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Evaluation of archaeometallurgical residues and associated material from Tai Cochion & Trefarthen Roman settlement, Anglesey (G1632-T, G1632)

Dr Tim Young
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Abstract

The submitted assemblage from this site produced a small quantity (2.5kg) of high-temperature residues, together with 224g of concretions around corroded metallic iron. There was also approximately 900g of natural materials.

Metalworking was represented by three smithing hearth cakes (SHCs) from the 2010 excavation area, together with fragments of others and related hearth slags, including a small quantity from the 2011 excavation phase. One of the SHCs showed charcoal inclusions, but several of the other pieces (including material from 2011 Trench 2) showed evidence for the use of coal as fuel. This is significant for it demonstrates that smithing was being undertaken in a manner similar to that in many other Roman forts, towns and other settlements, with the smith having access to a wide trade network and thus able to receive coal from some distance, rather than working in a traditional style and using more locally-produced charcoal. Such material is, however, apart from context c137, rare in the assemblage and it is likely that the origin of the smithing residues was not within the excavated area.

Other high temperature materials from 2011 Trench 1 are mainly fuel ash slags (FAS), produced by the high temperature partial melting of ceramic materials under the fluxing influence of alkali-rich fuel ashes. Some of this material in 2011 Trench 1grades into much less metamorphosed material, at least some of which is demonstrably daub/cob with wattle impressions. It is possible that some of this material may have been derived from the Phase 2 fire, but such material was not present in the main destruction deposits. These materials are therefore not 'industrial residues' but accidental products of conflagration.

Fuel ash slags were also the dominant residue class from 2011 Trench 2. 466g of this material came from the probable lime kiln in Phase 2. FAS has been previously described from corn-drying kilns, but not from lime kilns. It would imply the type of lime kiln where fire and charge are kept quite separate – as is the norm in a Roman intermittent flare kiln. Fuel ash slags were, however, also very common through the fills of Phase 1 pits- possibly implying similar processes had been undertaken nearby, prior to the use of the excavated kiln.

It must be borne in mind however, that FAS may be superficially similar from widely different processes and therefore that some of the FAS recovered may be from other processes – such as corn drying kilns – for which there is no other evidence in the excavated areas.

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Methods

The materials was examined visually, with a low-powered binocular microscope where required. As an evaluation, the material was not subjected to any high-magnification optical inspection, nor to any form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

The summary catalogue of material is presented in Table 1, with summaries of material classes by context (Table 2) and by Site/Phase (Table 3).

This project was undertaken for David Hopewell of the Gwynedd Archaeological Trust.

Results

Descriptions of materials

Fuel ash slag (FAS): most of the FAS is present in small fragments (pieces of greater than 15g are rare), so little can be said about the gross morphology of the majority of the collection.

There are two exceptions to this – firstly some of the material from 2011 Trench 1 shows gradation from FAS into fired clay with wattle impressions and secondly some of the material from the kiln in 2011 Trench 2 show slightly concavo-convex sheet-like forms with traces of ceramic (original soil lump?) on the concave side.

Most of the FAS pieces are of convoluted, highly vesicular forms. Some are spiky and just a few show signs of more fluid flow.

The FAS is rather variable in colour – the bloated vesicular pieces tend to be pale or grey, whereas some of the better flowed material is in the form of green (just occasionally blue), less vesicular, glass.

Iron-working residues: the major components of this group are three smithing hearth cakes (SHCs) from the 2010 excavations. There are also smaller pieces of similar slags, that may be fragments of SHCs or smaller pieces of hearth slag.

The SHCs are all small (originally less than 500g), which places them into the weight range of residues produced during blacksmithing (the end use of iron), rather than any part of the process of iron production. Two of the three SHCs and some of the smaller fragments show inclusions of coal and coal shale, indicating the use of coal as fuel. The largest SHC has charcoal inclusions, and whilst this may be simply a different smith or an occasional use of charcoal fuel, it also might possibly suggest a different task being undertaken, when a clean hearth was more important.

In addition to the dense, grey vesicular slags of the SHCs and associated hearth slags, there are two other types of residue.

Firstly the lime kiln produced a single fragment of vitrified hearth lining that has a dark glass surface, which would be more likely to be derived from a metalworking hearth than the kiln superstructure (note: the 'last use' layer of the kiln also yielded a small fragment of coal-fuelled blacksmithing slag).

Secondly, traces of iron-working micro-residues (flake hammerscale) were retrieved from sieving of deposits from the ash pit [1116]. The quantity of these was far too small to suggest any genetic connection with the ash-pit and the scale was most likely either residual or intrusive.

Other materials: other materials in the submitted assemblage include various samples of fired clay (both with and without an organic temper), none of which needs be of archaeometallurgical significance, concretions bearing corroded iron (mostly unidentifiable – but including a wide variety of bar and strip iron, as well some probable nails), a small lead prill and a variety of natural rocks.

The 2010 project produced a large number of fragments of magnetic material, one of which was submitted for examination. This proved to be an unusual rock, with irregular blebby veins, apparently of magnetite, hosted by a rather weathered siliceous rock – probably a feldspathic sandstone. Although magnetite occurs in a variety of places in both Anglesey and Snowdonia, none of the occurrences known to the author resembles the present material. Minor veining cutting Ordovician volcanic sandstones in Snowdonia is the most likely source. Such material would have reached the site by natural glacial or fluvio-glacial agency and does not indicate the material was an 'ore'.

Distribution of materials

Since the assemblage was quite sparse, only limited comment may be made on its distribution.

Evidence for iron working is concentrated on the 2010 excavation site, with only minor evidence from the 2011 trenches.

Trench 1 of 2011 shows no slag that is firmly indicative of any particular process, although some of the FAS (particularly that is pre-conflagration contexts) presumably derives from some pyrotechnological process.

Trench 2 of 2011 provides spatial evidence for a link between the FAS there and the lime kiln (although the lime kiln fills also contained blacksmithing residues, so any link between the FAS and kiln must be regarded as tentative).

Interpretation

The 'slaggy' materials in the assemblage can be seen to have three different components – residues from iron working, FAS from pyrotechnological processes (probably including, but not necessarily restricted to, lime burning) and FAS derived from high temperature alteration (pyrometamorphism) of daub or cob.

The ironworking residues are typical of those from blacksmithing of Roman age. Assemblages of SHCs with a weight range equivalent to the examples in this assemblage are typical for blacksmithing sites of Roman age. Examples from Wales include assemblages from Bulmore (Young 1999; range 125-770g, mean 270g) Carmarthen (Crew 2003; range

100-820g, mean 227g) and Cowbridge (Barford 1996; range 175-700g, mean 403g).

Coal fuelled blacksmithing occurred widely in Roman Britain (Dearne & Branigan 1995; Smith 1997; Travis 2008). Within South Wales it is now documented from a large number of sites including Bulmore (Young 1999), Cardiff Castle (Young & Kearns 2011), Caerleon (Young & Kearns 2010), Caerwent *basilica* (Young 2006) and Trowbridge (Young 2009a, 2010a).

There is little available information about sites farther from the coalfields of South Wales and the Forest of Dean, but a tentative suggestion of coal fuelled smithing at Tremadoc was made recently (Young 2011) and coal residues were suspected at Llanbeblig (Young 2012). Coal-fuelled smithing slags were identified at Parc Gybi, Anglesey (Young & Kearns 2010), but all the examples are believed to be post-medieval in age; earlier smithing slags on that site were all charcoal fuelled.

Clearly coal was a commodity that was distributed widely for both military and civilian activities – and the Tai Cochion / Trefarthen settlement must have had access to those networks. No samples of Roman coal from sites in N Wales have been provenanced, but Smith (1997) suggests that Flintshire or Denbighshire coals might have been employed at sites in the Cheshire/Wirral area. Supply from that area would be quite likely, given the sea traffic that must have existed around the N Welsh coast from Chester.

Fuel ash slags are a rather problematic material, for when ceramic materials (clay, soil...) are burnt at high temperature in the presence of fuel ash (wood and other plant ashes are typically rich in potassium and calcium, which help to flux the partial melting of the substrate) then resultant ‘slags’ are very similar in appearance and can be very hard to assign to a particular process.

FAS has been described from various corn drying kilns (e.g. Young 2005, 2010) and is also known from open hearths in suitable substrates (e.g. Young 2011a, in press; Young & Bowstead Stallybrass 2003). The same principles of formation should be applicable to a lime kiln of ‘flare’ type as used in the Roman period (English Heritage 2011). In such kilns the lime would not reach the hearth – which can therefore produce FAS (under appropriate conditions) - unlike later kilns in which fuel and lime are mixed.

In 2011 Trench 1 there are clear pieces of daub/cob which show transition to FAS across the specimen. That FAS may originate through conflagration and partial melting of structural materials is widely acknowledged (e.g. English Heritage 2001, p21), but there are few, if any, examples that have been properly documented in the literature.

Evaluation of potential

Although the occurrence of the coal-fuelled smithing is interesting, the present minor occurrences have little research potential. Should additional material, or the smithing site, be found in the future, then its investigation would be worthwhile. The origin of the coal is of particular interest and if suitable samples of coal exist, their provenancing would be of significance (no suitable coal was present in the material submitted here).

The FAS is also of interest and has some research potential, for FAS from lime-burning has not been investigated before. Further chemical analysis could be employed to discriminate between the FAS of different origins within the assemblage. Any such investigation would enhance understanding of FAS, but is unlikely to enhance the interpretation of the site.

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Table 1: Summary Catalogue by Context and Find

C	Find	Label	Wt. (g)	No.	Description
G1632-T					
unstrat		Sample MD find	80	1	Irregularly-veined magnetite ore hosed in fine (feldspathic) sandstone?
5	581		202	1	flat topped SHC, 65x65x40mm, base corroded onto clay, top has coal embedded in it, grey, vesicular, rather weathered
55	202		312	1	flat-topped SHC, maroon topped, with dense layer to 5mm over 30mm deep bowl of more vesicular material, base has charcoal, 90x(60)x35mm, c 70%, top has large quartz grains in very fine dense material with spherical vesicles, irregular vesicles in lower part.
			8	1	concretion around square sectioned object - nail shank? - c4mm across
			34	2	coarsely vesicular grey slag fragments with fine charcoal debris
137	398		44	1	small plano-convex mass, incomplete, base has lobes entrapping probable coke fragments, top is largely missing ,but upper part seems mixed with lining material.
			44	1	small mass of moderately well-flowed clinkery lobes, maroon surfaces, rather amorphous
137	580		118	1	70x60x30mm, small slightly concavo-convex SHC, dimpled base into coke fragments, top irregular, probably not original quite, rather rectangular in outline
			74	7	rounded nub of dense slag, lobate, spherical vesicles in places, probable ceramic contact at one end - fuel uncertain, slightly maroon metallic surface in places
G1632					
1	2598	burnt clay?	16	1	broken piece of very sandy and granule-rich fired clay, oxidised on outside, reduced within - daub or CBM?
1001 tr1	1138	slag	146	1	rounded piece of very dense iron ore (probably goethite), cavities show ?quartz. Probably a Cumbrian erratic
1001	1124	slag	136	1	part of burnt and fractured pebble of an basic igneous rock
1002	1103	slag	6	1	maroon-surfaced lobe of dark glassy slag with shale inclusions - clinker
1002	1214	slag	15	1	slagged and bloated reddish coarse ceramic, bulbous red and white lobes on exterior
1002	1147	slag	66	1	fractured pebble of basalt
			54	1	goethite iron ore concretions - complex botryoidal and laminar sheets filling and lining voids in host rock
			2	1	weathered limonitic rock - possibly fractured from above
1005	1336	slag	7	1	oxidised fired clay
			96	-1	dark rock (basalt) shattered into small fragments

C	Find	Label	Wt. (g)	No.	Description
1007	1227	slag	2	1	coarsely vesicular fuel ash slag fragment in greenish glass
1014	1327	2 pieces poss slag + 1 piece poss metal	2	1	small piece of corroded iron
			15	1	piece of FAS, highly vesicular slag, white to green-grey, coarse vesicles, inside of concave face has oxidised fired ceramic
1016	2072	slag	3	1	highly vesicular FAS, bluish white, large rounded vesicular spheroids coalesced on upper surface
			4	-1	dark rock fragment, smashed in many pieces
1017	2601	slag	1.8	1	coked coal fragment
1018	1435	slag/daub/limestone?.	3.7	2	sandstone?
			3	2	fired clay
			36	-1	dark rock fragment (basalt?), smashed in many pieces
			2	1	highly vesicular white to pale green FAS with attached area of reddish ceramic
1019	1530	slag?	3	1	concretion on small nail, c.25mm long
1020	1393	slag	15	1	worn rounded dark vesicular dense slag fragment, has one possible shale clast - coal fuelled smithing slag?
1020	1848	slag	112	11	FAS in mixture of spiky and more smoothly lobate forms, concave surfaces in complex shapes tend to have pale, more friable material adhering
1036	2630	tp slag/metal	18.7	1	14x10mm, almost rectangular, but rounded, 'D'-shaped cross section, 40mm long, complexly botryoidally coated object with smooth surfaces, probably magnetite-replaced iron artefact fragment
1037	1652	slag	11	1	dome-shaped lump of blebby FAS around reddened ceramic core
1038	1561	slag	90	(2?)	dark igneous rocks, fragmented
1042	1952	slag	33	1	disintegrated piece of igneous rock (with fine inclusions after chlorite) as in some other pieces
1046	2013	slag	7	1	dark sandy granule-rich concretion or conglomerate fragment
1046	2017		0.6	1	FAS, irregular shape
		slag	6	1	small corroded lead prill

C	Find	Label	Wt. (g)	No.	Description
1084	2069	slag	12	1 plus bits	hard fired, vitrified, slightly slagged and bloated ceramic, dark reddish, opposing sides have arcuate faces suggesting this is daub on wattles.
1084	2310	slag	118	8	dense fuel ash slag, all pieces show attachment to oxidised fired ceramic, typically with abundant organics moulds, including rounded grass/straw stems, in two pieces the ceramic surfaces are gently curved - similar to tuyère margins
			34	1	fired clay with rounded granules of quartz and some organics, trace of vitrification as inclusion in reduced fired body, one edge is oxidised and has rounded embayment cf. wattle impression
1105	2549	slag	106	1	concretion containing elongate iron object with approximately, 10mm square section at one end and c.60mm long
1105/6	2554	slag (found in bones & teeth bag)	3.5	1	corroded iron strip, 25x7x3mm
			8.8	1	concretion - probably formerly attached to iron object
			19.4	1	sandy fired clay with some fine quartz gravel and voids after organic material
1115	2530	slag	3.7	1	complex FAS, blebby on a fine sale
1116	1249	slag	36	-1	dark rock shattered into fragments
1128	2593	slag	2.6	1	rounded mass of coarsely vesicular FAS, proximal part dark brownish with inherited grains, mostly white and like lime in appearance, distal part coarsely vesicular and greenish
1135	2495	slag md find	64	2	pieces of corroded iron
1148	2721	slag	1	1	pale white-green FAS, highly vesicular
1153	1027	poss ash-pit from oven 1114 some Cu frags in oven/hearth		assm.	soil sample wet sieved at 100 micron. Contains a very few tiny fuel ash blebs, magnetic separation produced mainly natural grains with few microscopic particles of FHS that may just be background
1171	2455	slag	22	11	pale white-green FAS, highly vesicular, in rather small pieces
1184	2487	slag	162	11 (+bits)	over-fired reduced sandy ceramic, lots of organic temper, lots of coarse quartz grit, one piece with wicker moulds on faces, now brittle, friable and shot through with FAS films
			44	1	dark fine conglomerate

C	Find	Label	Wt. (g)	No.	Description
1193	2557	slag	134	c.40	pale FAS, highly vesicular white/green glass, coalesced bubble-like spheroids, some associated with white ash with charcoal flecks
			2	2	burnt bone
1193	2566	slag	13	17	fine white, tending green internally, FAS particles, moderately spiky and irregular
			1	1	oxidised fired clay
1507	1582	slag	26	7	white-green highly vesicular FAS in various flows (1 good prill) and usual blebby sheets,
1508	1395	slag	37	-1	disintegrated fragile mass of white to pale green vesicular FAS forming coalescing sheets in a wedge shape. Most of weight will actually be the included host sediment
1512	1464	slag	5	1	bone
			11	6	FAS, highly vesicular, piece with largest vesicles is slightly blue
1515	1808	slag	52	13	pale white-green FAS, highly vesicular
			4	1	fired clay, rather peletal texture, mainly oxidised fired but one edge reduced
			34	1	dense slag sheet with shiny dimpled base and broken top. Has internal white melted inclusion and on top surface has a large shale fragment. Most likely a coal-fuelled smithing slag
1516	1459	sag	126	1	oxidised-fired slightly gravelly sandy ceramic
			110	13	FAS. Larger piece tend to be variegated with dark brown and purple slags attached to ceramic substrate, oxidised fired. Small pieces tend to be pale colours with white surface, green-grey glassy slag. Some pieces show both pale and dark glasses in layers within slag
1516	1807 (1801?)	slag	*222*	*total*	
			42	1	glazed, reddened and slagged probable bloated ceramic lump, curved face makes it look a little like a tuyère side sherd. Most of associated FAS is maroon-surfaced and dark internally
			38	12	smaller FAS pieces, very variable. 2 of larger ones show red ceramic on concave side and show particularly maroon surfaces
			126	3	3 larger FAS pieces, all complex curved shapes, all show reddish ceramic remnants on concave side, slag mainly maroon, black glass, like a low-density clinker, but some lobe margins are pale
1517	1483	slag	5.6	2	complex masses of FAS, greenish grey inside, white externally, rounded masses
1518	1620	slag	*54*	*total*	
			44	30+	irregular blebby , white, pale green to grey cored FAS in small irregular pieces
			9	5	daub fragments - mostly reduced fired - several with concave contacts

C	Find	Label	Wt. (g)	No.	Description
1526	1591	slag	20	1	convoluted flowed dark glass FAS. Concave sections have white (ash/ceramic?), some of the smooth lobes have an iridescent maroon surficial layer.
1526	2651	slag	*64*	*total*	
			9.4	7	very spiky masses of white FAS, some smooth lobes are maroon-blue in colour on surface
			22	2	fired clay with abundant moulds after organic temper, buff-salmon, tending towards a hard coarse lithology that suggests a strong over-firing
			26	1	unusual FAS - shows small fragment of ceramic attached to FAS which has white, blebby sections and also smooth-wrinkled lobes with a metallic blue sheen.
1526	2104	slag	26	7	variable FAS particles - 1 a sort of spiky white prill - those others show some relationship to a ceramic substrate. FAS has white exterior and bluish mid grey interior. Variably but mainly finely vesicular
1528	1573	slag	2	1	FAS lobe, highly vesicular pale surface slightly blue internally
1530	1721	slag	33	12	FAS, spiky with some lobate pieces - lobate material is mainly pale and granular on concave surface
1531	1793	slag	15	2	larger piece is spiky-lobate FAS with pale ashy(?) ceramic on concave side. Small piece is rounded FAS bleb
1533	1891	slag	58	1	dark glassy lining slag, locally with maroon surface, resting on fine ceramic with odd pale colour and complex structure. Looks like a standard metallurgical hearth lining slag on a fine grained wall.
1542	1828		20	24	c10mm sized broken fragments of highly vesicular FAS, with small scale blebby texture
			<1	1	bone
			3	1	basalt?
1543	1957	slag	2.2	2	rounded blebby FAS lumps
1543	2346	slag	0.7	1	tiny complex involuted blebby mass of FAS
1544	2056	slag	4	1	rounded FAS bleb
1569	2375	slag	4	1	fuel ash terminating in relatively dense well flowed prills

C	Find	Label	Wt. (g)	No.	Description
1577	2668	slag	48	total	
			24	19	pale white-green FAS, highly vesicular, in rather small pieces
			18	1	burnt siltstone? (just possibly an artificial fired clay but probably not)
			1	3	chips of oxidised fired clay
			1	1	small natural flint flake
					plus dust
1585	2586	slag	1.6	1	small FAS mass - attachment to substrate at one end and inflated white spheroids at the other
doorway lifted stones	2470	slag?	4	1	corroded square section iron rod - small nail?
(tr3)	1181	slag	33	-1	dark fine grained rock – Mn-rich metamorphic mudstone??
fill of circular feature in SW of tr2	1156	slag	5.1	6	coarsely vesicular FAS in white-green glass, locally grey.
tr2 cleaning	1161		82	1 (4)	fine grey conglomerate, grey matrix rounded quartz and (?)volcanic granules, fragmented
			36	6	assorted other rocks - red conglomeratic sandstone, sandstone, siltstone
			3	1 (2)	pottery - sandy, dark
			50	23	FAS - very variable, small pieces are friable rounded blebs, larger pieces are dark, often with a black glass mixed with white and with dark maroon surfaces - all very clinkery in appearance. Some pieces show attachments to red ceramic

Table 2: class of material by context. Tone indicates where FAS has wattle impressions.

context		FAS	fired clay	metal-working	metal artefact	natural
5				202		
55				346	8	
137				280		
1? (S2598)		16				
1001		50				433
1002		15		6?		122
1005			7			96
1007		2				
1014		15			2	
1016		3				4
1017				2?		
1018		2	3			40
1019					3	
1020		112		15		
1036					19	
1037		11				
1038						90
1042						33
1046		0.6			6	7
1084		130	34			
1105					106	
1105/6			19		12	
1115		4				
1116						36
1128		3				
1135					64	
1148		1				
1153						
1171		22				
1184			162			44
1193		147	1			
1209					4	
1507		26				
1508		37				
1512		11				
1515		52	4	34		
1516		316	126			
1517		6				
1518		44	9			
1526		81	22			
1528		2				
1530		33				
1531		15				
1533				58		
1542		20				3
1543		3				
1544		4				
1569		4				
1577		24	1			19
1585		2				
???ignore (s1156)		5				
	totals	*1219*	*388*	*935*	*224*	*927*

Table 3: class of material by phase and context (G1632 2011 excavations). Tone indicates where FAS has wattle impressions.

Context	Context description	Phase	FAS	fired clay	metal-working	metal artefact	natural
	TRENCH 1						
1001	ploughsoil		50				433
1002	base ploughsoil		15		6?		122
1005	base ploughsoil			7			96
1007	base ploughsoil		2				
1014	base ploughsoil		15			2	
1016	base ploughsoil		3				4
1017	base ploughsoil				2?		
1018	base ploughsoil		2	3			40
1019	stone spread	4				3	
1020	stone spread	4	112		15		
1036	soil and rubble upper in building	4				19	
1037	soil and rubble upper in building	4	11				
1038	soil and rubble upper in building	4					90
1042	soil and rubble upper in building	4					33
1046	soil and rubble upper in building	4	0.6			6	7
1184	rubble layer	4		162			44
1084	upper floor/burnt horizon (1094)	3	130	34			
1193	reuse secondary floor	3	147	1			
1128	burnt cob (1218)	2	3				
1135	burnt cob (1218)	2				64	
1148	burnt thatch	2	1				
1209	burnt clay	2				4	
1105/6	main entrance	1		19		12	
1115	fill in oven/hearth	1	4				
1116	cut of ash pit	1					36
1153	fill of ash pit 1116	1					
1171	stake hole fill	1	22				
	TRENCH 2						
1528	ploughsoil	3	2				
1512	upper fill of lime kiln (abandonment)	2	11				
1517	upper fill of lime kiln (abandonment)	2	6				
1526	upper fill of lime kiln (abandonment)	2	81	22			
1530	upper fill of lime kiln (abandonment)	2	33				
1516	fill of flue of kiln (last use)	2	316	126			
1533	upper fill of lime kiln (last use?)	2			58		
1531	lower fill of kiln	2	15				
1569	lower fill of kiln	2	4				
1508	fill of sub-circular pit 1504	2	37				
1544	upper fill of ash pit 1521	2	4				
1585	fill of pit 1546	2	2				
1507	[=1579] fill of pit 1503	1	26				
1518	upper fill of irregular pit 1514	1	44	9			
1515	fill of irregular pit 1514	1	52	4	34		
1542	fill of pit 1532	1	20				3
1543	fill of pit 1572	1	3				
1577	fill of linear 1547	1	24	1			19

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geoarchaeological, archaeometallurgical & geophysical investigations

Unit 6,
Western Industrial Estate,
Caerphilly,
CF83 1BQ

Office: 029 20881431
Mobile: 07802 413704
Fax: 08700 547366
E-Mail: Tim.Young@GeoArch.co.uk
Web: www.GeoArch.co.uk