Ancient Monuments Laboratory
Report 125/91

THE CLASSIFICATION OF SLAGS FROM LAUNCESTON CASTLE, CORNWALL.

J G McDonnell BTech PhD MIFA

Ancient Monuments Laboratory Report 125/91

THE CLASSIFICATION OF SLAGS FROM LAUNCESTON CASTLE, CORNWALL.

J G McDonnell BTech PhD MIFA

Summary

Nearly 190 kg of slag and other residues were recovered from 11th-19th century contexts. Most of the 150 kg Of iron smithing slags came from two phases representing the third quarter of the 13th century and the mid 14th century. There was also some evidence for iron smelting. A small amount of non-ferous metalworking appears to have been carried out in the 16th century.

Author's address :-

J G McDonnell BTech PhD MIFA

Bradford University
Dept. of Archaeological Sciences
Bradford
West Yorkshire
BD7 1DP

The Classification of the Slags From Launceston Castle, Cornwall.

Dr Gerry McDonnell

1 Introduction

Nearly 190kg of slag and other residues were recovered from the excavations in Launceston Castle. They have been classified into six different types described below and grouped according to period. The date ranges of the periods and the number of phases within each period are given in Table 1. The broadest date ranges are given for each period, and there is therefore some overlap between periods.

Table 1 Date Ranges of Periods, and Number of Phases

Period	Date Range	Number of Phases
1	c1068-c1110	3
2	c1100-c1175	2
3	c1141-c1240	2
4	c1227-c1350	4
5	c1337-c1525	3
6	c1500-c1610	3
7	c1600-c1840	4
8	c1840-?	1?

2 Slag Classification

The slags were visually examined and the classification is solely based on morphology. In general they are divided into two broad groups. First are the diagnostic slags which can be attributed to a particular industrial process; these comprise the ironworking slags, i.e. smelting and smithing slags. The second group, the non-diagnostic slags, could have been generated by a number of different processes but show no diagnostic characteristic that can identify the process. In many cases the non-diagnostic residues, e.g. hearth or furnace lining, may be ascribed to a particular process through archaeological association.

The residue classifications are defined below.

2.1 Diagnostic Ferrous Slags and Residues

Smelting Tap Slag (TAP) - iron silicate slag generated by the smelting process, i.e. the extraction of the metal from the ore. Tap slag is one of the most characteristic forms and is distinguished by the ropey morphology of the upper cooling surface. There was only a small quantity of smelting tap slag positively identified. There were also slag pieces with some flow characteristics that could not be confirmed as tap slag and were classed as smithing slag.

Smithing Slag (SSL) - randomly shaped pieces of iron silicate slag generated by the smithing process. In general slag is described as smithing slag unless there is good evidence to indicate that it derived from the smelting process. Hence, in a mixed assemblage of smithing and smelting slags the quantity of smithing slag will include a low percentage that actually derived from the smelting process.

Hearth Bottom (HB) - a plano-convex accumulation of iron silicate slag formed in the smithing hearth. The range and mean dimensions of all the 66 individually recorded hearth bottoms are given in Table 1. All but one of these HB's came from Periods 4 and 5; there were no significant differences between these two groups. The full listing of the data is given in Appendix 3.

Table 1 Range and Mean Dimensions of All Hearth Bottoms (66 Values)

Dimension	Range	Mean	Standard Deviation
Weight (gms)	250-1950	825	385
Major Diameter (mm)	90-210	130	25
Minor Diameter (mm)	70-165	105	25
Depth (mm)	25-120	55	15

For Period 4 Hearth Bottoms (18 Values)

Dimension	Range	Mean	Standard Deviation
Weight (gms)	325-1600	750	365
Major Diameter (mm)	90-210	130	30
Minor Diameter (mm)	70-150	100	25
Depth (mm)	40-90	55	15

For Period 5 Hearth Bottoms (47 Values)

Dimension	Range	Mean	Standard Deviation
Weight (gms)	250-1950	855	400
Major Diameter (mm)	90-195	130	25
Minor Diameter (mm)	70-165	110	25
Depth (mm)	25-120	55	20

Cinder (CIN) - high silica-content smithing slag, often formed at the reaction zone between the smithing slag and the hearth lining.

2.2 Non-Diagnostic Slags and Residues

Hearth Lining (HL) - the clay lining of an industrial hearth, furnace or kiln that has a vitrified or slag-attacked face.

It is not yet possible to distinguish satisfactorily between furnace and hearth lining. In general the HL occurred as fragments, the total weight rarely exceeding 250gms in a single context. There was one major exception in Period 6, Phase 3 where there were 10kg of lining fragments. They were described as a base of a bowl furnace, but there was no real evidence to indicate what they derived from.

Cinder (CIN) - high silica-content slag that can either be formed as described above or by high temperature reaction between silica and ferruginous material. It can be considered either a non-diagnostic slag or a diagnostic slag depending on its iron content and morphology.

Other Material (OTHER) - comprised fragments of fired clay and/or brick, ferruginous concretions, possibly formed by the corrosion of iron artefacts, pieces of metallic iron, and pieces of lead or lead waste. A full listing of other material is given in Appendix 1.

2.3 Non-Ferrous Working Evidence

There evidence for non-ferrous metalworking included SSL and HL with copper alloy staining or attached corrosion products and pieces of lead. There was only one possible crucible fragment (ZP 54, 3392, Period 5, Phase 3). The SSL in Period 6, Phase 3 contained a high proportion of copper alloy inclusions and corrosion products.

3 Period Distribution of the Slag

A full listing by Period, Phase and context numbers is given in Appendix 2. A summary of the distribution of the slag by period and phase is given in Table 3. This shows that in Periods 1-3 there was a background scatter of ironworking slag, followed by large quantities of smithing debris deposited in Periods 4 and 5. There was some slag dumped in the later Periods (6, 7 and 8) but this probably represents disturbance of the earlier material by later activity. During the major periods of dumping the slag was concentrated in phases 4.3 and 5.1, and in the latter phase some smelting slag was also deposited. There were small deposits of hearth lining in Periods 4 and 5, but in both periods nearly half the hearth lining was recovered from contexts containing no slag. There was also a very large deposit (10kg) of lining material recovered from Period 6, Phase 3 which was originally described as the base of a kiln or 'bowl furnace'. However there is no strong evidence to associate this with the earlier deposits of slag. The only positive evidence for metalworking in this period is the occurrence of SSL containing copper alloy staining/corrosion products.

Table 3 Launceston Castle Slag, weight in grammes
Summary By Period/Phase

Period	Phase	TAP	SSL	HB	HL	CIN	OTHER
1	2		25				
1	3	110	40				560
Total		110	65				560
2	1		15				
2	2		480	700		15	3975
Total			495	700		15	3975
3	1	455	160				1955
3	2	50	225				
Total		505	385				1955
4	1		1295				150
4	3	495	21785	11475	110	115	3290
4	4		1165	2000	410	655	40
Total		495	24245	13475	520	770	3480
5	1	4625	57115	28610	1180		3130
5	2	270	7965	11055	30	15	1290
5	3	65	1055		350	170	1475
Total		4960	66135	39665	1560	185	5895
6	2		470				
6	3	450	965		10000		525
Total		450	1435		10000		525
7	1	1085			20	100	
7	2	50	285	550		250	
Total		50	1370	550	20	350	
8	1	75	70				
8	2	150	4400				
Total		225	4470				
SITE TOTAL		6795	98600	54390	12100	1320	16390

5 Conclusions

There is sufficient evidence to propose one or two periods of iron smithing activity in Period 4, Phase 3 (c. 1227 - c. 1240) and Period 5, Phase 1 (c. 1337 - c. 1376). It is also probable that there has been some small scale iron smelting; this could be confirmed by analysis. The first period coincides with the reconstruction of the Castle by Earl Richard of Cornwall, and the second to a period of repairs started in 1341, after a period of decline between 1272 and 1341. There is no evidence recovered from the excavations that can be associated with the initial construction of the Castle, nor with a period of demolition and rebuilding in the 1760's (Period 7).

6 Further Work

A list of samples taken to AML for analysis is given in Appendix 4. It would be useful to confirm or refute speculative identifications, and attempt to confirm the presence of smelting tap slag during the second rebuilding phase.

7 Note on Appendices

The Appendices are in Period and Phase order. There are three context/finds numbers as follows:

C1- Context Number 1 - Character String - trench or area reference

C2 - Context Number 2 - Integer - context number

C3 - Finds Number - Integer - Finds number

Some contexts or material did not have these numbers but had central Excavation Unit Numbers (eg 24/732, which refers to the CEU site Number (24) and the context number. Where possible these have been written in place of the absent C1-C3 numbers.

Note numbers such as '99999' indicate lost or illegible numbers.

Appendix 1 Full Listing of Other Material (OTHER)
(Listed by Period and Phase, weight in grammes)

PE	-	Period
PH	-	Phase
C1	-	Context 1
C2	-	Context 2
C3	-	Context 3
Weight	-	Weight of OTHER
Description	-	Brief description

PE	PH	C1	C2	C3	Weight	Description
1	3	24/1776			40	ore
1	3	24/1450			20	fired clay friable
1	3	24/1450			40	ore
1	3	ZK	115	1117	130	fired clay/daub
1	3	ZL	98	1995	330	ferruginous stone/ore
2	2	24/1805			125	iron ore?
2	2	ZA	12	304	225	iron ore?
2	2	ZA	319		3000	1 lump of Pb waste or ore
2	2	ZK	68	1031	130	fired clay powder/soil red
2	2	ZK	126	1299	200	fired red ferruginous stone
2	2	ZL	60	1103	210	iron ore?
2	2	ZP	136	3770	75	iron metal/slag
2	2	ZP	192	4304	10	feruginous stone/slag?
3	1	NGW	22		125	fired clay
3	1	ZP	111	3566	20	fired clay
3	1	ZP	187	3739	1450	ferruginous concretion
3	1	ZR	188	3691	360	feruginous stone
4	1	24/732			10	Cu metal prill?
4	1	24/1267			10	vitrified FAS/clay Pb glaze?
4	1	24/2314			25	lime
4	1	NGW	29	3545	105	fired clay
4	3	24/933			3250	Pb dribbles
4	3	ZL	28		20	feruginous stone?
4	3	ZO	76		10	pebble, heated
4	3	ZP	112		10	glazed stone/plaster
4	4	ZR	33		40	fired clay
5	1	ZK	46		330	stone + feruginous concretion
5	2	C			700	fired clay/brick + vitrified surface
5	2	C			15	fired clay
5	2	ZK	31		130	iron ore?
5	2	ZN	13		75	lava or fired clay
5	2	ZP	34		310	feruginous stone/ore
5	2	ZR	76	3396	60	limestone, burnt?
5	3	ZL	6		20	glazed clay or stone (green)
5	3	ZL	13		475	iron ore?
5	3	ZP	28	2308	160	red fired clay lining, not vitrified
5	3	ZP	54	2531	60	fired clay
5	3	ZP	54	3392	100	crucible?
5	3	ZP	54	3392	10	fired clay
5	3	ZP	54	3405	650	burnt limestone
6	3	W EXT			525	ore, Sn?

Appendix 2
Launceston Castle Slag, weight in grammes
By Period/Phase

C1	C2	C3	TAP	SSL	HB	HL	CIN	OTHER
PERIOD 1								
ZR	717	4423		25				
total in phase 2				25				
	24/1450							60
	24/1694		110					
	24/1776							40
ZK	115	1117						130
ZL	98	1995						330
ZR	545	4199		40				
total in phase 3			110	40				560
TOTAL IN PERIOD 1			**110**	**65**				**560**
PERIOD 2								
ZR	279	4245		15				
total in phase 1				15				
	24/994						5	
	24/1657			125				
	24/1805							125
ZA	12	304		160				225
ZA	319							3000
ZK	68	1031						130
ZK	126	1299						200
ZL	60	1103						210
ZP	136	3770		130				75
ZP	141	3865		50				
ZP	192	4304						10
ZR	119			15				
ZR	551	4035					10	
ZR	565	4186			700			
total in phase 2				480	700		15	3975
TOTAL IN PERIOD 2				**495**	**700**		**15**	**3975**
PERIOD 3								
NGW	22							125
NGW	22	3457		85				
NGW	36	3631		40				
ZO	89	4184	180					
ZP	111	3566		35				20
ZP	187	3739						1450
ZR	188	3691						360
ZR	553	4073	275					
total in phase 1			455	160				1955
ZR	93	2908		225				
ZR	255	4239	50					
total in phase 2			50	225				
TOTAL IN PERIOD 3			**505**	**385**				**1955**

Appendix 2 (Continued)
Launceston Castle Slag, weight in grammes
By Period/Phase

C1	C2	C3	TAP	SSL	HB	HL	CIN	OTHER
PERIOD 4								
	24/732							10
	24/1267							10
	24/1553				165			
	24/2314							25
NGW	21			250				
NGW	29			25				
NGW	29	3545						105
NGW	33			130				
ZR	210	3751		725				
total in phase 1				1295				150
	24/933							3250
CO	94						75	
ZJ	75					50		
ZK	33		10					
ZL	11		15					
ZL	24			210				
ZL	28							20
ZO	76							10
ZP	76				1125			
ZP	101			610			20	
ZP	103			110				
ZP	105			325	600			
ZP	106			150				
ZP	108			480				
ZP	112							10
ZP	113			6500	2000			
ZP	118			3500				
ZP	119			5475	1375			
ZP	120			20				
ZP	122			1650	4775			
ZP	123			330	800			
ZP	128			50				
ZP	130			100				
ZP	135					60		
ZP	144			15				
ZP	152			20				
ZP	152	4192		250	360			
ZP	171						10	
ZP	183			415				
ZP	404		200	200	440			
ZR	166			410				
ZR	173			130				
ZR	174			75				
ZR	197			600				
ZR	514		270					
ZR	518						10	
Z1	16			160				
ZP	55			25				
ZP	75			50				

Appendix 2 (Continued)
Launceston Castle Slag, weight in grammes
By Period/Phase

C1	C2	C3	TAP	SSL	HB	HL	CIN	OTHER
ZP	90			600	2000		5	
ZR	33					110	650	40
ZR	99			150		300		
ZR	100			340				
total in phase 4				1165	2000	410	655	40
TOTAL IN PERIOD 4			**495**	**24245**	**13475**	**520**	**770**	**3480**
PERIOD 5								
ZB	109			7000	7295	350		2800
ZK	11			29000	11565	280		
ZK	13		4625	11700	3925	100		
ZK	46							330
ZK	71			120				
ZK	73			8500	5550	420		
ZN	100			620	275	30		
ZN	102			175				
total in phase 1			4625	57115	28610	1180		3130
C								715
CO	91			375	1450			
ZB		267		1200				
ZB		295				30		
ZB		328		425				
ZJ	6			280				
ZJ	9		20		290			
ZJ	12			175			15	
ZJ	18			120				
ZJ	26			620	600			
ZJ	28				2365			
ZJ	35		250	1600	1525			
ZJ	37			10	1625			
ZJ	40			425	1925			
ZJ	41			1275				
ZJ	42			1275				
ZJ	46			10				
ZK	31							130
ZK	32				800			
ZM	10			175	475			
ZN	13							75
ZP	34							310
ZR	76	3396						60
total in phase 2			270	7965	11055	30	15	1290

Appendix 2 (Continued)
Launceston Castle Slag, weight in grammes
By Period/Phase

C1	C2	C3	TAP	SSL	HB	HL	CIN	OTHER
NGR	153			50				
ZB		312		25		40		
ZK	28			50				
ZL	6							20
ZL	13							475
ZM	1					310		
ZM	2	611	15					
ZP	25	2498		15				
ZP	28	2308						160
ZP	54			475				
ZP	54	2351		20				
ZP	54	2362					150	
ZP	54	2402		410				
ZP	54	2531						60
ZP	54	3392		10				110
ZP	54	3405						650
ZP	68	2442					20	
ZR	38	2855	50					
total in phase 3			65	1055		350	170	1475
TOTAL IN PERIOD 5			**4960**	**66135**	**39665**	**1560**	**185**	**5895**
PERIOD 6								
24/733				5				
24/737				15				
NG				450				
total in phase 2				470				
24/34				100				
24/568				850		10000		
24/1946				15				
W EXT								525
ZP	26	2235	450					
total in phase 3			450	965		10000		525
TOTAL IN PERIOD 6			**450**	**1435**		**10000**		**525**
PERIOD 7								
CR	102	417				20	100	
ZJ	7			375				
ZR	28	2668		10				
ZR	167	3322		700				
total in phase 1				1085		20	100	
CB			50	110				
DA				175	550			
V							250	
total in phase 2			50	285	550		250	
TOTAL IN PERIOD 7			**50**	**1370**	**550**	**20**	**350**	

Appendix 2 (Continued)
Launceston Castle Slag, weight in grammes
By Period/Phase

C1	C2	C3	TAP	SSL	HB	HL	CIN	OTHER
PERIOD 8								
CD	4			70				
DA			75					
total in phase 1			75	70				
9999	99999	99999		800				
9999999999		9999	150	3600				
total in phase 2			150	4400				
TOTAL IN PERIOD 8			**225**	**4470**				
SITE TOTAL			**6795**	**98600**	**54390**	**12100**	**1320**	**16390**

Appendix 3 Hearth Bottom Dimensions

PE - Period, PH - Phase, C1 and C2 as above
Wt - Weight of Hearth Bottom in Grammes
D1 - Major Diameter (mm)
D2 - Minor Diameter (mm)
Dp - Depth (mm)

PE	PH	C1	C2	Wt	D1	D2	Dp
2	2	ZR	565	700	130	100	40
4	3	ZP	76	1125	160	130	45
4	3	ZP	105	600	120	90	50
4	3	ZP	113	1100	140	140	80
4	3	ZP	113	900	160	100	60
4	3	ZP	119	500	100	70	60
4	3	ZP	119	875	130	100	60
4	3	ZP	122	1050	140	80	40
4	3	ZP	122	1000	130	130	90
4	3	ZP	122	1125	150	100	80
4	3	ZP	122	1600	210	150	60
4	3	ZP	123	375	100	95	40
4	3	ZP	123	425	120	80	50
4	3	ZP	152	360	110	70	40
4	3	ZP	404	440	120	110	45
4	4	ZP	90	325	90	80	50
4	4	ZP	90	625	100	80	50
4	4	ZP	90	725	120	90	50
4	4	ZP	90	325	100	80	50
5	1	ZB	109	1375	170	165	70
5	1	ZB	109	1175	170	130	80
5	1	ZB	109	1250	130	120	70
5	1	ZB	109	925	140	110	70
5	1	ZB	109	775	110	90	70
5	1	ZB	109	820	160	140	50
5	1	ZB	109	975	180	140	80
5	1	ZK	11	550	110	90	40
5	1	ZK	11	750	100	130	50
5	1	ZK	11	1025	130	120	55
5	1	ZK	11	700	130	95	45
5	1	ZK	11	840	100	100	70
5	1	ZK	11	525	110	100	30
5	1	ZK	11	620	120	110	45
5	1	ZK	11	625	120	85	70
5	1	ZK	11	1950	195	140	75
5	1	ZK	11	725	140	130	45
5	1	ZK	11	660	140	90	60
5	1	ZK	11	625	110	95	35
5	1	ZK	11	400	100	90	40
5	1	ZK	11	560	125	85	30
5	1	ZK	11	1010	160	145	30
5	1	ZK	13	975	140	110	70
5	1	ZK	13	900	140	100	50
5	1	ZK	13	1325	170	120	50
5	1	ZK	13	725	150	70	40
5	1	ZK	73	1600	160	130	120
5	1	ZK	73	1050	160	100	60
5	1	ZK	73	750	130	100	50
5	1	ZK	73	600	130	110	40

Appendix 3 (Continued) Hearth Bottom Dimensions

PE	PH	C1	C2	Wt	D1	D2	Dp
5	1	ZK	73	1550	160	130	80
5	1	ZN	100	275	110	70	25
5	2	CO	91	1450	160	150	70
5	2	ZJ	9	290	100	80	35
5	2	ZJ	26	600	120	100	50
5	2	ZJ	28	475	90	85	55
5	2	ZJ	28	990	130	110	50
5	2	ZJ	28	900	120	100	35
5	2	ZJ	35	850	140	110	60
5	2	ZJ	35	250	110	90	40
5	2	ZJ	35	425	110	100	60
5	2	ZJ	37	575	100	70	50
5	2	ZJ	37	1050	150	130	50
5	2	ZJ	40	1925	150	150	85
5	2	ZK	32	800	120	100	40
5	2	ZM	10	475	100	90	30
7	2	DA		550	100	80	55

Appendix 4 Samples taken to AM Laboratory for analysis to confirm speculative identifications

C1	C2	C3		description
ZA	319			lead waste or ore
ZB			Box 5:1Q	smithing slag
ZB			Box 5:1Q	smelting ?tap slag
ZK	11	1161		hearth bottoms
ZK	11		Box 5:1N	smithing/smelting slag
ZK	11		Box 5:1O	iron?
ZK	13			smelting slag
ZP	26	2235		?smithing slag
ZP	54	3392		fired clay
ZR	33			copper-rich slag
	186			ore?