, Bar Hill, and Balmuildy in the succeeding Antonine period.⁷⁹ Both the Elginhaugh and Hod Hill structures showed evidence of intensive heating, though neither produced any direct evidence of hearths, ovens or furnaces.⁸⁰ The raising on the *fabrica* structure at Elginhaugh above ground level on stone slabs was interpreted as a means of preventing accidental fires, and this notion formed the core of Hanson's argument for the industrial labeling of the feature. Hanson's conclusion regarding the nature of the building is thus largely based on deductive reasoning rather than tangible evidence.

The situation is complicated by the presence of definite metalworking in both the *principia* and along the rampart north of the W gate. Metalworking debris and a crucible lined with copper-based residue were found in the SW corner of the *principia* ambulatory, indicating small-scale metallurgical activity – most likely repair work.⁸¹ In the *intervallum* north of the W gate, an entire industrial area was uncovered. Comprising a rectangular area roughly 3-4m wide and 15m long, the S section yielded typical metal-working debris and crucible fragments (again lined with copper-alloy residue), while the N section contained the remains of two chronologically distinct structures (the first, a lean-to; the second set on stone slabs, like the *fabrica*) that were “in some way linked to the manufacture or repair of copper-alloy artefacts”.⁸²

Interestingly, there is no evidence for iron-working within Elginhaugh. Massive quantities of bronze, iron, and lead objects, as well as armor, indicate some level of either fabrication or repair activity being conducted on site, but the *fabrica* is devoid of either slag or furnaces.

⁷⁸ W. S. Hanson, *Elginhaugh: A Flavian Fort and its Annexe* (London: The Society for the Promotion of Roman Studies, 2007) 86-92.

⁷⁹ Hanson, *Elginhaugh*, 89.

⁸⁰ *Ibid*, 89.

⁸¹ *Ibid*, 36.

⁸² *Ibid*, 189-191. It should be noted that the *fabrica*'s dimensions measured roughly 32m x 4m – the length being nearly double that of the W workshop area, though its width nearly identical.

Following metallurgical analysis of nearly 300 samples, mostly labeled as “slag”, it was concluded that “...the quantities and form of the slags recovered at Elginhaugh are nowhere near the levels that current archaeological ...and experimental data... would suggest for Roman ferrous or non-ferrous smelting. The only clear, direct evidence of industrial processes – the melting and casting of copper-based metals – comes via the crucibles with their residues found in a number of contexts notably by the West Gate.”⁸³

23. Fendoch (NN 919 283, Perth and Kinross, ~ 5 acres)

Sources consulted:

1. I. A. Richmond, “The Agricola Fort at Fendoch,” *PSAS* 73 (1938-39): 110-154.
2. B. C. Burnham et al., “Roman Britain in 2004,” *Britannia* 36 (2005): 395-6.
3. I. A. Richmond and James McIntyre, “The Roman Fort At Fendoch In Glenalmond: A Preliminary Note,” *PSAS* 70 (1935-1936): 400-6.
4. “Roman Britain in 1937,” *JRS* 28 (1938): 170.
5. “Roman Britain in 1938,” *JRS* 29 (1939): 200.
6. <<http://canmore.rcahms.gov.uk/en/site/26132/details/fendoch/>>

The 1936-1938 excavations at Fendoch did not produce any convincing evidence of Roman metalworking or metalworking facilities. Two “open-ended” buildings were noted behind the granaries, and were assumed to be either “workshops or cart-sheds.”⁸⁴ A resistivity survey conducted in 2004 by the Roman Gask Project did not yield any results of direct importance to this paper.

24. Glenlochar (NX 735 645, Dumfries and Galloway, ~ 8 acres)

Sources consulted:

1. R. P. Wright, “Roman Britain in 1952,” *JRS* 43 (1953): 107-9, 130.
2. J. K. St. Joseph, “Air Reconnaissance of North Britain,” *JRS* 41 (1951): 60.
3. J. K. St. Joseph, “Air Reconnaissance in Britain, 1955-7,” *JRS* 48 (1958): 89.
4. J. J. Walker, “Glenlochar,” *DES* 1974 (43)
5. <<http://canmore.rcahms.gov.uk/en/site/64687/details/glenlochar/>>

⁸³ Ibid, 512.

⁸⁴ I. A. Richmond, “The Agricola Fort at Fendoch,” *PSAS* 73 (1938-39): 137.

No evidence for metalworking has yet been found at the fort, which was occupied in both Flavian and Antonine periods.

25. Inveresk (NT 342 720, East Lothian, ~ 6.5 acres)

Sources consulted:

1. Bishop, M. C., "*Roman Inveresk: Past, Present, and Future*", Armatura, Braemar, 2002.
2. I. A. Richmond, "A Roman fort at Inveresk, Midlothian," *PSAS* 110 (1981): 286-304.
3. W. S. Hanson, "Inveresk Roman fort: trial trenching," *PSAS* 114 (1985): 251-60.
4. R. P. Wright, "Roman Britain in 1946," *JRS* 37 (1947): 165.
5. R. P. Wright, "Roman Britain in 1947," *JRS* 38 (1948): 81.
6. D. R. Wilson and R. P. Wright, "Roman Britain in 1963," *JRS* 54 (1964): 155.
7. D. R. Wilson and R. P. Wright, "Roman Britain in 1964," *JRS* 55 (1965): 202.
8. D. R. Wilson and R. P. Wright, "Roman Britain in 1965," *JRS* 56 (1966): 176.
9. N. B. Rankov et al., "Roman Britain in 1981," *Britannia* 13 (1982): 339.
10. B. C. Burnham et al., "Roman Britain in 1992," *Britannia* 24 (1993): 280.
11. B. C. Burnham et al., "Roman Britain in 1993," *Britannia* 25 (1994): 257.
12. B. C. Burnham et al., "Roman Britain in 1996," *Britannia* 28 (1997): 410.
13. L. J. Keppie et al., "Roman Britain in 1997," *Britannia* 29 (1998): 381.
14. B. C. Burnham et al., "Roman Britain in 1999," *Britannia* 31 (2000): 384.
15. L. J. Keppie, "Roman Britain in 2000," *Britannia* 32 (2001): 321.
16. K. A. Steer, "Inveresk," *DES* 1968, 61.
17. G. S. Maxwell, "Inveresk," *DES* 1970, 32.
18. G. S. Maxwell, "Inveresk," *DES* 1971, 29.
19. W. S. Hanson, "Inveresk," *DES* 1981, 24.
20. J. H. Reid, "Inveresk," *DES* 1989, 52.
21. <<http://canmore.rcahms.gov.uk/en/site/53919/details/inveresk+musselburgh+roman+fort/>>

Though extensively excavated in certain areas, Inveresk does not yet have a comprehensive interior layout recorded. No metal artifacts indicative of metalworking were seen in the consulted sources.

27. Ladyward (NY 113 820, Dumfries and Galloway, ~ 5 acres)

Sources consulted:

1. S. S. Frere et al, "Roman Britain in 1989," *Britannia* 21 (1990): 312.
2. <<http://canmore.rcahms.gov.uk/en/site/69368/details/ladyward/>>

No excavations have been carried out at Ladyward at this time.

28. Loudoun Hill (NS 605 371, East Ayrshire, (Antonine and Flavian) ~ 3 acres)

Sources consulted:

1. Clarke, John et al., *The Roman Occupation of South-Western Scotland*. Glasgow: The University Press, 1952.
2. D. L. Kennedy, "Roman Fort at Loudon Hill," *Britannia* 7 (1976): 286-7.
3. I. A. Richmond, "Recent Discoveries in Roman Britain from the Air and in the Field," *JRS* 33 (1943): 50.
4. R. P. Wright, "Roman Britain in 1938," *JRS* 29 (1939): 201.
5. R. P. Wright, "Roman Britain in 1942," *JRS* 33 (1943): 71.
6. "Roman Britain in 1944," *JRS* 35 (1945): 79.
7. R. P. Wright, "Roman Britain in 1946," *JRS* 37 (1947): 165-6, 180.
8. "Roman Britain in 1948," *JRS* 39 (1949): 98.
9. "Roman Britain in 1954," *JRS* 45 (1955): 123.
10. I. A. Richmond, "Roman Britain, 1910-1960," *JRS* 50 (1960): 183.
11. A. Robertson, "Loudoun Hill," *DES* 1954, 7-8.
12. <<http://canmore.rcahms.gov.uk/en/site/44771/details/loudoun+hill/>>

Various iron implements, high-quality bronze objects, and a lead weight⁸⁵ were discovered at Loudoun Hill.⁸⁶ No structural remains of a *fabrica* or workshop were noted by J. K. St. Joseph, although a number of "sheds" (often the label for a building of indeterminate function) were identified.⁸⁷

29. Lyne (NT 187 405, Borders, ~ 5.5 acres)

Sources consulted:

1. Christison, D., "Excavation of the Roman camp at Lyne, Peeblesshire," *PSAS* 35 (1901): 154-186.
2. K. Steer and R. W. Feachem, "The excavations at Lyne, Peeblesshire, 1959-63," *PSAS* 95 (1964): 208-18.
3. K. A. Steer, "Lyne," *DES* 1959, 39.
4. B. C. Burnham et al., "Roman Britain in 1999," *Britannia* 31 (2000): 384.
5. R. P. Wright, "Roman Britain in 1959," *JRS* 50 (1960): 214.
6. J. K. St. Joseph, "Air Reconnaissance in Britain, 1958-1960," *JRS* 51 (1961): 121.
7. J. K. St. Joseph, "Air Reconnaissance in Britain, 1951-5," *JRS* 45 (1955): 85.
8. I. A. Richmond, "The water-supply of the Roman fort at Lyne," *PSAS* 75 (1941): 39-43.
9. <<http://canmore.rcahms.gov.uk/en/site/50065/details/lyne/>>

No structural evidence for metalworking facilities is present at Lyne. Iron remains include nails, a hook, a horse-shoe, and spearheads.⁸⁸

30. Malling (NN 564 000, Stirling, ~ 7 acres)

Sources consulted:

⁸⁵ R. P. Wright, "Roman Britain in 1946," *JRS* 37 (1947): 165-6, 180.

⁸⁶ "Roman Britain in 1944," *JRS* 35 (1945): 79.

⁸⁷ Wright, 1946, 165.

⁸⁸ Christison, D., "Excavation of the Roman camp at Lyne, Peeblesshire," *PSAS* 35 (1901): 185.

1. S. S. Frere et al., "Roman Britain in 1983," *Britannia* 15 (1984): 275.
2. J. K. St Joseph, "Air Reconnaissance in Britain, 1965-68," *JRS* 59 (1969): 109-10.
3. J. K. St Joseph, "Air Reconnaissance in Britain, 1969-72," *JRS* 63 (1973): 223-4.
4. <<http://canmore.rcahms.gov.uk/en/site/24065/details/malling/>>

No comprehensive excavations have taken place at Malling.

31. Milton (NT 092 014, Dumfries and Galloway, (Flavian and Antonine) ~ 5.5 acres)

Sources consulted:

1. Clarke, John et al., *The Roman Occupation of South-Western Scotland*. Glasgow: The University Press, 1952.
2. J. K. St. Joseph, "Air Reconnaissance of North Britain," *JRS* 41 (1951): 58.
3. J. Clarke, "Dumfriesshire," *DES* 1948, 5.
4. J. Clarke, "Dumfriesshire," *DES* 1949, 8.
5. J. Clarke, "Milton," *DES* 1950, 7.
6. <<http://canmore.rcahms.gov.uk/en/site/48383/details/milton/>>

No evidence was found for metalworking at Milton. As with the fort at Dalswinton, however, this site had its excavations published in the unavailable journal *TDGNHAS*.

32. Mollins (NS 713 718, North Lanarkshire, ~ 1 acre)

Sources consulted:

1. W. S. Hanson and G. S. Maxwell, "An Agricolan Praesidium on the Forth-Clyde Isthmus (Mollins, Strathclyde)," *Britannia* 11 (1980): 43-9.
2. B. C. Burnham et al., "Roman Britain in 1994," *Britannia* 26 (1995): 336.
3. R. Goodburn et al., "Roman Britain in 1977," *Britannia* 9 (1978): 416.
4. R. Goodburn et al., "Roman Britain in 1978," *Britannia* 10 (1979): 278.
5. W. E. Boyd, "Palaeobotanical Evidence from Mollins," *Britannia* 16 (1985): 37-48.
6. "Aerial Survey," *DES* 1977, 53.
7. "Mollins," *DES* 1978, 30-1.
7. G. S. Maxwell and D. R. Wilson, "Air Reconnaissance in Roman Britain 1977-84," *Britannia* 18 (1987): 18.
8. <<http://canmore.rcahms.gov.uk/en/site/45931/details/mollins/>>

Trenches dug in 1977-1978 did not reveal a structural plan of the interior of Mollins, nor were any metal artifacts revealed, save for a few nails.⁸⁹ A 1994 geophysical survey of the site corroborated plans of the fort's inner ditch, but did not provide information on the interior structures of the site.⁹⁰

⁸⁹ W. S. Hanson and G. S. Maxwell, "An Agricolan Praesidium on the Forth-Clyde Isthmus (Mollins, Strathclyde)," *Britannia* 11 (1980): 45.

⁹⁰ B. C. Burnham et al, "Roman Britain in 1994," *Britannia* 26 (1995): 336.

33. Oakwood (NT 425 249, Borders, ~ 3.5 acres)

Sources consulted:

1. K. A. Steer and R. W. Feachem, ““The Roman Fort and Temporary Camp At Oakwood, Selkirkshire,” *PSAS* 86 (1951-52): 81-105.
2. J. K. St. Joseph, “Air Reconnaissance of North Britain,” *JRS* 41 (1951): 52.
3. B. C. Burnham et al., “Roman Britain in 1995,” *Britannia* 27 (1996): 405.
4. R. P. Wright, “Roman Britain in 1949,” *JRS* 40 (1950): 95.
5. R. P. Wright, “Roman Britain in 1951,” *JRS* 42 (1952): 88.
6. R. P. Wright, “Roman Britain in 1952,” *JRS* 43 (1953): 109.
7. R. W. Feachem, “Selkirkshire,” *DES* 1949, 11.
8. K. A. Steer, “Oakwood,” *DES* 1951, 12.
9. <<http://canmore.rcahms.gov.uk/en/site/54330/details/oakwood/>>

Excavations at the Flavian fort of Oakwood did not include an exploration of the internal layout of the installation, as plow damage rendered it “...unlikely that the results would add materially to the knowledge already gained of the history of the fort.”⁹¹

34. Raeburnfoot (NY 251 990, Dumfries and Galloway, ~ 1.5 acres)

Sources consulted:

1. R. P. Wright, “Roman Britain in 1960,” *JRS* 51 (1961) 161.
2. R. P. Wright, “Roman Britain in 1959,” *JRS* 50 (1960) 214.
3. R. P. Wright, “Roman Britain in 1946,” *JRS* 37 (1947) 166.
4. J. K. St. Joseph, “Dumfriesshire (3),” *DES* 1947, 3.
5. A. Robertson, “Raeburnfoot,” *DES* 1959, 22.
6. A. Robertson, “Raeburnfoot,” *DES* 1960, 25.
7. <http://canmore.rcahms.gov.uk/en/site/67274/details/raeburnfoot/>

Three excavations took place at the Antonine fort of Raeburnfoot. None recovered any interior layout plan or artifacts of interest towards this paper.

35. Stracathro (NO 617 657, Angus, ~ 6 acres)

Sources consulted:

1. D. R. Wilson and R. P. Wright, “Roman Britain in 1969,” *Britannia* 1 (1970) 273.
2. A. Robertson, “Stracathro,” *DES* 1969, 2.
3. “Roman Britain in 1957,” *JRS* 48 (1958) 132.

⁹¹ K. A. Steer and R. W. Feachem, ““The Roman Fort and Temporary Camp at Oakwood, Selkirkshire,” *PSAS* 86 (1951-52): 96.

4. J. K. St. Joseph, "Air Reconnaissance in Britain, 1958-1960," *JRS* 51 (1961): 123.
5. J. K. St. Joseph, "Air Reconnaissance in Britain, 1955-7," *JRS* 48 (1958): 91.
6. <<http://canmore.rcahms.gov.uk/en/site/35945/details/stracathro/>>

Sufficient excavations of the interior of the Flavian fort of Stracathro have not yet taken place, and as such no plan or remains of note have been recovered.

36. Strageath (NN 898 180, Perth and Kinross, ~ 4 acres)

Sources consulted:

1. Frere, S.S., and J. J. Wilkes. *Strageath: Excavations Within the Roman Fort 1973-86*. London: Society for the Promotion of Roman Studies, 1989.
2. B. C. Burnham, "Sites Explored," *Britannia* 37 (2006): 386.
3. J. K. St. Joseph, "Air Reconnaissance in Britain, 1955-7," *JRS* 48 (1958): 90.
4. D. R. Wilson et al., "Roman Britain in 1970," *Britannia* 2 (1971): 248.
5. D. R. Wilson et al., "Roman Britain in 1973," *Britannia* 5 (1974): 402.
6. D. R. Wilson et al., "Roman Britain in 1974," *Britannia* 6 (1975): 225.
7. R. Goodburn et al., "Roman Britain in 1975," *Britannia* 7 (1976): 300.
8. S. S. Frere et al., "Roman Britain in 1976," *Britannia* 8 (1977): 361.
9. R. Goodburn et al., "Roman Britain in 1977," *Britannia* 9 (1978): 410.
10. F. O. Grew et al., "Roman Britain in 1979," *Britannia* 11 (1980): 351.
11. F. O. Grew et al., "Roman Britain in 1980," *Britannia* 12 (1981): 319.
12. N. B. Rankov et al., "Roman Britain in 1981," *Britannia* 13 (1982): 336.
13. S. S. Frere et al., "Roman Britain in 1982," *Britannia* 14 (1983): 284.
14. S. S. Frere et al., "Roman Britain in 1983," *Britannia* 15 (1984): 274.
15. S. S. Frere et al., "Roman Britain in 1984," *Britannia* 16 (1985): 263.
16. S. S. Frere et al., "Roman Britain in 1985," *Britannia* 17 (1986): 371.
17. S. S. Frere et al., "Roman Britain in 1986," *Britannia* 18 (1987): 309.
18. B. C. Burnham et al., "Roman Britain in 1992," *Britannia* 24 (1993): 278.
19. D. Lye, "Strageath," *DES* 1970, 39.
20. S. S. Frere, "Strageath," *DES* 1973, 42.
21. S. S. Frere, "Strageath," *DES* 1974, 50.
22. S. S. Frere, "Strageath," *DES* 1975, 38.
23. S. S. Frere, "Strageath," *DES* 1976, 46.
24. S. S. Frere, "Strageath," *DES* 1977, 28.
25. S. S. Frere, "Strageath," *DES* 1978, 32.
26. S. S. Frere, "Strageath," *DES* 1979, 43.
27. S. S. Frere, "Strageath," *DES* 1980, 40.
28. J. Wilkes, "Strageath," *DES* 1985, 50.
29. <<http://canmore.rcahms.gov.uk/en/site/25296/details/strageath/>>

The Roman fort of Strageath had three distinct phases of occupation (Flavian, Antonine I, and Antonine II), and the evidence for metalworking is present in each chronological stage. Numerous workshops of indeterminate function were identified in all three phases as well, so discussion will be limited to structures and evidence more directly relating to metallurgy.

In the Flavian period, Building D (located directly S of hospital and *principia*, abutting the *via sagularis*) was accepted by Frere and Wilkes as the fort's first *fabrica*.⁹² In the NW corner of the Flavian fort, Building V (presumed to be a workshop) showed signs of intensive heating of clay and soil, as well as producing suspicious amounts of charcoal.⁹³ The remains could, however, be from any number of industrial activities.

In the Antonine I period, Building IX (located in the SE corner), being too narrow to serve as a barrack, was deemed either a stable or workshop.⁹⁴ The discovery of a hearth in a trench dug through the S part of the feature, as well as arguments made by the excavators regarding the stabling of horses, would seem to support the latter hypothesis. However, in Building XV (located in the SW corner), "The presence of two small metal-working hearths S I suggested use...as a *fabrica*."⁹⁵ An assemblage of slag and metal artifacts corroborate the claim. Frere and Wilkes also asserted that a perplexing pit located within both the Antonine I *fabrica* and the preceding Flavian enclosure was a water-tank for the smithy.

In the Antonine II period, a Y-shaped furnace was discovered built into the W rampart in the NW corner of the fort.⁹⁶ The shape and fill of the furnace, as well as the discovery of sheet bronze within the feature, led the excavators to suggest it served as an "armourer's furnace". A similar structure, located ~60 feet to the south, again along the rampart, appeared to be another oven or furnace.⁹⁷

Iron, bronze, and lead finds at Strageath were numerous. Of particular interest to this paper are; an industrially worked iron bar, which was likely done on site, a small iron anvil, and

⁹² S. S. Frere and J. J. Wilkes, *Strageath: Excavations Within the Roman Fort 1973-86* (London: Society for the Promotion of Roman Studies, 1989), 53.

⁹³ Frere and Wilkes, *Strageath*, 71.

⁹⁴ Ibid, 92.

⁹⁵ Ibid, 110-11.

⁹⁶ Ibid, 80.

⁹⁷ Ibid, 80.

four iron ingots. Two ingots, when chemically analyzed, were concluded to be low-carbon and to have undergone an initial forging in preparation for further metallurgical working.⁹⁸ In the same trench as the ingots, a ~150 lb lead pig was discovered. Isotopically, the lead matches ore found in southern Scotland, near the Lake District. As stated by Frere, “The central Lake District shows no evidence of Roman occupation as early as Agricola. If the lead comes from Co Durham or Alston or somewhere in southern Scotland, it would be additional evidence from the very swift exploitation of mineral resources in the wake of military advance.”⁹⁹

37. Ward Law (NY 024 666, Dumfries and Galloway, ~ 7.5 acres)

Sources consulted:

- 1 G. S. Maxwell and D. R. Wilson, “Air Reconnaissance in Roman Britain 1977-84,” *Britannia* 18 (1987): 24.
2. R. P. Wright, “Roman Britain in 1939,” *JRS* 30 (1940): 160-161.
3. R. Goodburn et al., “Roman Britain in 1977, *Britannia* 9 (1978): 419.
4. Clarke, John et al., “*The Roman Occupation of South-Western Scotland*” Glasgow (1952), pg. 117-120.
5. <<http://canmore.rcahms.gov.uk/en/site/66099/details/ward+law/>>

Neither the interior layout of the fort, nor any evidence for metalworking has been recovered from Ward Law.

⁹⁸ Ibid, 176.

⁹⁹ Ibid, 175.

V. ANALYSIS

Considering the above information, it now remains to analyze the data. The following charts and groupings reflect areas of the archaeological data considered to be of value and worth exploring, but should not by any means be treated as a comprehensive list of possible tests. The first part of this section will look at general information gleaned regarding the sites themselves.

A. Evidence from the sites.

- a. Of the 18 Flavian forts, only three (Broomholm, Elginhaugh, and Drumquhassle) have direct evidence of metalworking on site, while a further two (Cardean and Fendoch) produced indicators of likely metallurgical activity without tactile results.

- i. **Broomholm** – Large hearth with slag

- ii. **Elginhaugh** – Structural *fabrica* identified, without artifactual support.

Crucible and metalworking debris also found in workshop-like structure as well.

- iii. **Drumquhassle** – Crucible fragments.

- iv. *Cardean* – Excavation notes discuss a potential *fabrica*.

- v. *Fendoch* – “Workshops” or “cart-sheds” identified structurally.

- b. Of the 6 Antonine forts, only one yielded concrete evidence of metalworking (Bishopton), and another (Carzield) showed potential for activity.

- i. **Bishopton** – Hearths, slag, tools, and iron bars found.

- ii. *Carzield* – Furnace in barracks with iron and bronze figurines.

- c. Among the 13 forts of both Flavian and Antonine (and Severan, for Cramond) date, 6 (Bertha, Birrens, Castledykes, Cramond, Crawford, and Strageath) produced evidence of metallurgy taking place on site, while two (Ardoch and Loudoun Hill) revealed likely activity, but no substantial evidence.
- i. **Bertha** – Workshop magnetometrically argued for.
 - ii. **Birrens** – Workshop with metal artifacts and crucible fragments discovered in vicinity.
 - iii. **Castledykes** – Furnace lead, slag, fused glass, burned clay found inside structure.
 - iv. **Cramond** – Industrial complex noted with hearth, kiln, unfinished lead and bronze.
 - v. **Crawford** – Hearth and slag noted in structure, crucible fragments with copper-alloy residue found.
 - vi. **Strageath** – *Fabrica* structurally noted, with associated burning and charcoal. Later workshop deductively noted, with hearth inside. Second *fabrica* with metal-working hearths, slag, and metal artifacts noted, later furnace excavated, and metallurgical implements found.
 - vii. *Ardoch* – Masses of lead found, structural correlate to Birrens workshop.
 - viii. *Loudoun Hill* – “Sheds” noted.

It is important to distinguish between evidence for *fabricae* and general metalworking facilities. Three sites have direct evidence for a *fabrica* within the fort and have the term mentioned in the excavation reports; Birrens, Elginhaugh, and Strageath. Three others (Cramond, Crawford, and Castledykes) have evidence of what appears to be a *fabrica* or workshop dedicated

to metalworking, but the excavators did not use definite language. Two, Bertha and Bishopton, have evidence for metalworking areas not necessarily restricted to a particular building.

B. Occupational Evidence for Metalworking

Having macro-analyzed the data for a basic breakdown, more specific trends can be focused on. Each occupational period's evidence for metalworking is listed in table #5. A total of 9 forts in the Flavian period had evidence for metalworking, 6 in the Antonine, and Cramond as the lone site in the Severan.

Table 5 : Occupational Period's Evidence for Metalworking

#5	Flavian	Antonine	Severan	Evidence
	Ardoch	Ardoch		Possible
	Berths	Bertha		Yes
	Birrens	Birrens		Yes
	Broomholm			Yes
	Cardean			Possible
		Carzield		Possible
	Castledykes	Castledykes		Yes
	Cramond	Cramond	Cramond	Yes
	Crawford	Crawford		Yes
	Drumquhassle			Yes
	Elginhaugh			Yes
	Fendoch			Possible
	Loudoun Hill	Loudoun Hill		Possible
	Strageath	Strageath		Yes

The orientation of metallurgical evidence within the Roman forts is presented below.

1. Flavian sites:

- a. **Broomholm** – (1) Hearth with slag, SW corner, along ramparts.
- b. **Elginhaugh** – (1) NE corner (*fabrica*), (2) Industrial area, N of W gate, built into ramparts, (3) Crucible and debris, SW corner of *principia*.

- c. **Drumquhassle** – (1) Crucible fragments, NE corner.
- 2. Antonine sites:
 - a. **Bishopton** – (1) Hearths, slag, debris, E half of *retentura*.
- 3. Flavian and Antonine sites:
 - a. **Bertha** – (1) Magnetometrically argued workshop, NW corner.
 - b. **Birrens** – (1) Workshop / *fabrica*, W end of central block.
 - c. **Cramond** – (1) Hearth, debris, NE corner.
 - d. **Crawford** – (1) Hearth, slag, debris, NW corner.
 - e. **Castledykes** – (1) Potential workshop / *fabrica*, along E rampart, N of E gate.
 - f. **Strageath** – (**Flavian**) (1) *Fabrica*, S of central block, along *via sagularis* (2) Workshop, NW corner, along *via principalis* (**Antonine I**) (1) Workshop / farrier, SE corner (2) *Fabrica*, SW corner (**Antonine II**) (1) Furnace, NW corner, along W rampart.
- 4. Sites with potential areas of metalworking:
 - a. **Ardoch** – Architectural correlate for *fabrica*, W end of central block.
 - b. **Cardean** – N/A
 - c. **Carzield** – Barracks, SE corner.
 - d. **Fendoch** – N part of central block.
 - e. **Loudoun Hill** – N/A

C. Sites With Sustained Metalworking

As noted above, slag is not necessarily an indicator of the kinds of metals being smithed or smelted on a given site. As such, when looking at which metals are definitely represented in the archaeological record, only those sites which have produced comparatively reliable indicators of

specific metalworking have been considered. The types of metals being worked on the Roman forts surveyed in Scotland, as available from the published evidence, are as follows:

1. **Bishopton** – Iron bars.
2. **Cramond** – Unfinished lead and bronze artifacts.
3. **Crawford** – Brass-working residue in crucible fragments.
4. **Elginhaugh** – Copper-alloy residues in crucible fragments.
5. **Strageath** – Sheet bronze found in Antonine II hearth

Chronologically, only Strageath has demonstrated a sustained metallurgical tradition throughout its history. While Cramond has evidence of Antonine metalworking, the Severan “metalwork” noted by Masser does not have direct evidence of being fabricated on site.

D. *Fabricae* Shapes

Of the sites which are argued by their excavators to have had a building dedicated to metalworking (some with more certainty than others), the general shapes of the buildings are presented:

Table #6: Shapes of Buildings

#6	Rectangular	Square
Bertha	√	
Birrens		√
Cramond	√	
Crawford	√	
Elginhaugh	√	
Strageath	√	√

E. Geographic comparison of data

The 37 forts were also compared geographically with the evidence for metalworking on site in the hopes that some correlate could be discerned. Basic latitudinal comparison was employed. The Antonine wall was used as a demarcation point, with one cluster of forts below it

and another encompassing the forts north of the wall to the River Tay. A third group, from the Tay north, was also created.

This specific grouping was chosen considering the psychological, military, and social impact of the Antonine Wall. The investments made by Antoninus Pius in securing the new Forth-Clyde frontier were immense, and it is clear that the area south of the wall was intended to be considered discrete from the territory to the north. Far from just a frontier barrier, "...it may be claimed that both the Hadrianic and Antonine frontiers had a social purpose as well as a military one, which may go some way to explaining the occasionally poor tactical use of terrain by the designers of the latter."¹⁰⁰

Site longevity of three Gask Ridge forts (Ardoch, Bertha, and Strageath) into the Antonine Period was also a factor in grouping the forts. The continuous re-occupation of these forts indicates a serious Roman interest in the region, especially when viewed in light of the newly constructed wall directly to the south. The possibility of a client-kingdom located in Fife¹⁰¹ should be kept in mind as well.

Past the river Tay, in Strathmore, it would seem Rome built few permanent bases. Whether this was by choice or a decision forced upon them is beyond the scope of this paper. However, it would appear as though Scotland north of Fife was a place of great danger; attested to geographically,¹⁰² by the placement of the legionary Fortress of Inchtuthil in the area, as well as by the repeated evacuation of Roman installations.

Tables 7, 8 and 9: Geographical Comparison for evidence of Metalworking

¹⁰⁰ Hanson and Maxwell, 164.

¹⁰¹ Keppie, 12.

¹⁰² Pat Southern, "Men and Mountains, or Geographical Determinism and the Conquest of Scotland," *PSAS* 126 (1996): 372.

#7	South of Antonine Wall	Evidence
1	Barochan	No
2	Birrens	Yes
3	Bishopton	Yes
4	Bothwellhaugh	No
5	Broomholm	Yes
6	Cappuck	No
7	Carzield	Possible
8	Castledykes	Yes
9	Cramond	Yes
10	Crawford	Yes
11	Dalswinton	No
12	Drumlanrig	No
13	Easter Haprew	No
14	Elginhaugh	Yes
15	Glenlochar	No
16	Inveresk	No
17	Ladyward	No
18	Loudoun Hill	Possible
19	Lyne	No
20	Milton	No
21	Mollins	No
22	Raeburnfoot	No
23	Oakwood	No
24	Ward Law	No

#8	Antonine Wall to Tay	Evidence
1	Ardoch	Possible
2	Bertha	Yes
3	Bochastle	No
4	Camelon	No
5	Dalginross	No
6	Doune	No
7	Drumlanrig	No
8	Fendoch	Possible
9	Malling	No
10	Strageath	Yes

#9	North of the Tay	Evidence
1	Cardean	Possible
2	Cargill	No
3	Stracathro	No

VI. CONCLUSION

Myriad caveats must be considered when approaching the collected data for this paper. Firstly, the incomplete nature of the data set must be stressed. While reasonable efforts were made to gather all available information on the 37 sites mentioned, some sources were unobtainable. The *TDGNHAS*, in particular, held a number of site excavations and interim reports, but collections in the United States are rare and incomplete. Unpublished theses, *RCHAMS* texts, and Oxford BAR publications were also largely unavailable outside of the United Kingdom.

Secondly, the incomplete nature of the data itself should be reiterated. Not a single Roman fort in Scotland has been completely excavated; even well documented sites like Strageath, where the internal layout of each occupation phase has been comparatively well discerned, has only had ~ 19% of its total area examined properly.¹⁰³ Bearing this in mind, the potential wealth of information yet to be gathered from future digs and syntheses will invariably alter our perception of Roman metalworking.

Thirdly, as stated above, the methodology employed to analyze the site reports (the use of structural and artifactual evidence) for metalworking remains is inherently incomplete as well. The possibility of multiple uses and interpretations of buildings, hearths, burned soil, slag, and smithing debris render all evidence gathered in this paper speculative, with the notable exception of crucibles remains. The strength of metalworking evidence varies from site to site, with Bertha (at the least conclusive end) being considered to have a workshop based entirely on

¹⁰³ S. S. Frere, and J. J. Wilkes, *Strageath: Excavations Within the Roman Fort 1973-86* (London: Society for the Promotion of Roman Studies, 1989), 1.

magnetometry, to Crawford and Elginhaugh (at the most conclusive end) with crucible fragments lined with metalliferous residue. Thus, even the conclusions ventured in this section of the paper must be treated with due skepticism and care.

Obviously, the fact that nearly 84% of the Roman forts in Scotland were built in the Flavian period, in addition to the incomplete nature of the excavations and limited means for metallurgical analysis duly inhibit our ability to accurately interpret this data. No inferential statistics are possible on such an ill-defined and incomplete data set,¹⁰⁴ and so there is little to be gained directly from the percentages and ratios gleaned from this papers' analysis. The geographic comparisons made, in the same way, are rendered useless by the lack of reliable information. Were the sites without metallurgical evidence definitively devoid of it, and not just labeled as such due to a lack of excavation, more could be theorized. However, at this juncture, other topics must be explored instead.

Roman marching camps were built with special care given to the placement of a *fabrica*,¹⁰⁵ and it can be inferred that the factors contributing to the shops' location in the camp (noise and air pollution, high temperatures, the sooty nature of the profession, etc.) would be taken into consideration in a Roman fort as well. This is certainly reflected in the archaeological record. Of the sites assigned to the more certain category of metallurgical activity, 9 had the evidence located in either the NE or NW sections of the fort. 4 had evidence in either the SE or SW areas; while 2 had evidence in the central block of buildings (although one was located in W end of the block, technically in the N half of the fort). The high proportion of evidence located in the N part of the forts can likely be attributed to the south-westerly prevailing winds in

¹⁰⁴ Pers. Comm., David Abrahamson, 4/15/2010.

¹⁰⁵ Pseudo-Hyginus, pg. 69.

Scotland,¹⁰⁶ which would direct the noxious fumes produced in the workshops away from the fort.¹⁰⁷

The shape of the buildings in which the metallurgical remains were uncovered is also of interest. It is curious to note that 4 of the 6 buildings considered either a *fabrica* or a workshop where metalworking took place were rectangular, and that while Strageath had both square and rectangular *fabricae*, Birrens was the lone site with only a square worksite. While the square *fabrica* at Birrens dates to the Antonine period, its counterpart at Strageath was identified as Flavian. Since there does not appear to be a connection between the chronology of the site and the shape of its *fabrica*, and neither Birrens nor Strageath stand out in overall size (measuring 5 and 4 acres, respectively), the reasoning why those two sites share this model of smithy is unknown.

The apparent lack of interest in this topic, at least in regards to site excavations, should also be noted. Antiquarian and post-war excavations have a distinct focus on establishing the size of forts, the location of the *principia* and barracks, and analysis of the defensive outworks. Little effort seems to have been expended identifying the form and function of *fabrica* in forts. Indeed, one of the great topical obsessions of the time was calculating the size and categories of Roman troop units in Scotland. Though an admirable area of exploration in its own right, the studies of other buildings and more obscure facets of frontier life have been largely marginalized because of this zeal. The topic of metalworking is accordingly much more open to new research, at least in Scotland.

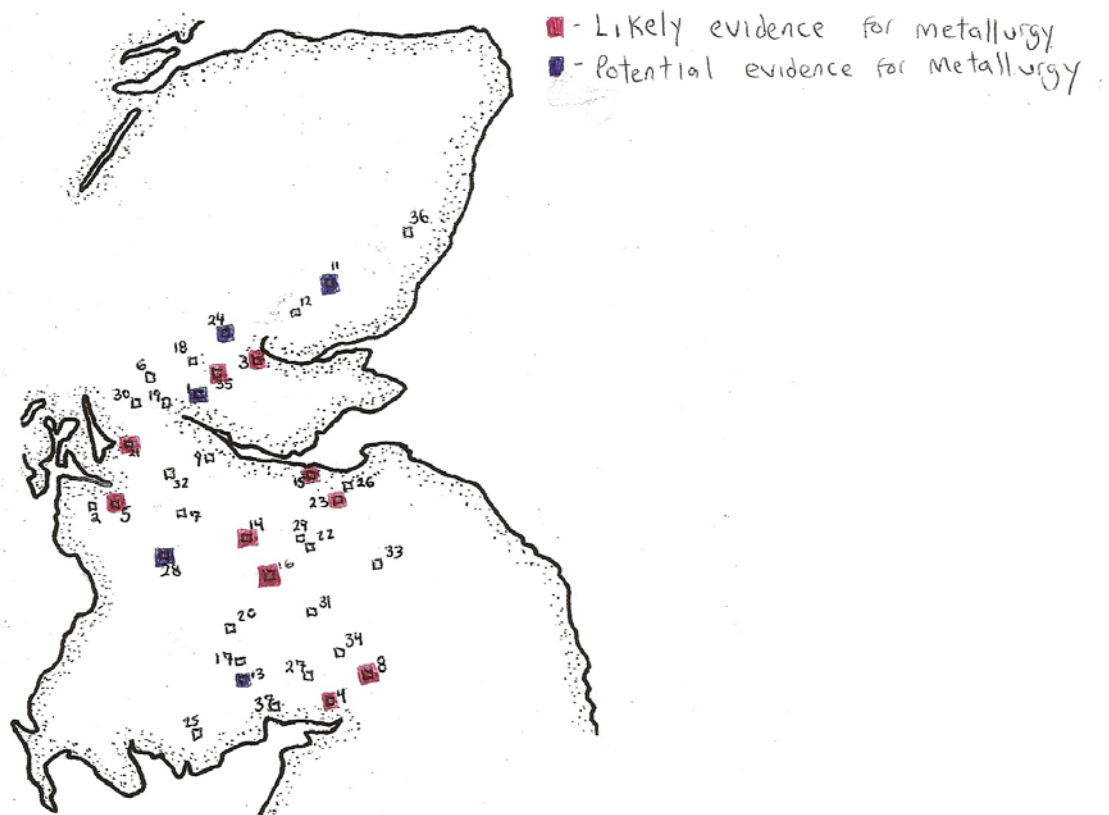
This paper, in many ways, can be read as an interim report on the status of metalworking in the Roman forts of Scotland. While no specific hypothesis was tested, the study managed to

¹⁰⁶ Michael Stetkiewicz, Rhode Island College, suggested this as a possible reason for the positioning of evidence in the forts.

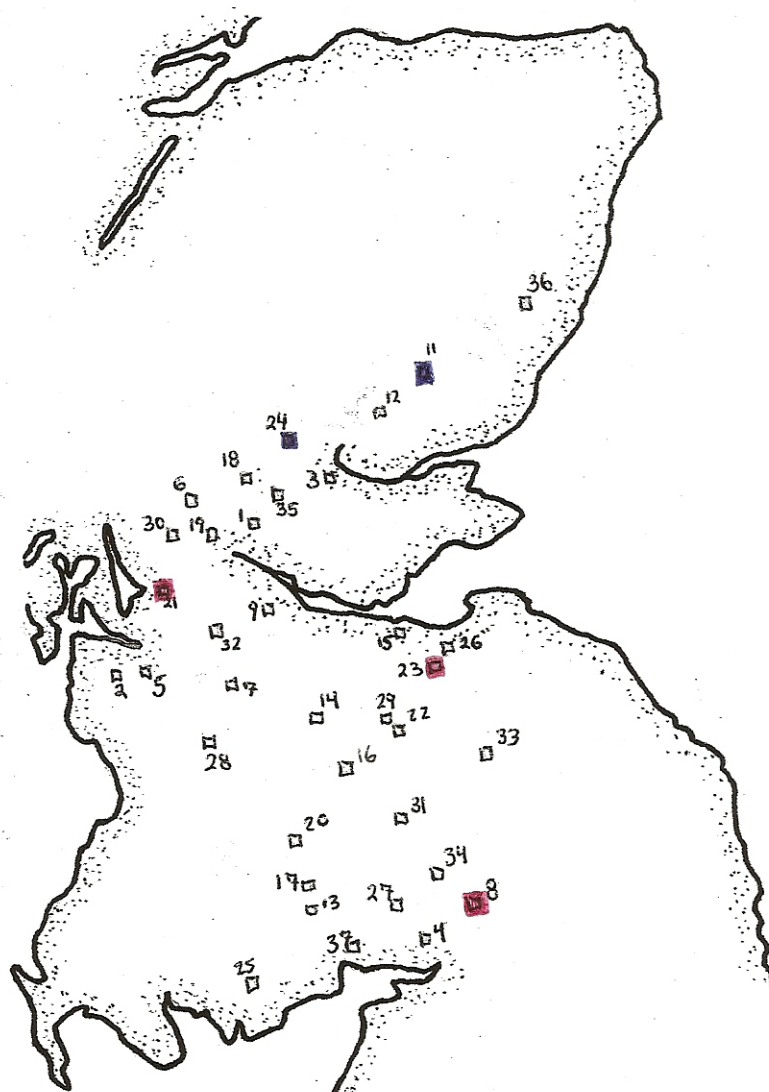
¹⁰⁷ <<http://www.scotland.gov.uk/Publications/2008/04/03093608/13>>

compile much information regarding the topic into a single paper and distill some of that material into (hopefully) a more digestible format. The potential for expanding this essay is great, given the ever-changing record of knowledge regarding the ancient world, and future iterations of this work will hopefully be even more inclusive.

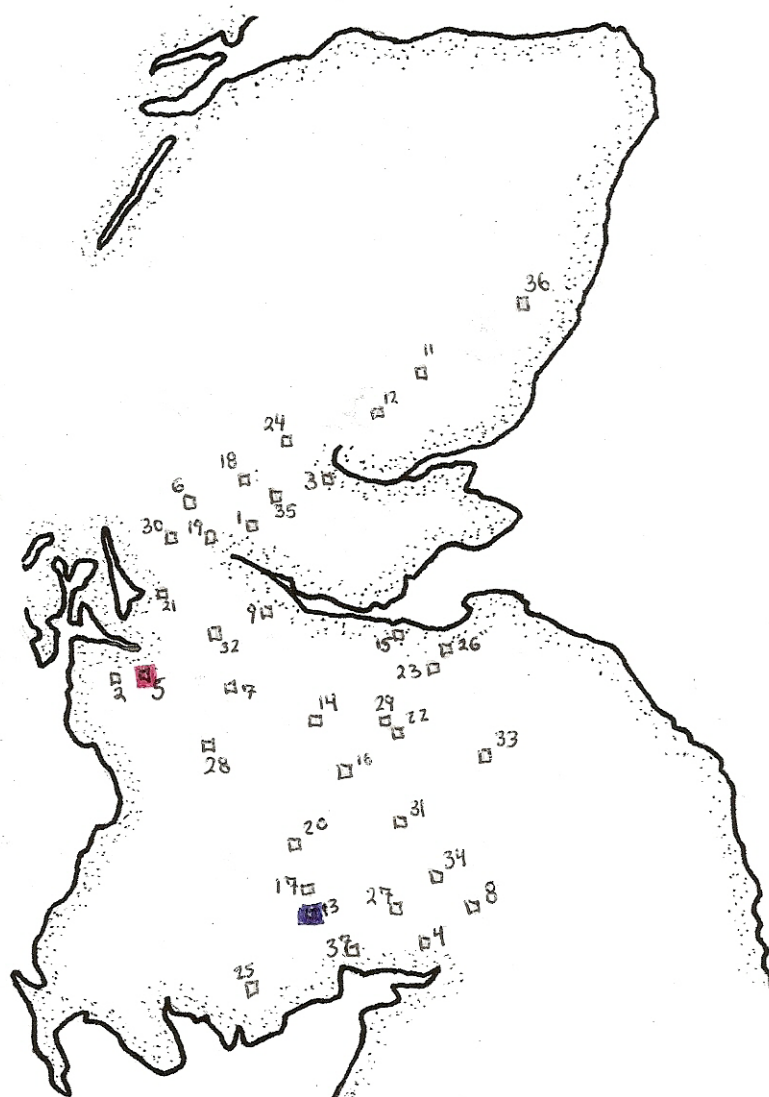
With regard to the broader implications of this study (the social value of metallurgy on Roman forts in Scotland), again, very little can be stated with any kind of certainty. The information gathered is hopelessly inadequate to serve as a platform for serious discussion, though it has raised some interesting questions for further research. For example, why is the most prevalent shape of *fabrica* in the Roman forts a rectangle, considering the only known full-scale *fabrica* in a legionary fortress in Scotland (Inchtuthil) was square? Investigation into the prevailing winds around Scotland could potentially answer the question regarding the situation of *fabricae* in plan, as well. Though these are relatively small questions, their answers may help to uncover further avenues of exploration, both within this data and in the more general field of Roman Scotland.



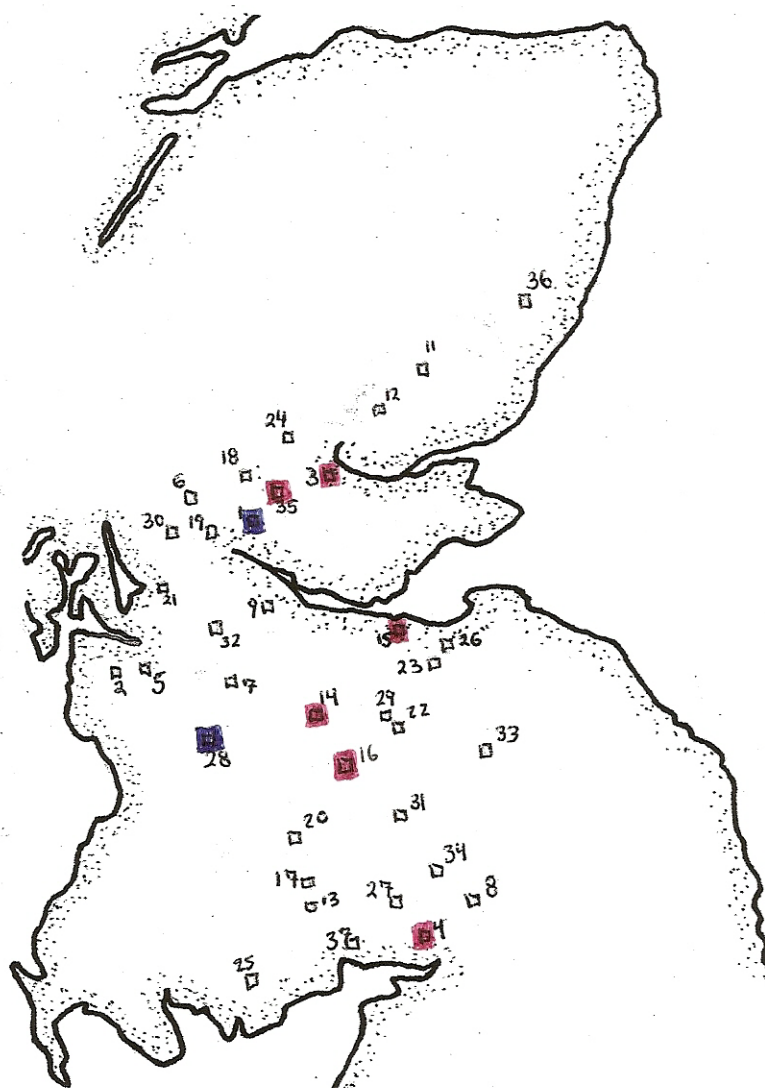
① All sites surveyed (Flavian, Antonine, and Severan)



② Exclusively Flavian forts



③ Exclusively Antonine forts



(H) Sites with Both Flavian and Antonine occupations

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