Trench 17 Soils Analyses

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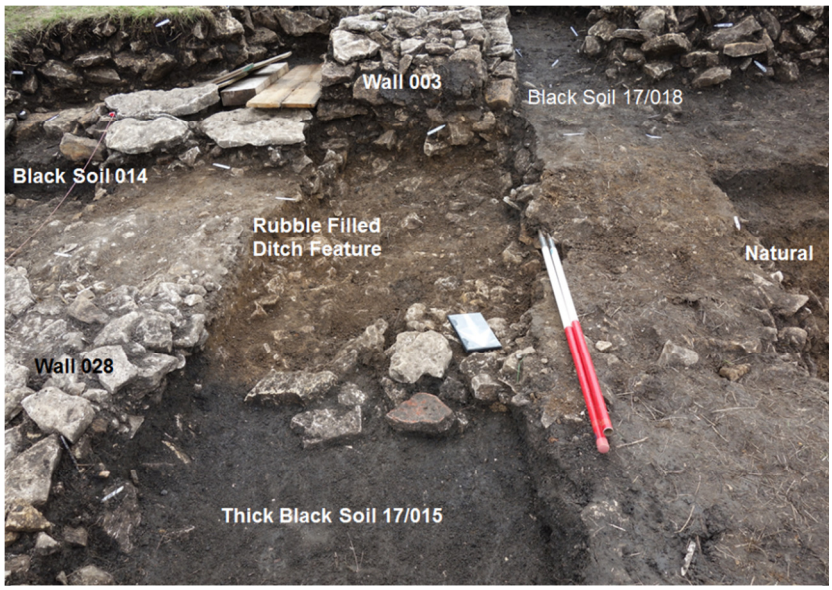
(Taken from a presentation given at the CAMP 'Metals Day' meeting, February 2016)

Introduction
Since 2011, members of CAMP have been undertaking phased excavations in the field north of Chewton Mendip church. In August-September 2015, Trench 17 proved a thick black soil deposit, including much charcoal, burnt bone, associated finds of iron and copper, a crucible and cupel fragments. The combined evidence from the trench suggested an area of metal working.

Lead deposits had been worked on Mendip since at least the Iron Age, with a Roman mining settlement at Charterhouse, but there is little evidence for metal working in the immediate area during subsequent centuries and the early Medieval period. The finding of a crucible and two fragments of cupels (or their lining deposit) during the excavation, was therefore notable. The site deposits previously excavated have been dominated by demolition rubble, walling, paving and cobbled surfaces, often directly overlying natural soils; few occupation deposits, and no evidence of industrial wastes or debris had been found prior to this.



Trench 17 looking south showing charcoal rich black soils either side of central rubble filled ditch feature

Soils samples from various contexts were therefore analysed for their metals content, with the aim of comparing these with typical background levels, and if elevated metals concentrations were confirmed, perhaps shedding further light on the metalworking techniques and materials being used. This article describes the sampling and analytical procedures, discusses the findings, and draws tentative conclusions on the origins of the deposits.

Deposits and Analyses
The 13 samples comprised a single topsoil (Context 001), 5 samples of the black ashy and charcoal rich deposit from a range of depths and trench locations (Contexts 014, 015, 017, 018, and 029), 4 samples of the central zone feature (Contexts 009 and 019 currently interpreted as a rubble filled ditch foundation trench for the north wall of the building), and finally 3 samples of the weathered surface of the natural soil (Contexts 021 and 025).

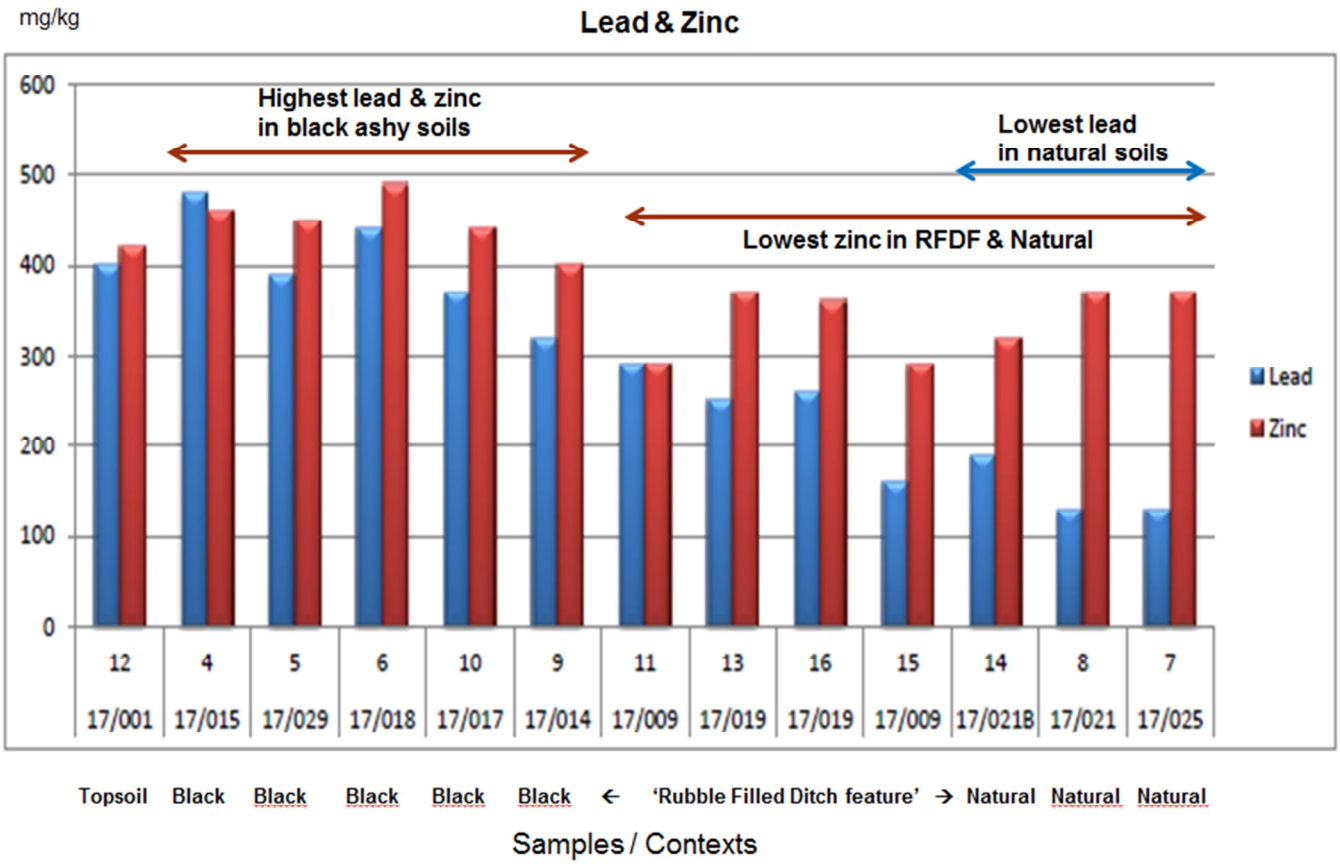
Samples were recovered using a stainless steel trowel into 1kg plastic tubs and couriered in a cool box to the laboratories of Chemtest UK Ltd. The testing schedule comprised initial (natural) moisture content, pH, and 11 total metals or semi-metals. The analyses were completed using ICP-MS (Inductively Coupled Plasma Mass Spectrometry), the industry standard technique for soils contamination analyses, giving repeatable results with sufficiently low detection limits.

Results
The laboratory results show total metals concentrations in mg/kg (equal to parts per million) as follows:

Results of Total Metals Analyses Trench 17 Soil Samples

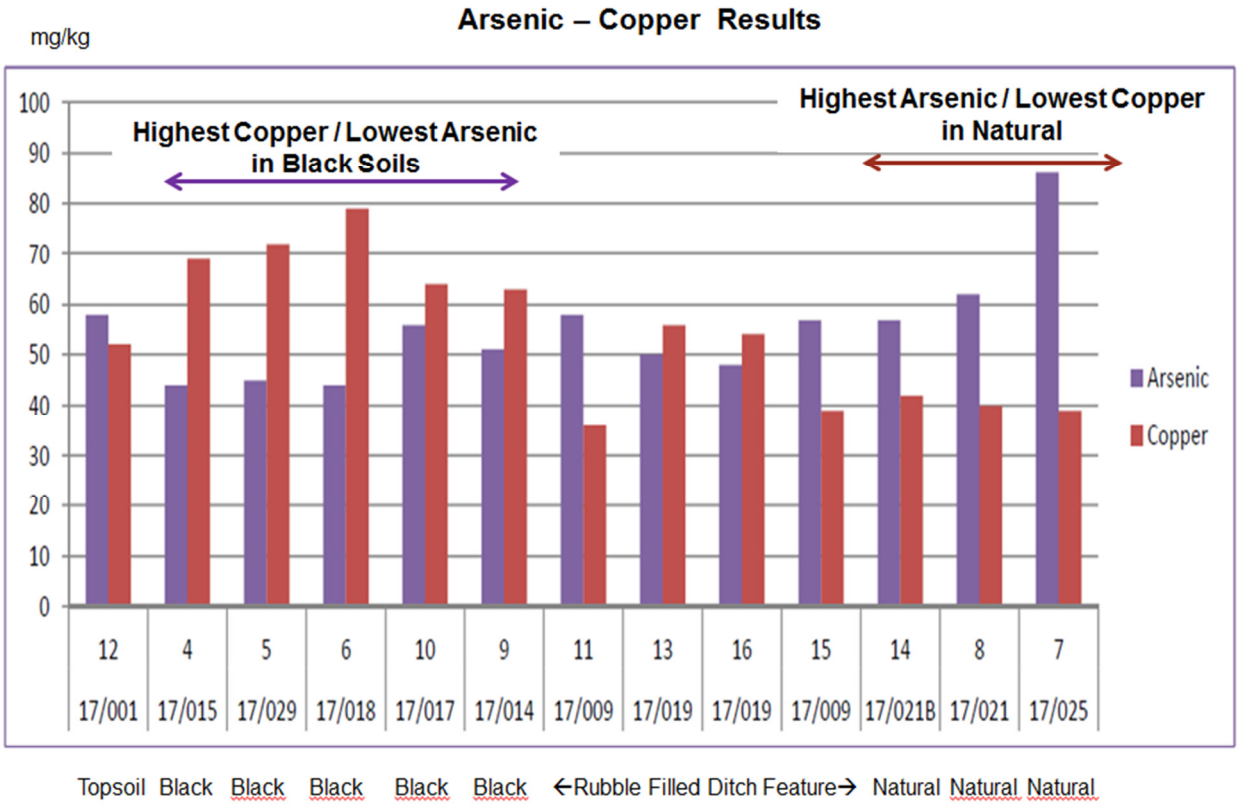
			15-22710	15-22710	15-22710	15-22710	15-22710	15-22710	15-22710	15-23960	15-23960	15-23960	15-23960	15-22710	15-22710
Lab Ref No.			199139	199131	199132	199133	199137	199136	199138	204531	204534	204533	204532	199135	199134
Context No.			17/001	17/015	17/029	17/018	17/017	17/014	17/009	17/019	17/019	17/009	17/021B	17/021	17/025
Soil Sample No.			12	4	5	6	10	9	11	13	16	15	14	8	7
Soil Type - Location			Topsoil	Black ashy North central	Black ashy NE	Black ashy SW	Black possible Saxon SE	Black ashy SE	Rubble Filled Ditch feature	Base of Rubble Filled Ditch feature	Base of Rubble Filled Ditch Feature	Rubble Filled Ditch Feature	Natural Subsoil	Upper Natural	Natural
Elevation mAOD			148.98	148.34	148.60	148.53	148.43	148.67	148.61	148.46	148.48	148.56	148.58	148.56	148.28
Determinand	Units	LOD													
Moisture	%	0.020	29	35	31	39	37	29	20	24	27	20	20	24	22
pH			7.2	7.7	7.6	7.7	7.7	7.9	7.8	8.2	8.2	8.3	8.1	7.8	7.7
Iron	mg/kg	100	15000	16000	17000	16000	16000	14000	17000	20000	19000	19000	20000	19000	20000
Potassium	mg/kg	N/A	3300	4400	4600	4600	4300	3500	3600	3500	3500	2900	3300	4000	5000
Silver	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Arsenic	mg/kg	1.0	58	44	45	44	56	51	58	50	48	57	57	62	86
Cadmium	mg/kg	0.10	1.8	2.1	2.0	2.1	2.0	1.9	1.6	1.7	1.6	1.4	1.6	1.6	1.5
Chromium	mg/kg	1.0	32	33	33	31	30	30	36	37	34	34	36	41	50
Copper	mg/kg	0.50	52	69	72	79	64	63	36	56	54	39	42	40	39
Mercury	mg/kg	0.10	0.26	0.10	0.17	0.16	0.18	0.14	< 0.10	0.12	0.1	< 0.10	< 0.10	< 0.10	< 0.10
Nickel	mg/kg	0.50	39	40	42	48	39	38	45	43	42	42	44	51	56
Lead	mg/kg	0.50	400	480	390	440	370	320	290	250	260	160	190	130	130
Zinc	mg/kg	0.50	420	460	450	490	440	400	290	370	360	290	320	370	370

For simple comparison purposes, the metals concentrations of the black ashy soil have been graphically plotted against those of the rubble filled ditch (009/019) and the natural soils:



This highlights the lead concentrations of the black ashy soils are 3 to 4 times those of the natural soils, and almost twice those of the rubble filled ditch feature. While zinc levels are not as significantly raised, the natural zinc concentration appears to be around 300-350mg/kg, compared to between 400-500mg/kg in the black ashy soils.

Copper and arsenic concentrations were then compared:



Copper peaked at 60-80mg/kg in the black ashy deposits, compared with typically 40mg/kg in the natural.

Surprisingly for such deposits of charcoal, ashy and burnt debris, the arsenic concentrations were lower than the background levels of the natural clays. Similarly, iron contents are highest in the natural clays, and the rubble/clay soils forming the possible foundation trench of the north wall have similar levels. The black ashy deposits were somewhat lower.

Natural Background Metals Concentrations

The site is located on Jurassic age Lias Group limestones and clays, with underlying Penarth Group limestones, mudstones and shales outcropping close to the lower northern boundary of the dig field. It lies just outside the 'Mendip mineralisation' zone. The nearest recorded lead deposits are approximately 2kms west, and so lead (or zinc and copper) levels would not be expected to be raised in the natural soils at this site. Typical background concentrations, adopted for comparison with the site results, have been taken from British Geological Survey topsoil sampling (UK Soils Observatory data at http://www.ukso.org), and surface soils data given in Davies & Ballinger (1990). The comparison in levels can be summarised as:

Metal	Typical Background Range mg/kg	Trench 17 Natural deposits (Contexts 021, 025) mg/kg	Trench 17 Black ashy soils (Contexts 014, 015, 017, 018, 029) mg/kg
Lead	110-200	130-190	320-480
Zinc	175-360	320-370	400-490
Copper	10-15	39-42	63-79

Discussion & Conclusions

A natural origin for the lead, zinc and copper has therefore been discounted. Overall the results suggest higher levels of these metals than would be expected from normal wood-burning ash deposits. There is no evidence to date of large-scale lead ore smelting or processing, such as found at Charterhouse and other mining areas on Mendip, where substantial amounts of lead ore fragments, slags and smelting residues, together with air-borne particulate and vapour residues have resulted in grossly contaminated soils. Concentrations in the order of > 30,000 - 50,000 mg/kg have been measured at such sites (Smith & Brown 2005; Tofts, 2007).

It is notable that only one lump of possible ore was recovered from this trench, and there have been no iron 'bloom' fragments or slags found. However, preliminary results from processing of soils samples, has recently identified several minute particles of 'hammerscale' and a possible droplet of 'silver', within the black ashy soils (see also Brian Irwin's article on metallurgical evidence). Further work on sieving, flotation and microscope examination of soils samples is therefore on-going.

Given the area of the excavated deposits within Trench 17, the laboratory analytical results, and the preliminary soils examination to date, it seems likely that the metal working undertaken was a small scale operation using wood-fired hearths. The scatter of metal objects within the deposits, and the identification of several cupel and crucible fragments might suggest cupellation of lead ore to extract silver, fire assay of ores or alloys to determine metals content, recycling of existing metal objects, or refining of metal alloys.

Further Work

Future investigations will include use of a flotation system to recover charcoal and burnt organic residues, and to assist with sieving of coarse residues to attempt to identify any metallic droplets, ore fragments, hammerscale etc. Additional metals analyses of soils from other site contexts are planned, as well as check testing of surface soils in the immediate vicinity. Further laboratory analyses of artefacts by x ray spectrometry are proposed.

References:

Steve Tofts (2000) Is this a Deserted Medieval Village – Investigations of Features in Lower Cowleaze, Charterhouse on Mendip. www.chert.org.uk

Alex T Smith & Richard Brown (2005) Excavation & Geophysical Survey of the Roman Settlement at Charterhouse on Mendip. www.sanhs.org/documents/149

Brian E Davies & Rhoda C Ballinger (1990) Heavy metals in soils in north Somerset, England, with special reference to contamination from base metal mining in the Mendips. *Environmental Geochemistry and Health Vol. 12, p 291*

UK Soils Observatory http://www.ukso.org http://mapapps2.bgs.ac.uk