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Research Report – A Conservation Audit of Archaeological Cave Resources in the Peak District and Yorkshire Dales

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1 INTRODUCTION

England is renowned for the diversity of its geology and the consequent effect that this has on the nature of its landforms and natural environments. Amongst the regions with the highest natural heritage and amenity values are the karstic limestone areas of the Mendip Hills, the Peak District and the Yorkshire Dales. The landscapes of these different areas, although all developed on Carboniferous Limestone, have their own subtleties and distinctive patterns that are determined by their climate, geomorphological histories and historical and present land use.

Karst is a distinctive landform that develops through solutional erosion of a rock formation in which underground drainage greatly predominates over surface drainage. Most of the hard limestone outcrops in England show evidence of karstic dissolution resulting in the development of caves, and some of these cave systems are known to contain archaeological deposits. Caves in England have been excavated sporadically from the early 1800s to the present day (Chamberlain, 2004), but little is known about the extent of the cave archaeological resource or of the condition of existing archaeological sediments. The sediments within caves are thought to be under threat from a variety of agencies such as intrusive human and animal activities, changing agricultural practices and industrial mineral and stone extraction.

The purpose of this audit is to review the state of the current knowledge of the caves of a defined region of England, to devise a programme of visits to survey and assess the condition of known caves and their contents, to develop a predictive model that uses topographical and geomorphological data to identify caves that have a high potential for containing archaeological evidence, and to generate recommendations for future research and management of the cave archaeological resource.

1.1 Context of the study

Natural caves, rock shelters and fissures (here after “caves”) are well recognised as locations which have a heightened potential for the preservation of archaeological remains. Cave environments provide protected depositional circumstances where archaeological and palaeontological remains can be insulated from external forces of erosion. The stable environmental parameters of the caves, including relatively constant temperature and humidity and reduced biological activity, enhance the preservation of organic remains. As natural features in the landscape, caves provide ready-made opportunities for shelter and concealment while in many instances cave entrances provide vistas that allow the occupant to observe the surrounding landscape from a position of security – such locations that simultaneously provide both prospect and refuge (cf. Appleton, 1996) are often favoured by animals and humans for resting and for the carrying out of vital tasks. In many cultures caves have additional symbolic and ritual importance (Moyes, in press) and this may have served as a further incentive for cave usage in the past.

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The tradition of field archaeological research in Britain has focused mainly on monuments, stratified occupation sites and humanly modified landscapes. Only in the last decade has an awareness of natural place archaeology become salient in scholarly and curatorial approaches to the archaeological record (Tilley, 1994; Bradley, 2000). As is the case with other elements of the natural landscape, the aesthetic and natural history values of caves are well established and appreciated, but archaeological caves are difficult to characterise and control within existing cultural resource management frameworks. The archaeological significance of a cave site is normally recognised only at the point when cave deposits and their contents are intrusively and destructively investigated, and most caves in Britain have never been visited by a professional archaeologist, thus even disturbed or eroding archaeological deposits at these sites may not be recorded as having archaeological significance. Coupled with the logistical difficulties and stratigraphic complexities that hinder traditional excavation methods inside caves, our knowledge of archaeological caves tends to be less complete and less reliable than is the case for equivalent archaeological sites at ‘open’ locations.

Current guidelines for the protection of archaeological cave sites focus almost exclusively on the rare Palaeolithic sites, which constitute a minority (15%) of the cave sites known to contain archaeological deposits. Myers (2002) has noted that in the East Midlands many archaeologically investigated caves have received only interim reporting, and there is therefore a need for further analysis of the cave archaeological resource. The present study was undertaken in response to issues raised recently by English Heritage (2003a, 2003b) and by other individuals and organisations concerning the conservation and care of underground archaeological remains.

1.2 Aims of the study

1.2.1 Principal aims

A1 Within the selected study areas of the Peak District and Yorkshire Dales National Parks, the project sought to increase our knowledge of the physical cave resource, to delineate that portion of the resource that is of archaeological and palaeoenvironmental importance, and to assess the archaeological potential, current management and threats to the integrity of deposits in a sample of archaeological caves.

A2 The project aimed to develop a predictive model that used visually recordable topographical and geomorphological data to allow estimates to be made of the archaeological potential of newly discovered and previously un-investigated caves.

A3 The project sought to establish a protocol for regional cave conservation audits that can be applied (with modification where necessary) both within the pilot project areas and in other English limestone regions, including South Devon, Mendip/Gloucestershire/Forest of Dean, and the Magnesian Limestone and Jurassic Limestone regions of southern, central and northern England.

1.2.2 Subsidiary aims

A4 The project aimed to generate recommendations that will assist future research and curation of the national cave archaeological resource, including new Monument Class Descriptions for post-Palaeolithic caves.
The project sought to identify potential pathways and opportunities for integrating the results of cave archaeological research with related non-archaeological research on cave and karst landscapes and environments.

The project was designed to encourage and enhance communication between archaeologists, conservation agencies and the recreational and scientific caving communities.

It was recognised that the project should aim to contribute to archaeological knowledge in the context of regional research frameworks and national research priorities.
2 CAVE ARCHAEOLOGY AND PREVIOUS RESEARCH IN THE STUDY AREAS

2.1 Cave archaeological research in the Peak District and the Yorkshire Dales

The Peak District's caves have attracted local antiquarian and archaeological interest for over 150 years (Bramwell, 1973; 1977), but systematic archaeological field survey of the cave resource has been limited. The caves of the Manifold Valley in Staffordshire were surveyed by Trent and Peak Archaeological Trust (TPAT) and the Royal Commission on Historic Monuments England (RCHME) (Trent and Peak Archaeological Trust, 1993). The TPAT/RCHME survey examined 81 caves by field visit and desk-based assessment, and 15 of the caves (19%) were found to have evidence of archaeological deposits.

Dr Randolph Donahue of the University of Bradford conducted a pilot field assessment of archaeological caves within a 160 km² area of the Malham plateau in the Yorkshire Dales (Donahue and Lovis, 2005). The study area contained 272 recorded caves, of which 42 were visited during the field assessment phase of the study. Six of the visited caves proved to have archaeological deposits, implying that between 10% and 20% of caves in the pilot study area contained archaeological evidence, a similar proportion to that found in the Manifold Valley cave survey.

A gazetteer of 44 Yorkshire Dales caves which have yielded identifiable non-human vertebrate remains has been compiled by Philip Murphy of the University of Leeds and Andrew Chamberlain of the University of Sheffield using records published in the scientific and recreational caving literature (Murphy and Chamberlain, 2002). This desk-based survey has proved useful in demonstrating that only half of the Yorkshire Dales caves with identifiable vertebrate remains have been recorded in the scientific media, and furthermore that the scientifically investigated cave sites are concentrated in the southern part of the Yorkshire Dales, close to population centres and major routes of communication, whereas sites reported in the recreational literature include more caves that are located in remote areas.

2.2 Work elsewhere in England

The most recent all-period national review of cave archaeology in Britain was published over forty years ago (Jackson, 1962) and since that time only a few, spatially restricted and period- or material-specific audits of the cave archaeological resource have been completed. Catalogues of caves containing vertebrate remains have been compiled for the Plymouth area in South Devon (Chamberlain and Ray, 1994) and for the Yorkshire Dales (Murphy and Chamberlain, 2002). Palaeolithic cave sites in England and Wales have been evaluated by Barton and Colcutt (1986) and Romano-British cave usage has been reviewed by Branigan and Dearne (1991). A prominent distribution of cave archaeological sites along the Magnesian Limestone outcrop to the north and south of Creswell Crags, a region known as the Creswell Crags Limestone Heritage Area, has been subject to intensive and comprehensive archaeological survey (Mills, 2001; Davies et al., 2004). A gazetteer of prehistoric cave burial sites in England has identified 170 caves that have contained human remains (Chamberlain and Williams, 2001) and selected cave burial sites in North Yorkshire have been appraised by Leach (2005).

The aforementioned reviews only encompass a portion of the 468 archaeological caves recorded in the National Monuments Record for England (English Heritage, 2003a), and with few exceptions they have focused on sites of known archaeological
value rather than on the more challenging task of establishing the archaeological potential of the many thousand caves that have been identified by cave researchers.
3 STUDY AREAS AND KARST GEOMORPHOLOGY

3.1 The Study Areas
The project assessed the cave archaeological resource in the Carboniferous Limestone outcrops of the southern Pennines (corresponding approximately to the White Peak natural area and falling mainly within the Peak District National Park) and the central northern Pennines (covering the limestone landscape contained within the Yorkshire Dales National Park). These represent two of the three principal recreational caving regions within England, the Carboniferous Limestone outcrop of the Mendip Hills/Gloucestershire/Forest of Dean being the third major caving region.

The study areas exclude the Magnesian Limestone outcrops which lie approximately 25 km east of the main Carboniferous Limestone outcrops. While the Magnesian Limestone caves are equally important from an archaeological perspective (Chamberlain, 2007) the geological, geomorphological and topographical context of these caves diverges sufficiently to require a different predictive model, and we judged that it was unwise to incorporate the Magnesian Limestone into the current project at this stage. We note that a comprehensive conservation audit of the archaeological caves and rock shelters in the southern part of the Magnesian Limestone region of Derbyshire and Nottinghamshire has recently been undertaken by ARCUS for the Creswell Heritage Trust as part of the development of a Management Action Plan for the Creswell Limestone Heritage Area (Davies et al. 2004). The survey of the Magnesian Limestone caves utilised a similar methodology to the present study, and can therefore be considered to complement the results reported here.

3.2 Karst Geomorphology

Plate 3.1 Classic fluviokarst in Lathkill Dale, Peak District
The limestone outcrops of the Yorkshire Dales and the Peak District are formed from the Lower Carboniferous (Dinantian) Limestone which was deposited between about 360 and 335 million years ago (Aitkenhead et al., 2002). One of the characterising features of the Carboniferous Limestone outcrops are large internal solutional channels or caves, which formed through limestone dissolution over the last few million years and now constitute an integral part of the karst landforms. Cavernous limestones are very strong and are capable of spanning large voids and forming stable cliffs and rock platforms. Bare rock outcrops are also common features of the Carboniferous Limestone regions, especially in the Yorkshire Dales.

In the Yorkshire Dales the landforms are also greatly influenced by Pleistocene glacial activity and the limestone regions here are referred to as a glaciokarst landscape (Waltham, 1990). The limestone in the Dales is exposed over an area of 320km² and reaches a thickness of nearly 200m, with substantial cliffline exposures on the steep sides of the glaciated dales and extensive areas of limestone pavement.
where the outcrops are not covered by shales, alluvium and glacial till (Waltham, 2004).

The Peak District limestone outcrop covers an area of over 500km$^2$ and is the largest contiguous karst area in Britain (Gunn, 2004). It is a fluvio-karst with a superimposed pre-karst dendritic drainage pattern that gives rise to meandering dales (many with no permanent surface drainage) separated by plateaus and limestone knoll-reefs. The limestone is heavily infiltrated in some areas by hydrothermal vein mineralisation generating valuable mineral deposits which have been exploited by surface and deep mining from Roman times onwards. There are over 200 known caves in the Peak District, with a noticeable concentration at the margins of the outcrop where the limestone abuts the overlying Namurian grits and shales. Significant cave development in the Peak District began in the Lower Pleistocene, as evidenced by the earliest palaeontological remains and dated flowstone deposits.
4 METHODOLOGY

4.1 Introduction

Our strategy in developing a framework for the assessment of the cave archaeological resource has been to combine existing knowledge with new data obtained from desk-based and field-based survey. Existing information in publications and archives has been accumulated over many years and requires some level of validation before being employed in a regional analysis. In addition, a field survey element to the project was deemed essential in order to place constraints on the numbers of caves present within the study areas. Much of the existing information about the caves of the study regions has been accumulated by recreational cavers who are inevitably selective in the caves that they explore, excavate and record. It was not our intention to examine all of the caves in our study regions, rather we aimed to undertake comprehensive field survey in a stratified sample of hydrological catchments around the major river drainages in order to gain information representative of the regions as a whole.

The fieldwork was carried out during the summer of 2004. The Peak District was field surveyed during May and June 2004 for 27 days: the field work in the Yorkshire Dales was carried out from early July until the end of October for a total of 54 days. After the main fieldwork phase had finished an extension to the project was negotiated and three additional weeks of survey time was allotted to the two areas. The extension gave us the time needed to complete a total survey of all known archaeological caves in the two areas, thus enhancing the data set required for the predictive modelling exercise.

Within each National Park the karst region was split into catchments following the structure outlined in Caves of the Peak District (Gill and Beck 1991) and Northern Caves, Volumes 1-3 (Brook et al. 1988, 1991, 1994). The criteria for defining catchments were different in each region due to differences in the nature of the geology and hydrology. The Caves of the Peak District (Gill and Beck 1991) uses the main river systems to define its catchments, while the Northern Caves volumes define catchments according to the spatial distribution of cave systems.

4.2 Scope of study and inclusion criteria

4.2.1 Definition of a cave for the purposes of the study

A cave was defined for the purposes of this audit as:

An enclosed but accessible natural void within a rock formation which has dimensions minimally sufficient to accommodate a person.

Caves typically have an entrance and up to five structural surfaces (roof, floor, walls on either side and a back/end wall). Rock shelters are caves of restricted depth which have a roof, a floor and a back wall but the side walls of a shelter are poorly defined or absent. Fissures are horizontal or vertical entry caves which lack a well-defined roof, while potholes are vertical entry caves with limited horizontal development of passageway. Sink holes or swallets and resurgence caves are hydraulically active caves which respectively receive and discharge surface water courses. Dolines or shakeholes are locations on the limestone surface where widening of vertical fissures through disolution or underground collapse gives rise to circumscribed local depressions in the soils covering the limestone bedrock.
The caves under consideration here are those that have developed through erosion and dissolution of limestone in karst terrain, and for inclusion in the field survey they had to meet additional criteria which are defined in the following section.

4.2.2 Inclusion criteria
The audit covered the caves mentioned above in 4.2.1, but excluded the following:

- hidden natural cave systems which have been intersected by ground works such as mines, tunnels and quarries: these were excluded if the intersected caves had no identifiable natural entrance other than that created by recent human activity. In such cases the *a priori* likelihood of the existence of cave archaeological deposits was deemed to be low.

- unexcavated shakeholes and dolines which have not been proved to connect to an accessible cave system. While such sites may well have archaeological potential, it is difficult to characterise their potential within the resources of the current study, and these sites were therefore excluded.

- sinks and resurgences which are accessible only to persons equipped with diving gear. Cave archaeological deposits are relatively uncommon in caves that carry active streamways, and considerations of access and safety precluded this category of cave from being investigated in this study.

- artificial caves and grottoes, except where these represent a modification of a pre-existing natural cave system. Most artificial caves are constructed in sandstone or soft limestone, and this category of cave is unusual in the Carboniferous Limestone regions that were covered by the present audit. Nonetheless it may be useful to include this category of cave in any future national study.

- evidence for mining history contained within natural cave systems: the presence of such evidence was noted but not investigated further, and was not used as part of the definition of an archaeological cave.

Cave deposits include both consolidated and unconsolidated sediments and clastic deposits that have accumulated within a cave or at the entrance to a cave. As cave entrances are subject to erosion, some deposits that were previously contained within a cave can eventually end up outside the cave, as can spoil excavated from within the cave by human or animal agents. For this reason, external talus deposits adjacent to cave entrances were included within the scope of this audit where it was shown that there was spatial continuity and visual proximity with deposits contained within the cave.

4.2.3 Definition of an archaeological cave
An archaeological cave is a cave (as defined in 4.2.1 and 4.2.2 above) that contains or used to contain archaeological artefacts, archaeological deposits (including charcoal) or deliberately deposited ancient human remains. The term archaeological artefact is interpreted broadly to include, for example, pre-modern built structures and cave art and other deliberate modifications to cave structures.

4.3 Data Acquisition

4.3.1 Desk-based study
The following were the main sources of data for the desk-based study.
Cave Registries: An up to date catalogue of Peak District caves is contained in the Derbyshire Cave Registry, available on CD as an Idealist database from John Beck, Glebe Cottage, Eyam, Derbyshire. The registry covers all of the southern Pennines Carboniferous Limestone outcrop including the separate limestone inliers at Ashover and Crich. The information is in the form published in Gill and Beck (1991), and the database contains separate text-based fields for cave location, description, dimensions, physical access, exploration history etc. The registry has been compiled from caving club records and the scientific literature and is believed to be fairly comprehensive though not including some recent discoveries and extensions of known cave systems (since the completion of the current audit, Iain Barker of the Derbyshire Caving Association has commenced a major revision of the database with a view to publishing a revised edition of *Caves of the Peak District*). The database contains over 500 entries, but after excluding mine workings, inaccessible sinks and flooded resurgences there are approximately 260 caves meriting archaeological assessment.

Approximately 1500 caves have been identified in the Yorkshire Dales (Brook et al., 1988, 1991, 1994), with perhaps half of these meeting the criteria for inclusion in the present project as worthy of archaeological assessment.

Information from the cave registries was supplemented by consultation of Caving Club documents and publications held in the BCRA cave studies library in Matlock, Derbyshire, and by personal communication with members of local caving clubs. Recreational clubs active in cave exploration were encouraged to report any new archaeological discoveries to the research project.

Archaeological information: In 1997 the National Monuments Record contained entries for 26 archaeological caves in the Yorkshire Dales and 62 archaeological caves in the Peak District (Martyn Barber, personal communication). The lower number recorded for the Yorkshire Dales is surprising given the density of caves in that region, and may partly reflect the lower intensity with which archaeological research has been conducted in the Yorkshire Dales. More detailed information about archaeological caves is recorded in the Derbyshire, Staffordshire and North Yorkshire local authority Sites and Monuments Records and in the archaeological archives of the National Park Authorities. Selected regional museums were contacted or visited to review accessions of materials from caves within the study areas, and local archaeological societies and amateur archaeologists were also contacted in the course of the study.

Online databases: websites including CAPRA ([www.capra.group.shef.ac.uk](http://www.capra.group.shef.ac.uk)) were consulted for further archaeological information that is not easily accessible from other sources. An important category of archaeological information that is not customarily appended to the national monuments record or to local authority archaeological records is radiocarbon dating information. The CBA radiocarbon database (available at [http://ads/ahds.ac.uk/catalogue/specColl/c14_cba/](http://ads/ahds.ac.uk/catalogue/specColl/c14_cba/)) and the date lists of radiocarbon determinations conducted by the Oxford Radiocarbon Accelerator Unit (available at [http://c14.arch.ox.ac.uk/embed.php](http://c14.arch.ox.ac.uk/embed.php)) were consulted.

### 4.3.2 Field assessment

Field assessment served a dual purpose: to assess the conservation status of a sample of archaeological caves and to collect quantitative data on cave location and landscape morphology that could be incorporated into the predictive model. Our original intention was to survey 50% of the known archaeological caves and 15% of the known non-archaeological caves within the study regions. This strategy was
revised in order to maximise the quantitative information obtained for archaeological caves, in the manner described below.

Following the desk-based phase of data acquisition, a sample of caves within each of the two study areas was drawn, by selecting valley segments within each of the previously defined catchments. The valley segments were selected so that as many as possible of the known archaeological caves were visited during the course of the survey. While visiting the known archaeological caves, all other known caves in the vicinity (i.e. in the defined valley segment) were also visited, along with any other unidentified caves that were detected while traversing the study area. In effect, the survey employed a ‘case-control’ sampling strategy (Thompson, 1994), with every archaeological cave matched to a selection of neighbouring non-archaeological caves in the same catchment.

Field visits were carried out with permission of land owners and tenants and in liaison with relevant conservation organisations including the National Park Authorities, English Nature and the National Trust. The field recording protocol is outlined in Table 4.1 below:

<table>
<thead>
<tr>
<th>Information</th>
<th>Attributes</th>
<th>Data Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cave location</td>
<td>National Grid coordinates and altitude above Ordnance datum</td>
<td>Handheld GPS and visual correlation with large-scale Ordnance Survey maps</td>
</tr>
<tr>
<td>2. Cave setting</td>
<td>Nature of physical access, land usage, landscape setting, visual grouping with other nearby caves</td>
<td>Text description; digital photography</td>
</tr>
<tr>
<td>3. Cave geomorphology</td>
<td>Cave type, length, depth, entrance orientation, entrance and chamber dimensions, light zone extent, ground slope at entrance, bedrock geology</td>
<td>Text description; compass, clinometer &amp; tape measurements; planning and profiling at 1:50 scale</td>
</tr>
<tr>
<td>4. Cave deposits</td>
<td>Internal deposits, external deposits, structural modifications of the cave or its setting, loose surface finds</td>
<td>Scaled digital photos; description of sediments and any visible markings and surface finds</td>
</tr>
<tr>
<td>5. Conservation status</td>
<td>Condition, stability and preservation of deposits, evidence of recent human and animal activity, current management regime</td>
<td>Text description; digital photography</td>
</tr>
</tbody>
</table>

Table 4.1 Protocol for field recording of caves

The quantitative dataset obtained from desk-based and field-based survey was entered on a database compiled in Microsoft Access, from which selected portions of the data were exported to other software applications (principally Microsoft Excel and SPSS) for quantitative analysis. Information on particular categories of archaeological finds from the caves was recorded in the database as simple presence/absence records in a series of fields for each category.
4.4 Data reporting and analysis

4.4.1 Catchment descriptions and evaluations
Catchment descriptions and cave archaeological resource evaluation and interpretation are presented in textual form and annotated illustrations in Sections 5 and 6 of this report.

4.4.2 Univariate and bivariate analyses
Initial explorations of patterns in the data were conducted using univariate and bivariate statistical analysis in Microsoft Excel. These analyses included variation between regions and catchments in the proportions of caves with identified archaeological finds, the relationship of archaeological caves with topographical and landform variables including altitude, aspect, size of cave, ground slopes, presence and status of cave deposits and proximity to water. The results of the quantitative analyses are presented in Section 7.

4.4.3 Predictive modelling
Predictive modelling is a powerful tool for landscape archaeology and cultural resource management that has been deployed in many studies over the last decade (for examples, see papers in Allen et al., 1990, and Westcott and Brandon, 2000). The essence of predictive modelling in landscape archaeology is to identify combinations of environmental variables that together are correlated with (and hence predictive of) the occurrence of archaeological sites. Predictive modelling is often undertaken using a GIS database, although this is not an essential prerequisite of implementing the method when the intention is to calculate the archaeological potential at discrete points rather than as a two-dimensional surface.

Most case studies in archaeological predictive modelling have used logistic regression to estimate the probability of site occurrence. The regression coefficients in the logistic regression equation can be interpreted as weights or scaling factors which encapsulate the contribution that each environmental variable makes to the probability of an archaeological site occurring at a specific location in the landscape. The logistic regression equation is established using a training set, a sample of known “sites” and known “non-sites” for which the environmental variables can be established. In this project the “sites” are defined as caves with recorded archaeological evidence while the “non-sites” are caves without archaeological evidence.

Similar results to logistic regression can be obtained with discriminant function analysis, and the latter method may in fact be more appropriate for predictive modelling when the data are mainly in the form of continuous measurements rather than as binary or categorical data. Preliminary studies with our data showed that while the overall correct classification of caves was similar with the two methods, discriminant function analysis was more successful in obtaining correct classifications for the archaeological caves (i.e. it was less influenced by the larger numbers of non-archaeological caves in the dataset). A related method for evaluating archaeological potential and threats to integrity of sites is the decision tree, which uses attributes singly or in combination to partition cases at each node of a branching tree. We have not evaluated this approach as a methodology for assessing cave archaeological sites in the present study, but it may well be worth evaluating in a future study.

Datasets for testing predictive modelling of archaeological cave locations were already available for the study areas based on the systematic cave surveys conducted in the Manifold Valley and in the southern Yorkshire Dales (see 2.1
above). These datasets have the advantage that the caves defined as non-
archaeological have been assigned to this category following field archaeological
assessment, rather than simply through absence of prior investigation. Initial
modelling studies with the Manifold Valley dataset showed that in the
Hamps/Manifold catchment the cave altitude, adjacent ground slope and orientation
of cave entrance were significantly correlated with the presence of archaeological
evidence (Chamberlain, 2003).

4.4.4 Analysis of finds data
Archaeological finds made during previous surveys and excavations in the caves of
the study regions were recorded as presence/absence data in the caves database.
The finds were listed under the following categories: Flint, Other Lithics, Prehistoric
Pottery, Historic Pottery, Glass, Human Bone, Faunal Remains, Worked Bone,
Bronze/Copper Artefacts, Iron Artefacts, Coins, Other Metal Artefacts, and Charcoal.
The finds datasets were analysed using Principal Components Analysis (PCA), a
technique which reduces a large number of variables into a reduced number of
components which account for most of the variation in the original data. As well as
identifying the main underlying factors accounting for variation in the finds
distributions, PCA is effective in revealing patterns of co-occurrence between
particular types of finds.

4.5 Project documentation and outreach
The primary output from this project consists of a Research Archive, a Research
Report, a Research Design and a Management Report. These outputs have been
prepared according to guidelines set out in MAP2 (English Heritage, 1991): the
reports have been made available as paper copies and the reports plus the archive
are also distributed on CD-ROM. The archive and reports consist of
- A Microsoft Access database with associated digital records (including digital
  photographs and EPS map files)
- A Research Report (the present document) containing summaries, syntheses
  and quantitative analyses of information collected in project
- A Research Design including fieldwork protocols for national study
- A Cave Archaeology Management document, including a summary of current
  threats and proposals for management action.

Recipients of the report and database will include English Heritage, the National Park
Authorities, the SMRs and regional curating museums.

Outreach work has included discussion with key stakeholders (including caving club
members) at the commencement of the project, and it is intended that this will
continue with the preparation of guidance notes for cavers, landowners,
arCHAEOLOGICAL curators and commercial archaeological units after the completion
of the project. The outcomes of the research project are being presented through
meetings and publications sponsored by the British Cave Research Association as
well as through regional archaeological forums such as those organised by the
Yorkshire Dales Archaeology Group and the Yorkshire Archaeological Society. There
were briefing meetings to which media representatives were invited at the start of the
fieldwork phase of the project, and further meetings will be planned to take place
following the completion of the analysis and project reporting.
5 PEAK DISTRICT CATCHMENTS

5.1 Introduction to the Peak District

The Peak District Carboniferous Limestone outcrop covers some 540 km$^2$ of northeast Staffordshire and central Derbyshire (Harrison and Adlam, 1985), of which 420 km$^2$ is cavernous karst terrain containing well-developed cave systems (Waltham et al., 1997). The limestone outcrop is continuous in extent apart from two detached inliers located to the east of the main outcrop at Ashover and Crich. The main limestone outcrop falls largely within the boundary of the Peak District National Park, but it is important to note that the boundary of the National Park deliberately excludes peripheral portions of the main Carboniferous Limestone outcrop in the northwest (Buxton), southwest (Waterhouses/Cauldon) and southeast (Matlock/Wirksworth) where much of the active minerals extraction industry is concentrated.

More than 260 surface-accessible caves are distributed throughout the Peak District limestone outcrop (Gill and Beck, 1991). Cave inception in this region is dominated by the physical factors of geology and hydrology. Caves are confined to the purer aggregate limestone and they are not found in the shale-dominated lithologies which occur in parts of the southern and eastern areas of the limestone outcrop (for example around Bakewell). Most caves are located either at the margins of the limestone outcrop or within the outcrop at locations where the water table is less than 60m below the present ground surface, such as along the sides of the dales. Cave inception is particularly active at the margins of the outcrop where impervious younger geological strata overlie the Carboniferous Limestone, bringing unsaturated surface runoff water into direct contact with the limestone and causing active dissolution along joints and bedding planes. As a consequence of the peripheral concentration of caves, and the fact that minerals extraction areas extend into the western half of the limestone plateau, about 15% of the Peak District’s caves lie outside the boundary of the Peak District National Park.

The current active hydrological systems have relatively little impact on most of the caves within this survey. The known archaeological caves, for the most part, sit well above the river systems and therefore are relatively unaffected by fluvial action or fluctuations in ground water levels. However it should be noted that water table levels have changed radically in the last 150 years, with the mean water level dropping by up to 40m in some places (J. Barnatt, personal communication). Mining has played a significant part in the fluctuating water levels; pumping in mines has lowered the water table locally and soughs have transferred water between different catchments. Extraction of water for domestic, industrial and agricultural uses has also played a role in the lowering of the water tables. Although this has had little observable impact on the known archaeological caves, changes in the water table could have adverse impacts on low level archaeological caves, and dewatering of cave sediments and alterations in cave environments may have resulted in subtle changes in the preservation potential of cave deposits. There have also been changes in agricultural practices that have led to the changing patterns of surface run-off water. Incidents of groundwater pollution that may be due to agricultural and industrial activities have been detected in several caves within the Peak District National Park.

The descriptions that follow in this Section of the report are summaries of the twelve Peak District limestone catchments together with the outlying catchments of Ashover and the Gritstone outcrops. For the purpose of the quantitative analysis some of the smaller adjacent catchments were grouped together to provide appropriate sized
samples of caves (see Section 7). The recorded locations of all of the known archaeological caves identified during the desk-based study were visited during the field survey, but in a few cases the caves could no longer be located or appeared to have been misidentified in publications or archival records. In some cases these misidentified caves appear to be ploughed out round barrows which incorporate a rock cut or kist burial. Cawdor Quarry Fissure burials are a good example of this. The skeletal remains of at least four individuals were found in a natural fissure in the bedrock, covered by a heavy capstone, during soil stripping prior to extending the quarry in 1893. Ward (1901) suggested that the site was an example of a robbed out burial mound, and he noted that other examples of rock-cut graves had been found beneath barrows elsewhere in the Peak District. During the field survey some similar sites were visited where the documented find spots were in flat fields with no visible exposed rock, and although there is a chance that in some instances the grid reference might be incorrect it is thought more likely that these sites fall into the destroyed burial mound or surface fissure burial category.

Another problem that was encountered when locating sites identified in the desktop phase was of multiple separate references to what appears to be the same locality. An example is from Micah Salt’s antiquarian investigations towards the end of the 19th century. Swallow Tor (DO33) and Tor Rock Rock Shelter were both excavated by Salt and they are reported to have the same assemblage of artefacts, even though the sites are recorded as being on different sides of the valley. Likewise the sites of Deepdale Cave (BU04) and Thirst House (BU03) have been confused in the literature, and to add further to the confusion there are several other localities in the Peak District called Deep Dale.

5.2 Ashover

Location and Geomorphology

The catchment of Ashover falls outside the Peak District National Park but it provides us with a good example of a restricted area of karst landscape that could easily come under threat from extensions of quarrying activities. The catchment lies to the east of the National Park and it forms an inlier of Carboniferous limestone completely surrounded by later Namurian rocks (Rhys, 1967). The main group of surface-accessible caves are the Fallgate Caves which are located in a low cliff line in Monsal Dale limestones on the south side of the Amber Valley. The River Amber forms a small watercourse over 100m away from the caves in the base of the valley, where it runs across the Ashover Tuff, an impermeable volcanic horizon below the limestone. The cave entrances have prospects across the narrow river flood plain towards Fall Hill, which is within a SSSI.

Ownership, land use and access

The crag containing the caves forms the rear part of the still-active Milltown Quarry and it is visited by rock climbers and occasionally by cavers. Along the base of the cliff is a narrow levelled area which appears to have been landscaped or perhaps...
modified by miners (there is some evidence of shot holes and enlargement of entrances in some of the Fallgate caves). The levelled area starts mid way along the cliff and runs along to the north-western end where it gradually slopes down to join another track at a lower level. A steep scree slope runs along the base of the cliff and towards the north-western end the scree could be hiding more caves. Despite the caves being visited when the vegetation was at its lowest point it was still difficult to see the entire cliff as parts of it were obscured by shrubs and trees, and the cave entrances are not prominent to casual visitors in the Amber Valley.

There is a wide, publicly accessible footpath/track below the cliff and the caves are on access land. The crag runs in a roughly straight line NW-SE in orientation and although the land is privately owned there are no restrictions on access by cavers. Periodic grazing by stock animals is carried out but the rougher land towards the NW end of the crag is very overgrown with rough grass and shrubs.

Caves, archaeology and conservation status

The Fallgate caves are the principal cave sites within the Ashover catchment. They form a series of small caves that are spaced closely along the limestone cliff. Gill and Beck (1991) records that there are four caves (Fallgate Caves Numbers 1 to 4) but a total of six sites were visited with five of them being recorded in this survey (four caves and one fissure). Fallgate Cave No. 2 was visited but the entrance has shot holes on either side and the chamber/passage appears to be wholly dug out by mining. Two of the caves, AS01 and AS05, have clear evidence of past badger use and it is likely that AS02 could also be occupied by badgers. AS03 has been modified by mining but the original cave mouth is still evident and inside the cave along one wall is a band of breccia with in situ small animal bones. None of the caves are of substantial size and except in those which have been modified, access is restricted and requires a crawl to get into them. Although the Milltown Quarry is very close to the site, the general level of threat for the Fallgate caves is currently low as they appear to be infrequently visited and there was very little discarded litter visible around or inside the caves.

5.3 Bradbourne

Location and geomorphology

The Bradbourne area is centred on the village of Parwich and is the catchment for watercourses that drain southwards to the Bradbourne Brook. The eastern part of the catchment falls outside the Peak National Park. The area is dominated by the reef limestones of the Bee Low and Monsal Dale groups, but the limestone is dolomitised to the east giving more resistant rocks with steep-sided hills and localised vertical exposures of bedrock, which can be seen in the periglacial tor formations of Rainster and Harborough Rocks. Silica sands, clays and gravels of the Tertiary Brassington Formation infill large solution hollows in the surface of the Carboniferous limestone in some areas and these pocket deposits can be associated

Plate 5.2 In situ breccia sediments in Fallgate Cave No. 1 (AS03)
with underground cave systems (as, for example, at Golconda Cavern in the adjacent Derwent South catchment: Ford, 1977b). Two active sinks lie to the west of Parwich but their risings are unknown: some drainage from this area may go westward and rise in the Dove Valley. Dry valleys and gorges such as Hipley Dale and Ballidon provide examples of surface drainage courses that have now either sunk below ground or have been diverted through mining into other catchments.

Ownership, land use and access

There are small areas of access land around Royston Grange and in Hipley Dale, but most of the land is owned privately and access is restricted to those caves that are known to exist. The land use is a mixture of pasture and a small amount of arable, and there are some active limestone quarries at Ballidon and Hoe Grange.

Caves, archaeology and conservation status

Large penetrable caves are unlikely within this catchment (Gill and Beck 1991) and because of the paucity of developed systems there is little threat from illicit digging of cave deposits. However threats from sand, gravel and minerals extraction could potentially impact on hidden cave systems. Six caves are recorded for the catchment by Gill and Beck (1991) but four of these have been severely damaged or destroyed by quarrying: one of the extant caves recorded is a group of swallets. Rains Cave is the only known archaeological cave in the catchment although Hoe Grange Quarry Cave was reported to have Pleistocene mammal remains: this site has probably been destroyed completely through quarrying. Rains Cave proved an elusive cave to locate, and despite several survey trips the entrance could not be found among the scattered blocks of reef limestone on Longcliffe Crags.

5.4 Bradford

Location and geomorphology

The Bradford catchment lies to the north of the Bradbourne catchment and covers the area drained by the River Bradford and its tributary streams. The rock here is mainly Monsal Dale group limestones. The area is speleologically under-researched with large blank areas for caving (Gill and Beck, 1991) and most of the identified caves are located near the River Bradford around Youlgreave and Middleton.

Ownership, land use and access

Access land within the catchment is confined to Long Dale and Gratton Dale. Of the areas visited during the survey, Rowlow Brook and Bradford Dale are in private ownership while Rushden Wood is in the care of the PDNP. Land use and access are discussed more fully in the terrain descriptions below.

Caves, archaeology and conservation status

Gill and Beck (1991) record 10 sites of speleological interest in the catchment but several were excluded as mines or resurgences and only one of the sites was located in the areas that were selected for survey. Three areas were surveyed within the catchment: two adjacent gorges, Rusden Wood and Rowlow Brook, which are
surrounded by pasture with low valleys and the occasional low crag, and Bradford Dale which carries the main surface drainage through the catchment. In total 16 sites were recorded: seven rock shelters, eight caves and a fissure. One of the sites (BF14) is known to have yielded archaeological remains, and there is considerable variety in the size and shape of the features.

5.4.1 Rusden Wood

Rusden Wood is a short dry valley NE-SW in orientation, located about 1km south of Middleton and cutting through the Monsal Dale limestone. This wooded valley is in the care of the Peak District National Park and has a well-walked path through the middle. The dale has scarped sides of exposed limestone with the occasional fallen block in the valley bottom. The valley appears to have no surface flow, although the central part was slightly damp during the field visit in May 2004. The south-western end of the gorge widens where a road cuts across it, with the south-east facing crag rapidly declining in height. At its north-eastern end the gorge emerges into the valley of the Rowlow Brook where again the sides of the gorge dissipate within 50m as they open into the broader Rowlow valley.

A total of nine sites were recorded in Rusden Wood: five rock shelters, two caves, one collapsed cave and one fissure. The rock shelters in the valley bottom tended to be devoid of sediments but this does not exclude them from having been used in the past. BF12 has been used very recently as a shelter, as two poles were found propped against the rock face with the remains of a small fire near the supposed entrance. Considering the frequency of rock shelters in the gorge it is surprising that the caves are not as well formed. The rock appears to be capable of supporting quite deep rock shelters but there are few developed caves.

5.4.2 Rowlow Brook

Rowlow Brook is a crescent-shaped gorge in Monsal Dale limestone that curves around a sheer south-west facing scarp of knoll-reef limestone formed in the Eyam limestones. The north-east facing side of the gorge is more sloping in contour. The valley is privately owned and there are no footpaths through the gorge. A stream runs through the gorge and a fishpond is situated towards the south-eastern end. Only the western side of the gorge was surveyed as permission for access was refused for the eastern side. The gorge has been used for pasture, however at the time of the survey in May 2004 much of it was overgrown with grass and nettles. The area that it was possible to survey had well hidden, short and low crags, no more than 2.5m high.

A total of four sites were recorded: two caves, one rock shelter and one collapsed rock shelter. One of the caves, BF02, has been partly quarried, probably during construction of the fishpond and the other, BF03, has high potential due to the seemingly thick sedimentary deposits within the cave.
Bradford Dale forms an L-shaped gorge cut in the Monsal Dale limestones and runs between the villages of Youlgreave in the east and Middleton in the south. The land is in private ownership but public footpaths run through the valley and the gorge is heavily walked as the region is a popular location for visitors and the area is served by many footpaths. The southern side of the gorge was not surveyed as permission for access was refused by the landowner. On the northern side two of the caves have been previously identified as archaeological but only one of these was located. It is likely that the other has either been masked completely by the dense vegetation or that there is an error on the grid reference number.

There is a river running through the bottom of the gorge with a series of small fishponds: the watercourse is permanent as it is underlain by impermeable volcanic rock. The water levels appear to be managed so flooding is likely to be rare. The vegetation consists mainly of trees and undergrowth but there are parts that are very overgrown with brambles and climbing plants covering over the rock faces. Badger setts were located at the base of some of the rock faces indicating the likely presence of caves or fissures below the current soil level. The gorge is steep sided with most of the exposed limestone being at the top of the gorge and therefore fairly inaccessible. The Monsal Dale limestone in this area is thinly bedded and it is only the rift caves that are likely to survive, as the thinness of the limestone beds will not allow large chambers to form.

BF14 (Owlet Hole) was the only known archaeological cave identified, and although there was meant to be another ‘Bradford Dale Fissure’ this was not located in our survey. BF14 is overlooked by BF15 which appears to have been formed by a large rock boulder falling out of the cliff. This site makes a good vantage point for looking along the gorge and there is a moderate sized talus in front of it which is now overgrown with brambles. BF14 has been previously excavated but no evidence of the excavation is now apparent. It is relatively untouched by the casual visitor as the cave is difficult to locate and tricky to climb up to.
5.5 Derwent South

**Location and geomorphology**

The Derwent South catchment is located to the east of the Bradbourne and Bradford catchments and it consists of the limestone area that is drained to the River Derwent south of Matlock. No large vadose caves and risings are known in the catchment and drainage and cave development are largely determined by the presence of volcanic rocks, mineral veins and dolomitisation within the limestones. Much of the present day drainage emerges from lead mine soughs indicating how the water table has been lowered and natural drainage altered within the last 300 years (Gill and Beck, 1991).

**Ownership, land use and access**

The southern half of the catchment falls outside the boundary of the Peak District National Park. Most of the land within this catchment is under private ownership and there is relatively little access land, but many of the caves are accessible from public footpaths. The catchment has several active limestone quarries but with the exception of Ivonbrook Quarry these are located outside the boundary of the National Park. Land use and ownership are discussed more fully in the terrain descriptions.

**Caves, archaeology and conservation status**

Gill and Beck (1991) record 59 caves, 34 of which are mines and soughs. Two of the three known archaeological caves, Harborough Cave and Carsington Pasture Cave, are in the southwest of the catchment on dolomitised apron-reefs of Bee Low limestone. The areas surrounding them have been heavily industrialised in the past and are now subject to quarrying and sand and gravel extraction although the caves themselves are not under immediate threat.

Four small areas in the catchment were surveyed: Bonsall Lane; Jug Holes Wood; Harborough Rocks and Carsington Pasture. Three of the areas each have a single archaeologically known cave whilst Jug Holes is a cave that has been much altered through mining. Thirteen sites were surveyed: seven caves and six fissures. There were great variety in cave and fissure size and most of the sites were above 300m in altitude.
5.5.1 Bonsall Lane

At Bonsall Lane, southeast of Winster, is a low approximately 300m long W-E orientated and roughly south facing crag, developed in low-purity dolomitised Monsal Dale limestone. Although on private land there appeared to be no restrictions in gaining access to the crag. The surrounding land is under pasture and to the immediate north there are the remnants of old mine workings and shafts. There is no surface water within 100m of the crag, which affords a good view across the countryside. The vegetation near the crag has been left to run wild and it is now very overgrown with trees and shrubs growing into the rock faces. The crag of exposed limestone is less than 3m high and is prone to breakdown. The entire crag was surveyed but there was only one cave (DS01) which is known to have yielded archaeological remains; nails from the original excavation are still pushed into cracks in the rock. The cave was formed by slabs breaking away from the rock face which is of fairly poor quality with thin bedding planes. At present there is no active care of the monument, and the steady invasion of the trees will damage the cave leading to its eventual collapse.

5.5.2 Jug Holes

Jug Holes is situated just inside the boundary of the Peak District National Park on the edge of the plateau overlooking the Derwent Valley to the northeast. The site is a series of natural caverns, developed in Monsal Dale limestone, that have been de-roofed by miners in the past and are now abandoned and accessed principally by cavers and mine historians. The caves are situated in a wood that is privately owned but there are a series of footpaths that cut through the area and it is also within the area of the Masson Hill SSSI. There is a small stream that runs to the west of the caverns that appears to have been altered by the miners. The woodland is managed and the paths are kept clear. There is little exposed limestone and mineral extraction appears to have shaped the little that there is. The main accessible cave, DS12, is very large, with dimensions of over 20m x 10m x 6m and has a very uneven surface from past mining and caving exploration. The cave appears to be well cared for in that it is visited regularly by cavers who appear to cause little erosion to the surface deposits and there is little evidence of discarded litter at the site.
5.5.3 **Harborough Rocks**

Harborough Rocks is a prominent tor-like outcrop formed from high-purity dolomitised reef limestone (Bee Low Group), geology of a similar nature to the less prominent crags further south on Carsington Pasture. The limestone at Harborough Rocks is grass covered with small exposed patches of limestone around the knoll. It is privately owned but open access is permitted to the rocks which are popular with parties of novice climbers. The land is used for periodic sheep grazing but is also visited as a picnic site as it is close to the High Peak Trail and provides delightful views over Carsington Water to the south. The area also has the remnants of old mine workings with the brick turrets of the aerial transport routeway from the mine to the processing floors dotted along the lower edges of the Rocks. The Golconda mine is to the north-east and other disused mine workings surround the site. To the south of the rocks is a sand and gravel works which is noisy and affects the visual aspects of the sites but has no immediate impact on their conservation status. Harborough Rocks are located outside the Peak District National Park but are one of the few areas of exposed limestone in the Derwent South catchment. There is no surface water within 100m of the rocks, but a boggy area to the south of the rocks indicates where the limestone is mantled by surficial drift deposits which probably would have allowed water to be obtained in the past.

**Plate 5.9 Harborough Rocks reef rocks**

Six fissures and four caves were surveyed in the area of Harborough Rocks with one of them being a known archaeological cave, DS02. This cave has been excavated and a large spoil heap is visible outside the cave entrance. The cave has some evidence of being further investigated by cavers and others in recent years and the cave contains a large amount of rubbish – it is also used by climbers and others for shelter. The outside of DS05 is used as the main climbing wall and erosion has exposed deposits of sands – these may have palaeontological interest but erosion and other forms of use has removed any later sediments. There is some evidence of deliberate blocking of the caves: both DS10 and DS11 have been walled up. This might be to stop sheep from entering but the caves are not really of a size to be able to get a sheep in. DS10 has a small mound outside that could be badger spoil or it might have been previously excavated but no record has been left of this. DS06 is also a cave that appears to have deeper, intact deposits still *in situ*. Most of the caves, excluding Harborough Rocks Cave (DS02), appear to be undamaged but this could be due to their size as they are not

**Plate 5.10 Harborough Rocks in the snow**
sufficiently large or obvious to attract attention. More worryingly, a carved limestone chair on the summit of Harborough Rocks, dateable from inscriptions to the 18th century, has recently been attacked by unknown persons with a heavy hammer, resulting in substantial and irreparable mutilation of a unique element of the local cultural heritage. This wanton destruction represents one of the hazards of unsupervised access to non-protected parts of the landscape. If attention from cavers becomes focused on Harborough Rocks then the smaller caves and fissures could come under threat from excavation, but equally a controlled surface dig with the collaboration of archaeologists might yield good results in some of the caves.

5.5.4 Carsington Pasture

Carsington Pasture is a unique area of unenclosed upland limestone situated outside the Peak District National Park between the villages of Brassington to the west and Carsington to the east. The limestone is extensively mineralised, mainly with lead and zinc ores together with gangue minerals. A dense network of mineral veins permeates the limestone under the Pasture and the area has been much altered through lead mining probably from as early as the Roman period, resulting in a historical industrial landscape of regional/national importance (Willies, 1995; Barnatt and Penny, 2004).

The one identified cave site, DS13, sits in dolomitised Bee Low limestone on a ridge crest that provides extensive views to the south over Carsington Water. The site appears to have been discovered initially through mining (a mined shaft enters the top of the cave) but the natural cave passages were not fully explored until the Pegasus Caving Club discovered human and animal bones in the cave in 1998. The walk-in and vertical shaft entrances to the cave are now gated, restricting human (though not chiropteran) access to all parts of the cave and thus providing a high level of protection to all of the deposits still in situ. The land is owned by a quarrying company but is farmed by a tenant who uses the land for sheep and cattle grazing as well as occasional field sporting events such as shooting and trail bike riding. There is no obvious surface water in the vicinity apart from modern dew ponds and residual pools in the quarried Tertiary pocket deposits further north on the Pasture, but the survey visit was carried out during a period of snow so it was difficult to assess surface conditions properly. The level of protection for the cave is very high and the site receives few, if any, casual visitors.
5.6 Castleton

Location and geomorphology
Castleton is the northernmost limestone catchment and the best known recreational caving area in the Peak District. The caves of the Castleton area are reviewed in detail in Ford (1977a) but subsequent decades have seen much additional work on extending, surveying and recording its often deep systems, culminating in the discovery in 1999 of Titan Shaft, the tallest vertical cave feature to have been discovered in Britain. The Peak Cavern-Speedwell Cavern system forms an extensive network of active stream caves and relict high-level passages, with the streamways converging on Peakshole Water and providing the main underground drainage for the catchment. A series of swallets and pot holes along the western side of the catchment mark the boundary of the impermeable Namurian strata and many of these are active sinks that conduct surface streams underground.

Ownership, land use and access
Most of the land within this catchment is under private ownership but with some access land in Cave Dale and on land owned by the National Trust in the Winnats Pass/Windy Knoll area. Castleton is a popular walking area and there is a network of heavily used trails crossing the area, including the Limestone Way. As a consequence visitor traffic is appreciably higher than in other parts of the northern White peak region. Most of the land is used for pasture or arable farming, and there are two active limestone quarries at Hope and Eldon Hill. Land use and ownership are discussed more fully in each terrain description.

Caves, archaeology and conservation status
Eighteen sites were surveyed in the catchment from a total of 72 known caves. Most of the caves surveyed were in Cave Dale, a narrow gorge that runs from Castleton behind Peveril Castle up to the limestone plateau. Two outlying caves were also surveyed: Windy Knoll Cave (CA16) and Gautries Hill Pot (CA18), both located towards the northwestern margin of the catchment.
5.6.1 **Cave Dale**

Cave Dale has four known archaeological caves although Peak Cavern (CA17) can also be included as avens and high level passages connect the show cave to Cave Dale. The dale runs NNE-SSW for a distance of approximately 1km and is cut through apron-reef limestones of the Bee Low group. The dale curves slightly to the west at the lower end where it debouches into the centre of Castleton. Cave Dale is in private ownership but the Limestone Way long distance footpath runs through the dale. The dale is within the Castleton SSSI and the farmer is currently within the Countryside Stewardship Agreement, which permits general public access to the land. The dale is used primarily for the grazing of sheep but many school parties also use the dale for fieldwork classes. There is no surface water in the dale, although towards the western end there is a spring that travels along the path and sinks into an underground connection with Peak Cavern. This stream rises during flood conditions but usually the dale is dry. The hillside vegetation is a mixture of short cropped grass and a few shrubs and trees. Some of the caves have dense stands of stinging nettles near them and this is often an indication of badgers being active in the caves. Most of the limestone exposures are high up on the dale sides, more so on the north-western side, but there are also some steep-sided reef knolls dotted over the dale, some of which are penetrated by caves.

Although Gill and Beck (1991) record only 8 of the larger caves our survey recorded 15 caves and rock shelters in the dale. Many of the caves surveyed were restricted to a few metres in depth. The caves towards the upper part of the dale sides, just below Peveril Castle, appear to be quite deep but none could be entered due to their restricted height: most were less than 0.70m high due to the accumulation of sediments within them. Some of these caves are being or have been used by badgers and the discarded bedding of these animals can be seen in several places. CA05 is directly below the castle garderobe and a small fragment of animal bone was noted on the top of the badger spoil heap. This cave, along with CA06, might have been excavated by Rooke Pennington in the 1870s but records are vague as to which caves were actually dug. Any traces of the excavation have been removed by the badgers that currently reside in the caves. Most of the caves that lie in the dale bottom are very short in length and some might have been

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**Plate 5.13 Cave Dale looking north-east with the archaeological caves below the castle just visible**

**Plate 5.14 Badger droppings at Cave Dale Cave No. 2 (CA06), a known archaeological cave**
enlarged through mining. CA14 appears to have shot holes in the rock and there are the remains of fluorspar in the walls suggesting that there was a mineral vein running through this part of the dale. Most of the caves are in a good preservational state but a few have large amounts of rubbish in them: CA02 and CA09 both had picnic litter which although not structurally damaging is unsightly and harmful to stock and wildlife. The caves at the top of the dale appear to escape the worst of the littering, possibly due to the steep grassy sides in the dale. This would suggest that much of the litter comes from the educational groups as these groups are not encouraged to climb the dale sides.

5.6.2 Gautries Hill Pot
Gautries Hill Pot (CA18) is a large open pothole with sheer sides that has been excavated by cavers. Members of the Mucky Duck Caving Club unearthed animal bones from the site but the location of these remains is now unknown. A wall has been built around the site to prevent grazing animals from falling into the pothole and it is possible that the animal bones found in the cave represent the remains of livestock that met an accidental death. The site is little visited by the public as it is on private land and away from footpaths, but the farmer allows cavers access to the site.

5.6.3 Windy Knoll
Windy Knoll is on National Trust property at the western end of Winnats Pass and is an upland col and former quarry site that is situated to the south of Mam Tor. The original fissure site that contained many thousands of animal bones appears to have been quarried away but the records of its location are imprecise. There is a large cave near to the supposed location of the fissure, Windy Knoll Cave (CA 16), which has been dug in the past by cavers and a large mound of spoil is now visible towards the rear of the main cave chamber. The site has been frequently visited by the public and by geological society field trips as it lies close to a main footpath and there are features of geological interest within the former quarry (Stevenson & Gaunt 1971). However the site is not obvious to the casual visitor as it sits below the normal ground level and is not visible from a distance. A recent rockfall at the cave entrance has led to the quarry being fenced off with warning signs, and there are now relatively few human visitors venturing into the cave (which is much appreciated by the swallows that nest just inside the cave entrance). There are very few in situ sediments within the cave and those visitors bold enough to enter the cave do not appear to go very far into it.

5.7 Bradwell

Location and geomorphology
This area is located to the east of the Castleton catchment and forms the northeast corner of the limestone outcrop. The catchment has many small caves though few large underground systems have been discovered with the exception of the extensive series of passages in Bagshawe Cavern. Gill and Beck (1991) record 40 caves within the catchment but over half of these have been discovered through mining and were therefore excluded from this survey.

The catchment is fed by swallets, some of which lie several kilometres from the main resurgence in Bradwell Dale. This dale is a sheer sided gorge that runs northwards between more resistant knoll-reefs within the Monsal Dale limestone.
Ownership, land use and access

Bradwell Dale has many caves (Ford et al., 1975, 1977; Gill and Beck, 1991) but unfortunately we were refused permission to survey this locality: the owner had had problems with unauthorised caving activity in the past and now prefers the caves to be left alone. Recreational cavers consider the Bradwell catchment to have great potential and therefore some of the caves maybe under threat from unauthorised digging in the search for new cave systems.

Hartle Dale is in private ownership although there are various footpaths that run along the side of the dale and through the adjacent land. The dale is also within the Bradwell Dale and Bagshawe Cavern SSSI. Currently the gorge is heavily wooded, but not obviously managed, although the NW end has been cleared and the immediately adjacent land is used for cattle grazing. The cattle do not seem to enter the woodland which is also used as a dumping ground for redundant farm equipment. Badgers inhabit the woodland but do not seem to have discovered any more caves in the short section of dale that was surveyed.

Caves, archaeology and conservation status

There are three archaeologically known caves within the catchment, all in Hartle Dale and this was the area chosen for intensive survey.

5.7.1 Hartle Dale

Hartle Dale is a narrow sheer-sided dry valley cut into Monsal Dale limestone and running NW-SE to enter Bradwell Dale from the west. There is very little exposed limestone as the rock tend to be hidden behind the vegetation but there are a few short rockfaces which are free of climbing vegetation. The bedding planes in the limestone are thin – between 0.15 and 0.50m in thickness - so the chances of large, stable chambers being formed in this outcrop are limited.

Three caves and a fissure were surveyed with all three caves being known to have produced archaeological remains. One of these caves may correspond to an imprecisely located cave in Hartle Dale that yielded remains of Pleistocene mammals (Pennington 1875). The caves are situated in the southern wall of the gorge at a variety of heights on the cliff-face. The gorge walls are slightly stepped so each cave has a narrow talus-covered ledge outside its entrance but in many cases tree growth made it difficult to traverse along the ledges. BW01 is a tall fissure cave requiring a slight climb from the bottom of the gorge to get to the entrance and there seems to be past evidence of digging at this site. The other caves are on the rock steps at a variety of heights along the gorge. As previously mentioned it is difficult to assess when previous episodes of digging took place since deposits within the caves are well protected against further erosion. The other caves were at a higher level but easy to access. BW02 has very obvious evidence of being used by badgers as there was grass litter spread at the back of the cave. There was also a relatively fresh large mammal bone on the sediment surface.
The management of the gorge and caves at the present time is one of neglect. The limestone has many joint fractures and bedding planes which encourage trees and other vegetation to work their roots into the cracks thus splitting the rock further. In the roof of BW01 tree roots can be seen as well as a small amount of daylight penetrating from above. The trees that line the top of the gorge will eventually weaken the rock outcrops, speeding up the natural processes of limestone erosion and eventually resulting in the destruction of the caves.

5.8 Stoney Middleton

Location and geomorphology
The Stoney Middleton catchment forms part of the northeast flank of the Peak District Carboniferous limestone. Most of the catchment’s caves are located in the E-W trending gorge of Middleton Dale, which is cut into the 100m thick Monsal Dale limestone between blocks of more resistant knoll-reef limestone immediately to its north and south. The predominant source of ground water is from a line of swallets along the shale margin about 1km north of the dale. The western part of Middleton Dale is dry, and surface water now emerges in the dale at Watergrove Sough which feeds into Dale Brook (Beck, 1975). Carlswalk Cavern, which underlies the junction of Eyam Dale with Middle Dale, is the largest cave system.

Ownership, land use and access
Middleton Dale and several of its tributary dales have been extensively quarried for limestone, and limestone extraction continues at present to the south of Eyam at the Goddards and Dalton Quarries. The land within the catchment is mainly pasture on the limestone plateau and a mixture of pasture and woodland in the steep-sided dales. Most of the land is privately owned with access restricted to footpaths, but there is some access land in Coombs Dale.

Caves, archaeology and conservation status
The caves of Stoney Middleton are reviewed by Beck (1975, 1977) and while additional speleological discoveries have been made in the area in the last twenty years these tend to be in the deeper parts of the cave systems and no new surface caves have been discovered recently. Much of the exposed limestone in the Stoney Middleton catchment has now been damaged through quarrying leaving very little of the original rock faces and scars untouched. 55 caves are recorded by Gill and Beck (1991) but 45 of them failed to meet the criteria for inclusion in the survey. Many of these excluded caves are underground caverns intersected through mining.

5.8.1 The Delph
Several survey areas were visited in the catchment as there were records of at least two archaeologically known caves, but on investigation Coomb Dale fissure appears to have been removed through quarrying and Cucklet Church Cave (SY01) has not been investigated archaeologically: it is recorded on the SMR purely because of its historical association with Eyam and the plague commemoration services held there.
every year. SY01 is prominently located at the north end of The Delph (also known as Cucklet Dale), a straight, steep sided tributary valley leading south from Eyam into Middleton Dale, parallel to and about 250m to the west of Eyam Dale. The Delph is in private ownership but there is a footpath that runs along the length of the valley. It is mostly managed woodland that has been turned into a nature reserve and the northern end is used for grazing. There is a small stream, the Jumber Brook, which runs through the bottom of the valley and the predominant vegetation is mature woodland and undergrowth.

There are small runs of exposed limestone crags on both sides of the gorge near to the top of the slope but this is weathering well and there is very little breakdown. The rock in this area consists of solid, deep beds of high quality limestone so the rock faces are not prone to frost shatter. SY01 was the only cave site recorded in The Delph although the dale was surveyed in its entirety. This site receives many visitors, especially during the summer months when tourist numbers increase markedly in the Eyam area.

5.8.2 Coombs Dale

Coombs Dale is a roughly W-E orientated broad valley that runs parallel and to the south of Middleton Dale, joining the larger dale just west of Calver. The sides of the valley are a mixture of intermittent woodland, undergrowth-filled abandoned quarries and grazing land and the upper reaches of the dale are designated as access land. The SMR had recorded a fissure burial site in Coombs Dale but at the grid reference is a small quarry so it is likely that the burials were found in the course of quarry work and this site has probably been destroyed.

Plate 5.17 The quarry at the site of the recorded fissure burial
5.9 Dove

Location and geomorphology

Divided into north and south catchment sections, the upper 10kms of the River Dove runs along the shale/limestone boundary before cutting into the outcrop of Bee Low limestones south of Hartington at Beresford and Wolfscote Dales. The river continues in the Dove Dale gorge, mainly in Milldale limestones, for the remainder of its course to its confluence with the River Manifold near Thorpe, where the combined rivers run out onto mudstone lithologies. An extensive flooded cave system has been hypothesised to feed the major risings in the central section of Dove Dale at Milldale (Gill and Beck, 1991), and there is a possible threat from cavers digging out new entrances in their attempts to gain access to this potential cave system. Monitoring of the caves and good relationships with the cavers would do much avoid any problems and would help to encourage co-operation between cavers and archaeological or heritage management groups.

Ownership, land use and access

The northwest end of the catchment between Earl Sterndale and Buxton contains a series of large limestone quarries, but these fall outside the boundary of the National Park. Of the areas surveyed, the Earl Sterndale area is a mixture of private and National Trust land, some of which is access land and includes the Chrome and Parkhouse Hills SSSI. The eastern side of Wolfscote Dale is in the care of the National Trust while the western side is in private ownership: both sides of the dale are now designated as access land. Dove Dale is in the care of the National Trust, and together with Wolfscote Dale is situated in the Dove Valley and Biggin Dale SSSI. The east side of Dove Dale has a well-constructed public footpath running through and attracts a large number of visitors, but the west side is closed to the public although there is a track that is used by the National Trust.

Caves, archaeology and conservation status

35 sites were surveyed in the Dove catchment from a total of 56 previously known caves: the surveyed sites include four fissures, five rock shelters and 26 caves. Seven of the caves are known to have yielded archaeological remains and one new discovery was made (DO28) that had in situ modern pottery. The areas selected for survey were in the northern part of the catchment near Chrome Hill and along the southern stretch of the Dove River around Wolfscote Dale.
5.9.1 **Earl Sterndale area**

Along the margin of the limestone outcrop near Earl Sterndale there is a distinctive range of hills overlooking the headwaters of the River Dove. From the north these are Chrome Hill, Parkhouse Hill, Hitter Hill, Aldery Cliff and High Wheeldon which together map out the Carboniferous marginal apron-reef limestones. Three areas were selected for field survey in this vicinity: High Wheeldon Hill, Dowel Dale and Tor Rock. The Earl Sterndale area is recorded as having four known archaeological caves but one of them, Tor Rock Rock Shelter, appears to be a misidentified site on the Derbyshire SMR. It is close to the site of Swallow Tor Cave (DO33) and was excavated by the same person. Despite searching for it around the grid reference number given, no sign of the rock shelter was found. Swallow Tor is on an uplifted fault block and is one of the most westerly outcrops of limestone in the Peak District. It sits in a sheltered valley below Chrome Hill and is a prominent landscape feature despite being lower than the adjacent hill. The cave, DO33, is low and now used by sheep as a shelter but it affords an impressive vista of Chrome Hill. The area is in private ownership with the hills being used for sheep grazing, but is now designated as access land which may encourage increased visitors. A series of springs and risings emerge at the base of the Tor and flow into Swallow Brook, a tributary of the River Dove. The level of protection at DO33 is very high as few individuals visit the site.

High Wheeldon is a large hill that is at the southern end of the apron-reef limestone ridge and has one known archaeological cave, Foxhole Cave (DO24). The cave is high up on the northwestern area of High Wheeldon and although the cave entrance has been enlarged by excavation it is still difficult to locate the cave from a distance. The hill is in the care of the National Trust and the entrance is double gated, although at the time of the survey the outer gate had been deliberately vandalised and was no longer locked (this outer line of defence has since been repaired, and the inner gate had not been breached). There is no surface water and the land on High Wheeldon is rough pasture currently grazed by sheep. Small industrial buildings and structures are located on the south of the hill and small stone quarries have been dug but these are old and now grassed over. The cave, which is a scheduled ancient monument, enjoys a high level of protection and the inside of the cave, which has *in situ* palaeontological and archaeological deposits dating back to the late Pleistocene, is only visited under supervision from the National Trust.
Etches Cave (DO25) and Dowel Cave (DO27) are both known as archaeological caves. They are located in the southern end of Dowel Dale, a small steep sided dale in Bee Low limestone running approximately NW-SE to the northeast of Chrome Hill. The caves are on private land but there are no access restrictions at present. DO25 is gated with the key being held by the Orpheus Caving Club but at the time of the survey the gate had been left ajar by the last visitors so there were no difficulties in gaining access. Both DO25 and DO27 are rift caves with DO25 being the lower but the longer and more complex of the two. Etches Cave is visited by cavers and a small amount of digging appears to be ongoing. The original entrance to DO25 was quite low and it appears to have been enlarged for access by cavers. DO27 is at the foot of a small crag that overlooks the road and has views out of the dale to the south, making it an excellent vantage point. On the sides of the cave are a series of sediment stains that may indicate the original sediment floor level prior to archaeological excavation. These caves, together with DO26, form a discrete group that are rarely visited as this dale is served by a minor road and is well away from the main tourist routes. The Dowel Resurgence Cave was excluded from the survey as it is an extremely active resurgence that discharges a large volume of water in flood. The resurgence is located a short distance below both caves DO25 and DO27. The level of protection for these caves is very good as the landowner is sympathetically managing the land surrounding the caves.
5.9.2 Wolfscote Dale

Wolfscote Dale lies to the south of the village of Hartington and runs in a NW-SE direction. The dale is incised into weaker rock along the line of an anticlinal axis through the Bee Low limestones. The valley meanders slightly and eventually, at its junction with the dry valley of Biggin Dale, leads into the main valley of Dove Dale approximately 3 km downstream. Only the National Trust land was surveyed as access permission was refused for the western side of the dale. There is a footpath running through the bottom of the dale along the east bank of the Dove which links up with the main path through Dove Dale and both paths are used intensively by hikers. The River Dove is a permanent feature in the dale and there are no other springs or risings. The valley as far south as Peasland Rock Shelter is grazed and further south is wooded. The more continuous exposures of limestone are concentrated on the upper slopes of the dale, but there are some small outcrops lower down the slopes as well. Of the five caves surveyed four were located toward the top of the dale sides at above 200m, but Peasland Rock Shelter (DO32), which is a cave, is in the valley bottom and is possibly the remnant of an older cave system.

The sites surveyed in Wolfscote Dales consisted of four caves and one rock shelter. One of the caves, Frank 'ith Rocks Cave (DO29), is a known archaeological site, although DO30 appears to have been emptied out and the entrance modified at some point in the past. DO29 has a generously sized spoil heap in front of it and the external surfaces of the cave entrance are used by climbers as there were permanent belay points inserted into the rock face. The general level of care for most of the caves in Wolfscote Dale is good; however this is definitely not the case for DO30 which had a lot of rubbish on the floor as well as graffiti along the inside walls. DO30 is very visible and is one of the first features that is noticed when entering the dale, hence it attracts a lot of attention. The caves DO28 and DO29, which are hidden around a corner to the south of DO30, are harder to see and are therefore visited less often. DO28 has pottery remains in it but these appear to be falling through a fissure from the surface and there might be a small 19th and 20th century rubbish dump above the cave which gives the illusion that the cave contains in situ archaeology. DO32 is at the junction of Biggin Dale and Wolfscote Dale and is prominently visible from the path in the dale bottom. It receives a fair number of visitors as it is the only obvious shelter in the dale and has some modern scratched graffiti on both the inside and the outside of the cave.
5.9.3 **Dove Dale**

Dove Dale is only accessible by hiking trails and it has not received the amount of attention from archaeologists as has its parallel neighbour the Manifold valley, and consequently there are not as many archaeologically recorded caves. Part of the purpose in selecting Dove Dale for survey was to establish whether there might be an ascertainment bias from lack of research, or whether the dale does indeed contain fewer suitable caves.

Dove Dale runs N-S and then turns to the SW at the southern end of the valley as it rounds the knoll-reef outcrop of Bunster Hill. The area is studded with knoll-reefs such as Thorpe Cloud, Tissington Spires and Buster Hill which loom above the valley forming dominant features in the landscape. The River Dove, which flows southward through the dale, is one of only two allogenic-fed rivers that maintain permanent flow across the Peak District karst (Gunn, 2004). The river levels may be maintained by a relatively high water table in this part of the limestone outcrop (Harrison and Adlam, 1985).

The sides of the dale are very steep with the west side being heavily wooded and the limestone crags being obscured by the vegetation. There is little visible scree on the west side of the dale and the vegetation may either have restricted any frost damage or may have stabilised the slope allowing soil to cover the existing scree. On the east side of the dale the vegetation is less dense and in parts the slopes are grassed to the top of the sides of the gorge. The slope on the east side appears to be a mixture of lightly grassed-over scree together with scrubby vegetation. The northern part of the survey area was more wooded on the dale sides but since the area is in the management of the National Trust it is generally well cared for.

23 sites were recorded in Dove Dale: 16 caves, three fissures and four rock shelters. Two sites are known to have archaeological remains but not all of the caves known in the dale were visited due to the presence of tall and dense vegetation. The level of most of the caves drops from the north to the south as most of them are in the valley bottom, but there was a problem with recording the heights of the caves because the narrowness of the gorge interfered with the signal to the handheld GPS.
Some of the sites are very obvious loci in the landscape but do not appear to have any recorded archaeological remains. Dove Holes (DO14 and DO 15) and Ilam Rock Cave (DO13) are prominent features but neither contain sediments *in situ* and are deemed likely to be archaeologically sterile. Many of the caves in the Dove Valley were considered to have low or moderate potential for archaeological deposits because of this lack of extant sediments. Pickering Tor Cave (DO17) for example is a prominent feature with a needle of rock towering above it and is located very close to the path through the dale. There are no sediments in the cave except those recently washed in and it appears to have been cleared out at some time. It is possible that this is an example of an excavation where nothing was found so was never recorded in archives or reported in the literature.

The two archaeological caves visited in the survey are Reynard’s Kitchen (DO03) and Reynard’s Cave (DO04). They are close together at the top of a steep slope behind a natural rock arch half way along the dale. Although there are no signs pointing out the route to them both caves receive visitors and DO03 contain a lot of rubbish. It seems to be used as a drinking den and there is scratched modern graffiti on the walls. There is also older carved graffiti dating back to 1767 on the walls, some of it quite low down suggesting that sediment deposits were never very thick in the cave even prior to archaeological excavation.

The level of care for many of the caves of Dove Dale is very good considering the number of visitors that the dale receives. Apart from the few caves on the west side of the gorge most of the caves are visible and easily accessible to visitors but the damage done and rubbish left is minimal. Only DO03 and DO13 have significant amounts of litter and this might be mitigated by having rubbish bins placed near to the sites.
5.10 Hamps/Manifold

Location and geomorphology

The Hamps/Manifold catchment consists of two separate valleys incised within the Ecton and Milldale limestones. These valleys carry the River Hamps and the River Manifold respectively, and they converge at the prominent knoll-reef of Beeston Tor. The Hamps valley runs roughly N-S and could be considered to partner the Dove Valley, which runs in the same direction a few kilometres to the east. In the summer months the River Manifold sinks into its bed near Wetton Mill, and the valley is then dry as far as the risings near Ilam. The River Hamps crosses onto the limestone at Waterhouses and then runs northwards in a narrow valley that, like the Manifold, is dry for most of the year. The section of the Manifold valley to the west and south of Wetton is particularly densely populated with caves (Gill and Beck, 1991).

Ownership, land use and access

Much of the land surrounding the Manifold valley near Wetton Mill is owned by the National Trust (now designated as access land) and most of the area is either included in the Hamps and Manifold Valleys SSSI or managed under CSA or both, and this will have obvious impacts on any future management plans. The areas included in the present survey comprise a mixture of privately owned land and that in the care of the National Trust. Several of the farmers are tenants to both the National Trust and the Chatsworth Estate which owns a portion of the valley. There are two current uses to the valley: one as farmland of mixed arable and pasture and the other as recreational/leisure. There is an old railway track alongside the Hamps and Manifold rivers that has been converted into the popular cycling and walking route of the Manifold Way. This trackway is well maintained and there are a number of car parks and refreshment facilities situated at convenient intervals along its length. As previously mentioned the river beds are usually dry during the summer months, but the extent to which this is the result of recent historical changes (including enhanced drainage for mining) is not clearly resolved.

5.10.1 Wetton Area

The section of the Manifold valley between Wetton Mill and Cheshire Wood has several archaeologically excavated caves. This area was surveyed in 1989 by the Trent and Peak Archaeological Trust (TPAT) in response to perceived threats to archaeological deposits from recreational caving activities (Trent and Peak Archaeological Trust 1992). Analysis of their survey results indicates that 19% of the 81 caves included in the survey contained archaeological deposits. Unfortunately all of the 81 caves surveyed by TPAT have now been entered into the Staffordshire SMR, regardless of their archaeological potential, giving the uninitiated researcher a spurious indication of the density of archaeological caves in this area. Our purpose in (re-)surveying the Hamps and Manifold valleys was to corroborate the data from the TPAT survey and to distinguish those cave sites containing actual or potential archaeological deposits.
The Hamps/Manifold catchment contains the highest number of known archaeological caves in the Peak District. The number of currently known archaeological caves is 18, and there is a strong possibility that more will discovered. Nan Tor (HM18) is a very likely candidate to contain undiscovered archaeology. Gill and Beck (1991) record a total of over 50 caves in the catchment (excluding the many active sinks, risings and mined levels in the area). 35 sites were included in the present survey: 33 caves, two fissures and one rock shelter, all located within a relatively small area of the catchment comprising approximately 3.5km of the valley. There are considerable variations in the altitude of the caves and they also display a difference in size from the very large and highly visible entrance of Thor’s Cave (HM14) to the restricted entrance of Falcon Low Cave (HM12). Some of the known archaeological caves are as high as 307m (HM35) while others sit in the valley bottom at 170m (HM04). This variety in height could be interpreted as relating to differences in use. The higher caves appear to have been used more for burial, or at least have human remains found in them, while the lower ones appear to have a more mundane ‘domestic’ use. Barnatt and Edmonds (2002) have commented on the phenomenon of high or inaccessible caves being used as places for burial, and the Hamps/Manifold appears to be witnessing this tradition in the Neolithic and Bronze Ages.

Thirteen caves were visited in the vicinity of Wetton Mill and seven of the caves show evidence of previous excavations. The area is dominated by a prominent rock outcrop, Nan Tor, that contains an obvious cave entrance (HM18). This cave site has never been reported as having been excavated, which is surprising considering its highly visible position in the dale. The cave receives many visitors since it is easy to get to from the car park and tea room at Wetton Mill, but despite its prominence it has only a small amount of litter and graffiti. Most of the caves in the Hamps/Manifold are fairly litter-free but this is attributable to the active management practices of the National Trust staff who regularly check all of the caves on their land. To the north of HM18 is the known archaeological site of Wetton Mill Minor (HM19). This cave was excavated in the 1970s and a sequence was found from the Palaeolithic to the 17th century. Many of the caves that have been excavated have their spoil heaps outside of the cave and these should be considered as a good source of future work for cave archaeology.
Some of the caves at Ossum’s Crag have been previously excavated and Ossum’s Crag Cave (HM21) is a scheduled ancient monument. This has not prevented the site from being explored further by cavers and illustrates one of the problems of the lack of monitoring at cave sites. Many of the sites are infrequently visited by conservation specialists so any damage done might not be picked up on until well after the event has occurred. Across the valley is the Darfur Crag with a line of three caves: HM30, HM31 and HM32. All three have been excavated at some time by either cavers or amateur archaeologists. HM31 and HM32 are small and potentially unstable near-surface caves, but Darfur Ridge Cave (HM30) is a deeper system that is currently securely protected by a well-hidden steel gate. The vegetation in this part of the dale is lightly wooded with small pastures that are used for sheep and cattle grazing. The area is well walked and visited but the caves, except for Nan Tor, receive relatively few visits.

Thor’s Cave and its neighbours again display a similar variety to those at Wetton Mill. Six caves were surveyed with three of them being known to have archaeological remains. The main cave is the prominent Thor’s Cave (HM14) which is visible from a considerable distance up valley and is a very impressive landscape feature when viewed from Wetton Mill. The cave is very large and has several chambers, which is unusual for caves in the Peak District, and has the remnants of several flowstone floors which appear to have been broken through at some time, probably during the original excavation/exploration. These floors are very high in the cave and appear to protect some in situ cemented sediments and breccias underneath them. Some of these deposits are rich in river washed pebbles and some are sedimentary silts and clays indicating a slower pace for the river at the time. These episodes may relate to a much earlier time of higher river levels, and they are unlikely to contain any archaeological material although they may contain palaeontological sediments.

Alongside HM14 is HM15, Thor’s Fissure Cave. This cave has been previously excavated and also has the remains of a flowstone floor. The level of the cave floor suggest that there are or were quite deep deposits in the cave, reaching a depth of at least 1m, but much of this former deposit has been removed. The cave does show signs of being previously excavated by cavers as there is a large mound of spoil
approximately 6m back into the cave, but this is covering the lower deposits so it might in fact serve to protect archaeological sediments.

Although HM14 is a visually impressive cave it is HM25 which has the more complex sequence. There are Palaeolithic remains and the cave was used episodically through to the Romano-British era. The cave was emptied of its sediment and now has two large spoil heaps on either side of the entrance. These are grassed over but have the potential to reveal items missed by the original excavation, or even the techniques employed during the original excavation (several of the caves excavated in the Hamp and Manifold valleys have been largely emptied of sediments and only the spoil heaps remain of the original deposits: the protection of these spoil heaps must be considered as well when considering the protection and monitoring of the caves). Thor’s Cave and its neighbours are divided geomorphologically into two distinct groups: the high level caves of HM14, HM15, HM16 and HM25 and the caves HM26 and HM27 in the valley bottom. The caves in the valley bottom have no recorded archaeological presence, although HM27 has graffiti dated 1721 and is reputed to have sheltered a Royalist soldier during the Civil War. It is likely that at an earlier time the lower caves were inaccessible as they are very close to the river bed and might have been periodically flooded and this could account for their lack of archaeological sediments. The vegetation of the area is similarly split with the upper parts of the dale being used for grazing with light tree cover while the valley bottom is heavily wooded.

Beeston Tor is a large crag that is similar in shape to both Thor’s Cave crag and Ossum’s Crag. Beeston Tor is located at the junction of the Hamp and the Manifold Rivers and contains many caves. Nine sites were included in this survey with two of them having been recorded as archaeological (although HM11 has palaeontological remains rather than archaeological remains). The vegetation across much of the Tor makes surveying difficult and this factor may also have served to protect the caves from other visitors. Access is easiest during the summer when the river has sunk but then the vegetation is at its highest: in the winter the caves are more visible but are defended by the rise of the River Manifold. Most of the caves on Beeston Tor are relatively small and there appears to be little prehistoric activity in the caves. Whether this reflects a lack of previous research effort is difficult to say as the caves are no more inaccessible to a determined
excavator than are many others within the Peak District. The caves cluster more towards the top of the crag even though the only known truly archaeological cave (HM04) is in the valley bottom. This cave has a sequence from Palaeolithic through Neolithic and Bronze Age finds; a Saxon hoard was also discovered in the cave. The caves span a range of sizes but none of them are large, open caves and they are not really suitable for protection against the weather. The apparent lack of archaeological remains in caves that are so prominent appears surprising, as Beeston Tor is such a prominent feature in the landscape.

5.10.2 Hamps valley and outlying caves

The Hamps valley has relatively few caves compared to the nearby Manifold valley and there are only three proper caves in the valley. All of these and their immediate surroundings were visited but the dense vegetation on the lower slopes of the valley hindered further searching. The caves are situated at different altitudes on the valley sides. Falcon Low Cave (HM12) sits at the top of the hill and although the cave mouth is not obvious the small knoll that it is set into is a prominent landscape feature. From a distance this site appears to be a burial mound, and there may be a topographical relationship with Seven Ways Cave (HM16), another prehistoric burial cave which is situated approximately 1km to the north-west on the top of a hill on the opposite side of the Manifold valley. The land around HM12 is used for grazing and it is mainly grass covered with some light scrub. The caves HM01 and HM02 were very different to each other with HM01 being a small almost rock-cut cave half way up the northwest facing slope of the valley. The vegetation was very dense near the cave and the site was hard to find. This might have made it attractive for some uses in the past, but equally if the vegetation was of a similar extent to today, would have made it very difficult to locate and return to. HM02 is a low passage cave near to the bottom of the valley and very close to the river. It contains sediment with a small amount of charcoal although the latter could be a recent deposit. The vegetation at HM01 was very dense and even in the winter it is likely that the cave would be well hidden in the bushes. HM02 though would be visible in the winter but during the summer it was hidden behind nettles.

Four isolated caves that are outliers within the Hamps/Manifold catchment were also surveyed. Sycamore Cave (HM35) is the most northerly of the Hamps/Manifold caves and sits on the east-facing slope of Ecton Hill. The Ecton area has been heavily modified through mining but the southern part of Ecton Hill is relatively unscathed. The cave is well hidden in the landscape and the entrance is not obvious to the casual visitor. It is on private land and there are no footpaths nearby, although the farmer does not appear to mind the occasional curious visitor. The surrounding land is used for sheep grazing but these animals do not appear to use the cave for shelter: there were some sheep droppings when the cave was surveyed in February 2005 but they were not recent. Surveying the rock faces around the cave was difficult due to the deep snow but there did not appear to be any other caves in the vicinity. If, however, they had low mouths like HM35 it would be difficult to detect them until the snow had cleared.

Plate 5.31 Sycamore Cave (HM35)
Old Hannah’s Hole (HM29) sits between Wetton Mill and Thor’s Cave and is a small rift cave in a secluded dell on the southwest side of Wetton Hill. The cave is in a small wood and on National Trust land with no obvious footpaths running near it. It is little visited and the section from the excavation carried out in the early 1900s is still standing, although this might possibly be from a later and unrecorded excavation. There is no litter or graffiti inside the cave and although animals graze the hill side they do not appear to use the cave. The animal management on the slope is mainly cattle so the steep slope in front of the cave could be a factor in them not gaining access to the cave.

Ladyside Cave (HM28) is one of the few caves located on the west bank of the Manifold valley. It is in dense woodland and difficult to find. There are the mossed over remains of a stone wall across the front of the cave about 2m from the entrance. There are sediments inside the cave but they appear to either have been washed in or have been removed from deeper in the system by cavers. The cave appears to be relatively untouched as it is on National Trust land but there are no easy routes up to it. The main footpath through the valley runs about 40m from the cave but since the cave is not visible then it is unlikely to receive unwanted attention.

Cheshire Wood Cave (HM13) was the most southerly of the caves surveyed and is located in the eponymous Cheshire Wood on the west side of the Manifold valley. The cave is difficult to find as it is in dense woodland and at the top of a very steep slope. There is an easier route to the site which is just down from the top of the dale and this is possibly the original access route. The cave has a small cist like structure in the centre of it which appears to have one of the sides still in situ. On the right side of the cave is a small passage that goes into the hill and the ceiling of this passage is covered with fossils. There is flowstone on the base of the passage way which has small piece of charcoal embedded in it and this could indicate the presence of archaeological deposits. The cave is in a remote location and is rarely visited as it is away from any footpaths and is on private land. The cave is in unmanaged woodland but vegetation growth does not appear to be affecting the structure of the cave at the present time.
5.11 Lathkill

Location and geomorphology

The Lathkill catchment contains relatively few caves that are accessible to non-cavers as the more extensive cave systems are at or below river level and only normally enterable during times of drought. Most of the water entering Lathkill Dale drains from the Monsyash area and in flood emerges at the major resurgences in Lathkill Head Cave, Critchlow Cave and Lower Cales Dale Cave as well as at other risings and resurgences along the main channel of the River Lathkill down as far as Cales Dale (Gill and Beck 1991). The geology, hydrology and mining history of the area are described in Ford and Beck (1977).

Plate 5.33 General view of Lathkill Dale

Lathkill catchment is dominated by the main Lathkill Dale gorge which is incised into the Monsal Dale limestones. The dale runs approximately from W-E with the tributary valleys of Cales Dale and Calling Low Dale joining from the south. The main surface water source normally emerges below Cales Dale at Lathkill Resurgence, although in flood conditions Lathkill Head and Critchlow Cave also discharge water. In Cales Dale the Lower Cales Dale Cave (which was not surveyed due to it being perennially wet) discharges water 250m from the junction of the dale with the main valley. Calling Low Dale carries no surface water.

Ownership, land use and access

Lathkill Dale is privately owned and most of it is a National Nature Reserve in the care of English Nature. Part of the western end of the dale is designated as access land. The valley has variable vegetation cover with a grassy valley side in the western end of the dale and heavily wooded central and side valleys. Only the western end is used for agriculture where there is managed sheep and cattle grazing.

Caves, archaeology and conservation status

Gill and Beck (1991) list 27 caves for the catchment but 16 of these fell outside the criteria for inclusion in the survey. During the field survey 28 sites were found: 20 caves and eight rock shelters. These include five known archaeological sites: one in Calling Low Dale, two in Lathkill Dale and two in Cales Dale. All of the caves are at altitudes of between 200m and 300m and the known archaeological caves are at a variety of altitudes within this range, with three being higher on the dale sides and two at almost floor level. The sides of Lathkill Dale below the junction with Cales Dale are very heavily wooded and even on the return visits during February 2005 it was still difficult to observe all of the rock faces.
5.11.1 Lathkill Dale

The caves located in Lathkill Dale tended to up at the higher altitudes within the dale with the archaeologically known caves being tricky to find due to the dense vegetation. Many of the caves at the lower levels show signs of being used by badgers and this was especially noticeable in Critchlow Cave (LA07). Below One Ash Shelter (LA14) is another small cave (LA12) that showed signs of being used by badgers, but the depth of deposits also suggests that this cave has a greater potential to be archaeological. There were no signs of recent excavation except for litter thrown up by the badgers and this did not contain any artefacts or bone. The other archaeologically known cave, Monyash Fissure (LA24), is towards the western end of the dale and was well hidden behind nettles. It appears to have been overlooked as an archaeological cave as it is not a fissure, more a rock shelter, and it is not in Monyash.

The level of care in many of the caves was very good in the dale as most of them are well hidden. Badgers might prove to be more of a menace to some of the caves marked up as being potentially archaeological such as LA 12 but careful monitoring would reduce this problem.

5.11.2 Cales Dale

This is a side dale that runs north-south from Lathkill Dale. Its main resurgence is Lower Cales Dale Cave which was not surveyed due to it being a wet cave. The rest of the dale is dry and does not have any surface water except in times of very heavy rain. The dale is known to have two archaeological caves: one at the top of the dale: Upper Cales Dale Cave (LA17) and one at the bottom of the cliff sides, Lynx Cave (LA21). Upper Cales Dale Cave was being used as a badger sett at the time of the survey so we could not explore deep into it but a broken bottle was found in the soils at the side of the cave and might relate to the original excavation.

Lynx Cave is located at the southern end of the dale and there was no evidence of human occupation noted in the original excavation. However, the cave site is just to the north of a narrowing of the gorge walls and there were several rock shelters further along the gorge which might have been used as shelters by hunters as animals moved through the gorge.

Plate 5.34 Interior of LA12 showing badger litter

Plate 5.35 Upper Cales Dale Cave (LA17)
5.11.3 Calling Low Dale

Calling Low Dale was one of the areas surveyed on a repeat visit during February 2005 since the vegetation during the summer made it impossible to survey. The dale has one known archaeological cave and the survey discovered another two caves and one rock shelter. One of the ‘new’ caves (LA26) and the rock shelter (LA27) both showed signs of previous investigation which may have occurred during the excavation of Calling Low Dale Rock Shelter (LA25). The other cave (LA28) had been modified with the construction of a stone wall in the northern end and had been used as a shelter as recently as 1989 as evidenced by abandoned rubbish. It is likely that other small caves exist in the Dale but the vegetation, even in the winter, was dense and hindered the search. The dale is in very good condition with no rubbish apart from at LA28, but the woodland appears to be unmanaged. There are no signs of badgers using the caves surveyed but some evidence of these animals was found on the pasture and in the woodland at the top of the slope.

5.12 Wormhill

Location and geomorphology

The Wormhill catchment occupies an elongated area running NW-SE between the margin of the limestone north of Buxton at Dove Holes and the River Wye south of Wormhill. Only the southeastern end of the catchment lies within the National Park and the remainder of the catchment has been heavily affected by the minerals extraction industry with active limestone quarrying at Dove Holes, Old Moor and Tunstead Quarries. The major resurgence for the catchment is at Wormhill Springs on the north bank of the River Wye: in volume terms this is one of the largest risings in the Peak limestone indicating the presence of large underground streamways. However, many of the accessible cave sites in the catchment have been discovered through quarrying and there are few areas of exposed, untouched limestone. Gill and Beck (1991) recorded 12 caves in the Wormhill catchment but none of them fulfilled the criteria to be included in the survey. Victory Quarry Fissure at Dove Holes was discovered at the end of the 19th century and contained Lower Pleistocene mammal remains (Spencer and Melville, 1974) but it seems that this important site has since been quarried away.
5.13 Wye

Location and geomorphology

The Wye catchment is the largest in the Peak District limestone region, yet for its size has surprisingly few large cave systems. The River Wye is a permanent watercourse but its tributary valleys are usually dry apart from in wet weather. Monks Dale, Tideswell Dale, Cressbrook Dale and Deep Dale carry surface water fed by risings from perched groundwater reservoirs below the valley floors. There are many shakeholes within the catchment, some of which have been backfilled by farmers, and the topography is further complicated by the mineral workings scattered across the landscape.

Deep Dale (one of several dales bearing this name in the Peak District) lies to the south-west of Taddington Wood and is a grassy, steep sided valley in the Monsal Dale limestone. At the time of the survey there was a stream running along the bottom of the valley but this was after heavy rain: normally the valley appears dry. There is very little exposed limestone: only a few crags exist high on the valley sides.

Taddington Dale is a large tributary valley to the west of Monsal Dale where the River Wye flows round the promontory of Fin Cop. The dale is formed in Monsal Dale limestone and is roughly NW-SE aligned with the main A6 trunk road running along the bottom of the valley. During construction of the road a cave was found but the location of this site has subsequently been lost. There is very little exposed limestone except for the bands that are terraced along the slope. The quality of the stone is variable: the exposures at the top of the slope are of the purer stone whilst those around Old Woman’s House (WY19) are more fragmented and part along thin bedding planes.

Monsal Dale is the portion of the Wye valley that runs along the foot of Fin Cop, which is the site of a large prehistoric landslip and is surmounted by an Iron Age promontory fort. The slip has created a series of tower-like rock structures that are rich in fossils as well as exposing beds of chert in the limestone. Monsal Dale is deep and steep-sided with limestone knoll-reefs on top of bedded limestone. The direction of the main gorge follows a dog-leg course, running approximately west from Monsal Head and then turning south around the headland of Fin Cop before turning southeast after its junction with Taddington Dale and Deep Dale. The area surveyed was heavily wooded although Hob’s House has only grass and low shrubs. Hob’s House has been formed by the landslip but it is relatively stable. It attracts fossil hunters and the curious but is generally left alone.

Blackwell Dale is a narrow, steep sided N-S running dry gorge which carries the B6049 south from Miller’s Dale. Road construction has altered the faces of many of the crags and so it was difficult to distinguish which exposures of limestone were natural and which had been modified. The limestone, which is dark with prominent bedding planes and seemingly of good quality, runs the length of the gorge.
Ownership, land use and access

Deep Dale is used for animal grazing, primarily cattle. There is no vehicular access but there is a footpath running along the dale bottom. The south-east facing slope of the dale side is heavily wooded whilst the north-west facing slope (which is now designated as access land) is mainly grass with isolated shrubs.

Taddington Wood, on the southwest side of Taddington Dale, is access land in the care of the National Trust and is managed as a nature reserve. The wood forms a densely vegetated slope, it has very few paths running through it and the trees together with the mature undergrowth of nettles and brambles make the wood fairly impenetrable. Badger paths are numerous, and these can be followed through the wood to a certain extent. The north side of Taddington Dale is managed as private woodland.

Plate 5.38 Rock Shelter WY18

Monsal Dale is heavily wooded and although there is a footpath alongside the Wye, access to the steep sides of the dale is difficult. The Wye valley north of Monsal Head carries the Monsal Trail, which is the line of a disused railway now used as a recreational route. Monsal Head attracts a great number of visitors but few proceed into the valley bottom or along the path to Hob’s House – the area of the landslip on the south side of the River Wye.

Cave, archaeology and conservation status

Gill and Beck (1991) record 42 caves within the catchment of which 17 fitted the parameters of the survey. Seven areas were surveyed in the catchment: some were selected because they included known archaeological caves, others because of the lack of previous information on them. In total 24 sites speleological sites were surveyed: 12 caves and 12 rock shelters with 7 of the sites being known archaeological caves.

5.13.1 Deep Dale

No caves are recorded in Gill and Beck (1991) but the SMR indicates there are three recorded archaeological rock shelters in the valley. Two of these have the same name – ‘House Under Cliff’ - but very different National Grid Reference numbers placing them on opposite sides of the valley.

The lack of exposed rock faces in the dale meant that we had to limit the survey and we targeted the sites recorded in the Derbyshire SMR. The rock shelter of House Under Cliff was not located at all. On arriving at the designated grid reference only a long low crag was evident and although this does not preclude it from being an archaeological site no evidence was found to support this as the site listed in the SMR. WY20 was another of the known archaeological sites, but is little more than a low rock face at the top of the valley side. This site is little visited, if at all, and there are no obvious problems with its care. The other known archaeological site is Sheldon Rock Shelter (WY21). This site is tucked into a corner of Great Shacklow Wood and overlooks the River Wye.
5.13.2 Taddington Dale

Gill and Beck (1991) record a cave and a rock shelter in Taddington Dale but in addition to these the survey found two more rock shelters. The two localities recorded in literature are both archaeological sites: Demons Dale Cave (WY16) and Old Woman's Cave (WY19). Both sites are located away from the paths and WY19 in particular was very difficult to find and is unlikely to receive casual visitors. WY19 is suffering from breakdown as the bedding planes of limestone are very thin and are interspersed with thin lenses of chert. All of the caves in the wood face eastwards and look towards Fin Cop. There is some variation in height of the caves, with the known archaeological caves sitting at the lowest levels.

5.13.3 Monsal Dale

Only one cave is reported: Hob’s Hurst House (WY01). Although other small fissures were seen in the area none of them were large enough to be considered admissible for the survey. WY01 possesses beds of chert next to the entrance and it is likely that prehistoric peoples knew of these resources and could have used them as raw materials for the production of stone tools.

5.13.4 Blackwell Dale

There are four recorded caves in the dale but none are known to contain archaeological remains. The visit to the gorge was predicated on a rumour that a cave with possible archaeological sediments had been found, but the survey team could not locate it. The caves that do exist are mainly towards the north end of the gorge. One rock shelter was located, WY24, which is used by climbers and has a small amount of rubbish at its base. There appears to have been an abortive dig in the northern part of this shelter which might have prompted the rumour of it being archaeological. This case illustrates the need for greater mutual trust and facilitation of communication between cavers and archaeologists.

5.14 Buxton

Location and geomorphology

The Buxton catchment consists of the area containing the drainage that feeds the headwaters and upper reaches of the River Wye, which rises on the Namurian rocks in the high moorland just to the southwest of Buxton. Most of the catchment lies outside the boundaries of the National Park, but Deep Dale, a dry tributary valley south of the main Wye gorge falls inside the Park. Deep Dale and a small side dale, Marl Dale were the areas chosen to survey in the Buxton catchment. Deep Dale is an irregular, steep-sided and winding dale that runs roughly NNE-SSW, subdividing at its head into Back Dale and Horsehoe Dale. Marl Dale is a short spur to the south which branches from Deep Dale behind the Topley Pike Quarry.

Plate 5.39 General view of Deep dale, Peak District
In the northern part of the dale the exposed limestone tends to be along the tops of the dale sides but further down into Deep Dale the limestone cliffs close in and exposed limestone occurs nearer the dale bottom. The positioning of the still active Topley Pike Quarry, which exploits an outcrop of partially dolomitised Woo Dale limestone of very high purity, shows that the limestone here is of good quality and three of the caves are of good sizes showing that the limestone is self supporting.

Ownership, land use and access

In the dales that were surveyed the land is privately owned but there are public footpaths running through both dales and they are now designated as access land. The dales have a recreational use and there are no grazed pastures or other agricultural uses. There is a limited amount of surface water from the Deepdale Resurgences about halfway along the main dale. Even though these discharge a large volume of water this rapidly drains away, sinking within 300m of the resurgences. The footpath leading through Marl Dale is the more regularly used although both have overgrown vegetation due to the lack of grazing. The middle part of Deep Dale is crossed by the Midshires Way, and although there is a cave very close to this crossing point, BU02, that receives casual visitors, the other nearby caves (BU03 and BU04) do not appear to be visited. In Deep Dale some of steeper slopes have grassed-over scree which may conceal further cave sites.

Caves, archaeology and conservation status

Three of the caves visited in this catchment are recorded as having archaeological remains, although the identification of Deepdale Cave (BU04) is problematic. This cave has been recorded as being excavated by Micah Salt but he was also responsible for excavating a cave in the Deep Dale at Taddington and there appears to be some confusion with the finds and other archives concerning these sites. Salt also excavated at Churn Hole (BU01) but again there is another site called Churn Hole in Deep Dale, Taddington, that has the same archive and suite of artefacts recorded as coming from it. These problems of provenance might be intractable, as there is currently no clear way to identify finds to individual caves and insufficient surviving information to resolve the issues.

Plate 5.40 Thirst House Cave (BU03)
5.15 Gritstone Caves

The White Peak limestone outcrop is almost completely surrounded by extensive linear escarpments of gritstones (coarse-grained Namurian sandstones) that have no solution caves. Any caves and fissures that do exist in the gritstone tend to be created through wind erosion or through displacement and detachment of large blocks from the scarp faces, and these can be subject to further erosion and rapid breakdown. As gritstone areas are rarely explored by recreational cavers, a small area of gritstone was surveyed in order to provide a sample of the potential of this landform, and although there are over 10 archaeological sites recorded at various gritstone rock shelters around the Peak District, no other areas were surveyed due to the difficulty in locating the sites from often inadequate records.

Eight sites were surveyed: one cave and seven rock shelters. They are all at the southwest end of the Kinder Plateau at altitudes above 550m and are very exposed to the prevailing wind and weather. The land is in the care of the National Trust and rough grazing is practiced on the fell slopes. The area does have a high number of visitors including hikers starting or finishing the Pennine Way, but few people appear to wander from the tracks on the plateau top. All of the sites were in good condition and did not contain any rubbish. One site, GK03, has graffiti across its wall but this is a very obvious shelter that walkers along the Pennine Way often stop at. Only one site, GK08, showed signs of deliberate human use as stones had been stacked at the back of the shelter to block up gaps in the rear wall.
6 YORKSHIRE DALES CATCHMENTS

6.1 Introduction to the Yorkshire Dales

The Carboniferous Limestone outcrop of the northern Pennines is extensive, with approximately 320 km$^2$ of karst terrain located within the boundary of the Yorkshire Dales National Park and an additional 220 km$^2$ of karst distributed north of the National Park along Teesdale, Weardale and the Vale of Eden as well as west of the Park in East Lancashire and around the shores of Morecambe Bay (Waltham et al., 1997; Waltham, 2004). Cave development has been less active in these marginal areas and the majority (>70%) of the region’s caves are located within the National Park. It is estimated that the Yorkshire Dales region contains approximately 1500 caves and over 330km of accessible passages, based on the records maintained by the Limestone Research Group (Gunn, 2004) and the Northern Cave Registry (Brook et al., 1988, 1991, 1994). This represents a much higher density of caves than is the case in the Peak District, and the caves of the Yorkshire Dales are generally longer and deeper than their counterparts in the Peak District. In the Yorkshire Dales there is more vertical development of cave passages along structural joints in the limestone, whereas in the Peak District caves tend to develop along bedding planes and mineral veins (Waltham et al., 1997).

Many of the major caves lie in the Craven Uplands, a dissected carbonate platform stretching from Grassington in the east to Kirby Lonsdale in the west. The Craven Uplands are cut through by deep, N-S trending river valleys such as the Ribble and Wharfe which show the classic U-shaped profiles formed by glacial action. The southern part of the Craven Uplands is dominated by near horizontal exposures of limestone whose top surface forms a series of benches at around the 400m level. The area surrounding Ingleborough, Penyghent and Whernside (the Three Peaks) has the greatest relief and the best exposed limestone. Namurian sandstones and gritstones covered by upland peats cap the highest ground, and the underlying Carboniferous Limestone is either exposed as pavement or covered in other areas by thin deposits of glacial till. The till cover is frequently perforated by shakeholes (the local term for dolines) and by isolated larger potholes, many of which serve as stream sinks. The region contains the finest glaciokarst landforms in Britain (Waltham, 2004) and the geological and hydrological conditions are ideal for the development of large caves.

The valleys tend to be free of snow during the winter but this is not the case for the higher slopes: average daily minimum temperatures are at or below 0°C from December to March at an altitude of 380m at Malham Tarn (Waltham, 1974). The limestone outcrops tend to be at high elevations and support grassland with some scrub growing in where grazing animals are excluded: some of the more sheltered slopes are also lightly wooded. Farming on the higher limestones is almost totally restricted to sheep grazing but recent changes in farming practices has led to some farmers diversifying into native upland cattle breeds. There is usually more mixed farming on the valley bottoms. Quarrying is an obvious presence and both the limestone and the harder basement and igneous rocks have been exploited for aggregates and minerals. Currently the most active quarrying region within the National Park is concentrated on Horton and Settle and around Grassington but there is now no mineral vein exploitation. Some areas of karst have been severely damaged during recent decades through the removal of pavement formations for decorative rockery stone, and this damage has continued (albeit at a reduced level) despite the implementation of Limestone Pavement Orders under Section 34 of the Wildlife and Countryside Act 1981 (Goldie, 1993; Webb, 1995).

A Conservation Audit of Archaeological Cave Resources in the Peak District and Yorkshire Dales National Parks – Research Report
ARCUS 743b – January 2006
6.2 Geology
The limestone strata of the Yorkshire Dales National Park are laid above the elevated basement rocks of the Askrigg Block, which is bounded to the south, west and north by the North Craven, Dent and Stainmore faults respectively (Aitkenhead et al., 2002). A slight tilt to the Askrigg Block imparts a regional dip in the Carboniferous strata towards the northeast. Most of the hills above 400m are formed by the Namurian rocks of the Millstone Grit Series. These overlie the Carboniferous limestone, which in turn rests unconformably on the pre-Carboniferous basement rocks that reach the surface on the west (upthrow) side of the Dent Fault. The valleys of Swaledale and Arkengarthdale form the northern limit of the Carboniferous limestone outcrop within the National Park.

The Lower Carboniferous Great Scar Limestone (GSL) Group and its lateral equivalents contain most of the caves in the region. Recent revision of the lithostratigraphy has formally subdivided the GSL into the Kilnsey Formation and the overlying Malham Formation, the latter forming the most prominent scars (Arthurton et al., 1988), but the Great Scar Limestone is a useful and apposite term for the massive scar-forming beds of Lower Carboniferous limestone and is therefore retained here. There is some variation in the thickness of the GSL, for example around Ingleborough it varies between 100m and 200m in thickness but thickens northwestwards to over 400m near Hawes. Most of the GSL consists of well-bedded massive limestones, with apron-reef and knoll-reef development south of the Mid-Craven Fault. Stratigraphically above the GSL there are further limestone units in the Wensleydale Group and in the basal part of the Namurian (Arthurton et al. 1988) and these limestone units provide additional opportunities for cave development, particularly in the northern dales where the GSL is less exposed at the surface.

6.3 Cave exploration
Visits to the region’s caves began to be recorded in the mid-eighteenth century (Craven, 1999). In the nineteenth century adventure caving commenced with first deep explorations in caves and potholes such as Gaping Gill, Alum Pot and Ingleborough Cavern, but it was not until the 1930s that caving developed as a popular sporting recreation (Waltham, 1974). The early phase of exploration concentrated on the obvious caves systems and passages in the southern parts of the Yorkshire Dales, and from about the 1960s onwards work has proceeded in the deeper systems with the vanguard of exploration increasingly being assigned to cave divers. The full extent of the cave systems of the Yorkshire Dales is not yet known and the discovery of new caves and extensions of existing caves occur on a regular basis. Most new discoveries are associated with exploration of the deeper systems but occasionally a new surface entrance is found (as, for example, at Rawthey Cave) and these instances should be monitored for the presence of any archaeological remains or palaeontological material. Most new discoveries are reported promptly in the caving literature although precise details of location are often retained for security and to ensure priority to the discoverers.

The Yorkshire Dales contains some of Britain’s longest and most challenging sporting caves and the region attracts much attention from recreational cavers from throughout Britain. There are several active caving clubs whose members live within or near the Yorkshire Dales, with the Bradford Pothole Club, Craven Pothole Club, Northern Pennine Club and White Rose Pothole Club being amongst the most prominent. Although trips are still made to the ‘classic’ caves in the region, much of the digging attention is focused on gaining access to new passages via the shakeholes and potholes that proliferate across the limestone. The deeper cave systems such as Gaping Gill are undergoing periodic digs, but these are in the lower
parts of the systems well away from any in situ archaeological deposits. This is not to say that the Yorkshire Dales caves are safe from digging, as smaller caves do undergo periodic testing to evaluate their potential to ‘go’, but intensive surface digging activity appears to have been scaled down in recent years. During the survey of the Yorkshire Dales only one cave (Dib Scar Cave) was found to be under excavation by cavers, and this was obvious from the large mound of spoil outside the entrance in which were finds of deer antler and other faunal remains. There has been recent (mid-2005) digging at a cave south of Kinsey Cave (R. White pers. comm.).

6.4 Ingleborough and Whernside Area

6.4.1 Alum Pot

The Alum Pot catchment forms the east side of the Ingleborough plateau, a broad area of limestone benches surrounding the peak of Ingleborough, all of which is contained within the Ingleborough SSSI. The land mainly comprises open moorland dotted with shakeholes and large areas of limestone pavement, with few well developed or large caves but there are a number of potholes and wet sinks and resurgences. Many of the recorded caves are tucked along the edges of the limestone pavement. The upper slopes towards South House Moor are mantled with hill peat while the lower levels around Selside are partially covered by glacial till. The higher slopes towards Ingleborough are designated as access land.

In the Alum Pot catchment the survey included the Selside fissure burial site (AP01) and a small un-named cave (AP02). The Selside fissure burial was discovered in the 1930s during limestone pavement stripping: a female skeleton was found below a stone slab. At the time, it was reported that a polished stone axe was found with the burial and this artefact was subsequently displayed in the Pig Yard Club Museum together with the skeleton (Gilks and Lord, 1985). Later investigations of the archive have cast doubt on this association (Tom Lord, pers. comm.) and it now seems as though the axe was found some distance from the burial site.
6.4.2 Newby Moss

Newby Moss is located within the access land at the southern end of Ingleborough Hill, where a broad bench formed of Great Scar Limestone is partially obscured by glacial till. Cave development here is almost entirely characterised by vertical stream sinks, potholes and areas of shakeholes, and only one recorded site (Newby Moss Pot, inaccessible to this survey) shows substantial horizontal cave development (Brook, 1974; Brook et al, 1991). The site recorded in our survey (NB01) is an unnamed vertical fissure that is assessed as having low archaeological potential.

Plate 6.2 The Newby Moss catchment is typified with deep potholes

6.4.3 The Allotment

This catchment is within the access land on the southeast side of Ingleborough Hill, occupying the space between the catchments of Alum Pot and Gaping Gill. The area is on the plateau of Great Scar Limestone which is partly covered by hill peat on the upper slopes towards Ingleborough. Nearly all cave development is in the form of shakeholes, vertical sinks and potholes all draining to a substantial rising in the valley below at Austwick Beck Head. Long Kiln East Cave (AL01) was the only cave meeting the inclusion criteria for the survey.

Plate 6.3 The Allotment catchment was characterised by very low crags
6.4.4 Kingsdale Head

This area forms the upper part of Kingsdale on the southwest side of Whernside. There are a number of small wet caves all associated with sinks and tributary streams feeding into Kingsdale Beck. All of these caves are on access land except Upper Kingsdale Head Cave, and those sites to the south of Kingsdale Head are within the Whernside SSSI. Three unnamed caves and two previously recorded non-archaeological caves were included in the survey (KH01 to KH05).

Plate 6.4 General view of the Kingsdale Head catchment

6.4.5 Marble Steps

This is an area of partially till-covered Great Scar Limestone located at the southern end of Kingsdale, northwest of Ingleton and on the east side of Ireby Fell. The catchment contains a large number of potholes (including one with archaeological remains) but few horizontal entry caves. All of the caves are on access land, and are within the Whernside SSSI. One cave (MS01) and the archaeological site of North End Pot (MS02) were visited in the survey.

Plate 6.5 A general view of the crags typical of the Marble Steps catchment
6.4.6 Gaping Gill

The Gaping Gill catchment is on the south side of Ingleborough Hill and includes the caves of Clapdale and Clapham Bottoms as well as the caves on the plateau above. There are many potholes and stream caves developed in the Great Scar Limestone, together with a few dry caves; all are on access land apart from Ingleborough Cave and its associated resurgences. The main resurgence for the area is at Clapham Beck Head, just above the main entrance to Ingleborough Cave. Nine sites were visited including the two known archaeological caves, Gaping Gill (GP03) and Foxholes (GP07), and two previously unidentified rock shelter sites.

Plate 6.6 Foxholes (GP07) with debris from cavers

6.4.7 Bruntscar

The Bruntscar catchment occupies the area between Winterscales Beck and the summit of Whernside to the northeast. The upper slopes of Whernside are designated access land and within the Whernside SSSI, while the land alongside Winterscales Beck is enclosed but well served by footpaths. There are two areas of cave development – higher up on the northeast side of the summit of Whernside above Greenset Crags, in the basal Namurian Main Limestone, and lower down on the Great Scar Limestone plateau near Winterscales Beck. There are no archaeological caves reported from this catchment, and no sites were visited during the survey.

6.4.8 Park Fell

The Park Fell catchment is situated at the northern end of the Ingleborough ridge, overlooking Ribblehead, and includes the Scar Close national nature reserve. The caves are situated on the Great Scar Limestone bench surrounding Park Fell and are mostly on access land and within the Ingleborough SSSI. Most of the caves are vertical entry potholes or stream caves, and none were visited in the survey.

6.4.9 White Scar

This is the catchment to the west of Ingleborough, situated between Ingleborough summit and the town of Ingleton and including the extensive limestone benches of White Scars and Raven Scar. The caves are developed in the Great Scar Limestone and all are on access land and within the Ingleborough SSSI. Most of the caves are potholes or wet stream caves, but six sites proved suitable for inclusion in the survey. These comprised two unnamed rock shelters and four caves, including the archaeological site of Raven Scar Cave (WS03).
6.4.10 **Scales Moor**

Scales Moor forms the southern side of the ridge extending from Whernside southwest towards Ingleton, and the catchment includes the Great Scar Limestone exposures of Twisleton Scars. Scales Moor has extensive limestone benches and some of the finest limestone pavements in Britain. The plateau is devoid of trees and scrub vegetation. Twisleton Scars form a staircase of rock terraces each with its own scree apron and with vertical scars of between 2m and 15m in height, with some intermittent cover of glacial till concealing some of the uppermost terraces. A spring line at the base of Twisleton Scars marks the junction between the base of the Great Scar Limestone and impermeable basement rocks. All of the caves are on access land and are within the Whernside SSSI. Two caves were visited in this area, including the archaeological site of Thaw Head Cave (SM01).

Plate 6.7 *Thaw Head Cave (SM01) interior*

6.4.11 **West Kingsdale**

The catchment includes the west side of the middle part of Kingsdale and encloses the limestone between Kingsdale Beck and the summit ridge of Gragareth, all of which is now designated access land and is within the Whernside SSSI. The area includes the major resurgence of Keld Head which emits most of the water sinking on both flanks of Kingsdale as well as taking water from the Marble Steps area of Ireby Fell (behind the resurgence are 7km of explored flooded passage, the most extensive such system in Britain). There are many potholes and a few caves on the Great Scar Limestone plateau above Keld Head Scar, Green Laid Scar and Shout Scar, of which Yordas Cave (WK01, a former show cave) was the single site visited in the catchment.

6.4.12 **East Kingsdale**

This catchment covers the opposite side of Kingsdale extending from the Kingsdale Beck to the summit of Scales Moor. The catchment contains many potholes, all of which are on access land and within the Whernside SSSI, but no sites were visited during the survey.

6.4.13 **Chapel-le-Dale**

The catchment includes the dry valley at the head of Twisleton Dale and the limestone benches on the northern flank of Ingleborough. There are many sites of speleological interest in the catchment but these are nearly all potholes and stream caves, and the catchment was not visited in the survey.

6.5 **The Central Dales**

This group of catchments includes the small dales feeding into the upper ends of Wharfedale and Litton Dale together with the valleys of Coverdale and Bishopdale, which lead northeasterswards towards the River Ure.
6.5.1  **Langstrothdale**

The valley runs west to east and it accommodates the upper reaches of the River Wharfe and its tributary, the Green Field Beck. Four caves were visited on the south side of the River Wharfe, all of which were evaluated as having a low archaeological potential as they were either wet or had evidence of carrying water in flood conditions. There is little exposed limestone in the catchment and most of the caves recorded are either sinks and shakeholes or resurgence caves.

Although the caves were wet, it does suggest that there might other uses for the caves rather than the typical habitation or votive sites. The deposition of objects into water is known in many examples and these caves that take water deeper into the earth might have had some significance to earlier peoples.

**Plate 6.8  Haggs Beck**

6.5.2  **Cosh and Foxup**

This catchment encloses the drainages of the Cosh Beck and Foxup Beck, which together with the separate catchment of Pen-y-Ghent Gill to the south form the headwaters of the River Skirfare. The Cosh and Foxup valleys drain the northern slopes of Pen-y-Ghent. Most of the caves in these catchments are wet caves located close to the becks. There are numerous pot and shake holes as the catchment crosses the boundary between the limestone and the mudstone. Three cave sites of low to moderate archaeological potential were visited in the survey.

**Plate 6.9  General view of the Cosh and Foxup catchment**
6.5.3 **Coverdale and Bishopdale**

Coverdale and Bishopdale are long parallel valleys that run approximately northeastwards to join Wensleydale at Aysgarth and Middleham respectively. Both valleys are floored with glacial till deposits. The caves are concentrated towards the heads of these valleys, though there is another cluster of caves on the south side of the River Cover between West Scrafton and Calverbergh. The gorges are characterised by having steep scree with crags rising vertically above the scree. Many of the cliff faces appear to have suffered considerable frost damage and this has made them unstable in some parts.

Three caves were visited in the survey, all have *in situ* sediments and are therefore rated as having moderate with CB01 as having potentially high archaeological potential.

6.5.4 **Lower Littondale**

This catchment includes the lower part of the Littondale around Hawkswick, together with the side valley of Cote Gill. The sides of Littondale are formed in Great Scar Limestone while the valley bottom alongside the River Skirfare is floored with alluvium, river terrace deposits and glacial till. The catchment takes drainage from Hawkswick Moor, north of the River Skirfare, and Hawkswick Clowder, Low Cote Moor and High Cote Moor to the south. The catchment includes the well-known archaeological site of Dowkerbottom Cave (LL01). This cave and eight other sites (five caves, two rock shelters and a fissure) were visited in the survey. Several of the sites had *in situ* deposits and were judged to have moderate archaeological potential.
6.5.5 Upper Littondale

The catchment covers the land either side of the upper part of Littondale from Arncliffe to Nether Hesleden, and receives drainage from the extensive area of high fells to the north and south of Littondale. The area includes the archaeological sites of Scoska Cave (UL01) and Potts Beck Sink No. 2 (UL03), both of which contained human remains. These and one other site, Bown Scar Cave (UL02), an active resurgence cave of low archaeological potential, were visited during the survey.

Plate 6.12 Scoska Cave (UL01)

6.5.6 Upper Wharfedale

This catchment covers the section of Wharfedale from Kettlewell to the junction with Langstrothdale at Hubberholme. Six caves were visited during the survey, all located on the southwest side of the valley, and none were rated as having more than moderate archaeological potential.

6.5.7 Darnbrook and Cowside

Darnbrook Beck and Cowside Beck drain a large area of Fountains Fell and Darnbrook Fell, to the north of the Malham Plateau. The dale is characterised by sheer cliffs with banks of scree. It is not known whether any caves exist below the scree line but this seems unlikely.

Six caves were surveyed and all but one had low archaeological potential. The caves tended to be of two types: either very narrow and deep or broad and shallow. The one cave (DC03) that had in situ deposits lies behind a bank of rocks which appears to have fallen from the cliff face over the years, although the cliff now appears to be stable. Inside this cave were the skulls of two sheep, which had either been dragged in by animals or had died inside the cave.

Plate 6.13 View looking north along Darnbrook Beck
6.6 Attermire

Location and geomorphology

The limestone scars around Settle, in particular Attermire and Giggleswick Scars, contain over half of all the known archaeological caves in the Yorkshire Dales. The caves at Attermire witnessed the birth of cave archaeology in the Dales, and the discovery and excavation of Victoria Cave in the 1830s lead to further exploration of cave sites throughout the Craven District.

The catchment is centred on two prominent exposures of limestone: the first of these is the shear crag of Attermire Scar, which is L-shaped in plan view and runs from Jubilee Cave in the north to Attermire and Horseshoe Caves in the east. At its northern end the crag is approximately 2m tall but gradually heightens until at its eastern limit the cliff face stands over 40m high. Most of the caves along the scar have been examined in some way - usually by both cavers and archaeologists, with the result that many archaeological finds have been made.

The slightly lower crags of Warrendale Knots face south and east towards Attermire Scar across a shallow dry valley. Warrendale Knotts is a mass of reef limestone with many small caves dotted over it, very few of which seem to have been excavated or tested either by cavers or archaeologists. Because of their small size, habitation in the caves is unlikely but they could have been used for other activities.

Ownership, land use and access

The land is under private ownership but is designated as access land and is also within the Attermire and Langcliffe Scars SSSIs. Footpaths run through the areas and the access land status means that visitors are not confined to the footpaths. The area is less than 2km from Settle and receives a lot of walking traffic. The main farming practices are sheep and cattle grazing. There is no standing water but seasonal springs running from the foot of the limestone scarp feed into a mire in the south of the catchment, but this has only been drained in historical times. The area is treeless and the predominant vegetation ranges from short grassland on the pastures and valley bottoms to the rougher grasses of the moorland.

Caves, archaeology and conservation status

Brook et al. (1991) record 30 caves in the catchment, and six of these are recorded as having contained archaeological remains, but in the course of intensive survey of the area 34 sites were discovered comprising 32 caves and two rock shelters. Most of the caves examined on Warrendale Knottts were rated as having moderate archaeological potential on the basis of their possession of in situ sediments.

The well known caves along the Attermire Scar are Jubilee Cave (AT02), Albert Cave (AT04), Victoria Cave (AT06) and Attermire Cave (AT29). These have all produced archaeological artefacts but are also the caves that are under the most serious threat from both cavers and the casual visitor. The screes that run from the caves are a
potential source of archaeological material too as are the spoil heaps that are outside of Jubilee and Victoria caves.

Victoria and Albert Caves were both excavated in the 1870, some work was done in Victoria Cave earlier but there is little detailed information available, with Jubilee and Attermire Caves being explored in the 1930s. As a result only small amount of sediment survives in the caves and this is now under threat from a variety of sources. The method of excavation favoured total removal of the deposits including the flowstone floors and this pattern has been noted across the early excavation in both National Parks, making it difficult to offer any re-interpretation of the sites with the currently available information.

Of the caves in the catchment, only a few showed signs of being explored by cavers: Attermire Cave (AT29) and Albert Cave (AT04) were the most noticeable. Despite being gated, Albert Cave shows signs of recent caving exploration with the spoil being stored in the main chamber, which could potentially cover any archaeological deposits still remaining within the cave.

Plate 6.15 Upcast from cavers’ digs in Albert Cave (AT04)

6.7 Malham

Location and geomorphology

The Malham catchment contains some of the most dramatic limestone scenery in the Yorkshire Dales including the much-visited features of Malham Cove and the narrow gorge of Gordale. The catchment covers a block of limestones between the North Craven and Middle Craven Faults, with each of the surveyed areas containing different beds of limestone, which in stratigraphic succession are the Chapel House, Kilnsey, Gordale and Lower Hawes limestones (Arthurton et al., 1988).

The diversity of rock has resulted in a variety of cave formation across the catchment: the west of the area contains many shakeholes and potholes, while most of the caves are situated either in Gordale or along Langscar.

Plate 6.16 Malham Cove
Apart from Malham Tarn with its associated stream there is very little surface water and the only above-ground streams are Malham Beck, which emerges from Malham Cove Rising at the foot of Malham Cove, and Gordale Beck.

Ownership, land use and access

In Langscar most of the land is tenanted from the National Trust and it is designated as access land and is within the Malham-Arncliffe SSSI. The land use is mainly for sheep grazing and it receives a great number of visitors who mainly keep to the well trodden paths which include the Pennine Way. At Janet’s Foss the gorge is in the care of the National Trust and is also within the SSSI, and it receives a large number of visitors who walk up through the gorge from the village of Malham towards Gordale. Both sides of the dale are in woodland which is well managed. Great Close Scar is close to the National Nature Reserve of Malham Tarn and is within the SSSI under the ownership of the National Trust. The surrounding area is access land used for sheep grazing and there are several footpaths that cross the land to the NE.

The West Malham part of the catchment is privately owned and used mainly for sheep grazing, but as with other parts of the catchment it is crossed with footpaths and is designated as access land, although it falls outside the Malham-Arncliffe SSSI. Malham Cove is owned by Malham parish council and is a well recognised tourist attraction a short distance from Malham village and just off the Pennine Way, so it is a place much visited by hikers and rock climbers.

The Broad Flats and Gordale Scar areas are in private ownership and are also access land that is part of the Malham-Arncliffe SSSI. The land is used for sheep grazing, and there are footpaths that skirt the northern edges of the pavement as well as following Gordale Beck through Gordale Scar.

Caves, archaeology and conservation status

Of the 68 individual caves in the catchment recorded by Brook et al. (1991) many are potholes entered from within shakeholes, so these were outside the criteria for inclusion in the survey. A total of 22 caves were surveyed in eight separate areas, these included 18 caves, three rock shelters and one fissure. Three archaeological caves are known in the area but it is possible that the Watlowes Caves and other sites within the catchment may have been archaeologically investigated, although there are no written records to substantiate this conjecture.
6.7.1 **Langscar**

This locality was the most intensively surveyed area as it has the highest concentration of caves (as opposed to potholes) in the catchment. It contains the L-shaped dry valley and gorge of Watlowes, a former glacial meltwater channel that runs SSW and then SE from the sinks below Malham Tarn to Malham Cove. There are terraced scars and stretches of limestone pavement along both sides of the gorges.

There was no surface water visible during the survey, and although there are dry streambeds running through the gorge it seems that these are rarely, if ever, active. The exposed rock is Gordale Limestone which forms prominent crags. Only one archaeological cave (MM01) is known but other caves in the Watlowes valley appear to have been cleared at some point, though in a few cases sediments are still *in situ*. Twelve sites were visited: ten caves and two rock shelters. Most of the caves surveyed were of relatively small size with low entrances and were not very deep. MM01 has evidence of being excavated with a small spoil heap outside the entrance but there is confusion between the archaeological evidence from this cave and the site named 'Tot’s Langscar Cave' which is located about 1km to the west. There are five caves in the Watlowes Gorge, four of which appear to have been explored at some point either by cavers or archaeologists.

The general level of care for many of the caves is good, although MM06 appears to be in danger of natural collapse. The proximity of many of the caves to the footpaths results in their receiving a fair number of visitors, with MM01 getting most of the attention. MM08, MM09, MM10, MM11 and MM12 are very close to the Pennine Way but are slightly hidden behind the spoil dumps, although they show signs of rock erosion at their entrances. The sediments in many of these caves are relatively safe despite being previously dug, although there is an additional threat from the presence of badgers. The caves on the higher slopes (MM04, MM05 and MM06) receive very little attention as most visitors tend keep to the paths rather than explore the higher limestone pavements.

Plate 6.17 Langscar looking north
6.7.2 Janet's Foss

Janet's Foss is a NE-SW stream gorge which carries the Gordale Beck to the south of Gordale. The NW facing crag contains the best exposure of limestone, as the SE facing side of the gorge is partly concealed by scree. Brook et al (1991) list only one of the caves, MM13.

Five sites were surveyed: four caves and one rock shelter and all of the sites except Janet’s Cave (MM13) were relatively small. Two of the caves (MM13 and MM16) had in situ deposits and were assessed as having high archaeological potential. MM13 overlooks the waterfall of Janet's Foss and is visited frequently despite having to cross the beck to do so. The soil around the cave is badly eroded and the rock has been worn smooth. There is some damage to the internal structure of the cave from fire setting and rubbish accumulation, but this is relatively minimal considering the attention it receives. MM16 is located across the river from the main path and its entrance is not obvious from the path. There is only a little evidence of minor erosion from occasional casual visitors and sheep trampling at this site.

The level of care for the caves is very good, and although there are some concerns over the condition of MM13 the National Trust maintains the gorge to a high standard.

6.7.3 Great Close Scar

The Scar is an L-shaped crag running NW-SE that looks out over Malham Tarn to the SW. There is scree at the foot of the crag and the southern end of the scar shows much recent large block breakdown. Malham Tarn is approximately 200m from the crag and there are grasses and reeds in the surrounding area. Great Close Scar Cave (MM18) was the only site surveyed, and was assessed as having low archaeological potential. This is a fissure used for nesting by birds, so it is well protected and receives little attention from visitors.

6.7.4 West Malham

The western part of the Malham catchment extends to Grizedales and the north side of Kirkby Fell and this is an area that has a high density of shakeholes and shallow potholes. The landform is characterised by low hills and very few exposed limestone crags, although there are limestone pavements scattered across the area. One of the low crags of exposed limestone faces NE onto Langscar and this is the one with the archaeological site known as Tot’s Langscar Cave (MM20). There are some areas of low lying bog as well and a few small streams funnelling into the shakeholes.
Two cave sites were surveyed, Tot’s Langscar Cave (MM20) and Great Hole (MM21) and they are of very different character. MM20 was excavated before 1947 and is a small low cave tucked into the foot of the crag. It is not marked on Ordnance Survey maps, neither is it recorded by Brook et al (1991), and appears to receive little attention from visitors as it is away from the main footpath. It is used for shelter by sheep which are eroding the remaining sediments on the floor so there is a need to institute protective measures at this cave. There has been confusion of this site with another Langscar Cave (MM01) which is recorded by Brook et al (1991) as being an archaeological cave, but information given by Tom Lord (pers. comm.) has identified MM20 as the cave described as having archaeological remains.

The other surveyed cave (MM21) is situated in an area of mined shafts and does look as though it has been modified in some way. It is a very large single chambered cave that has been explored by cavers, although no archaeological or palaeontological finds have been recorded. The cave is difficult to find and this undoubtedly protects it from excessive attention. There is much agricultural rubbish in the base of the cave but it appears to have been there for some time.

6.7.5 Broad Flats

Broad Flats is an area of limestone pavement mid way between Malham Cove and Gordale and is known to have one archaeological cave, MM22. The area is relatively high and overlooks Malham Tarn to the north and Malham Cove to the southwest. MM22 is a small cave tucked into the base of the pavement with a small enclosure surrounding it. The excavation trench has been back filled with rocks and the entrance way is small but this is possibly from the build up of soil or deliberate back filling to disguise the entrance. The cave was excavated by a professional archaeologist but a final report has not been made available so the exact nature of the archaeological finds (which apparently include human remains) is unknown.

6.7.6 Malham Cove

The Cove forms a continuous curved crag of exposed limestone almost 80m high and facing south and west. Malham Beck rises at the foot of the crag. The Cove was surveyed but no caves or rock shelters were recorded. There is a lot of break down
of the crags and there is tree covered scree on either side of the cove, and although some rock shelters and possible caves were visible but it was too difficult to visit them. The general level of care for the Cove is good, as is to be expected from its ownership by the National Trust, and visitors are not encouraged to climb the sides of Cove or the cliff faces.

6.7.7  **Gordale Scar**

This is a short N-S running, high-sided gorge, and on the day of the survey visit the wind was very strong so no more than a cursory survey was made of the lower stretches of limestone as it was too hazardous to survey the higher crags. Gordale Beck flows through the bottom of the gorge and halfway along there is a set of waterfalls but these are usually dry. The sides of the gorge have some grass covered scree and there are sporadic trees and shrubs too. There are no archaeological caves known and the caves that are mentioned by Brook et al. (1991) tend to be concentrated around the waterfalls and are only safely accessible using climbing equipment.

6.7.8  **Chapel Cave**

This is in a small area of limestone that crops up to the west of Malham Tarn. Chapel Cave is an archaeological cave excavated by the University of Bradford between 1996 and 1999. The outcrop of rocks that it is within is farmed under the tenancy of the National Trust as grazing land. The cave itself is in a good state of repair and receives little interest as it is fairly low lying and is not obvious from the road or the main footpath.
6.8 Stockdale

Location and geomorphology

The Stockdale area forms a broad limestone plateau between the Attermire and Malham catchments. The catchment is delimited to the south by the Middle Craven fault which separates the limestone to the north from the later Namurian strata to the south, and the trace of the fault is clearly marked by a prominent line of shakeholes (some up to 5m wide) along the south side of Stockdale Beck. The caves surveyed lie in the limestone crags that run roughly E-W to the north of Stockdale Farm. The limestone is thinly bedded resulting in the exposures being prone to frost damage and other forms of weathering. There are potholes further to the north towards Black Hill that were not surveyed.

Ownership, land use and access

The land is in private ownership and all of the caves are on designated access land within the Langcliffe Scars SSSI. Sheep and cattle grazing forms the main land use. There is no surface water in the area surveyed although small seasonal springs rise from the foot of the limestone. The catchment is mainly grass covered with a few scrubby trees, but on the higher limestone there are small boggy patches and there is some wetland vegetation in the mires.

Caves, archaeology and conservation status

Five caves were surveyed with none being assessed as having a high archaeological potential. The caves tended to be small with the exception of Stockdale Cave (ST01). The Bridleway Caves (ST03, ST04, ST05) were clustered close together but there appears to be little obvious relationship between them. ST01 is the most substantial of the caves but this site and ST02 may have been modified through mining. ST02 is very close to a disused limekiln and may have been used during the kiln’s life either as a shelter or as a store.

The condition of the caves is generally good as they are of little interest to cavers and walkers tend to stay on the footpath that runs along the foot of the crags. There was evidence of badgers using ST03 as a latrine but no sign of their den, which typically for these animals would be located in another nearby cave.

6.9 Giggleswick Scar

Location and geomorphology

The Giggleswick catchment includes Giggleswick Scar and the broad area of limestone terraces and pavements between the scar and Ribblesdale to the east. Giggleswick Scar is famous for its many archaeological caves and the catchment has the highest proportion of archaeological caves in the Yorkshire Dales (see Section 7.2). Giggleswick Scar and Common Scars (its continuation to the northwest) form prominent fault scarps on the line of the South Craven Fault, which exposes the Lower Hawes limestone in the cliff faces. The limestone is of very high quality and the beds of rock are deep, up to 8m in height, resulting in stable faces to cave walls.
and roofs. Further back from the main scar the landscape rises in a series of gentle limestone bands with a few caves scattered across the area. There is some limestone pavement in the central part of the catchment, which also has a few potholes. Smearssett Scar and Feizor Nick represent the northernmost limit of the catchment.

Ownership, land use and access

The land of Giggleswick Scar is in private ownership managed as woodland along the scarp edges and as grazing land on the plateau above. The access land boundary follows the line of the lowest scar and includes most of the caves in the catchment. Giggleswick Scar and the area around Kinsey Cave are designated as SSSIs.

Caves, archaeology and conservation status

Brook et al. (1991) list 28 caves in the catchment, most of these were visited and surveyed together with two unnamed rock shelters at the northwest end of Giggleswick Scar. A total of 24 caves were surveyed with 9 being recorded as having archaeological remains.

6.9.1 Giggleswick Scar

Giggleswick Scar has one of the highest concentrations of archaeologically known caves in the Yorkshire Dales. The Pig Yard Club under the direction of Tot Lord excavated many of the caves and it is only through his work that the caves are known. The Scar runs along the limit of the National Park and has an active quarry within it. Most of the Scar rises steeply from the road making the detection of caves difficult with dense vegetation hampering progress too. Climbers use the cliffs and there are small tracks that run along the cliffs leading to good climbing walls. Few of these are in the vicinity of the caves. Two of the known archaeological caves, Lesser and Greater Kelco Caves (GG01 and GG02), are at the south-eastern tip of the catchment with the other cave surveyed being further to the west along the crag, Staircase Cave (GG03). This cave has in situ deposits and although climbers have used it as a shelter the sediments are in very good condition. Graffiti inside the cave suggests that it has been visited since the early 1880s but the cave seems to have escaped the attentions of the early cave archaeologists.

Plate 6.24 Staircase Cave being used as a shelter by the survey team
At the top of the crag the limestone bands form a series of terraces and these also contain caves. Many of the caves show signs of frost damage and are unstable so were rated as of having low archaeological potential. The exception to this was Kinsey Cave (GG08) which is known to have archaeological deposits and was excavated in the 1930s by the Pig Yard Club. Kinsey Cave is a good example of how badgers are threatening the archaeological deposits as during the summer of 2005 bone was found in some of their spoil, something that was not recorded at the time of the survey in July 2004. The spoil heaps from the original excavation do a good job of protecting the cave from the casual visitor as it screens the entrance, although climbers use the crag that it sits in.

6.9.2 Cave Ha and surrounding area

Giggleswick Scar becomes less high towards the western end of the crag. The cliff shows signs of more breakdown and the bands of limestone become thinner. The main and most visible cave is Cave Ha (GG 12), which was excavated in the 1870s and although material culture was found there are few records of where the material came from or even what was found. To the east of Cave Ha there are a series of smaller rock shelters all of which have had some archaeological material (GG10, GG22 and GG23) and a narrow fissure cave that has been completely emptied of its sediments (GG11). Blackriggs Cave, or Cave Ha 3 (GG10) is tucked behind a large spoil heap. A charcoal horizon contained within the tufa has been radiocarbon dated to 3915 +/- 50 BP (Tom Lord pers. comm.) suggesting a Neolithic date for the use of the cave as a site for burial.
Further to the west of Cave Ha are the twin caves of Sewell’s Cave 1 and 2 (GG13 and GG14). Tot Lord and the Pig Yard Club also explored these caves in the 1930s. The caves were originally reported by Arthur Raistrick as only being one cave and the report is somewhat muddled but this has been recently re-evaluated by John Howard and Tom Lord so it is hoped that more complete interpretation can be drawn from the data available. Both of the caves are difficult to find and they are somewhat protected by not being visible from the road. Their general level of care is very good but care will be needed to monitor them in the future as the cliff above them is beginning to show signs of tree root activity that is splitting the rock.

6.9.3 Feizor Nick and Smearsett

The remaining caves that were surveyed were on the plateau above Giggleswick Scar across the Smearsett Scar and the wide gorge of Feizor Nick. The plateau has a small amount of limestone pavement although indications suggest that it has been quarried heavily in the past and so only isolated patches remain. In the 1930s a human burial and 2 iron knives were reported found in a grike at Stainforth (GG15) and although the survey team attempted to locate it, the exact site was not recorded fully so it proved to be elusive.

To the east of the grikes and limestone pavement was Deadman’s Cave (GG16). This cave appears to have been completely emptied but no records exist as to when or by whom. Graffiti low to the cave floor suggests that it was at some time before 1896 and it could have been one of the many caves to be explored by Joseph Jackson between 1830 and 1860. The name suggests that it might have been used as a place of burial but it is not known why or when the cave got its name.
To the north of the catchment and within sight of the grike burial and Deadman’s Cave is Smearsett Scar and a single cave was recorded as being located there. Clearly visible across the fell the cave is situated at the base of the cliff up a steep bank of scree. This is not recorded on the SMR as an archaeological cave but an Anglo-Saxon strap end was found in the cave and is now in the British Museum. The museum piece is listed as being from Smearside and it is not recorded as coming from a cave deposit thus suggesting that other archaeological finds might be in museums but have not been recognised being part of the archaeological cave resource.

Plate 6.29 An obvious Smearsett Cave (GG18)

Feizor Nick is a small dale that heads north from the main catchment towards Moughton. It is characterised by a wide gorge with steep cliffs and large amounts of scree on its west facing slope. Three caves were surveyed in the gorge with all of them having been previously excavated. The caves were initially explored in the early part of the 20th century and then re-assessed by Tom Lord in the early 1980s (pers comm.). No documentary sources are available for the original cave excavation and they are not recorded on the SMR as having any archaeological potential.

Plate 6.30 Feizor Nick Cave No. 1 (GG20)
6.10  The Northern Dales

6.10.1  Barbondale

Barbondale is a short, straight and high-sided glaciated valley that carries Barkin Beck southwestwards from a watershed near Dentdale. The catchment sits at the far northwestern end of the Yorkshire Dales and only the upper part of the dale, above Short Gill, falls within the boundary of the National Park. The upper part of Barbondale also follows the line of the Dent Fault so that the west side of the valley, which is on the upthrow of the fault, is formed of Silurian rocks. On the east side of the dale a narrow outcrop of Great Scar Limestone is exposed alongside Barkin Beck and in the small side valleys of the gills running down from Calf Hill. Barbondale has very little open limestone crag, the limestone is folded and fractured due to the proximity of the Dent Fault and the caves (which are concentrated in the gills) tend to be small, low in the dale side and wet. Because of these factors, their potential for containing archaeological deposits is limited. Although Short Gill was dry during the summer, flood conditions carry a fair amount of water into the sinks within the riverbed. Most of the caves in Short Gill are choked with loose rocks and washed-in boulders. The entire dale is designated access land and the east side of Barbondale either side of Short Gill is designated as a SSSI.

The caves of Barkin Gill and Short Gill are described by Sutcliffe (1974) and 30 caves are listed in Brook et al. (1994). Most of the caves fell outside the inclusion criteria and just one cave (BB01) was visited and surveyed.

6.10.2  Swaledale and Arkengarthdale

Swaledale and Arkengarthdale are long WNW-ESE trending river valleys and they are the northernmost dales within the National Park. As with Wensleydale to the south, the Great Scar Limestone is not exposed and the caves are located in the thinner limestone units of the Wensleydale Group and the basal Namurian Main Limestone, often high up in the side dales. The landscapes of Swaledale and Arkengarthdale have been affected by quarrying and mining and few open crags survive in their original form. Fremington Edge is several
kilometres long but little of the crag is unmodified and this pattern is repeated across
the catchment.

Several areas were visited in the catchment to ascertain whether the lack of known
archaeological caves was due to excavation bias or if the rock was simply not
capable of containing caves. Five caves were recorded, all of low or moderate
archaeological potential.

6.10.3 Wild Boar Fell

The catchment covers the extensive area to the west and north of Wild Boar Fell and
is limited to the west by the Sedbergh to Kirkby Stephen road which also runs
approximately along the line of the Dent Fault. Nearly all of the area lies to the north
of the boundary of the Yorkshire Dales National Park. The Great Scar Limestone is
exposed near the Dent Fault and caves are found in this unit as well as in the
Wensleydale Group limestones and the Main Limestone which crop out at higher
altitudes on the slopes of Wild Boar Fell. Nearly all of the caving sites are potholes,
stream caves and sinks and were therefore not suitable for inclusion in the survey.
The area was not known for archaeological caves until the discovery of prehistoric
human remains in Rawthey Cave (WB02) in 1998. The river level entrance of WB02,
and a nearby fissure cave also at river level, were recorded during the survey.

6.10.4 Mallerstang

The catchment is defined as the drainage on Mallerstang Common that feeds into the
headwaters of the River Eden to the north and the River Ure to the south. The watershed
between these two river systems forms the boundary of the National Park and only the
southern (Ure) part of the catchment falls within the Park. The Eden and Ure valleys are
filled with glacial till and most cave development is in the Main Limestone which
forms broad bench-like outcrops flanking either side of the valley. The Main Limestone forms
low scars, and these scars are paralleled upslope by prominent lines of shakeholes and
potholes which mark the contact of the limestone with the overlying Stainmore Group
rocks.

The Mallerstang catchment as defined in Brook et al (1994) also includes the Dover Gill
caves, though these are located on Nettle Brow which is an area that is drained by Grisedale Brook and therefore hydrologically these caves belong to the Garsdale catchment. One of these caves was recorded in
the survey and was rated as having moderate archaeological potential as it had been
deliberately blocked – possibly to keep sheep from entering it but it was tricky to get
to.

Plate 6.33 East Bank Cave (MA01)
6.10.5 Dentdale and Garsdale

Dentdale and Garsdale are parallel, roughly E-W oriented dales in the North West part of the Yorkshire Dales. Due to the shallow northerly dip of the Carboniferous rocks only the upper units of the Great Scar Limestone are exposed in the floor of Dentdale and its southern tributary valley of Deepdale. Caves are found both in the Great Scar Limestone, at river level, and at higher altitudes in the limestone units of the Wensleydale Group (Lyon, 1974).

Brook et al (1994) list numerous caves and potholes in this catchment but most are adjacent to (or even under) the beds of the rivers and gills, and most are too wet to be included in the survey. Two caves were surveyed, both of low archaeological potential.

Plate 6.34 Popple Cave (DG02) almost at the river level with water inside

6.10.6 Wensleydale

Wensleydale is a large broad valley that carries the River Ure in a W-E direction across the northern part of the Yorkshire Dales. The catchment extends about 20km from Garsdale Head in the east to Aysgarth in the west. Much of the valley floor is mantled in glacial till, topped with alluvium alongside the course of the River Ure and its major tributaries. As a consequence the caves are mainly developed towards the sides of the dale where the Wensleydale Group limestones are exposed. The floor of the dale is quite elevated and there is no exposure of Great Scar Limestone in the dale.

No archaeological caves have been identified in Wensleydale. Brook et al (1988) list 66 speleological sites in the catchment of which the majority are potholes, sinks or resurgence caves. Eleven caves were visited during the survey, all were found to be in a stable condition but their archaeological potential was either low or moderate.

Lady Algatha’s Cave (which is located outside the Wensleydale catchment) was included in the field survey but its site could not be determined on the ground. This could be due to cliff erosion and the site may have been destroyed.
6.11 The Lower Wharfedale Caves

6.11.1 Grassington

The Grassington catchment covers a short section of the lower Wharfe valley together with the adjacent dale sides. Only 20 caves are listed for the catchment (Brook et al., 1988) but these include three that are known to have been productive of archaeological remains and one palaeontological cave. Nine caves were recorded during the survey: five of these were on Elbolton Hill, a knoll-reef south of Grassington that is designated a SSSI. The others were at Dib Scar (two caves with in situ sediments and high archaeological potential, within the Conistone Old Pasture SSSI), Cove Hole and Heights Cave, the latter both known to be archaeological caves.

Plate 6.35 Heights Cave (GS06) with revetted wall constructed by the excavators

6.11.2 Great Whernside

Not to be confused with Whernside (which is one of the Three Peaks), Great Whernside is the upland ridge to the east of Wharfedale. The catchment includes the caves to the east of the River Wharfe between Kettlewell and Conistone (the caves to the west of the river, except those on Kilnsey Crag, are included in the Lower Littondale catchment). Great Scar Limestone is exposed in the floor of the valley while Wensleydale Group limestones and the Main Limestone are revealed at higher altitudes on the dale sides. All of the caves are on access land. Eight sites were visited and recorded within the catchment, including a group of unnamed caves on Grassington Moor.

Plate 6.36 Bands of Limestone characterising the Great Whernside catchment
6.11.3 Stump Cross

This catchment forms the most easterly limestone catchment within the Yorkshire Dales National Park, and includes groups of caves along the River Dibb and Skyreholme Beck (both tributaries of the Wharfe) and on the plateau of Craven Moor at Stump Cross where the caves are included in a SSSI. Mining has blighted the area around Stump Cross and there are very few open limestone crags with intact surfaces for examination. Six caves were visited and surveyed in the vicinity of Trollers Gill, a narrow gorge in the Great Scar Limestone that intermittently carries the Skyreholme Beck when in flood. Four of these caves were rated as having moderate archaeological potential on the basis of their surviving sediments. The geology and hydrology of this locality has been described by Murphy (1998).

6.12 Penyghent Plateau

6.12.1 Birkwith

The Birkwith catchment occupies a small area of the eastern side of Ribblesdale, north of the Penyghent catchment. Both catchments are transected south to north by the Pennine Way long distance path. Most of the floor of Ribblesdale is covered by glacial till, but the Birkwith catchment defines an area of exposed Great Scar Limestone that forms scars and limestone pavements with a fairly dense distribution of caves, many of them are wet and none of them known to contain archaeological remains. Part of the catchment is designated as the Birkwith Caves and Fell SSSI. The area with most promise of caves is Ling Gorge, but the gorge proved difficult to enter during the survey and no caves were recorded. The gorge has very steep sides and there is the potential for caves to exist and for them to have sediments still extant.
6.12.2 **Fountains Fell**

This catchment occupies an area of access land to the southwest of the summit of Fountains Fell. A large number of cave sites are recorded in the catchment but most of them are vertical potholes. Many of the caves are either within the Brants Gill Catchment SSSI or within the Pen-y-ghent SSSI. One site was surveyed and recorded within the catchment: Churn Milk Cave (FF01), which was located within a large shakehole and marked as having low archaeological potential.

![Plate 6.39 Churn Milk Cave (FF01) showing collapse of the shakehole](image)

6.12.3 **Moughton**

The Moughton catchment includes the high ground to the west of Horton in Ribblesdale, an access area within the Ingleborough SSSI that has been heavily disturbed by minerals extraction. The main groups of caves are clustered on Moughton Scar and in Arcow Wood, with several isolated caves to the north of these on the west side of the River Ribble. Fifteen caves were recorded in this survey, including the Arcow Wood caves (MO1 to MO11) and two known archaeological caves, Combs Cave (MO12) and Fern Cave (MO16). The Arcow Wood caves had *in situ* deposits and were rated as having moderate archaeological potential, but the extension of the Arcow Quarry will destroy the sites of these caves.

Much of the limestone in the catchment has been stripped and although vast stretches of pavement still survive and are now protected it is not known what impact this has had on any grikes that might have been used for burial or deposition of archaeological material. Several of the caves surveyed appeared to have been modified in some way – usually with a low wall being built across the entrance. This might be to keep sheep, which graze freely over the catchment, out or there could be some other reason.

![Plate 6.40 The view across the scar from Fern Cave (MO16)](image)
6.12.4 Penyghent

Like the Birkwith catchment this area occupies a section of the east side of Ribblesdale just to the north of the village of Horton in Ribblesdale. The area covers a broad outcrop of Great Scar Limestone that is partially covered by till and, on the higher slopes, by hill peat. Most of the caves are on access land. Six caves were surveyed and all but one had in situ sediments with some inferred archaeological potential.

Plate 6.41 Penyghent Gill

6.12.5 Penyghent Gill

The headwaters of Penyghent Gill drain the northeast side of Pen-y-ghent and Plover Hill, taking the water eastwards towards Wharfedale. Penyghent Gill occupies a deep and narrow valley cut into the Great Scar Limestone and the catchment contains many caves and potholes, most of which are closely associated with the gill and its tributaries. The gill forms the boundary of the access land, with the caves located south of the gill being on open access land and within the Pen-y-ghent Gill SSSI. Six caves were surveyed, all of low to moderate archaeological potential.

Plate 6.42 Old water courses showing breakdown of the limestone

6.12.6 Ribblehead

This area is at the north end of Ribblesdale and is on Great Scar Limestone that is partially covered by glacial tills, alluvium and hill peats on the higher slopes. The catchment was not visited in the current survey.

6.13 Gritstone caves and other surveyed areas

As is the case in the White Peak, sandstone and gritstone escarpments are found near to the limestone outcrops and a small area of gritstone was surveyed in order to provide a sample of the potential of this landform.
Although archaeological sites are recorded in the gritstone areas, no archaeological caves are known so the main areas chosen to survey were near to the village of Thorlby in the south-east of the Dales where it is recorded to have a single archaeologically known rock shelter, and the area around Cautley Spout on the far western side of the National Park where no archaeological remains have been located.

### 6.13.1 Thorlby

A single archaeological site was known from this area but this was not verified by the survey. The area was very over grown with bracken that hid many of the low rock shelters so although GD01 appears to be the site in question it cannot be guaranteed. Six other sites were surveyed: two caves and four rock shelters. The site receives few casual visitors although climbers use several of the rock faces. The sites were clean with no litter. Signs of wind erosion were evident with several of the caves showing damage that will cause their fronts to collapse. None of the sites showed any deliberate use as shelters by people.
7 QUANTITATIVE ANALYSIS OF THE CAVE SURVEY DATA

7.1 Introduction
This section of the report sets out the results of quantitative analyses of the data collected during the course of the field survey. In these analyses, archaeological caves are defined as in Section 4.2.3, i.e., as caves known to have contained archaeological artefacts, archaeological deposits (including charcoal) or deliberately deposited ancient human remains. The archaeological category excludes caves that only provide recent historical evidence of human activity, such as industrial modifications of cave structures and modern carvings and graffiti.

The analyses include comparisons of the proportion of archaeological caves in different catchment areas, associations of cave archaeology with landscape and cave geomorphological variables, associations of cave archaeology with internal sediment condition, and the development of separate predictive models for the two study regions based on the identified correlations and associations of cave archaeology with the variables measured in the cave surveys. A separate study of the associations between finds categories is also presented.

7.2 Proportion of identified cave sites with known archaeological remains
The proportion of caves that have been recorded as containing archaeological material is significantly higher in the Peak District than in the Yorkshire Dales (see Table 7.1).

<table>
<thead>
<tr>
<th></th>
<th>Archaeological Caves</th>
<th>Total Number of Caves</th>
<th>Percentage</th>
<th>Chi-squared significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak District</td>
<td>45</td>
<td>178</td>
<td>25%</td>
<td>p = 0.02</td>
</tr>
<tr>
<td>Yorkshire Dales</td>
<td>35</td>
<td>221</td>
<td>16%</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.1 Total number of caves surveyed and proportions of archaeological caves in the Peak District and Yorkshire Dales.

Within each of the National Parks, there is significant variation between the catchments in the proportion of archaeological caves (see Figures 7.1 and 7.2 below). In the Peak District, the proportion of archaeological caves varies from over 40% in the Hamps/Manifold catchment to about 10% in the South East catchment (chi-squared significance: p = 0.01), while in the Yorkshire Dales, the proportions of archaeological caves are higher than average in the Giggleswick, Ingleborough and Attermire catchments (chi-squared significance: p = 0.03). In the Yorkshire Dales, some of the heterogeneity in the frequency of archaeology may reflect a greater intensity of archaeological fieldwork in the southern part of the Dales, close to the major centres of population (see Murphy and Chamberlain, 2002, for evidence for the concentration of published palaeontological caves in the southern Yorkshire Dales). It is not clear whether the same argument holds true for the Peak District, as caves have been excavated intensively throughout the White Peak region: the higher density of archaeological caves in the Wye and Hamps/Manifold catchments may reflect a genuine spatial pattern of higher archaeological potential in the caves in those catchments, although it is not known whether this also reflects the density of prehistoric settlement in the areas.
7.3 Relation between archaeological caves and altitude

In the Peak District there is a strong positive relationship between altitude above sea level and the proportion of caves with reported archaeological evidence (Figure 7.3). This relationship is statistically significant (Pearson correlation coefficient $r = 0.94$, $P<0.001$) and the correlation of cave archaeology with altitude is seen both across the region as a whole and within separate catchments (Figures 7.4 and 7.5).

Figure 7.1 Proportions of archaeological caves in the Peak District catchments

Figure 7.2 Proportions of archaeological caves in the Yorkshire Dales catchments
It is possible that caves located at greater altitude are more visible within the surrounding landscape, and are hence more likely to have been investigated by archaeologists, but the same argument would also apply to past human activities – higher altitude caves may have been more likely to be used by past inhabitants of the landscape. We also note that many of the archaeological caves were used in prehistory for burial or votive deposition, rather than for occupation or subsistence-related activities. There is some evidence that higher altitude locations were preferred for these types of activities, as is the case for burial mounds which were often situated at topographically elevated locations. In the Peak District all burial caves are located at an altitude of 200 metres or greater.

Figure 7.3 Relationship of archaeological caves to altitude, Peak District

Figure 7.4 Relationship of archaeological caves to altitude, Dove catchment
In the Yorkshire Dales there is no clear relationship between the proportion of archaeological caves and altitude (Figure 7.6). There is a slight non-significant negative trend for decreasing frequency of archaeological caves with altitude (Pearson correlation coefficient \( r = -0.49 \)), and no caves situated more than 450m above sea level in the Yorkshire Dales have been recorded as containing archaeological material. An important geomorphological distinction between the Yorkshire Dales and the Peak District is that in the Dales the limestone stratigraphy is complicated by faulting and by variations in the elevation of the underlying pre-Carboniferous basement rocks. However, even within specific catchments in the Yorkshire Dales there does not appear to be any relationship between the presence of archaeology and the altitude of the cave site.

![Figure 7.5 Relationship of archaeological caves to altitude, Hamps/Manifold catchment](image)

![Figure 7.6 Relationship of archaeological caves to altitude, Yorkshire Dales](image)
7.4 Relation between archaeological caves and aspect of cave entrance

Aspect (direction faced when looking out of the cave entrance) is potentially an important factor in the selection of caves for past human activities. Aspect affects the nature of the light and the quantity of solar radiation entering the cave entrance, it controls the exposure of the entrance to prevailing winds and precipitation, and it also determines the visual prospects and viewshed from the cave entrance. Aspect also relates to the hinterland from which the cave may be visible – for instance, if settlement and subsistence activities were preferentially located on the south-facing slopes on the north side of a valley, then north-facing caves on the opposite (i.e. south) side of the valley might be more noticeable to such a community. Finally, as regularities in entrance orientation are characteristic of built structures, the same factor might have influenced the selection of caves for particular activities in the past.

In the Peak District there is a tendency for archaeological caves to have entrances facing either towards the north-east quadrant or towards the west, with a deficit of south-facing archaeological caves, whereas the non-archaeological caves show a slightly higher frequency of southerly aspects (Figures 7.7 and 7.8). Statistical evaluation using the chi-squared test indicates that these trends fail to reach statistical significance.

![Figure 7.7 Distribution of entrance directions, Peak District Caves](image-url)
In the Yorkshire Dales there is a similar tendency for archaeological caves to have entrances facing either towards the east or towards the west-southwest, whereas the non-archaeological caves appear to be more evenly distributed in entrance aspect, again with a slight tendency towards southern aspects (Figures 7.9 and 7.10). As was the case with the Peak District, these trends do not reach statistical significance. The prominent number of archaeological caves in the Yorkshire Dales with entrances facing WSW is partly attributable to the inclusion of the large sample of caves in the Attermire and Giggleswick Scars. These landscape features form prominent scarps that face towards the south and the west, and the majority of their cave entrances are oriented towards the western quadrant.
Combining the two regional cave datasets, there is a noticeable difference in distribution of entrance aspect in the archaeological caves compared to the overall sample of caves (Figure 7.11). The pattern is suggestive either of an avoidance of archaeological activity in caves that face towards the south (even though there is a predominance of south-facing caves in the dataset as a whole), or of a preference for using caves that face towards the east and the west. The distribution of the proportion of archaeological caves by entrance direction shows a marginally significant difference from a uniform distribution (one-sample KS test, p=0.04).

Various explanations of these patterns are possible. The total dataset recorded in our surveys may contain a bias towards south facing caves partly because caves facing this direction may be more easily identifiable in field survey due to better lighting conditions on south facing slopes in limestone terrain. Although the new caves recorded for the first time in our survey were in fact randomly distributed in relation to entrance direction, the bias in the total dataset may be due to the inclusion in our surveys of many historically documented caves. Differential rates of limestone erosion and cliff recession depending on the orientation of scarp faces may also have an effect on whether cave systems are accessible from the ground surface, and this may also contribute to a non-uniform distribution of cave entrance directions. Ice sheet movement during the last glacial maximum may be another factor that could have affected the orientation of limestone exposures, and hence the directions of cave entrances. The karst landscape of the Yorkshire Dales is a glaciokarst in which the directions of the major valleys reflect the directions of movements of icefields during major glaciations, whereas the Peak District is a fluviokarst in which the major river systems (the Wye and its tributaries) have been superimposed onto the exposed limestone. In both regions the orientations of cave passages reflect tectonically controlled jointing in the limestone as well as the principal drainage directions, and exposure of cave systems at the ground surface is a function of valley development.

A preference for caves with east and west facing entrances as sites for the deposition of archaeological material may reflect the general favouring of these orientations in the entrances of prehistoric monuments such as chambered tombs, stone and timber circles, earthen enclosures and roundhouses. Entrance orientations towards the eastern quadrant (i.e. between NE and SE) are characteristic of many
prehistoric funerary monuments including Scottish chambered tombs (Henshall, 1972), Cotswold-Severn chambered tombs (Darvill, 1982) and British non-megalithic long barrows (Kinnes, 1992), as well as being the preferred entrance orientation in British Iron Age round houses (Parker Pearson, 1999). These easterly azimuths are generally linked to the orientation of sunrise, which in central Britain varies between approximately NE and SE depending on the season of the year. Entrances facing towards the western quadrant are less frequently encountered in funerary monuments, but have been noted in some British stone circles, timber circles and henges (Burl, 1976; Gibson, 1998; Harding, 2003).

![Figure 7.11 Total number of archaeological caves (columns), smoothed average of archaeological caves (solid line) and smoothed average of total number of caves (dashed line) for combined Peak District and Yorkshire Dales data sets, according to entrance direction.](image)

### 7.5 Relation Between Archaeological Caves and Size of Cave

A very strong and statistically significant relationship exists between the recorded presence of archaeological evidence and the size of the cave, as expressed variously by cave entrance width, cave entrance height, cave entrance size (i.e., width multiplied by height) and by cave depth (Table 7.2). In the Peak District the relationship is primarily with cave entrance height and with cave depth, as cave entrance width is not associated with the presence of archaeological remains in this region (Figures 7.12 to 7.15).
Figure 7.12 Relationship of cave entrance size and archaeological evidence in the Peak District.

Figure 7.13 Relationship of cave entrance height and archaeological evidence in the Peak District.
In the Yorkshire Dales cave entrance width and cave entrance height both individually and when combined as entrance size are strongly associated with the presence of archaeological evidence (Figures 7.16), as is cave depth (Figures 7.17).
Figure 7.16 Relationship of cave entrance size and archaeological evidence in the Yorkshire Dales

There are several competing explanations for the pattern of association between measures of entrance size and the recorded presence of archaeological evidence: (a) large caves can hold more sediment, therefore increasing the probability of their containing archaeological material; (b) large caves may be more noticeable or more attractive to antiquarians and archaeologists, increasing the likelihood of excavation and recovery of archaeological material; and (c) large caves may have been more
noticeable or attractive to people in the past, enhancing the likelihood of deposition of archaeological material in antiquity.

It is certainly true that some of the largest cave entrances recorded in our survey achieved their size through the efforts of archaeologists – Victoria Cave in Yorkshire is the classic example of this, being a cave with a small entrance prior to the commencement of excavation in 1870 (Dearne and Lord, 1998). The Giggleswick Scar caves have also had their entrances enlarged through the removal of sediment. However, not all excavations of cave entrances result in wholesale enlargement of the cave entrance. An example of this would be Fox Hole Cave in Derbyshire, where only a small amount of entrance enlargement occurred despite the removal of very large quantities of sediment from the cave.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Peak District</th>
<th>Yorkshire Dales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log (cave entrance height)</td>
<td>$r = 0.89$</td>
<td>$r = 0.92$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.04$</td>
<td>$p = 0.03$</td>
</tr>
<tr>
<td>Log (cave entrance width)</td>
<td>$r = 0.40$</td>
<td>$r = 0.96$</td>
</tr>
<tr>
<td></td>
<td>$p &gt; 0.5$</td>
<td>$p = 0.002$</td>
</tr>
<tr>
<td>Log (cave entrance area)</td>
<td>$r = 0.83$</td>
<td>$r = 0.98$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.08$</td>
<td>$p = 0.003$</td>
</tr>
<tr>
<td>Log (cave depth)</td>
<td>$r = 0.99$</td>
<td>$r = 0.91$</td>
</tr>
<tr>
<td></td>
<td>$p &lt; 0.001$</td>
<td>$p = 0.03$</td>
</tr>
</tbody>
</table>

Table 7.2 Pearson correlation coefficients and statistical significance of associations between measures of cave size and proportions of caves with recorded archaeological remains. n.b. cave entrance area = entrance height x entrance width

7.6 Relation Between Archaeological Caves and Ground Slope

In both of the surveyed regions there were only very weak and non-significant relationships between the presence of archaeological material in caves and the general topographical slope as assessed by the average of the ground slopes to the right, left and below the cave (Figures 7.18 and 7.19). This indicates that the presence of archaeological evidence is not related to the general topographic gradient surrounding the cave.
However, the ground slope immediately outside the cave did show a relationship with the presence of archaeological material – in both of the districts surveyed, the archaeological evidence was more likely at caves where the area immediately outside the cave entrance was either horizontal or had a negative slope, i.e. sloped
down approaching the cave entrance (Figures 7.20 and 7.21). This pattern was statistically significant overall and in the Yorkshire Dales, and approached significance in the Peak (Peak: chi-squared test, p=0.07; Dales: chi-squared test, p=0.004). As with the size of the cave entrance, the presence of a level or even raised area immediately outside the cave entrance may be indicative of past archaeological excavation, nonetheless this feature could also be an indicator of human activity at the cave site in the more remote past.

Figure 7.20 Relationship of ground slope outside and archaeological evidence, Peak District

Figure 7.21 Relationship of ground slope outside and archaeological evidence, Yorkshire Dales

As with the ground slope outside the cave, the ground slope inside the cave entrance also showed a slight trend in relation to archaeological evidence, with archaeological caves being associated with a more positive slope, i.e. ground sloping down into the cave (Figures 7.22 and 7.23). This effect was statistically significant for the Peak
District caves (chi-squared test, p=0·02), but was slight to non-existent in the case of the Yorkshire Dales caves. The trend is understandable in the same manner as the ground slope outside the cave, perhaps as a result of removal of deposits from inside the cave passages to spoil tips outside the cave entrance either in antiquity or more recently during excavation by archaeologists or cavers.

Figure 7.22  Relationship of ground slope inside and archaeological evidence, Peak District

Figure 7.23  Relationship of ground slope inside and archaeological evidence, Yorkshire Dales
7.7 **Relation Between Archaeological Caves and Condition of Internal Cave Deposits**

The presence and nature of internal sedimentary deposits was recorded in a descriptive fashion in the cave survey database. This information was assigned to three categories of deposit condition: 0 = sediments either absent or present in minimal or residual quantities; 1 = *in situ* sediments in a damaged or eroding condition, and 3 = *in situ* sediments present in a stable or accruing condition. The distribution of each deposit condition was determined for archaeological and non-archaeological caves in the two study areas. A very similar pattern emerged in both study areas: the majority of archaeological caves had sediments in damaged or eroded condition, with a smaller number having stable or accruing deposits and very few archaeological caves having no or minimal sediments (Figures 7.24 and 7.25). The difference in proportions of archaeological versus non-archaeological caves for the three sediment condition categories was statistically significant for the Yorkshire Dales (chi-squared test: p=0.03) but not for the Peak District (chi-squared test: p=0.28). The pattern can be understood as reflecting the fact that caves with little or no sediment are unlikely to produce archaeological finds, while many archaeological discoveries are the result of controlled or uncontrolled excavations which inevitably result in erosion and damage to sedimentary deposits. The data also corroborated our intuitive supposition that previous archaeological excavations have rarely resulted in complete emptying of sediments from cave entrance chambers. However, it was decided not to include this factor in the predictive model as the presence of sediments, either disturbed or undisturbed, appears to be a relatively weak predictor of the presence of archaeological remains (the majority of caves with sediments are currently classified as non-archaeological).

![Figure 7.24 Relationship of sediment condition and archaeological evidence, Peak District](image)

*Figure 7.24 Relationship of sediment condition and archaeological evidence, Peak District*
7.8 Relation Between Archaeological Caves and Proximity to Water

Water is a vital commodity for subsistence and craft activities, and proximity to water is often incorporated into models of archaeological site location. In limestone landscapes water may be less accessible due to enhanced underground drainage affecting surface watercourses. In the Peak District there was a trend towards archaeological caves being located at a greater distance from water, whereas in the Yorkshire Dales this trend was not apparent (Figures 7.26 and 7.27). The reason for this difference between the two study areas is probably due to the finding that archaeological caves are related to altitude in the Peak District, and the higher altitude caves are also those that are located further away from the permanent watercourses in the valley bottoms. In the Yorkshire Dales a relationship between archaeological caves and altitude was not observed, and the same is the case for the relationship between archaeological caves and proximity to water.
7.9 Developing Predictive Models for Cave Archaeology

The pattern of associations between the environmental variables and the recorded presence of archaeology in each of the study regions, which were investigated individually (see sections above) are summarised in Table 7.3 below.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Peak District</th>
<th>p-value</th>
<th>Yorkshire Dales</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>Strong, positive</td>
<td>p&lt;0.001</td>
<td>Slight, negative</td>
<td>n.s.</td>
</tr>
<tr>
<td>Aspect</td>
<td>Slight, NE &amp; W</td>
<td>n.s.</td>
<td>Slight, E &amp; WSW</td>
<td>n.s.</td>
</tr>
</tbody>
</table>
Table 7.3 List of environmental variables that were useful in building the predictive models and their statistical associations with presence of archaeological remains. Strong statistical associations are those which have a p-value of less than 0·05.

These associations were used as a guide to selecting variables for inclusion in multiple discriminant analyses, which were conducted separately for the Peak District and Yorkshire Dales datasets. Discriminant Analysis is a widely used method for predicting category membership. A discriminant function is constructed from linear combinations of the predictor variables, such that the ratio of between-category to within-category variation is maximised. The score of any given site on the discriminant function can be converted into a probability of category membership.

The discriminant analyses were run in SPSS for Windows version 12.0. The approach taken was to enter the variables that had been established as being strongly or moderately associated with the presence of cave archaeology, and then to iteratively check the resulting discriminant function by manually adding and subtracting additional variables until the best results were achieved, as defined by maximising the correct classification of archaeological caves. The results of the discriminant analyses were also checked by entering the same variables into binary logistic regressions, but it was found that the logistic regressions were less successful in predicting the status of the archaeological caves.

7.10 Peak District Predictive Model

The success of discriminant analysis is assessed by evaluating the proportion of cases in the analysis that are attributed correctly to their corresponding categories. 100% success would mean that all archaeological caves were classified as archaeological on the basis of their predictor variables.

The discriminant function for the Peak District caves successfully classified 80% of the total sample of caves, with 81% of non-archaeological caves (64/79) and 76% of archaeological caves (31/40) being correctly classified. The discriminant function coefficients (see table) indicate that Altitude, Cave Entrance Height, and Cave Depth make the largest contributions to the discriminant function, with Cave Entrance Width, Proximity to Water, and Ground Slopes Inside and Outside the entrance making subsidiary contributions to the function.

Thus in the Peak District, larger caves located at higher altitudes were more likely to contain archaeological remains, especially if they were associated with ground slopes directed towards the cave entrance.

<table>
<thead>
<tr>
<th>Variable</th>
<th>D.F. Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log (cave entrance height)</td>
<td>0.388</td>
</tr>
<tr>
<td>Log (cave entrance width)</td>
<td>-0.073</td>
</tr>
</tbody>
</table>
Table 7.4 Discriminant function coefficients for variables included in the Peak District predictive model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log (cave depth)</td>
<td>0.560</td>
</tr>
<tr>
<td>Altitude</td>
<td>0.769</td>
</tr>
<tr>
<td>Proximity to Water</td>
<td>0.176</td>
</tr>
<tr>
<td>Ground Slope Inside</td>
<td>0.164</td>
</tr>
<tr>
<td>Ground Slope Outside</td>
<td>0.052</td>
</tr>
</tbody>
</table>

The discriminant function scores for individual caves were compared for the four categories of archaeological potential recorded during the survey (Figure 7.28). The archaeological potentials were coded as numeric values for this analysis, with 'low', 'moderate', 'high' and 'proven high' coded as 1 to 4 respectively. The figure shows the median, quartiles and range plus outliers of the discriminant scores for each category of archaeological potential. The caves recorded as having a 'high' archaeological potential (category 3) have on average slightly higher discriminant scores than categories 1 and 2, although the difference does not reach statistical significance. As expected, the caves recorded as 'proven high' are distinguished by high discriminant function scores.

Figure 7.28 Discriminant Function scores versus Archaeological Potential (Peak District)
<table>
<thead>
<tr>
<th>Number</th>
<th>Cave</th>
<th>DF</th>
<th>p(A)</th>
<th>Comments</th>
<th>Pot</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS12</td>
<td>Jug Holes</td>
<td>2.95</td>
<td>0.97</td>
<td>Eroded deposits, damaged by mineral extraction</td>
<td>1</td>
</tr>
<tr>
<td>BU02</td>
<td>Pool Cave</td>
<td>1.38</td>
<td>0.73</td>
<td>Some eroding deposits, mineral extraction damage</td>
<td>1</td>
</tr>
<tr>
<td>WY12</td>
<td>Unnamed Cave</td>
<td>1.20</td>
<td>0.68</td>
<td>In situ deposits very badly eroded</td>
<td>1</td>
</tr>
<tr>
<td>DS10</td>
<td>Unnamed Cave</td>
<td>0.82</td>
<td>0.55</td>
<td>In situ deposits with badger activity</td>
<td>3</td>
</tr>
<tr>
<td>DO03</td>
<td>Reynard's Kitchen</td>
<td>0.75</td>
<td>0.52</td>
<td>Excavated deposits, with some still in situ</td>
<td>3</td>
</tr>
<tr>
<td>HM18</td>
<td>Nan Tor Cave</td>
<td>0.72</td>
<td>0.51</td>
<td>Some erosion of in situ deposits</td>
<td>3</td>
</tr>
<tr>
<td>LA21</td>
<td>Lynx Cave (Lathkill)</td>
<td>0.65</td>
<td>0.48</td>
<td>Excavated deposits with some animal bones</td>
<td>3</td>
</tr>
<tr>
<td>CA09</td>
<td>Cave Dale Cave #4</td>
<td>0.64</td>
<td>0.48</td>
<td>Some erosion of in situ deposits</td>
<td>2</td>
</tr>
<tr>
<td>HM24</td>
<td>Unnamed Cave</td>
<td>0.63</td>
<td>0.47</td>
<td>In situ deposits with some erosion</td>
<td>2</td>
</tr>
<tr>
<td>DS08</td>
<td>Unnamed Cave</td>
<td>0.58</td>
<td>0.45</td>
<td>No deposits within cave</td>
<td>1</td>
</tr>
<tr>
<td>CA02</td>
<td>Cave Dale Cave #1</td>
<td>0.49</td>
<td>0.42</td>
<td>Excavated deposits</td>
<td>1</td>
</tr>
<tr>
<td>LA02</td>
<td>Ricklow Cave</td>
<td>0.43</td>
<td>0.40</td>
<td>Some erosion of in situ deposits</td>
<td>1</td>
</tr>
<tr>
<td>LA23</td>
<td>Unnamed Cave</td>
<td>0.43</td>
<td>0.40</td>
<td>In situ deposits</td>
<td>2</td>
</tr>
<tr>
<td>HM28</td>
<td>Ladyside Cave</td>
<td>0.42</td>
<td>0.40</td>
<td>Deposits (?primary) eroded by cavers</td>
<td>2</td>
</tr>
<tr>
<td>CA12</td>
<td>Unnamed Cave</td>
<td>0.30</td>
<td>0.36</td>
<td>Shallow deposits eroded by sheep</td>
<td>1</td>
</tr>
<tr>
<td>DO26</td>
<td>Unnamed Cave</td>
<td>0.09</td>
<td>0.29</td>
<td>In situ deposits</td>
<td>2</td>
</tr>
<tr>
<td>HM31</td>
<td>Darfur Crag Cave #3</td>
<td>0.09</td>
<td>0.29</td>
<td>Excavated deposits</td>
<td>3</td>
</tr>
<tr>
<td>HM33</td>
<td>Darfur Crag Cave #1</td>
<td>0.07</td>
<td>0.28</td>
<td>Excavated deposits</td>
<td>2</td>
</tr>
<tr>
<td>BF03</td>
<td>Unnamed Cave</td>
<td>0.04</td>
<td>0.27</td>
<td>Undisturbed in situ deposits</td>
<td>3</td>
</tr>
<tr>
<td>LA05</td>
<td>Unnamed Cave</td>
<td>0.03</td>
<td>0.27</td>
<td>In situ deposits</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7.5 ‘Non-archaeological’ Peak District caves with the highest scores on the Discriminant Function. p(A) = Probability of having archaeological material, Pot = Archaeological Potential recorded during cave audit survey.
The 20 non-archaeological caves with the highest discriminant function scores were listed (Table 7.5) and examined to determine their characteristics. According to the discriminant function these caves had probabilities of having archaeological material that ranged from 0.97 to 0.27. All except one of these caves has some sedimentary deposits in place and just over half (12 out of 20) were recorded in our survey as moderate or high in archaeological potential. Five of these caves (CA02, DO03, HM31, HM33 and LA21) showed signs of previous excavation by archaeologists or cavers, and about half of the cave sites show signs of active ongoing erosion of sedimentary deposits.

Also of interest is that nearly half (9 out of 20) of the caves accorded high archaeological probabilities by the predictive model are not recorded in archives or the caving literature. These sites were identified for the first time during the course of this survey. This implies that despite a history of relatively intensive archaeological investigations in the Peak District there may still be a substantial undocumented archaeological resource in the region’s caves.

### 7.11 Yorkshire Dales Predictive Model

The discriminant function for the Yorkshire Dales caves classified 79% of the total sample of caves correctly, with 80% of non-archaeological caves (123/154) and 76% of archaeological caves (22/29) being correctly classified. The discriminant function coefficients (see table) indicate that Cave Entrance Height, Cave Entrance Width, and Cave Depth make the largest contributions to the discriminant function, while East-West aligned aspects and Ground Slopes Inside and Outside the entrance made subsidiary contributions to the discriminant function.

<table>
<thead>
<tr>
<th>Variable</th>
<th>D.F. Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log (cave entrance height)</td>
<td>0.524</td>
</tr>
<tr>
<td>Log (cave entrance width)</td>
<td>0.408</td>
</tr>
<tr>
<td>Log (cave depth)</td>
<td>0.415</td>
</tr>
<tr>
<td>East-West aspects</td>
<td>0.210</td>
</tr>
<tr>
<td>Ground Slope Inside</td>
<td>0.223</td>
</tr>
<tr>
<td>Ground Slope Outside</td>
<td>-0.292</td>
</tr>
</tbody>
</table>

**Table 7.6 Discriminant function coefficients for variables included in the Yorkshire Dales predictive model**

The discriminant function scores for individual caves were compared across the four categories of archaeological potential recorded during the survey (Figure 7.29). The figure shows that the caves recorded as having a high archaeological potential (category 3) have on average higher discriminant scores than the caves recorded as having low or moderate potentials, with this difference approaching statistical significance (chi-squared test: p=0.09).
Figure 7.29 Discriminant function scores versus archaeological potential (Yorkshire Dales)

The 20 non-archaeological caves in the Yorkshire Dales with the highest discriminant function scores were listed (Table 7.7) and examined to determine their characteristics. Unlike the case in the Peak District, the probabilities of these sites being archaeological caves were much higher, ranging from a maximum of $p=0.96$ to a minimum of $p=0.61$. These higher average probabilities seem unrelated to the accuracy of the discriminant function in predicting the status of the known archaeological caves, and may instead reflect that the Yorkshire Dales has been much less intensively documented for its cave archaeology, so we anticipate that there may be many more undiscovered archaeological caves in this region.

Twelve out of the 20 were recorded in the audit survey as moderate or high in archaeological potential, while five had no sediments present. Six of the caves (AT07, GG10, GG13, GG16, GG21, WD09) showed signs of previous excavation, probably due to unrecorded activities by archaeologists, and ongoing active erosion of deposits was noted at several of the cave sites. Unlike the Peak District, all of these caves have been recorded on cave registers (e.g. the volumes of Northern Caves), and over half of the sites are located on the Attermire and Giggleswick Scars where intensive cave exploration has taken place.
<table>
<thead>
<tr>
<th>Number</th>
<th>Cave</th>
<th>DF</th>
<th>p(A)</th>
<th>Comments</th>
<th>Pot</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM21</td>
<td>Great Hole</td>
<td>2.63</td>
<td>0.96</td>
<td><em>In situ</em> deposits which are eroding</td>
<td>2</td>
</tr>
<tr>
<td>AT07</td>
<td>Black Pot Cave</td>
<td>2.25</td>
<td>0.93</td>
<td>Excavated deposits and spoil, no archaeological remains recorded</td>
<td>1</td>
</tr>
<tr>
<td>PG04</td>
<td>Penyghent Hse Cave</td>
<td>2.05</td>
<td>0.91</td>
<td><em>Active stream</em> cave</td>
<td>1</td>
</tr>
<tr>
<td>AT33</td>
<td>Benscar Cave</td>
<td>1.90</td>
<td>0.89</td>
<td><em>In situ</em> deposits eroding from activities of cavers</td>
<td>2</td>
</tr>
<tr>
<td>WK01</td>
<td>Yordas Cave</td>
<td>1.71</td>
<td>0.86</td>
<td>Former show cave with eroding deposits</td>
<td>3</td>
</tr>
<tr>
<td>LS01</td>
<td>Beckermonds Cave#1</td>
<td>1.64</td>
<td>0.85</td>
<td>Wet cave (no sediments), but potential for votive deposition</td>
<td>1</td>
</tr>
<tr>
<td>AT30</td>
<td>Lookout Cave</td>
<td>1.61</td>
<td>0.84</td>
<td>Deep <em>in situ</em> deposits, some digging by cavers – archaeological remains revealed in sediment coring</td>
<td>3</td>
</tr>
<tr>
<td>WD09</td>
<td>Bobscar Cave #1</td>
<td>1.47</td>
<td>0.81</td>
<td>Possibly excavated cave with <em>in situ</em> deposits</td>
<td>1</td>
</tr>
<tr>
<td>AT31</td>
<td>Horseshoe Cave</td>
<td>1.44</td>
<td>0.80</td>
<td><em>In situ</em> deposits which are eroding</td>
<td>2</td>
</tr>
<tr>
<td>GW07</td>
<td>Dow Cave</td>
<td>1.43</td>
<td>0.80</td>
<td>No sediments <em>in situ</em></td>
<td>1</td>
</tr>
<tr>
<td>DC04</td>
<td>Falcon Cave</td>
<td>1.35</td>
<td>0.78</td>
<td>No sediments <em>in situ</em></td>
<td>1</td>
</tr>
<tr>
<td>GP06</td>
<td>Trow Gill Cave</td>
<td>1.33</td>
<td>0.77</td>
<td><em>In situ</em> deposits which are eroding</td>
<td>2</td>
</tr>
<tr>
<td>GG10</td>
<td>Blackriggs Cave</td>
<td>1.28</td>
<td>0.76</td>
<td>Excavated deposits and spoil, no recorded archaeological remains</td>
<td>3</td>
</tr>
<tr>
<td>UL02</td>
<td>Bown Scar Cave</td>
<td>1.19</td>
<td>0.74</td>
<td>Resurgence cave, no known sedimentary deposits</td>
<td>1</td>
</tr>
<tr>
<td>GG09</td>
<td>Gully Cave</td>
<td>1.06</td>
<td>0.70</td>
<td>No sediments <em>in situ</em></td>
<td>1</td>
</tr>
<tr>
<td>GG16</td>
<td>Dead Man's Cave #1</td>
<td>0.98</td>
<td>0.67</td>
<td>Excavated deposits, no archaeological remains recorded</td>
<td>3</td>
</tr>
<tr>
<td>GG13</td>
<td>Sewell's Cave 2</td>
<td>0.95</td>
<td>0.66</td>
<td>Excavated deposits and spoil, with animal bones</td>
<td>3</td>
</tr>
<tr>
<td>GG21</td>
<td>Feizor Nick Cave #2</td>
<td>0.92</td>
<td>0.65</td>
<td>Probably excavated deposits, no recorded archaeological remains</td>
<td>3</td>
</tr>
<tr>
<td>AT05</td>
<td>Wet Cave</td>
<td>0.84</td>
<td>0.62</td>
<td><em>In situ</em> deposits, some digging by cavers</td>
<td>3</td>
</tr>
<tr>
<td>GG03</td>
<td>Staircase Cave</td>
<td>0.81</td>
<td>0.61</td>
<td><em>In situ</em> deposits</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 7.7 ‘Non-archaeological’ Yorkshire Dales caves with the highest scores on the Discriminant Function. p(A) = Probability of being an archaeological cave, Pot=Archaeological Potential recorded during cave audit survey
7.12 Discussion of Predictive Models

Several quantitative approaches can be used to assign sites to categories of archaeological potential from proxy environmental data (Table 7.8). These methods have in common the measurement of predictor variables on a dataset of known category membership (the ‘training set’), from which an algorithm is computed that captures the optimal criteria for assigning sites to categories of archaeological status or potential, and quantitative estimates of the probability of category membership can then be calculated for known and unknown sites alike.

<table>
<thead>
<tr>
<th>Discriminant Analysis</th>
<th>Finds the linear combinations of predictor variables that maximise the between-category variation. The scores on the discriminant function provide the basis for calculating the probability of category membership for any individual case.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistic Regression</td>
<td>Uses a linear combination of predictor variables to construct a ‘logit function’, which is equivalent to the natural logarithm of the odds of category membership. Achieves similar results to Discriminant Analysis, but may be better suited to binary (presence/absence) predictor variables.</td>
</tr>
<tr>
<td>Decision Trees</td>
<td>Allocates sites to categories by using the predictor variables singly or in combination to partition the cases at each node of a branching tree. Decision trees are particularly appropriate for economic (cost-benefit) calculations and, as with Logistic Regression, the technique is optimised for binary or categorical predictor variables.</td>
</tr>
</tbody>
</table>

Table 7.8 Methods for estimating the archaeological potential of sites from proxy indicator variables

We opted to use discriminant analysis in our predictive modelling exercises, for two principal reasons. First, nearly all of the predictor variables in the analysis are continuous measurements that are amenable to the discriminant function approach. Secondly, logistic regression was tested but proved to be less effective in correctly classifying the known archaeological caves.

The use of discriminant analysis for predictive modelling depends heavily on the correct classification of the sample of cave sites used to develop the model. We believe that we have correctly located and identified on the ground most of the cave sites in our study regions that are recorded in the published literature and in the archives as having contained archaeological evidence, although there is a small probability that the sites of some of the older archaeological discoveries may have been mis-recorded or attributed incorrectly to particular caves. The assistance of Tom Lord has been particularly useful in clarifying the provenance of archaeological finds in the caves of the Settle area. However, it is inevitable that some of the cave sites that are currently classified in our database as ‘non-archaeological’ either do in fact, or once used to, contain archaeological material. We rely to a certain extent on the large ‘non-archaeological’ cave sample in our datasets being dominated by truly non-archaeological caves, but this is a supposition that can only be tested by future intrusive ground-based investigations.

We are encouraged in our analysis by the finding that in both of the study regions some of the variables that predict the presence of cave archaeology are consistent, including measures of cave entrance chamber size and measurements of ground slopes inside and outside the cave entrance that are directed towards the interior of the cave. As these predictors are contingent on the nature of the caves already
identified as containing archaeological deposits, to a certain extent these variables may reflect the impacts of excavation of the cave entrance deposits by archaeologists or by cave explorers. However, they may also reflect enlargement of cave entrance areas in antiquity, either by human agency or by the activities of carnivores. There is copious evidence that human use of caves creates an archaeological record that is a palimpsest of disparate activity episodes, and that caves amenable for use by humans are also attractive to cave-dwelling animals - the strong association between faunal remains and prehistoric cultural material (see below) reaffirms this latter point.

Additional predictors of cave archaeology that appear to be regionally specific include altitude and distance from surface water sources, which in the Peak District are strong and weak predictors respectively, and aspects directed towards the East or West, a minor predictor of archaeological material in the Yorkshire Dales. Our analysis is a preliminary one that has not considered more complex topographic predictors such as spatial proximity to other categories of archaeological sites, extent and nature of viewsheds, terrain morphology, bedrock geology, etc., and these kinds of more sophisticated analysis might best be performed in a separate project using a GIS software application incorporating a digital elevation model and geological data overlays.

7.13 Analysis of Finds Data

The following categories of finds were listed as present or absent at each cave site:

Flint, Other Lithics, Prehistoric Pottery, Historic Pottery, Glass, Human Bone, Faunal Remains, Worked Bone, Bronze/Copper, Iron, Coins, Other Metal Artefacts, Charcoal

The datasets for both study regions were combined and the data were analysed using Principal Components Analysis, a technique which reduces a large number of variables into a reduced number of components which account for most of the variation in the original data. The analysis generated two principal components with eigenvalues greater than 1.0; together these accounted for 65% of the variation in the finds dataset. The principal components were rotated to provide maximal separation between clusters of variables.

The analysis is effective in identifying a distinct cluster of intercorrelated variables associated with prehistoric finds, and a separate cluster of variables representing mainly finds of historical period artefacts (Figure 7.30). The ‘prehistoric’ variables have high scores on Component 1 and low scores on Component 2, and they include flint artefacts, prehistoric pottery, charcoal, human bones and faunal remains. The ‘historic’ variables (which also include a few examples of late prehistoric metalwork) have a broad range of scores on Component 1 but they have uniformly high scores on Component 2. These artefact types are primarily metal artefacts (including coins), historic pottery and glass. Other lithics (i.e., non-flint stone artefacts) and worked bone occupy an intermediate position on the component plots, but appear to be more closely associated with the cluster of historic variables.

The close association of human skeletal remains with prehistoric artefacts in cave deposits confirms what is now a well-established pattern, first identified by John Gilks from artefact associations (Gilks, 1989) and subsequently corroborated by direct radiocarbon dating of human remains (Chamberlain, 1996). Human remains in British caves date almost entirely to the prehistoric and Romano-British periods, and a similar pattern is emerging from studies of Irish caves (Marion Dowd, pers.comm.). The separation of the cluster of Roman and post-Roman period artefact types indicates how the deposition of cultural material in British caves continues into the
historical period, but with a change of character, as human remains become a less frequent and eventually an absent component of the depositional assemblages.

The close association of human and faunal remains could relate to their co-occurrence under the same preservation conditions, but note that they are separated on the component plot from worked bone, so taphonomic factors alone do not account for this association. Faunal remains in caves are accumulated mainly by natural processes including carnivore activity, colluviation in dolines and accidental falls of animals into vertical shafts. Although faunal remains are amongst the most common finds in the caves of the study regions, the range and extent of natural faunal accumulation in caves may have undergone a reduction in historical periods as large carnivore faunas were steadily persecuted to extinction and wild ungulates were excluded from the limestone uplands.

![Rotated Principal Components Plot of Finds Data](Figure 7.30)
8 SUMMARY OF MAJOR RESEARCH FINDINGS

8.1 Summary of desk-based and field survey

Desk-based and field-based assessment were used to obtain data on cave sites in the limestone regions of the Peak District and Yorkshire Dales National Parks. The data included information about cave locations, landscape settings, the geomorphology of the cave site, cave entrance dimensions, deposits, finds and conservation status. A cluster/case-control sampling strategy was adopted whereby all known archaeological caves were visited together with a sample of caves of unknown archaeological status located in the same geographical area. Approximately 190 caves in the Peak District and 230 caves in the Yorkshire Dales were sampled for inclusion in the study. The survey effort per unit of data return was higher in the Yorkshire Dales than in the Peak District, reflecting the more expansive nature of the Yorkshire terrain and extension of travel times to sites. Many previously unrecorded cave sites were located and recorded in both study areas.

The data acquisition procedures adopted for this study appear to be robust and reliable and may be adopted, with appropriate modification, in other karst limestone areas of Britain. There were problems in gaining permission for access to some localities, but these were mitigated by selecting nearby alternative areas to conduct the field surveys. Problems with vegetation hindering visual walkover survey were mitigated by repeat visits to certain localities in different months of the year. Some ongoing threats to vulnerable caves and their deposits were identified, but the general extent of these threats was lower than previously thought, especially in comparison with other surveyed regions such as the southern Magnesian Limestone outcrop (Davies et al., 2004). The desk-based and field survey elements of the project produced a comprehensive and reliable dataset from which quantitative analyses of patterns in the distribution of cave archaeological remains could be undertaken.

8.2 Summary of results of the quantitative analysis

The quantitative analysis of the data obtained in the desk-based research and field surveys generated some important and novel findings. These are summarised as follows:

(Section 7.2) A significantly greater proportion of sites were recorded as archaeological caves in the Peak District compared to the Yorkshire Dales, and within both study regions there were significant variations between catchment areas in the frequency of cave archaeology. These variations may in part reflect genuine spatial variation in ancient cave usage, rather than simply reflecting a historical research bias towards archaeological investigations in certain regions or areas.

(Section 7.3) In the Peak District there is a strongly significant association of cave archaeological remains with increasing altitude, but this relationship is not seen in the Yorkshire Dales.

(Section 7.4) A slightly significant association was found between the aspect of the cave entrance and the presence of archaeological caves, with an apparent increase in the likelihood of finding archaeological evidence in east and west-facing caves.

(Section 7.5) In both study regions a strong positive correlation was found between the presence of archaeological caves and various measures of cave entrance size.

(Section 7.6) No significant association was found between archaeological caves and general topographic ground slope, but negative slopes outside and inside cave
entrances (i.e. slopes into the cave) were significantly associated with the presence of archaeological caves. This pattern of association may reflect the impact of archaeological excavation on cave deposits, but this is nonetheless a good marker for identifying cave sites with unrecorded excavations.

(Section 7.7) A weak association was found between the presence of archaeological caves and the condition of the cave sediments – this association only reaches statistical significance in the Yorkshire Dales, where there is a clear association of recorded archaeological remains with damaged and eroding sediments. The analysis also confirmed that previous excavations rarely resulted in the complete removal of all sediments from the cave.

(Section 7.8) Proximity to water was not found to be a strong predictor of the presence of archaeological caves. In the Peak District archaeological caves were located on average further from water, but this is likely to be a direct function of the association between cave archaeology and higher altitude.

(Section 7.10) The predictive model developed for the Peak District caves gave a correct classification for 80% of the caves in terms of the known presence or absence of archaeological evidence. It also identified a group of non-archaeological caves with high discriminant scores on the model, and therefore high probabilities of being archaeological caves: many of these sites were unrecorded in cave registries and were first identified as cave sites during this survey.

(Section 7.11) The predictive model for the Yorkshire Dales caves also gave correct classifications for about 80% of caves. Unlike the Peak District, no caves with high discriminant scores were newly identified caves: all had been recorded on the regional cave registries. The probabilities of containing archaeological material in these high-scoring Yorkshire Dales caves was higher than for their equivalents in the Peak District. This may be because a much smaller proportion of caves appear to have been subjected to archaeological investigation in the Yorkshire Dales, so that more high-potential sites remain untouched in this region.

(Section 7.13) The analysis of the finds data revealed an interesting pattern that indicated that a quite different assemblages of finds accompanied cave usage in the prehistoric and historical periods. Human skeletal remains are clearly associated with prehistoric artefacts in the caves of both regions, confirming the pattern observed from radiocarbon dating that places most cave burial in the prehistoric or Romano-British period.
9 GLOSSARY

Aven - A vertical extension from a cave passage, not breaking through to the surface but sometimes leading to passages at higher levels.

Bedding Plane - The parting between two beds of rock, which may be enlarged by limestone solution to form a low wide cave that is penetrable by flat-out crawling.

Carboniferous - The geological time period from about 360 to 290 million years ago.

Cave - A natural underground cavity or passage large enough to be entered by a person. The term is often restricted to those cavities not requiring specialised equipment for exploration, as distinct from potholes (vertical cave passages) and sumps (flooded sections of cave passage). Caves in limestone are formed by dissolution, erosion and gravitational breakdown of the rock.

Cavernous Karst - Limestone landscape that includes both surface karst features and also extensive underground cave systems.

Choke - A mass of boulders or other material blocking progress in a cave passage.

Clint - Block of limestone within a limestone pavement, bounded by grykes.

Doline - A subcircular bowl-shaped depression in the ground surface of karst terrain, formed by one or more of several processes: localised dissolution of the bedrock surface, roof collapse into underground cave passage, and suffosion of surface deposits into underlying solution pipes. In northern England dolines are often referred to by the local term ‘shakehole’.

Dolomite - A carbonate rock in which more than 50% of the mineral is composed of calcium magnesium carbonate.

Dry Valley - Former drainage channel abandoned by surface flow when underground drainage is established in a karst region.

Erratics - Boulders of non-local lithology that have been transported by ice action.

Fault - A tectonic fracture in rock showing relative displacement of the two sides, either vertically or horizontally.

Fissure - A natural narrow but relatively high passage, often developed along a natural joint or fault and sometimes with roof open to the ground surface. Natural fissures with no dissolution are termed ‘crevice caves’, and these can develop in any type of massive rock.

Flowstone - A speleothem formation deposited from flowing water as a sheet on walls or floors.

Fluviokarst - A karst landscape with landforms dominated by valleys cut by surface rivers. Most fluviokarsts are relicts with dry valleys and little perennial surface drainage.

Glaciokarst - A karst landscape that is strongly influenced by glacial and periglacial processes. The Yorkshire Dales contain Britain’s finest glaciokarst.

Gryke or Grike - A fissure between clints within a limestone pavement

Joint - Natural vertical fracture in rock strata without displacement. Often perpendicular to bedding planes.

Karst - A distinctive terrain created by aqueous dissolution of a (usually carbonate) rock, where the landforms are a consequence of efficient underground drainage.
**Limestone** - A sedimentary rock composed of more than 50 per cent calcium carbonate and therefore soluble in weak acids including rain and soil water. Dolomitised limestone has been altered by the introduction of magnesium after deposition.

**Limestone Pavement** - Exposed bedding plane surface, usually scraped clean by glacial action, and subsequently carved by dissolution into clints and grykes. Best developed where the regional dip of both rock beds and ground surface is low.

**Phreatic** - Pertaining to features in a cave that were formed by solution and erosion of rock below the water table, where dissolutional processes act evenly on all passage surfaces. Includes rounded or elliptical passage cross sections, scalloped walls and roofs, etc.

**Pitch** - A vertical or near vertical descent usually negotiated using ladders or vertical access equipment.

**Pothole** - A vertical pitch open to the surface, or a cave system dominated by vertical descents requiring caving equipment.

**Rake** - A large mineral vein emplaced in a joint or fault line.

**Resurgence** - The re-appearance of an underground stream at the surface. Technically the term is restricted to underground streams that are recharged from allogenic sources.

**Rift** - General term for a large underground chamber elongated in the vertical plane.

**Rising** - A karstic surface spring whose source is unknown. Technically termed an exsurgence if the source is known to be autogenic, i.e. from groundwater.

**Rock shelter** - A cave of shallow depth and broad entrance characterised by an overhanging roof and poorly defined side walls.

**Shakehole** - see doline

**Sink or Sinkhole** - Any place where water disappears underground or has done so in the past. Also referred to as swallow or sinkwell.

**Sough** - A mined passage that serves to divert water from an underground mine to a nearby or distant surface drainage course.

**Speleothem** - A secondary carbonate mineral deposit found in caves and formed primarily by chemical precipitation from supersaturated solution.

**Squeeze** - A narrow part of a cave passable only with effort.

**Stalactite** - A speleothem formation hanging from the roof.

**Stalagmite** - A speleothem formation building up from the floor.

**Swallet or Swallow** - See sink

**Vadose** - Pertaining to features in a cave that were formed by solution and erosion of rock above the water table, where dissolutional processes act primarily on those sections of the cave that carry water (i.e. the passage floor). Characterised by continuous downslope profiles and canyon passages formed by floor erosion.

**Water-table** - The surface of the zone of permanent saturation. It may fluctuate with weather and seasons. A perched water-table is held above the usual height by a local barrier to downward percolation such as an impermeable geological stratum.
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