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SCORDALE LEAD MINES, NEAR APPLEBY-IN-WESTMORLAND, CUMBRIA IDENTIFICATION AND DENDROCHRONOLOGICAL ANALYSIS OF SOFTWOOD TIMBERS

SCIENTIFIC DATING REPORT

Ian Tyers

ARCHAEOLOGICAL SCIENCE

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CUMBRIA

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SUMMARY

A tree-ring dating and timber identification programme was commissioned on timbers excavated from Scordale Lead Mines, Cumbria. This programme was commissioned on this Scheduled Monument as part of an archaeological field evaluation of the site. This report archives the results of these analyses.

CONTRIBUTORS

Ian Tyers

ACKNOWLEDGEMENTS

The analysis of timbers excavated at Scordale Lead Mines was funded by English Heritage (EH), at the request of Stewart Ainsworth, Senior Investigator in EH's Archaeological Survey and Investigation Team. Context details and excavation diagrams were provided by North Pennines Archaeology, English Heritage's partners in the North Pennines AONB Partnership research programme, entitled 'Miner-Farmer Landscapes of the North Pennines AONB'.

ARCHIVE LOCATION

Cumbria Historic Environment Record
Historic Environment Service
Economy, Culture and Environment
County Offices
Kendal
Cumbria LA9 4RQ

DATE OF INVESTIGATION

2008

CONTACT DETAILS

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INTRODUCTION

This document is a technical archive report on the tree-ring analysis of softwood timbers from Scordale Lead Mines, Cumbria. It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the material.

Scordale Lead Mines are an extensive Scheduled Monument located on an MoD training range high in the North Pennines *c* 25km east of Penrith, and *c* 30km west of Barnard Castle (NGR NY 761 225) within the county of Cumbria (Fig 1). Archaeological evaluation work in 2007 (excavation site code NPA07 SCM-A) revealed timber drains or culverts and settling tanks associated with lead extraction. The mine closed in the early twentieth century, and had probably operated since at least the sixteenth century. These timbers were thought to date from the latest phases of activity on the site.

METHODOLOGY

Tree-ring dating employs the patterns of tree-growth to determine the calendar dates for the period during which the sampled trees were alive. The amount of wood laid down in any one year by most trees is determined by the climate and other environmental factors. Trees over relatively wide geographical areas can exhibit similar patterns of growth, and this enables dendrochronologists to assign dates to some samples by matching the growth pattern with other ring-sequences that have already been linked together to form reference chronologies.

The material was supplied as 24 individually wrapped timbers in February 2008. The timbers were unwrapped and they were sampled by cutting cross-sections at the locations that were assessed to retain the most rings, and also avoided branches and other distortions. An assessment of the dendrochronological potential of each of these timbers had been requested by Stewart Ainsworth. This assessment aimed to identify whether any timbers with sufficient numbers of rings for analysis existed within the assemblage. This assessment concluded that all the material was softwood, probably of several different types, and that only one or two of the timbers may have contained suitable sequences for analysis. The bulk of the timbers were considered unsuitable for tree-ring analysis because of the generally low numbers of annual rings present in the samples, and some material was badly degraded.

All the samples required identification. For the wood identification analysis, microscopic cross-sections were taken from each sample in three planes (tangential, radial, and transverse). These were prepared as temporary glass slides and examined at between 40x and 400x magnification. The microscopic comparison of these sections with permanent reference slides and reference keys such as Schweingruber (1978), Wheeler *et al* (1986), and Wilson and White (1986) enabled identifications to be made for the material. It should be noted that it is usually not possible to identify timbers to species level, and that the degraded nature of this material prevented some of the samples from being assigned a certain identification.

The samples that appeared to be suitable for tree-ring analysis were frozen and the surfaces prepared with a variety of bladed tools. This preparation revealed the width of each successive annual tree ring. Each prepared sample could then be accurately assessed for the number of rings it contained, and at this stage it was also possible to determine whether the sequence of ring widths within it could be reliably resolved. Dendrochronological samples need to be free of aberrant anatomical features, such as those caused by physical damage to the tree, which may prevent or significantly reduce the chances of successful dating.

Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to the only suitable sample. The complete sequence of the annual growth rings in the sample was measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequence of ring widths was then plotted onto semi-log graph paper to enable visual comparisons to be made with reference sequences. In addition, cross-correlation algorithms (eg Baillie and Pilcher 1973) were employed to search for positions where the ring sequence was highly correlated with reference data. Any highly correlated positions would have been checked using the graphs and, if any of these were satisfactory, these would have provided dates for the new sequence. Dating requires high correlations at the same absolute calendar position with a range of independent sequences, and these positions also need satisfactory visual matching.

Not every tree can be correlated by the statistical tools or the visual examination of the graphs. There are thought to be a number of reasons for this: genetic variations; site-specific issues (for example a tree growing in a stream bed will be less responsive to rainfall); or some traumatic experience in the tree's lifetime, such as injury by pollarding, defoliation events by caterpillars, or similar. These could each produce a sequence dominated by a non-climatic signal. Experimental work with modern trees shows that many softwoods cannot be reliably cross-matched, even when enough rings are obtained.

If any of the material had proved datable, the conversion of the date obtained for a tree-ring sequence into a useful date requires a record of the nature of the outermost rings of the sample. If bark or bark-edge survives, a felling date precise to the year or season can be obtained. If no sapwood survives, the date obtained from the sample gives a *terminus post quem* for its use. If some sapwood survives, an estimate for the number of missing rings can be applied to the end-date of the heartwood. This estimate is quite broad and varies by region and species. The identification of sapwood on softwood timbers such as spruce and pine is not as straightforward as that for oak.

RESULTS

All 24 of the samples were identified by taking microscopic thin sections; the results of this are listed in Table 1. Several of these were prepared for dendrochronological analysis, and one sample was assessed to be suitable for dendrochronological analysis. The remainder, although they contained more than the minimum required number of rings, were found to contain aberrant sequences that could not be reliably resolved.

This sample was prepared for analysis and the tree-ring sequence was measured (Table 2). The resultant ring series was compared with dated pine tree-ring data from throughout Europe, and elsewhere in the world, as well as with dated and undated pine tree-ring data from other sites in England and Scotland. The series was not found to provide any consistent dating evidence.

The measurement data for the measured sample are listed in Appendix 1.

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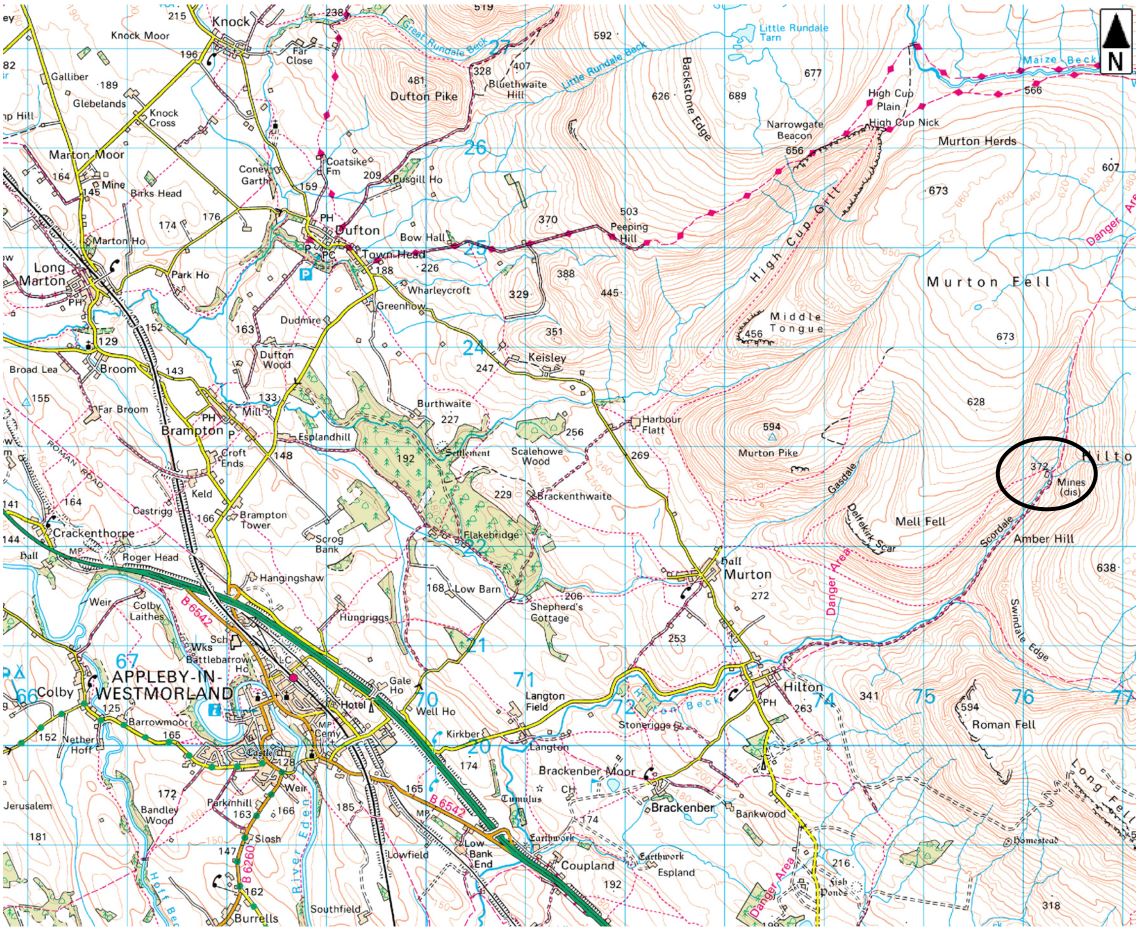

Figure 1. Location of Scordale Lead Mines (circled).

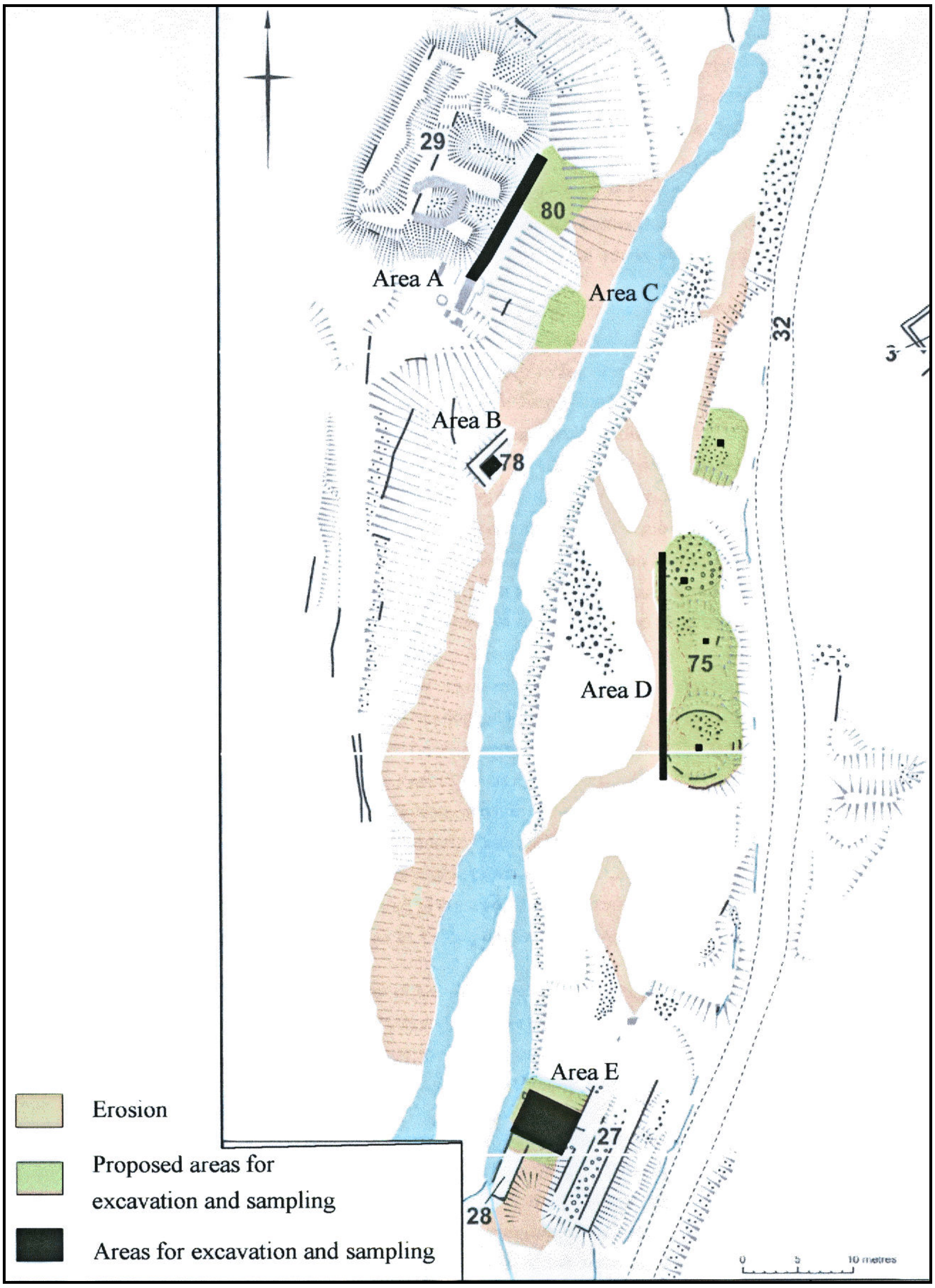

Figure 2. Plan showing excavation Areas A–E at Scordale Lead Mines, based on a diagram supplied by North Pennines Archaeology

Table 1. Location and identification details of the 24 samples from timbers from Scordale Lead Mines.

Sample/Location	Identification
110.2 Area B building 78 floor	Picea
110.11 Area B building 78 wall	Picea
111.9 Area B post	cf Larix
113.14 Area A Crushing House drain	Pinus
113.14 Area A Crushing House drain	Pinus
113.14 Area A Crushing House drain	Pinus
113.14 Area A Crushing House drain chock	Pinus
113.14 Area A Crushing House drain base	Pinus
113.14 Area A Crushing House drain cover	Pinus
113.14 Area A Crushing House drain cover	Pinus
113.14 Area A Crushing House drain side	Pinus
113.14 Area A Crushing House drain side	Pinus
113.14 Area A Crushing House drain side	Pinus
116.15 Area A Crushing House drain base	Pinus
116.15 Area A Crushing House drain base	Pinus
116.15 Area A Crushing House drain top	Pinus
116.15 Area A Crushing House drain side	Pinus
116.15 Area A Crushing House drain side	Pinus
116.15 Area A Crushing House drain side	Pinus
118.12 Area E building	Pinus
135.13 Area E machinery support beam	Pinus
178.10 Area B building 78 wall	Pinus
193.16 Area A drain cover	cf Picea
196.17 Area A separator tank	Pinus

KEY for Areas A–E see Figure 2. Pinus; probably *Pinus sylvestris*, European or Scots Pine, Picea; *Picea abies*, European Spruce, Larix; *Larix decidua*, European Larch, cf comparable to

Table 2. Details of the measured sample from Scordale Lead Mines.

Sample	Location	Rings	Sap	Date of measured sequence	Interpreted result
135.13	Area E machinery support beam	156	-	not dated	-

APPENDIX 1

SCMA135 13

102	112	116	172	147	137	160	176	225	171
144	128	119	183	142	175	131	107	152	94
222	183	153	146	108	167	180	176	134	116
163	135	108	119	154	132	113	183	127	137
112	61	111	134	111	174	102	89	56	83
51	118	63	83	89	130	80	101	116	122
75	115	63	65	101	70	65	102	111	173
111	137	137	124	127	115	103	70	39	61
76	67	51	77	65	47	55	54	58	39
53	72	65	68	90	98	116	79	75	84
101	59	56	65	67	52	73	76	62	59
123	83	78	148	164	114	106	196	166	125
131	86	77	119	80	74	56	88	80	169
186	87	69	109	104	121	163	135	81	115
128	97	70	77	105	100	75	65	69	80
87	53	60	51	65	50				