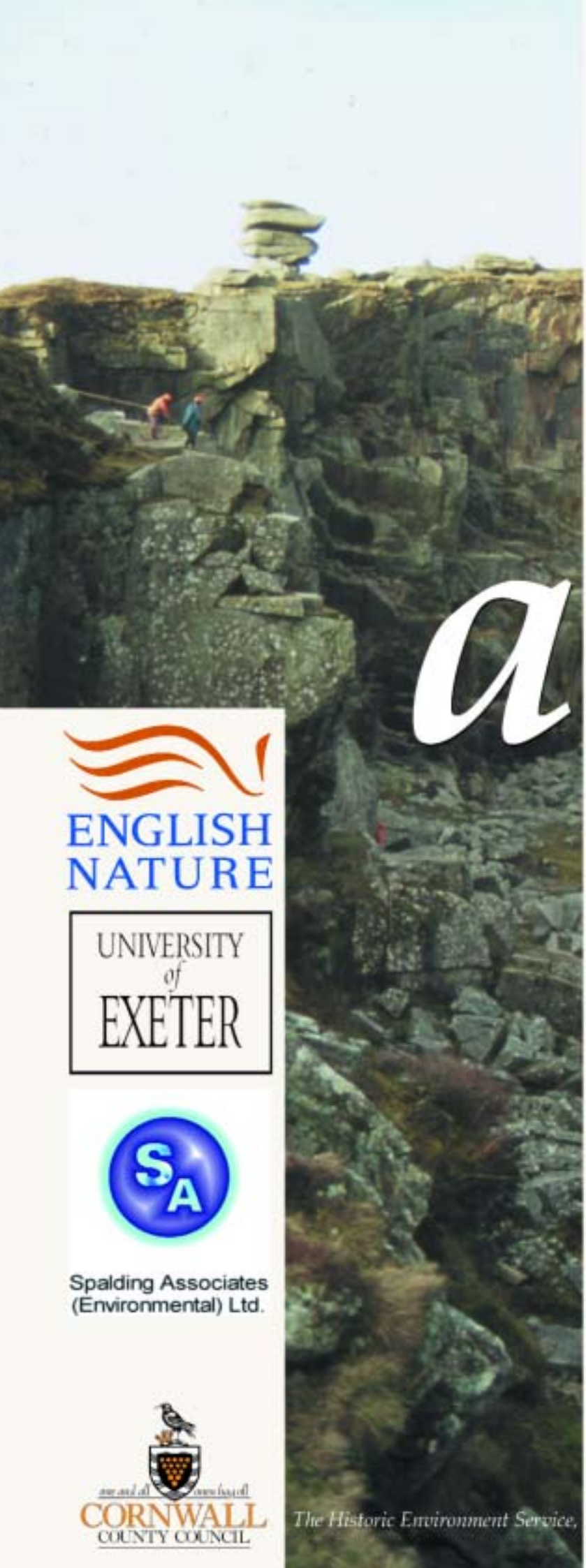

ENGLISH NATURE

UNIVERSITY of EXETER

Spalding Associates (Environmental) Ltd.

CORNWALL COUNTY COUNCIL

the conservation value of

abandoned pits and Quarries

in

CORNWALL

edited by: Adrian Spalding
Stephen Hartgroves
John Macadam
David Owens

The Historic Environment Service, Cornwall County Council

a the conservation value of *bandoned pits and Quarries in* CORNWALL

edited by: *Adrian Spalding*
Stephen Hartgroves
John Macadam
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for the Derelict Land Advisory Group

A report of the conference on 22nd March 1999

The Historic Environment Service,

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Foreword

This report is the result of the conference held in Truro in 1999 on the conservation value of abandoned pits and quarries. The conference highlighted the importance of these quarries for industry, geology, nature conservation, archaeology, amenity, education and research. It brought together planners, industrialists, statutory advisors and academic researchers to work towards an integrated holistic approach.

Abandoned pits and quarries in Cornwall in their day represented a major resource for local building stone but today many are of national importance for their historic, geological and wildlife value. Large numbers have already been lost, through such activity as rubbish dumping, and many are under threat, particularly from the presumption that quarries should be filled in or restored after production has ceased. Some of the pre-war quarries are especially in danger of being filled in because of their small size and perceived nuisance value, coupled with a lack of knowledge of their conservation importance. This report sets out the way forward and encourages planners and landowners to recognise that maintaining or enhancing the conservation value of pits should be considered an acceptable after use. It is equally important, however, for conservationists to understand that, even though currently abandoned, many quarries represent a resource that should not be sterilised in the interests of conservation. This is particularly true of those quarries that can be used to provide distinctive stone for the repair and conservation of historic buildings.

This report is the work of the Derelict Land Advisory Group which was established in 1995 with the aim of highlighting the conservation value of the derelict post-industrial landscape. As this report demonstrates, to achieve this aim the group needed to draw together evidence on biodiversity, mineralogy, geology and historic heritage. The next task for the group is to facilitate an audit of quarries in Cornwall to provide the basic information to guide their management and conservation. The group secretariat is based at Camborne School Mines and we are pleased to support the work of this group and hope that the lessons learned in Cornwall can be applied elsewhere in Britain to inform the future management of our industrial landscape.

Professor Keith Atkinson

Head of Camborne School of Mines
University of Exeter.

DERELICT LAND ADVISORY GROUP

1. History

The Derelict Land Advisory Group (DLAG) was established in 1995 in response to the 1995 conference organised by the Cornish Biological Records Unit (University of Exeter) on the theme of Derelict Land: a challenge for conservation and community. At this conference, papers were presented on planning, mining, ecology, education and research, mineralogical and geomorphological conservation. It was clear that this conference met a real community need for the establishment of a holistic approach in which the different scientific disciplines met together in the consideration of derelict land reclamation. The Group was set up to take the initiative forward and maintain the consensual approach. The first outputs were the publication of a report on the conservation value of metalliferous mine sites in Cornwall and a small colour leaflet available at a wide range of outlets.

2. Partners

Participating organisations have included the following: Camborne School of Mines, Cornwall Archaeological Unit, Cornwall County Council, Cornwall Wildlife Trust, Environment Agency, Imerys, English Nature, Institute of Cornish Studies, Kerrier District Council, National Trust, RIGS and Trevithick Trust.

The secretariat is based at Camborne School of Mines (contact: Vicky Watkins)

Chairman: Steve Hartgroves, Historic Environment Service, Cornwall County Council

3. Rationale, aims and objectives

Rationale: to highlight the conservation value of the derelict post-industrial landscape for its biodiversity, mineralogy, geology and historic heritage.

Objective: to conserve a range of derelict mining and quarrying sites in Cornwall for future generations to appreciate and use for amenity, scientific research and education, as part of the biodiversity, history and culture of the Cornish landscape.

Aims:

- to encourage the conservation of the best examples of derelict land
- to inform planners, land managers and the general public of the importance of derelict land
- to promote best practice in the survey and management of derelict land sites
- to promote research into the value of these sites for biodiversity, mineralogy, geology and historic heritage

4. Achievements

- *The conservation value of metalliferous mine sites in Cornwall* (1996) edited by N. Johnson, P. Payton & A. Spalding. 54pp
- A colour leaflet highlighting the importance of derelict mining sites
- A conference on *The conservation value of abandoned pits and quarries*. March 1999
- This report on *The conservation value of abandoned pits and quarries in*

Cornwall forms part of the process of informing planners, land managers and the general public of the importance of derelict land

Adrian Spalding

Chairman 1995-2001

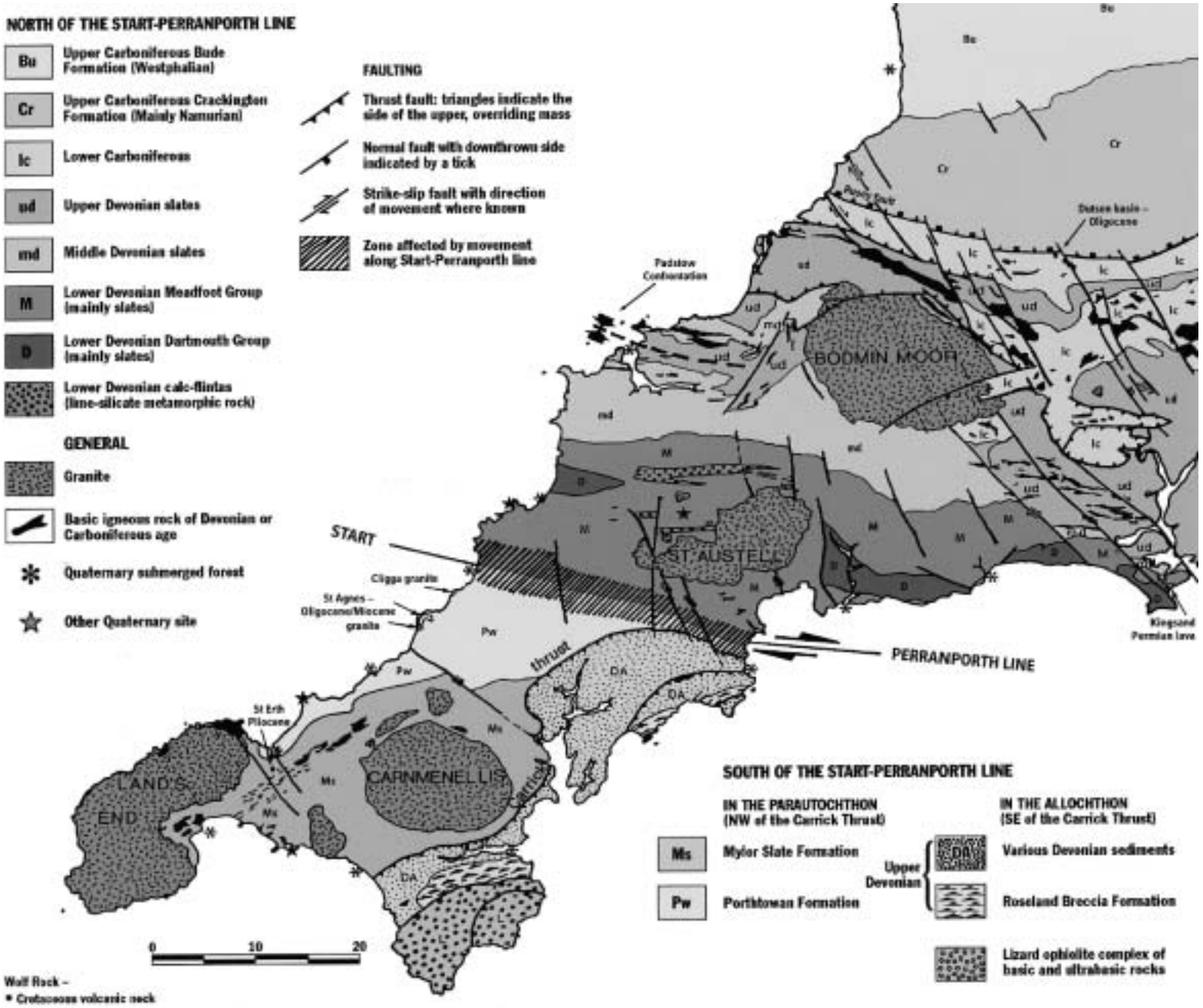

Figure 1: *Geological map of Cornwall showing the different types and ages of rocks found in the county, together with the main faults and structural units. Partly based on the 1:250,000 scale British Geological Survey maps by permission of the British Geological Survey, IPR/27-24C. c. NERC. All rights reserved. From: Cornwall's Geology and Scenery - an Introduction (Bristow, 1996).*

CHAPTER *One*: GEOLOGY

Colin Bristow (Camborne School of Mines)

Abstract

Arising from its exceptionally interesting geological history, Cornwall has a rich variety of non-metallic raw materials which have been extensively exploited, both for local use and for export outside the County. This has created a legacy of abandoned quarries and pits scattered all over the County which, together with their waste tips, involves a substantial area, comparable to that affected by former metalliferous mining activity. Many of these sites offer unusual habitats and the biodiversity in old quarries and pits is often greater than the undisturbed ground before quarrying. As a result, many sites of former extractive activity have become valued wildlife reserves or biological SSSIs. Abandoned pits and quarries also often provide valuable information about the underlying geology, especially in a county like Cornwall where inland exposures are few and far between, so many have a geological conservation designation. One of the greatest threats to these sites is infilling and fly tipping. In terms of conserving our local heritage and character, there is also a long overdue need to identify and conserve the sources of building and ornamental stones, such as Cataclews, Pentewan, Newham, Polyphant, Tremore, various granite quarries, etc., which give the Cornish built environment much of its character. It is recommended that consideration be given to restoring facilities for small amounts of these stones to be extracted for the maintenance of listed buildings and for special projects which are going to reflect the local tradition of building. It is also recommended that an inventory of abandoned pits and quarries be drawn up, based on archive maps, field visits and literature search.

1. Introduction

Mankind's extractive activity has a long history going back to the times when Stone Age peoples first utilised stone for building, exploited clays to make pottery and opened mines for flint. Over the course of millennia this extractive activity has created many abandoned pits and quarries. Most of the early workings which were abandoned a century or more ago were relatively small and have been used as a convenient place to dispose of a great variety of unwanted materials. Subsequent revegetation has merged these early workings back into the landscape with little indication that a pit or quarry once existed. Generally speaking, the softer the rock which was exploited, the more rapidly the indications of an excavation have disappeared. Nevertheless, there are many abandoned pits and quarries still recognisable and this chapter will examine the conservation aspects of these from a geological point of view.

The geology of Cornwall has been covered in two recent books (Bristow, 1996 and Selwood, Durrance & Bristow, 1998). The former is an introduction to Cornwall's geology and scenery suitable for the general reader, whilst the latter is a more detailed account with each chapter written by a specialist in the field concerned, together with a list of Cornish geological SSSIs, GCRs (Geological Conservation Review

sites) and RIGS (Regionally Important Geological/ Geomorphological Sites) in an Appendix. Valuable reviews describe the igneous rocks of South-west England (Floyd, Exley & Styles, 1993) and the minerals of Cornwall and Devon (Embrey & Symes, 1987). Some notable Cornish building and decorative stones were reviewed by the author recently (Bristow, 2001). A report on the mineral resources of Cornwall by the British Geological Survey (Scrivener et al., 1997) and the Cornwall Minerals Local Plan (1997) also contain much useful information.

This chapter is going to open with a brief discussion of the case for conservation of this type of site, followed by a brief description of the geological history of Cornwall. The non-metallic geologic materials which have been extracted in Cornwall and the kinds of exploitation associated with each are then reviewed although, in the space available, this review is by no means exhaustive.

2. Conservation and abandoned pits and quarries

Why do we want to examine the case for conserving abandoned pits and quarries? Nowadays, any proposal to open a new quarry is perceived by the general public as a 'threat to the environment', but the paradox is that abandoned pits and quarries are often associated with greater biodiversity and more unusual habitats than the farmland or moorland which formerly existed before the quarry was opened (Leake, 2002). There is, therefore, a case for conserving some of these unusual biological habitats; this topic will be explored in greater depth in other contributions to this report.

Quarries can also provide valuable geological information about the underlying rock types which, in a county like Cornwall where inland rock exposures are few and far between, can be extremely valuable. Many geological Sites of Special Scientific Interest in Cornwall are therefore in abandoned pits and quarries. These sites also attract visiting parties of geology and geography students as well as tourists interested in geology.

There are many threats to small abandoned pits and quarries, as they are convenient receptacles to dispose of unwanted material, whether it be building rubbish, garbage or just stones from an old hedge which has been removed. An example of this would be the elvan quarries between Penrice House and Castle Gotha, near St Austell (SX 027498), which were open 100 years ago, but are now completely invisible (the stone to build Georgian Penrice House may well have come from these quarries). Planning law is often ineffectual in preventing old excavations from being used as tips. In any case, natural processes will always cause excavations to fill with material washed in from the surrounding area and for the abandoned faces in a quarry to revegetate and grow over, ultimately to become weathered and cloaked in plant growth and soil so that all traces of the geology are lost. The Cornwall RIGS Group exists to identify regionally important sites, and many small abandoned pits and quarries have become RIGS. These are registered with the Local Planning

Authorities so that future planning activity can take into account the existence of the site. In some instances there may be a case for clearing vegetation, soil and rubbish from the faces of a quarry so the geological features can be properly seen, as has recently been done for the Polpuff pegmatite quarry, near Trezaise, Roche (SW 996586), now a geological nature reserve leased by Cornwall Wildlife Trust from the Goonvean china clay company. Planned partial backfilling of a quarry need not be incompatible with maintaining its geological interest. In a few cases there may be limited conflict between the interests of biological and geological conservation, but generally the two can happily live alongside one another, as in the example quoted at Trezaise above.

There is yet another conservation aspect - the conservation of the Cornish built environment. When we look back at the First Edition (ca. 1880) of the 1:2500 series of Ordnance Survey maps we find that there were far more small quarries than now exist, and many villages had a quarry for building stone and/or a borrow pit to extract material to mend the roads with. Many of these quarries were for building stone which gave the local built environment much of its character; some quarries were for building and ornamental stones which were more widely used all over Cornwall or even further afield. With the almost universal use of concrete and brick building materials over the last fifty years, most of the quarries which supplied Cornish stone for Cornish buildings have gone out of use, with some notable exceptions such as Delabole slate and De Lank granite.

Cornwall is particularly well endowed with a wide variety of building stones, ranging from strong granites used to build lighthouses in some of the most exposed situations around the British Isles, to durable freestones such as Cataclews, Pentewan and Newham, as well as ornamental stones such as Polyphant, Tremore elvan and Luxullianite, which have been used nationally in cathedrals and palaces.

In terms of conserving our local heritage and character, there is a long overdue need to identify the sources of these special stones and take steps to preserve a facility for stone to be extracted for the maintenance of listed buildings and for special projects which are going to reflect the local tradition of building. Building conservation is therefore one of the important topics to arise from this report and Planners are urged to require new building work to use Cornish materials wherever this is appropriate.

3. Geological history

Whilst the deep cleft of the Tamar valley forms a clear boundary, both on geographical and cultural grounds, to Cornwall; the same cannot be said of the geology. The entity to which Cornwall belongs is the Cornubian Massif, which includes all of the South-west peninsula area west of a line from Minehead to Torquay.

The Cornubian Massif is a much eroded stump of a mountain range composed of

folded and faulted Devonian and Carboniferous rocks, which was thrown up during the Variscan mountain building episode (orogeny) between 350 and 290 million years ago. The Cornubian Massif extends offshore out under the Atlantic, but millions of years of attack by the sea have reduced this part of the massif to a level below the waves.

The Devonian and Carboniferous rocks were laid down during the period extending from 400 million years ago up to the Variscan orogeny and were largely deposited under the sea, at a time when Cornwall lay close to the Equator. They were laid down mainly as muds and sands, now converted into slates and sandstones by the heat and stresses of the Variscan orogeny. There was also extensive basic volcanicity, which resulted in lavas such as basalts being extruded onto the sea floor. Sometimes the volcanicity was explosive and beds of agglomerate and volcanic ash settled onto the bottom of the sea. Some of the volcanic magma did not reach the surface and was intruded into the sediments underlying the sea floor, typically forming dolerite intrusions. Basalts, dolerites and related rocks are basic igneous rocks (basic = low silica content) and are known colloquially as 'greenstones'. Occasionally the greenstone has an even lower silica content and is then called 'ultrabasic'.

The Lizard is also composed mainly of basic and ultrabasic igneous rocks, mostly as intrusions, which originally formed the earth's crust beneath the waters of a long vanished ocean. High temperature metamorphism and thrust faulting affected parts of the Lizard Complex and somehow this battered mass of oceanic crust has been translated by faulting to lie adjacent to the Devonian sediments of the Gramscatho Basin in southernmost Cornwall. Much of the ultrabasic rock has been converted by later lower temperature circulating water into serpentine, sometimes with veins of talc.

The Gramscatho basin lay in west Cornwall and contains deep water muddy and sandy sediments of Middle and Late Devonian age. The north side of this basin is formed by a major structural feature, probably a dextral fault, which extends from Perranporth on the north coast to Polrudden Cove, near Pentewan on the south coast. Submarine slump breccias are found on the south side of the Gramscatho Basin and separate the Lizard Complex from the main part of the basin; these breccias continue eastwards along the south side of the Roseland peninsula and include large blocks up to 1 km long of quartzite and limestone.

In very general terms, the early part of the Devonian period in the rest of Cornwall is characterised by a mixture of mud and sand deposition, with occasional impure limestones, whilst the middle and later parts of the period are characterised by mud deposition. Curiously, the extensive Middle Devonian limestones of South Devon do not extend into Cornwall, with the exception of a tiny patch of limestone at Marble Cliff, near Trevone and some impure limestones south of Liskeard.

The early part of the Carboniferous saw the earliest phase of the Variscan Orogeny affecting the south of Cornwall, whilst in

the north of the County we find deep water sediments, mainly of a muddy nature, with other sediments such as chert and occasionally limestone. The occurrences of limestone are small and confined mainly to the area between Bodmin Moor and Launceston. There is evidence of extensive volcanicity in the early Carboniferous. The later part of the Carboniferous is only found in North Cornwall and the muddy and sandy sediments laid down at this time represent the final infilling of the sedimentary basin. As a crude generalisation, Devonian rocks are generally found south of an east-west line through Launceston and Carboniferous rocks are found to the north of this line (Figure 1).

The Variscan Orogeny represents the collision between two tectonic plates, one moving up from the south and the other lying north of our region. It affected the region as a series of pulses, starting in the south in the early Carboniferous and culminating in the north of Cornwall late in the Carboniferous Period. After the Variscan Orogeny molten granites welled up into the heart of the Variscan Mountain Range between 300 and 270 million years ago (late Carboniferous/early Permian), forming a series of large granite intrusions (Figure 1). Granites are 'acid' igneous rocks, as they have a high silica content.

Heat from the granites caused metals to be sweated out from the granite and the surrounding rocks ('killas'), and hot solutions containing these metals moved through cracks until they reached cooler locations where the ores of tin, copper and other metals and industrial minerals crystallized to form veins. The hot fluids also extensively rotted the granites, so that later altering fluids could penetrate into the granite and convert the feldspars to china clay.

Following the emplacement of the granites in the Permian, come the geological periods known as the Triassic, Jurassic and Cretaceous, known collectively as the Mesozoic, when Dinosaurs ruled the land. For much of the 180 million year time span of the Mesozoic the Cornubian Massif appears to have been an island, although there are no rocks of this age preserved onshore today in Cornwall. Cornwall had a much warmer climate at this time and chemical weathering affected the granite and killas to a considerable depth. Most of this weathered material has been removed by erosion, but remnants of the deepest pockets of weathering can still be found. This deep weathering also contributed to the formation of the china clay deposits.

Although the outcrops of the still younger Tertiary rocks in Cornwall are quite small, they contain a wide range of ages and give us a useful picture of palaeogeographic and palaeoclimatological conditions. During the Tertiary the present shape of Cornwall's scenery began to be formed, partly as a result of further deep weathering of the rocks under a sub-tropical climate, and partly as a result of fault movements. The flat-topped Cornish killas plateau seen throughout the County is a product of the long periods of weathering in the Mesozoic and Tertiary.

After some very warm and wet conditions at the beginning of the Tertiary, the world's

climate cooled and, at the end of the Tertiary, about 2 million years ago, further cooling took place and the period of the Ice Ages began. Cornwall was not glaciated but the climate, during the coldest periods, was comparable to Northern Canada or Siberia today. At the same time, the world's sea levels fell by up to 120m due to significant quantities of water being locked up in ice sheets on land. Consequently, valleys were cut into the Cornish killas plateau by the torrential mud-laden floods in the spring thaws and, near the coast, were cut well below present sea level. As the climate ameliorated after each glaciation, sea level rose and the overdeepened valleys were filled with sediments. The first sediment to be deposited at the base of each infill sequence was usually a poorly sorted clayey gravel which, in those areas where the catchment is mineralised, usually contained significant quantities of the tin-bearing mineral cassiterite. This was exploited by tin streamers from the Bronze Age onwards and some 40% of all tin produced from Cornwall came from this source. Most of the valleys draining mineralized ground in Cornwall have been turned over at some stage by tin streamers, although in the majority of cases there is little surface evidence to show that this has taken place.

In the short temperate interludes between the glaciations, the sea level rose and flooded the overdeepened valleys to produce the estuaries reaching into the hinterland of Cornwall, which are such a characteristic feature of present-day scenery. At times during the interglacials sea level was higher than present, which resulted in the formation of raised beaches, some of which are largely composed of biogenic calcareous sands. These have become naturally cemented in places to form a rock known as 'sandrock', which was exploited on a small scale for building. These calcareous sands have also been extensively exploited as a source of lime-rich material for treating the generally acid soils of Cornwall.

4. Extractive activity leading to the creation of derelict land

Extractive activity will involve the creation of a 'quarry' (for hard rocks) or a 'pit' (for soft or unconsolidated materials), together with dumps of unwanted material composed of overburden and waste material from the pit or quarry. In addition, there may be buildings associated with the extractive activity which may be of interest to the industrial archaeologist. Occasionally, the extractive activity involved underground mining. Most of the larger quarries were carried down below the water table and therefore became partially flooded after working ceased.

The following account mentions many quarries, but it is far from comprehensive and many important quarries have not been mentioned. There is clearly a need to produce an inventory of quarries (active and abandoned) in Cornwall. Ideally, this should involve visiting each site to assess its state and significance, together with a search of the literature and archives, especially maps. A systematic survey of this kind would probably throw up further proposals for RIGS sites, or maybe SSSIs.

China clay is excluded from this survey, as it has been extensively covered in recent

investigations and reports (see Scrivener *et al*., 1997 for list of relevant publications). Derelict land associated with metalliferous mining was dealt with in an earlier report (Johnson, Payton & Spalding, 1996).

In simple terms we can sub-divide other extractive activity in the County into:

- Granitic rocks, including elvans of 'acid' composition
- Greenstones, mostly 'basic' or 'ultrabasic' igneous rocks, both extrusive and intrusive
- Slates
- Sandstones
- Limestones and cherts
- Industrial minerals, e.g. feldspar, fluorspar
- Unconsolidated materials of Tertiary or Quaternary age
- Brick clays

4.1. Granitic rocks

Stone has been extensively used for building in Cornwall since Neolithic times, and the most durable material has been **granite**. Many of the standing stones and hut circles in Cornwall are made of granite, so the use of granite may well have a history stretching back four thousand years or more. Throughout most of history, working involved retrieving large blocks of loose granite ('moorstone') lying on the surface and then shaping them for use; only in the last few hundred years have quarries been opened to provide stone. A useful review of the granite quarrying industry in South-west England has recently been published (Stanier, 1999).

Figure 2 *Flooded former dimension stone quarry at Higher Trolvis, near Longdowns. Note the waste tip on the right composed of large flawed blocks of granite. There is around 1.5 km² of land affected by granite quarrying in the Carnmenellis granite. (c. Colin Bristow)*

Two types of granite quarry can be recognised. The quarries which were opened for building stone are usually deep and steep sided, as granite quality tended to improve downwards. They are usually accompanied by tips composed of large flawed blocks of granite (Figure 2). Such tips provide an unusual ecological environment, with gaps between the blocks providing a refuge for small animals. On the other hand, quarries for aggregate are usually more extensive and are often benched (Plate 1). Most present day quarries are worked for aggregate production. Their tips are composed of overburden, weak granite and unsaleable granite fines, and there may be a small slimes pond as well. Both tips and slimes ponds from aggregate quarries will readily and naturally revegetate.

Granite quarries have been opened in all the main granite plutons in Cornwall, for full details see Stanier (1999). The easternmost small granite mass in

Cornwall, at **Hingston Down**, has been quarried and one large quarry presently produces granite aggregate for concrete and road construction (SX 410717). A quarry on the north side of the Kit Hill granite mass (SX 374716) exploited granite mainly for dimension stone.

Excellent quality granite, for use as a dimension stone, (dimension stone = stone which can be cut into blocks which can be used in ashlar masonry or cut to form facing slabs) is still worked in De Lank quarry (SX 101755) and the nearby Hantergantick quarry (SX 103757), on the west side of the **Bodmin Moor** granite. This coarse-grained biotite granite (biotite = an iron bearing mica) was used in many famous lighthouses (e.g. Eddystone, Bishop Rock and Beachy Head) and bridges (e.g. Tower and Blackfriars Bridges in London). There are a number of other abandoned quarries in the St Breward area. A large quarry below the Cheesewring (SX 258723), on the southeast side of Bodmin Moor, also yielded high quality granite which was taken for shipment at Looe via the Caradon railway. Some of the finger tips of reject granite blocks have recently been removed (see Case Study 3).

In the eastern part of the St Austell granite, high quality coarse grained biotite granite with large megacrysts (megacryst = large crystal) of orthoclase feldspar, renowned for its strength, was formerly quarried from the Luxulyan area (Tregarden [SX 053590], Carbean [SX 065579], Colcerrow [SX 063577] and Orchard [SX 060568] quarries), and many famous buildings (e.g. the British Museum) and engineering structures (e.g. the old London Bridge and Plymouth Breakwater) were constructed from it. The exterior of Porphyry Hall and the Tower at Place, Fowey are of Luxulyan granite. Tregarden quarry at Luxulyan currently produces aggregate, but is scheduled for closure (Plate 1). A striking variant of the Luxulyan granite is 'luxullianite', which is made up of black tourmaline and pink orthoclase feldspar. The Duke of Wellington's sarcophagus in St Paul's Cathedral is made of luxullianite and it is also superbly displayed in polished slabs at Porphyry Hall, Place, Fowey (Plate 2). Luxullianite occurs in Tregarden quarry and discussions are currently taking place as to how to best preserve access to the luxullianite, if and when the quarry is closed. It will be an interesting test case to see how well this can be done. Nearer St Austell, the Carn Grey quarries (SX 034551 and 035552) yielded a granite intermediate in character between the Luxulyan type and the more unusual lithian mica types of the western part of the granite. Much of the Carn Grey stone was used in older constructions in the St Austell area. Now abandoned, the main Carn Grey quarry has been made into an amenity area by Restormel Borough Council (Figure 3). China Stone-type granites are low in iron and high in lithium and fluorine containing minerals, hence they are pale coloured. Because of their fine grain, attractive pale colour and slightly softer, more easily worked nature, they are attractive as building stones and are known to architectural historians as 'St Stephen's stone'. This has been extensively used in building, notably as the interior stone for Truro Cathedral, which came from Cathedral Quarry, Nanpean (SW 950560).

Also the granite used in St Paul's church at Charlestown came from a quarry (SX 012569) in a small boss of china stone-type granite at Stenalees, recognisable by containing occasional turquoise blebs and veins. Small quantities of china stone are still produced from Rostowrack quarry near Nanpean (SW 954564) for use in the ceramic industry. There are a number of other derelict granite quarries in the Nanpean-St Stephen area, which have been used as a source of building stone, notably Burthy quarry (SW 917555), now buried beneath china clay waste.

Figure 3 *Carn Grey quarry, now made into an amenity area by Restormel Borough Council, note natural tor at the top of the quarry face. Many of the older buildings in St Austell are built with stone from this quarry and megaliths such as the Tristram Stone and the Penrice Longstone were probably sourced from the vicinity of the tor.*
(c. Colin Bristow)

Granite has also been extensively quarried in the south-eastern part of the **Carnmenellis granite**, where proximity to loading wharves in the Fal Estuary led to a substantial industry (Figure 4) in the nineteenth century (see Stanier, 1999). Although Leveridge *et al*. (1990) reported four quarries still producing some dimension stone, all the currently active quarries (2000) are now only producing crushed aggregate for general constructional work. Carnsew Quarry, near Mabe (SW 759346), provided the stone for the exterior of Truro Cathedral (for a description of the building and ornamental stones used in the Cathedral see Cartwright, 1997). A considerable area of land within the area of the Carnmenellis granite has been affected by granite quarrying, a rough estimate suggests this could be as much as 1.5 km^2, most of which is currently derelict, with deep, partly water-filled quarries and tips composed of large reject blocks of granite. The ecology of this unique type of landscape has not been studied in detail. A good example are the quarries and tips at Higher Trolvis (Figure 2), (SW 744345). Quarries in the Carn Marth mass provided stone for the Camborne-Redruth area, one of these quarries is described in greater detail in Case Study 2. Kaolinized granite from the St Day area provided material for brickmaking.

Figure 4 *Polkanuggo quarry, near Mabe, towards the end of the nineteenth century. A traction engine is loading blocks of granite onto a wagon.*
(c. Royal Institution of Cornwall)

Some granite has been obtained from the **Tregonning-Godolphin granite**, which includes some high lithian mica granites similar to those in the St Austell granite. Kaolinized granite from this area has also been used for brickmaking.

A derelict quarry at Lamorna Cove (SW 452243), on the southern side of the **Land's End granite**, formerly produced high quality dimension stone from a coarse grained biotite granite, which was used locally and exported from a small harbour in the cove. There is a large aggregate quarry at Castle an Dinas (SW 488347) and there are many other small quarries in the Land's End granite, now abandoned; they were mostly for building and walling stone, used locally.

4.2. Felsitic elvans

The felsitic elvans of Cornwall (not to be confused with 'blue' elvans, see below) are one of Cornwall's finest building materials. They are usually in the form of igneous dykes, typically 2-10m wide, and have the same chemical composition as the granites but, because they cooled more rapidly, are of much finer grain and are often greisened. Greisening is a process which can affect both granites and elvans; it is caused by hydrothermal fluids altering the feldspar to a fine grained mixture of quartz and mica.

The most famous elvan is near Pentewan, where it forms a dyke in the cliffs northeast of Pentewan at Polrudden Cove. This is one of Cornwall's few freestones (freestone = a stone which can be carved freely into intricate shapes) and has been worked from medieval times. St Austell parish church (Plate 3) and Place, Fowey (Plate 4) used this stone. It is a lovely golden yellow colour and stands up to weathering surprisingly well, partly because it is not slowly dissolved away by the rainwater, as limestone is. Prolonged exposure to the weather, as can be seen at the base of St Austell church tower, leads to the surface layer of the stone developing a fine honeycomb texture, due to the greisened feldspars being washed away by the rain. Mottershead (2000) carried out XRD examinations of Pentewan Stone used in old buildings, and showed that they were extensively greisened. Flett (in Ussher *et al.*, 1909) also commented on the extensive greisening of elvans. The alteration of the feldspar to more resistant quartz and mica may explain the stone's durability.

There are quarries in the cliffs at Polrudden Cove (SX 027476) and some larger overgrown quarries inland, north of Pentewan village (SX 022478). Many buildings which appear to have been built with 'Pentewan stone' are of similar stone from small quarries near Sticker (SW 985505 and 971506), Penrice (SX 023505), etc.; hence, if one is not absolutely sure about the source, it is better to refer to the stone as 'Pentewan-type'. Because a high proportion of the stone removed from the quarry could be used in building, the quarries often appear to be small in relation to the buildings erected from their products. The case for re-establishing a small active quarry in Pentewan stone to provide new stone for restoration and special projects is one worth consideration. The inland quarry at Pentewan (SX 022478) would be a good place to look at in this context; landowners, planners, etc. willing.

Another important elvan was formerly quarried at Newham (SW 829437) and was extensively used for many of the older properties in Truro. The appearance of

Lemon Street, as described by Pevsner (1951) "*Lemon Street is one of the most completely Georgian streets preserved anywhere, all two-storeyed, stone-fronted houses of uniform character*", owes much to the use of Newham stone, although some recent additions in concrete products have not helped its architectural coherence. How one wishes that a small quarry to supply Newham stone had been available, so the Planning Authority could have insisted on its use! Newham stone frequently contains small veins and often has a foliation; this suggests it belongs to an earlier phase of elvan intrusion, which was subjected to the closing stages of the Variscan orogeny. It can, at times, resemble the more massive silty sandstones from the local Devonian succession, in spite of having a completely different mode of origin. It does not stand up to weathering quite as well as Pentewan stone. This can be seen in the early 16th century St Mary's church, now incorporated into Truro Cathedral, which is a wonderful hotch-potch of Newham Stone, Pentewan Stone and Bath Stone. Nineteenth century accounts (Thomas, 1889) record that an additional elvan-type stone used in St Mary's is 'Wild Duck', but the source of that stone is unknown.

A particularly handsome elvan, with prominent phenocrysts of white orthoclase feldspar and quartz set in a red fine grained matrix with spherulitic growths of black tourmaline was extensively quarried at Tremore, near Withiel (SX 010649). This stone was quarried by Joseph Treffry in the 1830s to provide stone for the polished slabs used to line the spectacular Porphyry Hall in Place, Fowey (Plate 4). On a visit in 1846 Queen Victoria and Prince Albert so admired the stone that Joseph Treffry presented them with a slab, which can now be seen forming sills in ornamental alcoves in the main passageway of Osborne House on the Isle of Wight. For those who would like to see what the stone looks like, there is a large polished slab forming a table top at the rear of Lanlivery Church and tiles made of Tremore elvan have been incorporated into the floor of the Baptistry in St Austell Parish Church. The front of West Hill Baptist church in St Austell and part of the facing of a bank at the west end of Boscawen St. are also made of Tremore elvan.

Felsitic elvan dykes have been worked in many different parts of the county; wherever a suitable one occurs, one frequently finds that it has been quarried along its length, producing a feature like a railway cutting. An elvan which runs from Davidstow Woods to Rock on the Camel estuary was extensively quarried along its length (e.g. near St Kew, SX 014768), and used for the railway bridges between Camelford and Wadebridge as well as for many chapels, halls and other buildings (Reid *et al.*, 1910) Reid (op cit) mentioned that this stone was sufficiently soft to be cut with an axe. Elvans at Temple (SX 140734) and near De Lank quarry (SX 100754 and 101751) have also been worked but, in these cases, seem to have been crushed and used predominantly as aggregate for roads and concrete.

A small quarry at Withnoe (SX 404517), above Whitsand Bay, shows volcanic rocks which appear to related to the Bodmin Moor

elvans (Plate 5). It is a unique occurrence and is exactly the kind of quarry that could easily be inadvertently backfilled, so it has been designated a RIGS site. Another small quarry on the hill above Kingsand (SX 433509) shows Lower Permian rhyolite and most of the older buildings in Kingsand and Cawsand were built of this material.

4.3. Greenstones

Greenstone is a convenient colloquial term for a variety of basic and occasionally ultrabasic igneous rocks. Basic rocks are low in silica and high in magnesium and iron, ultrabasic even more so. Sometimes a band of dark greenish-blue basic igneous rock will be called 'blue elvan', particularly in West Cornwall, so the term elvan has to be used with care.

Greenstones were some of the earliest building stones to be used in Cornwall. Lower Carboniferous tuffs (tuff = hardened volcanic ash) were used in North Cornwall in the Tintagel and Launceston areas in Norman structures. The similar Hurdwick stone was used extensively for Medieval and later buildings in Tavistock.

Cataclews stone is a dolerite (basic igneous intrusion) which was intruded into Upper Devonian rocks at Cataclews Point (SW 873761), about 3 miles west of Padstow, near Harlyn Bay. It has been used in a number of churches, such as St Merryn and St Petroc, Padstow (Plate 6) and in many of the churches and older buildings in and around Padstow. It is a tough dark green stone, resistant to weathering, which is capable of being carved into intricate shapes. Many of the carvings in the Padstow area appear to be the work of a single 15th century sculptor, whose name is unknown, so he is referred to by architectural historians as 'The Master of St Endellion'. At present, the quarries at Cataclews Point house a sewage outlet. A disused quarry at Stepper Point (SW 915784), north of Padstow also exploited a dolerite intruded into Upper Devonian slates.

Active aggregate quarries exploit a dolerite east of Polyphant (SX 268817 and 269820) and a small quarry exploits both a dolerite and associated metamorphic rocks at Tregunnon (SX 223833). However, the most famous stone in this area is an exotic type of greenstone which has been worked at Polyphant (SX 260826), near Launceston since Norman times. This was originally intruded as the ultrabasic igneous rock picrite, and then subsequently altered so the original olivines and other minerals were converted to a mixture of talc, chlorite and various carbonates (Power & Scott, 1995). The resulting rock is quite soft, but is a superb medium for carving and will take a lustrous polish, producing a handsome dark green shiny surface. Many churches in East Cornwall and farther afield have interior features made of Polyphant stone. The War Memorial adjacent to the West Door of Truro Cathedral is a fine piece of carving in Polyphant Stone (Plate 7). Launceston Priory and Castle also contain much Polyphant stone, but it does not weather well in exterior use, presumably because it is so soft and porous, and therefore susceptible to frosts. After a fire severely damaged Newquay Parish Church, it was

found that the Polyphant Stone in the building would have to be replaced. The quarry at Polyphant, which had not been worked for many years, was reopened and supplies of stone obtained. This emphasises that it is less difficult than might be imagined to reopen an old quarry and extract sufficient stone for restoration purposes.

A similar talcose stone occurs at Duporth, near St Austell and has been used locally for the rood wall in St Paul's church, Charlestown and for some of the columns in Truro Cathedral (Thomas, 1889). A quarry at Menheniot (Clicker Tor Quarry SX 285614), now partially flooded, formerly exploited another intrusion of ultrabasic rock; it is now a SSSI.

A series of quarries between Pentewan and Trewoon (Molingey SX 013499, Tregongeeves SX 000515 and near Trewoon SX001522) exploit dolerite intrusions into Lower Devonian rocks. All are no longer in use, although Tregongeeves is used as a Highway Depot. The Black Head dolerite is part of the same series of intrusions.

Greenstones are extensively quarried nowadays as a source of good quality strong aggregate, and are often used in the wearing course of main roads, where good skid resistance is needed, which requires that the stone does not become polished as it is worn away by the traffic. Greystone Quarry (SX 365805), near Launceston, provides much of the stone required for road maintenance in east Cornwall.

Penlee Quarry (SW 468278), near Newlyn, formerly performed the same function for west Cornwall. Two large coastal quarries in the Lizard gabbros and dolerites - Dean (SW 803207) near St Keverne and West of England (SW 808215) at Porthoustock - provide stone which is used locally and is also shipped out via loading jetties alongside the quarries. Both these quarries show many features of geological interest. There are other abandoned coastal quarries between Porthoustock and Porthallow. Tubbs Mill quarry (SW 962432), near Veryan, currently not active, is also of considerable interest, as it exposes pillow lavas with MORB (Mid Ocean Ridge Basalt) affinities within the Roseland Breccia Formation.

4.4. Slates

Slate is extensively used in Cornwall for building, both for walls and roofing. It is the most natural material to use for building throughout most of Cornwall outside the granite areas. Delabole quarry (SX 075840) in North Cornwall is the largest and best known source of roofing slate, which has a pleasant pale grey colour. The large quarry at Delabole (Figure 5) works Upper Devonian slates and is said to have been continuously worked since Tudor times, with a considerable export trade already in existence by 1602. Tips of waste slate, approaching 0.5km^2, surround the quarry at Delabole. Other quarries in the area between Delabole and Tintagel have extensively exploited Upper Devonian slates and have waste slate tips associated with them. Trevillet Quarry (SX 082881), near Tintagel, is still active. The Prince of Wales Quarry (SX 074862) has been turned into a country park with a quarry trail by

North Cornwall District Council (Case Study 4). Coastal cliff quarries south of Tintagel (SX 048884), last worked in 1936, provide much interest in this area of bleak cliffs (see the National Trust leaflet on the Tintagel section of the coast).

Active quarries in Middle Devonian slates in the Wadebridge, Bodmin and Liskeard areas yield large quantities of slate (e.g. Tredinnick SW 935688), which is used for constructing 'Cornish hedges' alongside roads and for a variety of purposes where a natural stone finish is desired. There are a large number of other small abandoned quarries throughout Cornwall which yield Devonian slate which have been locally used for walling and construction. Scrivener *et al.* (1997) and the Cornwall County Council Minerals Local Plan list locations where quarrying has recently taken place and/or locations where planning permissions have been granted.

Figure 5 *Delabole slate quarry in 1993, which has been worked continuously since at least the 16th century. The lower part of the quarry has been allowed to flood and working is now concentrated on the right hand side. (c. Colin Bristow)*

A number of old quarries exploit the Middle and Lower Devonian slates in south-east Cornwall and the St Austell Bay area. An example would be the quarries in Lower Devonian Bovisand Formation slates at Gerran's Point (Plate 8) on the west side of St Austell Bay (SX 040488). Some of the slates belonging to this formation are pyritic and weathering of these slates can cause problems analogous to those caused by the oxidation of sulphides in 'mundic blocks'.

A series of disused coastal slate quarries southwest of Boscastle (Grower SX 085907, Welltown SX 088908 and California SX 090908) expose the Transition Group slates covering the Devonian/Carboniferous boundary. Many old quarries in the Launceston area yielded roofing and building slate from Carboniferous rocks, but these are nearly all now abandoned. The refuse and recycling facility set up by North Cornwall District Council and Cornwall County Council near Launceston is on the site of the filled-in Bangor slate quarry (SX 319834). A number of smaller quarries in the Launceston area (e.g. Yeolmbridge SX 322875 and Stourscombe SX 344839) have been designated SSSIs or RIGS sites, because of their importance in correlating the Upper Devonian and Lower Carboniferous stratigraphy of South-west England with the standard sequences in Continental Europe. Several of these are at risk from fly-tipping.

4.5. Sandstones

Sandstone has been worked on a small scale from a few localities in the Gramscatho Beds in mid-Cornwall (e.g. Grampound SW 931492 and Treworgans SW 899495). Mottershead (2000) recently studied the durability of various building stones used in south Cornwall in coastal

locations. Somewhat surprisingly, the Devonian Portscatho Formation sandstones, as used in St Mawes castle, turned out to be the most durable. Syntectonic recrystallization of all finer grained material in these turbidite sandstones (Leveridge *et al*., 1990) must have created a very tough rock which is resistant to the weathering conditions in this area. The Staddon Grits in southeast Cornwall have also been quarried in a small way; the main use has been as a local building and walling stone. Quarries in North Cornwall (e.g. Cansford Quarry, SS 168931) currently provide a useful source of aggregate, but have been extensively used in the past as a source of building stone. It is interesting that villages in Cornwall constructed from sandstone, whether it be Lower Devonian or Upper Carboniferous, tend to have a similar appearance because of the use of sandstone in building. Ordovician quartzites from the Roseland Breccia Formation (e.g. small quarries at Carne, SW 913380) have been used locally and have been considered as sources of high purity silica.

4.6. Limestones and cherts

Limestone is almost absent from Cornwall. There are a few lenses of Upper Devonian or Lower Carboniferous age in the Launceston area, which were intensively exploited in the 18th and 19th centuries, mainly for lime-burning. Some of the workings were underground, as at Trenault near Launceston (Figure 6), (SX 262830). Some of these old limestone quarries (e.g. Landlake SX 328823) have yielded rich palaeontological assemblages, including brachiopods, clymenids and conodonts, which enables a correlation to be made with continental successions. A recently published book on lime kilns and lime burners in Cornwall (Isham, 2000) includes useful details of limestone quarrying in Cornwall.

Figure 6 *Underground working for limestone at Trenault, near Launceston. The limestone is a condensed sequence ranging from the uppermost Devonian into the lowermost Carboniferous. Conodont microfossils enable this limestone to be correlated with other limestones of this age in SW England and on the Continent. Most of the limestone from this mine was used for lime burning. (c. Colin Bristow)*

Masses of Devonian limestone occur in the Roseland Breccia Formation east of Veryan. An inverted sequence of limestone turbidites, alternating with slates, occurs at Marble Cliff, near Trevone but has never been exploited in a significant way. Sporadic limestones occur in the Bovisand Formation along the coast from Rame Head to Fowey and have been exploited for limeburning in a small way, notably in small quarries north of Looe (Isham, 2000). In the past, much limestone from the Plymouth area was brought into the coastal areas of Cornwall for lime-burning (Isham, 2000).

A peculiar variant of calcareous rock is **calc-flinta**, which is found in a series of east-west bands north of the St Austell

granite. This type of rock lies within the thermal aureole of the granite and has been produced by the effects of heat on a mixed sequence of limestones and sandstones, or possibly cherts, probably belonging to the Lower Devonian Bovisand Formation, which have chemically reacted to form various calcium silicate minerals, such as pyroxene, epidote, wollastonite, axinite, actinolite, garnet and zoisite (Ussher *et al.*, 1909). These minerals cause the rocks to be often vividly striped in green, white and brown and are very hard, hence the name calc flintas. They have been widely exploited as a source of aggregate as, for example, at Glebe quarry near Roche (SW 9885930), where there have been recent discussions about preserving a face of calc flintas after backfilling. Other small quarries are found on the north side of the Belowda - Castle an Dinas ridge and at Tremore. It is important that some quarry faces in calc flintas are preserved, as this unusual rock type is not seen in any coastal exposure. Calc flintas also occur around Perranporth and pure white marbles have been encountered in boreholes near Duchy Peru mine. These lie within the thermal metamorphic aureole of the Cligga Head granite.

Radiolarian **cherts** occur in the Lower Carboniferous of North Cornwall, and were exploited in the now abandoned Barracadoes Quarry, near Launceston (SX 322862).

4.7. Industrial minerals, e.g. feldspar, fluorspar

Industrial minerals, apart from china clay and constructional raw materials, have only been exploited in a small way in Cornwall. Small quantities of **fluorspar** have been produced as a by-product of metalliferous mining, although there is no mine which was exploited solely for the production of fluorspar. The Bere Old Mines, in the Callington area, were one of the more important sources of fluorspar.

Talc was produced in the 18th century from the cliffs at Gew-graze, on the west side of the Lizard (Plate 9), (SW 675144) to be used for early porcelain production in the mid-eighteenth century, notably in Bristol. Polyphant stone has also been looked at as a potential source of talc.

Feldspar has been produced from pegmatites at a number of localities in the St Austell granite, notably at Polpuff quarry, near Trezaise (SW 996586), Trelavour Downs (SW 960574) and just west of Kernick china clay works. Polpuff has become a combined biological/ geological nature reserve leased by Cornwall Wildlife Trust from Goonvean Ltd., with a boardwalk for access. A geological trail, including Roche Rock and Polpuff, is under consideration.

A greisen mass, rich in **topaz**, was formerly exploited in a small quarry at St Mewan Beacon (an SSSI) for making the floor of grinding pans for china stone (Collins & Coon, 1914). Topaz is a very hard material (hardness of 8 on Moh's scale). Some of the floors at Place, Fowey, are made of polished slabs of topazfels, which must have excellent hardwearing characteristics. Greisened masses containing up to 30% topaz occur in some china clay pits and the possibility of producing topaz as a by-

product of china clay working has been examined.

Mica has also been produced from china clay wastes although there is currently no commercial production.

The '**Treamble Fullers Earth**' was produced in a small way from an excavation associated with Treamble Mine near Perranporth (SW 786559); it was in fact a kaolinitic material and contained no montmorillonite, as Fuller's Earths normally do.

Figure 7 *Small pit excavated in the Crousa Gravels near St Keverne being examined by a University of Exeter Extra-Mural class. These gravels are composed of siliceous pebbles set in a clayey (kaolinitic) matrix, indicating that they have been subjected to sub-tropical chemical weathering, which suggests a Palaeogene age. Since this photograph was taken microscopic fossil spores have been found which confirm the Palaeogene dating.*
(c. Colin Bristow)

4.8. Unconsolidated materials of Tertiary or Quaternary age

Palaeogene sediments laid down during the Tertiary have been an important source of industrial clays and sands. The **Crousa Gravels** of presumed Tertiary age on the Lizard (Ealey et al., 1999) were formerly worked in a small way and can be seen alongside a small pond created by St Keverne Parish Council as a picnic area (Figure 7), (SW 771199). **Palaeogene ball clay-type clays** were formerly extracted from a small pit (Freshney et al., 1982) north of Launceston at Dutson (SX 344862). Similar ball clay-type clays, of presumed Oligocene age, were extracted from the Beacon Cottage Farm outlier (approx SW 705502) at St Agnes (Walsh, 1999), although there is very little surface evidence nowadays to show where the workings lay. These clays had the curious ability to stick candles to the walls of mines and to miners hats, hence the formation is known as the 'Candle Clay'.

Neogene sediments laid down during the later part of the Tertiary include the sands and clays of Miocene age north of St Agnes Beacon , which have been worked by the Doble family for generations as moulding sands and for the manufacture of stoneware pottery (approx SW 707511). The workings cover a considerable area and are of considerable interest to geologists because Miocene deposits in the British Isles are few and far between (Walsh, 1999). **Late Pliocene clays and sands at St Erth**, near Hayle (SW 557351) were intensively worked as a source of foundry sands (Figures 8 and 9) and clays (Bernard Leach used the clay from St Erth for his pottery), over the period from ca.1834 up to the Second World War (Roe & Hart, 1999). Important marine fossil remains have been discovered in these pits which provide valuable information about climatic conditions immediately before the onset of the Ice Ages (= Quaternary). One of the pits (Harvey's Pit) has become Cornwall's first geological nature reserve, owned and managed by Cornwall Wildlife Trust.

Figure 8 *St Erth sand pits in about 1910. These sands and clays were used as moulding sands for casting iron and the clays were later used by Bernard Leach for his pottery. They have yielded a rich fossil fauna and flora which provides a valuable insight into climatic conditions just before the onset of the ice ages. (c. Royal Institution of Cornwall)*

Quaternary deposits have been extensively exploited for alluvial tin and peat, and sometimes sand and gravel was also produced for local building requirements. During the sixties and seventies, when alluvial tin was being worked by Hydraulic Tin at Bissoe, sand and gravel was an important by-product. Many of the former sites of alluvial tin working in the valley bottoms have now been returned to agriculture, housing or industrial use. However, there are substantial areas of alluvial tin working in mid-Cornwall which were worked using large-scale mining plant and machinery around a hundred years ago (Goss Moor, Breney Common and Redmoor). These must have presented a scene of the utmost dereliction shortly after operations ceased in the first decades of the 20th century. By a curious twist of fate, these areas have naturally revegetated and are now either a National Nature Reserve (Goss Moor), or valuable local nature reserves (Breney Common and Redmoor which belong to Cornwall Wildlife Trust (Deveney, 2002). So much for destruction of the environment by the extractive industry!

Figure 9 *Fly-tipping in St Erth sand pits in 1991. Since then the site has been acquired by Cornwall Wildlife Trust and cleaned up and provided with an explanatory board (twice vandalised!). (c. Colin Bristow)*

The **Holocene bioclastic sands** in the Hayle and Padstow estuaries are still worked as a local source of fine sand for building purposes. The deficiency in lime-bearing rocks in Cornwall was also overcome by using beach sands which are composed of sea-shells which have been pounded up to a fine sand on the beach by wave action (bioclastic sand) and which typically contain 40-70% $CaCO_3$. When applied to acid soils, these sands neutralised their acidity. This type of sand forms the dunes north of Hayle and at Perranporth and many of the beaches on the north coast. A canal was opened in 1823 from Bude to Holsworthy to take this sand to the farms of mid-Devon situated on the sour 'Culm' soils. Occasionally these Quaternary sands are cemented by calcium

carbonate e.g. Godrevy Point, Padstow and Fistral Bay, and have been used as a building stone in some of the older churches, as at Crantock (Plate 10) and Padstow; the font at St Enodoc is carved from sandrock. This must be one of the geologically youngest freestones to be used anywhere in Britain.

4.9. Brick clays

Bricks have, in the past, been produced in a multitude of small brick kilns scattered all over Cornwall, mostly using superficial clays and weathered material. In most cases all traces of the extractive operation have now disappeared; many of these small brickworks also used mud from the intertidal zone of estuaries and creeks. One was discovered, more or less by accident, when the Sticker by-pass was constructed (SW 983509). Bricks are no longer produced in Cornwall, but the North Cornwall Brick Co's works (actually in Devon) near Bridgerule (SS 262016) and the brickworks at Millbrook, near Torpoint (SX 435528) were active in the post-war period up to the late sixties.

Waste materials from the china clay industry now represent some of the most widely used raw materials for the construction industry in SW England. In recent times just under one million tonnes a year of this waste has been used by the construction industry. The sand is used for concrete and plasters, and is the principal source of raw material for manufacturing concrete blocks, which is the main building medium in Cornwall nowadays. Crushed waste rock from the china clay industry has also been successfully used as a road foundation material on a number of trunk and main road schemes. In a recent initiative, Aggregate Industries Ltd have decided to use hard rock from the upper benches of Wheal Remfry China clay pit as a principal source of aggregate for mid-Cornwall. Waste has also been used on a number of major engineering structures, such as the wall of Colliford dam on Bodmin Moor. Unfortunately the total amount of china clay waste produced (about 25 million tons a year) is far greater than the local market can absorb, and the cost of transportation to big cities such as Bristol and London is a serious handicap. However, the imposition of the Aggregate Tax is causing a serious re-appraisal of the potential for export and a deep water jetty at Par is under consideration at the time of writing.

Besides china clay waste, other waste materials from metalliferous mining have been exploited for constructional use. In most of the mining areas, large cobbles of mining waste, typically slate and quartz vein material, have been used for rough stone walls and even for domestic cottage construction. Large stones from tin streaming have also been extensively used. In the case of concrete blocks made with a certain type of mine waste, known as 'mundic blocks', this can sometimes turn out to be a liability. Mundic means iron pyrites, and this pyrites, when exposed to damp slowly oxidises, releasing sulphuric acid, which eats away at the cement, so the block eventually crumbles to dust. This process takes a long time to become apparent and in recent years has become a serious problem, with a number of

properties having to be demolished as a consequence.

5. Conclusions and recommendations

- Cornwall has a rich variety of good quality building and decorative stones, which have been extensively used in the past, mostly for local use, although some have been exported out of the county. Use of these stones is an important element in maintaining the character of the local built environment.
- The biodiversity in quarries, with their associated tips and flooded areas, is often greater than the farmland or moorland which preceded it, leading to considerable wildlife interest.
- Inland quarries provide valuable information about the geology in inland Cornwall, where rock exposures tend to be few and far between. Many quarries show geological/mineralogical features of considerable scientific interest, which attract researchers, students and geological tourists to the county.
- A survey of all old quarries and abandoned pits needs to be undertaken, based on field visits and document surveys. This may well lead to proposals for new RIGS sites and possibly SSSIs as well.
- Thought should be given to the possibility of opening up sources of the more important building stones for restoration and special projects. This need not involve any permanent facilities at the quarry, apart from a face from which blocks can be extracted as and when required. It is unlikely that this sort of quarry would justify continuous working. A 'flying team' of experienced quarrymen, based on an active (?Cornwall County Council) quarry, would be needed to operate such a scheme.

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CHAPTER *Two*: THE HISTORIC ENVIRONMENT

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1. Introduction

For most of our long history people have been moving stone from one place to another. For sheer hard work few activities can beat the quarrying, shaping and use of stone for building. Stone is durable, it is available almost everywhere, and is capable of being shaped for a myriad range of uses. Despite all this the industry is not well studied and until recently there has been no attempt to assess the significance of sites. No quarries or pits have been statutorily protected for their heritage value.

Examples of the use of stone are all around us - practically every field boundary, every house, every road, every building, every military or industrial complex - the making of almost every structure has required the movement of large amounts of stone. Most of the many thousands of kilometres of field boundary in Cornwall have involved the movement of stones, from the fields where they were turned up by the plough, to their edges to form hedges and walls. Until the First World War the vast majority of buildings in Cornwall were built of stone. All roads are constructed of stone - millions of tons of it - and of course concrete and cement are also made from stone. The amount of stone moved about in the last two hundred years is truly staggering. Think of the volume of all quarries, all china-clay pits and all mines - think of the volume of stone in all buildings and all hedges and you begin to get some idea of just how fundamental to our way of life the winning, the movement and use of stone has been.

In many ways the exploitation of our geological resources has been in no small part responsible for the distinctive character of our county. The excavation of hundreds of quarries, pits and mines have produced a distinctively pock-marked landscape within which local variations in geology (principally between granite and slate) have been a major contributory factor to the diversity of local vernacular architecture. Some communities have developed to serve the quarry industry - Delabole; villages in the Mabe and Rame area and St Breward (Plate 11).

Having already examined the conservation value of mine sites (Johnson et al., 1996), attention here is turned towards quarries and pits. Clay working, whether for china clay, for brick making or for more specialised uses is not examined in this paper, the focus of which is the production of rock, gravel and sand.

English Heritage is carrying out a national review of Scheduled Monuments (Monuments Protection Programme - MPP). Quarrying is being considered at present. The MPP and definition of **quarry** makes an interesting starting point (Ashbee, 1996).

> "The word quarry is derived from the Latin *Quadrare* and in the strictest sense of the word, should only be used for sites producing *Saxa Quadrata*, squared (or otherwise shaped) blocks of stone (for architectural purposes) - the modern term is dimension stone quarries. However modern usage also

allows aggregate or roadstone quarries. Here the term quarry is used for any stone extraction site. The term pit is used for the extraction site of less consolidated materials, such as sand, and gravel. Not included here are clay pits (china-clay and brick clay), nor china-stone quarries, since these are regarded nationally as a separate class of site and are being assessed separately for statutory protection".

As with so much of our heritage, quarries are first and foremost artefacts. They have been created by people and have become geological exposures, and later habitats, with their own special characteristics. Before 1800, most stone was taken from the surface, was turned up through cultivation or was hacked from available outcrops. Prehistoric stone circles were built from moorstones, and it was these surface rocks which were worked to provide quoins, jambs, sills and lintels for medieval buildings. The random rubble from which the remaining wall fabric was built would have been picked up from the moorland surface or dug out of shallow pits.

Hundreds of small quarries, where roadstone and building stone was extracted in this fashion, can be found throughout Cornwall. Alongside every old road can be seen the shallow pits where material was dug to fill in potholes. In contrast, present day sources of aggregate or building stone are produced only at a few large quarries. Aggregate quarries tend to be simple and distinctive - massive voids with few dumps, almost all stone having been crushed and transported away. At dimension stone quarries, in contrast, the waste dumps may be very extensive, since masons demand high quality, unflawed stone for lintels, quoins, facing stones and ornamental work. Different geologies have different characteristics - durability, ease of carving, the degree to which a stone can be polished, texture and colour. Each will distinguish the rock which is prized from that which is rejected at a dimension stone quarry.

The Cornwall Historic Environment Record (Cornwall County Council) notes over 4,000 quarries but fewer than 500 of these were worked for *dimension stone*. Whilst the vast majority of building stone has been moved less than 500 metres from its source, the specialist products of dimension stone quarries were moved all round the world. The streets of London are paved with Cornish granite, whilst the material from which several of its bridges were constructed was cut from Cornish quarries during the 19th century. This is not simply a 19th century phenomenon, however. The stone for the polished Neolithic axes made five to six thousand years ago and found all over Southern England came from greenstone outcrops throughout Cornwall and the movement and use of special building stones is a very important indicator of power, wealth and influence in the past. Glasney College in Penryn was built in the 14th century using Caen stone imported from Brittany - at a time when the English monarchy controlled half of France and the great religious orders spread across Europe like multi-national companies. Other specialist building stones quarried in Cornwall have been incorporated into historically and architecturally significant buildings

throughout the county. See Colin Bristow's contribution to this volume for a detailed discussion of this. It is important that the sources of these stones (eg: Cataclewse, Pentewan, Polyphant) remain available for further use, given that there will always be a need to repair historic buildings built of these distinctive materials.

2. Types of quarry and pit

Stone can be obtained from the following sources:

- Loose stone lying around on the moors (**moorstones**, generally granite), ploughed up in fields (**fieldstones**) and material from rivers and beaches.
- Solid stone extracted from quarries through splitting, blasting or cutting. In some cases slate was mined in caverns. The earliest quarries were at rock outcrops such as tors (eg Carn Brea; Roughtor, Kilmar Tor) or on cliffs and headlands and only generally became pit quarries with the introduction of blasting.
- Decomposed stone, alluvial gravel and sand extracted from pits through digging and washing. In some areas growan (decomposed granite) was extracted by mining (Rule *et al* 1970).
- Re-used stone recovered from demolition sites.
- Mine waste (often used for hedging or for buildings during the 19th century, where it was available).

Stone in all its infinite variety was and is used in a few relatively well defined ways, or if unsuitable, is rejected as waste. These uses are usually determined by the geological characteristics of the raw material, the method of extraction and its abundance. The principal uses are:

- **dimension stone** - stone used for fine work (freestone), ashlar masonry, engineering stone, cladding, flooring, tiling, roofing and decoration e.g.: granite, slate, greenstone (Cataclewse, Polyphant) elvan (Pentewan) (Plate 12). Usually much of the stone shaping or dressing is done at the quarry. There is a long tradition of serpentine being used for fine quality decorative objects.
- **aggregate** - stone or gravel usually crushed on site and used for road building and maintenance as well as for the aggregate in concrete. e.g.: greenstone, elvan, granite gabbro, serpentine, rab (decomposed granite or periglacial head deposits).
- **building stone** - unshaped material used for building hedges, walls and buildings.
- **bulk raw materials** - used in manufacturing processes e.g.: the limestone burnt in limekilns or used during iron smelting; manganese gravel used in iron making; specialist sands (eg: St Agnes pit) used in cements; talc deposits north of Kynance Cove on the Lizard were used in the manufacture of porcelain before china-clay was used.
- **engineering sands** - specialist moulding sand used in the green sand and dry sand shops of Cornish foundries e.g.: St Erth Pits and Lowland Point.

3. Significance of quarries and pits

The extraction of rock, gravel and sand is fundamental to the understanding of our built heritage. The remains of quarries and

pits are everywhere and they are a record of once great industries exporting far beyond the Tamar, employing thousands of people and responsible in no small part for the development of tramways, railways and harbours.

The abandoned sites themselves have the following qualities:

- They give direct insight into the extraction process - how the material was extracted, dressed and transported. The sites are the only record of ancient extraction methods and sometimes even relatively modern but now redundant techniques.
- They give indirect insight into the wider contemporary scene - the rab pits and small roadstone quarries evoking the many centuries since Elizabethan times when parishes and later the County Council were responsible for the gangs of roadmenders employed to fill up potholes before the advent of tarmacadam.
- They demonstrate the power of the great medieval landowners to source their various building stones from quarries across their dispersed estates or from outside.
- They nurture the persistent public fascination, particularly with serpentine objects, which began after Queen Victoria's interest in the display at The Great Exhibition in 1851.
- They are part of a wider related context embracing not only extraction sites but also transport systems linking them to river quays and coastal harbours, stone yards and workers housing. In the case of moulding sand, one significant component of the evidence for this industry is to be found within the remains of the Cornish Foundries - themselves very important components of industrial complexes which serviced Cornwall's central place within the development of hard rock mining technologies.

Quarries are being assessed by English Heritage for statutory protection at present (2000), as are metalliferous mines and china clay-pits and brick works. A very large number of uniquely interesting abandoned quarries and pits have already been infilled or otherwise obliterated. It is vital that the remainder are assessed as soon as possible.

4. Examples of types of site

4.1 Granite extraction

Kit Hill (information taken from Herring 1998a - Cornwall Archaeological Unit survey 1987)

Kit Hill and eastern Hingston Down are two small islands of granite in a sea of slate; demand for the strong durable stone found here was such that these two hills were quarried as intensively as any in the South West. Kit Hill contains examples of all the various types of granite quarrying.

Until the 19th century when the use of plug (tare) and feather splitting and the improvement in controlled blasting techniques enabled commercial granite quarrying to develop, the rock was split relatively casually from the thousands of loose boulders (moorstones) on the hillslopes by masons and farmers, miners and millwrights. Moorstones are the loose surface stones scattered around tors and known collectively as clitter. For many centuries this was the principal source of

raw granite. There is much evidence of stone splitting around most tors in Cornwall - particularly well worked areas include Carn Brea, Roughtor, Stowe's Hill, Bearah Tor, Kilmar Tor, Kit Hill and the rest of Hingston Down. Stone splitting pits and the characteristic marks of the masons (early wedge and groove; later plug and feather) on broken stone are very common in the granite districts, and the pits where stone was extracted are often mistaken for mine prospecting features. The Cornwall Young Archaeologists Club are undertaking surveys of moorstone workings on Bodmin Moor.

Stanier (1999) documents extensive moorstone cutting in the Carnmenellis area with some tors being removed completely - Penwith and Hensbarrow were also exploited, though to a lesser degree. The tens of thousands of tramway and railway sleeper blocks (setts) required in the early 19th century were almost certainly mainly produced from moorstones. Stanier also notes the two large granite working areas at Cheesewring and Kilmar (Bodmin Moor) leased from the Duchy of Cornwall, both containing quarries but also extensive evidence for moorstone working. The large number of loading points adjoining the Cheesewring and Kilmar railway branches of the Liskeard and Caradon Railway (five and fourteen ramps respectively) were specifically designed to exploit moorstones rather than the major quarries which the railway was constructed to serve. Abandoned dressed work for bridges, lighthouses and other structures made from moorstone can still be found around Stowe's Hill.

Example 1 Moorstone cutting stone splitting pits - Kit Hill

There are 4,839 stone splitting pits recorded on Kit Hill. This granite was used to produce quoins, arches, lintels, jambs, millstones, cider and cheese presses, rollers, troughs and the like. Pits were dug around large stones, and wooden wedges placed in lines of chiselled grooves to split the stone into useable pieces which were often subsequently shaped in situ. After 1800 hand drills and plugs and feathers were used. The characteristic marks left by the use of both methods can be found.

It is likely that the abundance of moorstones delayed the introduction of quarrying to the South West long after the Aberdeen area (the principal rival) began quarrying in the 17th century (Stanier *ibid*).

By the 1810s small quarries were being developed on Kit Hill, probably as family concerns. Scores of the small pits (the first quarries) which they cut into the bedrock survive. Each would have yielded hundreds of blocks.

Example 2 Early (proto) Industrial quarries - Kit Hill

On the north-eastern slopes is a cluster of tiny quarries, each less than 10m across and no more than 2m deep. Others are scattered over the Hill's higher slopes. They have simple downhill entrances, wide enough to admit a wagon or sledge, and worked exposures of bedrock, not just moorstones. Low heaps of covering earth (overburden), edge the pits which were large enough to produce hundreds, even thousands of usable blocks. These are rare

surviving examples of the earliest industrial granite quarries, made viable by the invention of the plug and feather splitting technique.

During the early 19th century, developed industrial quarries used black powder for blasting and employed large numbers of men and boys. A group of three such quarries high up near the summit on the south side are known to have been abandoned by 1872 and are thus good examples of relatively primitive ventures.

Example 3 Small developed quarries - Kit Hill

High on the southern slopes c75m apart are three well preserved fully industrialised granite quarries, active into the second half of the 19th century, but unusual in having then closed, not developing into the more mechanised era of the late 19th and early 20th century so well described by Stanier (1999). The quarries relied on a metalled track running away down the hill to transport the stone away.

As the quarry deepened towards the south-east, the earliest workings in the north-west, probably dating to the first quarter of the century, were left high and dry. Overburden dumps were low and flat topped. The working faces, their lines following natural east-west cleavage, contain both the thicker drill marks of plug-and-feather splitting, and the circular-sectioned charge-holes, drilled to take the explosives used to dislodge larger blocks of granite.

As the later south-eastern part reached depths of over 4m, its access became confined to the narrow channel carved out of its bottom end. Dumps here were also larger, reaching 7.5m high, and tended to be more finger like, tracks laid with temporary rails allowed waste to be trammed along to their ends for tipping.

The two northern quarries on the hill belong to a whole new industry. They may well have started by supplying the same local building-stone markets as the three southern quarries, but by the last quarter of the 19th century they were producing precisely cut, shaped and finished blocks for civil engineering projects and mighty monuments.

Markets were no longer local but national, even international. A well-constructed inclined tramway running down the northern slopes was linked to the East Cornwall Minerals Railway (opened 1872) at Downgate Sidings. From here, the stone was carried along the Railway via another incline to Calstock Quays for export.

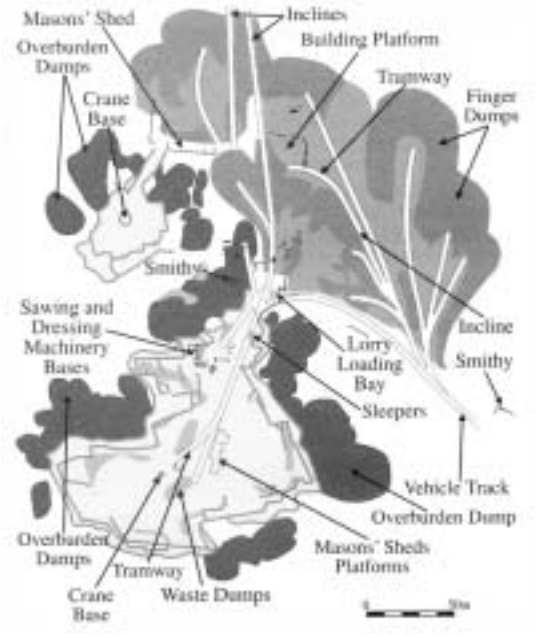

Figure 1: *Kit Hill Quarry, Interpretative plan taken from detailed 1:100 and 1:500 survey plans (1987-88). (Cornwall Archaeological Unit 1987). North is to the top. (c. Historic Environment Service, Cornwall County Council)*

Example 4 Large quarries - Kit Hill. Fig. 1

The Hill's largest quarry complex is on the northern slope above the line of the East Cornwall Minerals Railway, and consists of two quarries. The southern quarry opened earlier in the 19th century, long before the railway came in 1872. The floor of an impressive hollow-way running away from this quarry to the north-east, and which was replaced by the railway incline, has in places been worn down to over 2m deep by wagons and sledges carrying away the heavy blocks.

At first the floor of the quarry was kept on the level as it ate its way southwards into the hillside. A fairly shallow pit, now waterfilled, was dug in the south-east corner before attention was turned to the south-west. The lake here is now as deep (13m) as the cliffs above it are high, the finest flawless granite being found at depth. Pumps kept the pit dry, the water being pumped to the dressing sheds for cooling saws and polishers and dampening down the lethal silica-laden dust.

Large blocks were carefully eased away from the quarry face by the highly skilled, almost delicate use of black powder explosives. Quarrymen made good use of the horizontal cleavage planes and it is still possible to see the long vertical charge holes in the cliff face.

Granite from these quarries was excellent stuff, being used in major civil engineering works including six London Bridges (Lambeth, Putney, London, Blackfriars, Chelsea and Waterloo), the Thames Embankment and docks at Millwall, Tilbury and Devonport, Gibraltar and Singapore. The outer skin of the Bishop Rock (Scilly) lighthouse also came from here. Such works required very large blocks of clean granite, precisely cut and perfectly finished, no error allowable. Stone dressers served several years apprenticeship. In the 19th century much work was done by hand using hammers and chisels. Sawing, shaping and polishing machinery, powered first by oil engines and then by electricity, was installed in large corrugated iron sheds within the southern quarry in the early decades of the 20th century. Concrete floors and plinths for the engines and the machines they drove still survive. Earlier dressing sheds, extant by 1905 and serving both quarries, stood at the rear of the level platform made on top of the dumps to the east of the incline; some footings of these survive.

Cranes and tramways moved the granite. Still visible under water in the lake is a square foundation block whose four bolts were the mounting for a fixed crane hoisting blocks out of the pit. Traces of earlier fixed cranes can be found, as can lengths of anchor chains (guys) high on cliff faces or anchor rings on rocks beyond the quarry's edge. The northern quarry has a central circular crane base. Other cranes were mobile, carrying blocks along tramways to the dressing floors and to the long lines of stonemasons' sheds which turned out thousands of gravestones and paving stones.

Ancillary buildings included a smithy and two magazines, whilst the smithy probably incorporated the quarry office. A nearby wheelpit powered machinery - perhaps a drill sharpener and grindstone. One of the magazines was latterly used as the manager's toilet.

The early incline had narrow gauge track and trucks on either end of a cable attached to a drum, set within a shed which also housed a small turntable. The tracks crossed at a passing loop halfway up the incline. The replacement incline was standard gauge and at its foot had a safety buffer to prevent runaways from careering onto the railway. The Downgate sidings survive. After closure, the granite was taken out along a metalled roadway.

4.2 Slate quarrying

Trebarwith to Tintagel - (information taken from Sharpe (1989, 1990), Cornwall Archaeological Unit).

Slate quarrying in this area is recorded at least as far back as the 14th century and quarrying was for two principal purposes:

- building stone (rubble)
- roofing slates, paving etc.

There are two main types of quarry in this area

- The conventional quarry - with quarry pit, waste dumps, cranes, tramways and dressing sheds. Delabole is the largest and most famous of these conventional quarries.
- Coastal slate quarries - in order to work the vertical cliff faces, strong points were built to support poppet heads over which cables dropped down the vertical working faces. Horse whims were used to lift the slate up to platforms from where it was taken to the dressing sheds. Waste was dumped into the sea. Vertiginous working areas and horse whims characterise these sites which are very spectacular (Figure 2). Little is known about the history of these enterprises, which are confined exclusively to an area of 5 miles either side of Tintagel and in St Gennys parish above Strangles and near Crackington Haven.

Figure 2: *Bagalow, south of Tintagel. Each of the inlets in the cliffs are coastal slate quarries where the cliff faces have been formed by workings. Horse whims (winding capstans) and dressing sites lie on top of the cliffs. The quarries from left to right are Dria, Bagalow, Caroline, and Lanterdan. (c. Historic Environment Service, Cornwall County Council)*

Example 5 Coastal quarrying - Lambshouse and Gull Point quarry

It seems likely that Lambshouse Quarry worked the rear of the cove which bears its name, whilst Gull Point worked the north and west facing exposures to the south. These are amongst the most dramatic of all the coastal quarries, and those in which the working methods used to win the slate can be most readily appreciated.

Three horse whim platforms sit above the vertical cliffs which constitutes the working faces and are particularly well preserved. Unlike many horse-whims in use on mines in which the winding drum was overhead and supported on a massive wooden frame, these whims are relatively small (c9m diameter) and the drums were set beneath the platform in neatly built

chambers. They sit above stone built strong points at the heads of the working areas - in this case good examples of box caves where the working faces were developed horizontally into the foot of the cliffs where the best slate was found.

From the horse whims, trackways lead via a short length of tramway to the dressing floors where the slate was shaped and then split. The sites of these floors are marked by a series of levelled terraces but also by a dramatic plume of splitting waste that cascades down the cliff slope above the cove, in places revetted with walling to prevent it slipping onto the working faces. Not much survives of the splitting sheds, but close by, the quarry offices and smithy survives as a Youth Hostel.

Example 6 Conventional slate quarry - Prince of Wales Quarry, Trewarmet, Tintagel. Plate 13.

This medium-sized enterprise is one of a cluster of quarries which stretch for nearly a kilometre on both sides of the valley that leads to Trebarwith on the north coast south of Tintagel. The complex consists of three elements:

- Prince of Wales Quarry (west). Abandoned since before 1900
- Prince of Wales Quarry (east). Now expanded and still in use for decorative stone
- Bowithick Quarry. Also the site of the principal dressing floors for all three quarries and connected to them across the road by several bridges. The quarry is now mostly obscured by a landfill site

Only a small number of historic features now survive at this site, including traces of the chimney of a steam winding engine house. The western quarry has now been taken into local authority care (North Cornwall District Council). The winding engine house (for hauling the slate from the quarry floor) has been consolidated and is still roofed, a wheelpit has been partially exposed and there are extensive waste dumps, the flooded quarry itself and a substantial box cave at its rear. The whole of this site is now part of a nature reserve with paths and steps leading to the various features as well as a series of panoramic views across the site (see Case Study 4 this volume).

Example 7 Carnglaze Slate Mine (caverns), St Neot SX 1865 6685

Details taken from Pascoe (1974)

The St Neot quarries at Carnglaze are of particular interest, because unlike any other slate quarry apart from some in Wales, the slate was mined in a series of large underground chambers.

Slate production started perhaps 250 or more years ago where the slate was exposed in the steep valley sides - the 1844 road along the valley running over the top of pre-existing slate dumps. Huge areas of waste were contained by a retaining wall along the river bank. In the early part of the 19th century the quarry went underground following the best quality slate, and saving the huge costs associated with the removal of overburden. Originally the slate was taken by packhorse to St Winnow Quay on the Fowey or down the valley to Looe and Polperro. After 1859 the slate was taken to Doublebois station for shipment.

As the caverns were extended, leaving pillars for support, the waste or deads was used to fill up the redundant galleries. This business of waste disposal became a critical factor in the working of this site, and the entrance to the caves gradually rose up the hillside so that the water level in the caves is now 50 feet or more below the present entrance. The slate was mined using traditional mining techniques of drilling and blasting, whilst dressing was undertaken in the shelter of the cave entrances. All underground work ceased c1903 but during the Second World War the Royal Navy's rum stocks from Plymouth were stored here.

Slates (shillet) were extensively quarried throughout the county from at least the medieval period and there are probably thousands of features of this type within Cornwall. Many of the quarries are very small scale and some have been backfilled, but it is common to find a small quarry on most farms, used to supply the building stone for cottages, barns and other outbuildings, or as a source of material for hedging stone. Most were very small (it is possible to get a surprisingly large amount of rough slate from a small quarry), have been long abandoned and have become overgrown with scrub and trees. Some were probably worked intermittently as the need for stone arose. The majority of these small domestic quarries would have been worked by the farmers themselves. Besides slight generally overgrown waste dumps (much of this material would have been taken for track surfacing), little now survives but the quarries themselves, any rudimentary dressing being undertaken *al fresco* at the quarry or on the building site.

4.3 Other dimension (specialist building) stone quarries

(Information taken from Bristow (1996) and Stanier (1990)).

Details are given in Chapter One of the great variety of building stone used in Cornwall. Most of the quarries now lie abandoned. It is of great concern that the original sources of stone for so many of the county's protected buildings should be available in the future when repairs to those buildings are required. Some of the more important quarries are given below.

Cataclews (St Merryn) - A greenstone (dolerite) quarry producing cut stonework particularly for churches in the St Merryn Padstow area. Of particular note are the fonts carved by the 15th century 'master of St Endellion'. Latterly the quarry was used for roadstone and now is a formless cutting on the cliff edge with a sewage treatment works in it.

Polyphant, Launceston - A soft greenstone (picrite), much used in the past for decorative work in churches in East Cornwall.

Pentewan, St Austell - An elvan dyke in the cliffs north of Pentewan has been extensively quarried for freestone for decorative work since the medieval period. Other important elvan quarries producing building stone include Newham (Truro), Polgooth, Sticker and Temple.

Serpentine - There are many small serpentine quarries scattered across the

downs on the southern part of the Lizard peninsula. Made popular by Queen Victoria, serpentine is still used to make stone ornaments.

4.4 Aggregate/roadstone quarries and pits

Roadstone and aggregates

According to Stanier (1995), roadstone represents by far the most common type of quarry worked in the 20th century, and the term embraces the crushed and graded stones sought for road-making, railway ballast, aggregates for concrete and increasingly for paths and ornamental gravels.

Whilst there are still a few aggregate quarries at work (exploiting deposits of granite, gabbro, serpentine, and blue elvan), a very considerable number of aggregate quarries are now abandoned. Most of the material quarried has been crushed and removed, leaving only waste heaps of overburden and dumps of inferior stone. Given the period during which most of these sites were worked, the only evidence for the crushing plants consist of scattered concrete machinery bases. Unusually, substantial remains survive at De Lank granite quarry. Other large quarries include Castle an Dinas and Hingston Down. The largest coastal quarries were at Stepper Point (Padstow), between Porthallow, Porthoustock and Lowland Point (St Keverne) and at Penlee (Newlyn). At each, traces of jetties survive, together with some evidence for the sites of crushing plant and administrative and service buildings, but aggregate quarries have little to tell of their working history, in contrast to dimension stone quarries.

Figure 3: *West of England Quarry, Porthoustock. This Gabbro quarry is typical of aggregates quarries in having few waste dumps and the interior is relatively formless. Few structural remains survive here except parts of the jetties. Prograded beach at Porthoustock shows on the right. (c. Historic Environment Service, Cornwall County Council)*

Example 8 Porthoustock Quarries, St Keverne. Details taken from Bird (1987) (Fig. 3)

Coastal rock formations in this area are made up of hornblende schists, gabbro, and greenstone (blue elvan) and have undoubtedly been quarried on a small scale for many centuries. The era of large scale quarrying began on the east coast of the Lizard Peninsula in the early years of the 20th century, when companies were formed to extract and process roadstone, notably on the coastline between Porthallow and Lowland point . Only one quarry, at Dean Point, is still active, but abandoned quarries, quays, and heaps of waste still survive. In addition to these remains, there is now substantial evidence that the beaches in the area have prograded (extended seawards) significantly due to the accumulation of spilled (migrated) quarry waste. This is an unusual and interesting phenomenon.

The rock was crushed into categories ranging from sand to pebbles (6.35cm), then carried by tramway to quays

constructed for the export of the stone on either side of Porthoustock Cove. Later quays were sited at Dean Quarry. As each area was quarried, the waste from the quarry and from loading activity at the quays accumulated on the beaches. This beach progradation ceased as each quarry closed and at Porthoustock the beach advanced 110 metres between 1878 and 1985. The somewhat formless quarries and substantial remains of the quays at Porthoustock and Dean Point still survive.

4.5 Gravel and sand pits

Extraction of gravel and sand takes unusual forms in Cornwall.

Alluvium - River gravels, so common elsewhere, have been substantially disturbed in Cornwall through the activities of tin streamers over the last 500 years. The Pleistocene gravels in most valleys have been systematically turned over in the search for tin rich deposits (**tin ground**). The pits and other excavations (**tyes**) associated with this industry are often now filled with water and/or peat.

Rab pits - The quarrying of gravel for road dressing is mostly related to the exploitation of rab, pits for this material being a common occurrence beside roads in granite areas. Many small examples of these features can be seen, for example, beside the St Ives to St Just road in Penwith. These provided the material for road construction and maintenance before tarmac-surfaced highways were introduced in the early 20th century.

Gravel mines - The layer of decomposed granite above the bedrock is sometimes deep enough to mine. This was desirable both because the land above might not be available for surface quarrying, and also because the finished mine or cave would become a useful storage place. There are some very good examples of gravel mines in west Cornwall.

Example 9 Hulls (information taken from Tangye, 1973)

West of Redruth there is a tradition of digging underground chambers into the decomposed granitic gravel to provide stores or cellars for either domestic or farm use. Tangye (1973) describes a number of examples in detail. They are sometimes 50 feet long comprising single, multiple or a complex groups of tunnels, usually with a well constructed single doorway and in some cases, internal walling and shelves. Tangye suggests that in areas remote from the coast and access to sand, the material excavated provided the principal material for bedding building stones and paving slabs, as well as the 'growder' being specifically used for scouring pots, pans, wooden tops, granite floors and steps.

Example 10 Gravel Mine - Boscadjack Mill, near Helston

A spectacular variation on the theme of gravel mines is provided by Rule et al. (1970). Near Boscadjack Mill, by Coverack bridges, is a complex of tunnels. They are cut through compact gravel and stop where solid granite is encountered. There are nearly 200 metres of tunnel from which perhaps 600 tons of gravel might have been excavated. It is believed that the gravel was used to bed the granite paving (setts) in the main streets of Helston.

These unusual mines are of great historical and cultural significance. Whilst hulls are found on Dartmoor, gravel mines are very rare anywhere. Behind Harvey's Foundry in Hayle are a series of tunnels that connect to a complex of galleries dug into the rab, now partly filled in and no longer accessible (Cornwall Historic Environment Record). It is possible that the gravel was used as part of the Foundry process. Whilst there are undoubtedly many more hulls and gravel mines to be discovered, they represent a peculiarly south western and particularly West Cornwall tradition.

Sand pits - moulding sand - Particular types of sand with a good clay content can be used in the manufacturing process to make casting moulds

Example 11 St Erth Pits (taken from Herring (1998b) and Webber (1997) Cornwall Archaeological Unit 1998. (See Chap. 1, Fig. 8)

(Harvey's Pit) at St Erth is a good example of the production of a specialist type of sand used in the casting process at iron foundries. Foundries needed a sand 'in which every grain is coated with a thin film of clay'. The addition of approximately three per cent water would render the clay plastic if milled for a short time. The sand grains, when compacted in a moulding box around a wooden pattern, allowed the pattern to be removed without the sand impression collapsing inwards. Casting sand of the quality used in preparing mouldings for casting metal in the 19th century foundries that serviced Cornwall's extractive industries was found in only a few places in the county: Beacon Pit in St Agnes, Lowland Point in St Keverne, and the pits a little way east of St Erth are the principal sites.

St Erth Pit was the last and deepest of the St Erth group. It was worked between 1899 and 1950, serving in turn Harvey's (Hayle) and Holmans (Camborne) Foundries. Six strata were worked separately (1-2 overburden; 3-4 moulding sand; 5-6 clay) with overburden being dumped separately. The sand was worked by hand, loaded onto skips and trammed to the entrance, loading bay, and the weighbridge. The site today clearly shows the different areas and strata worked. No built structures survive and the site is now a very important nature reserve due to the extreme geological and ecological significance of these Pliocene deposits.

Sand pits - Sea sand - Within the very large areas of sand dunes in Cornwall, there are a number of large sand pits dug specifically for sweetening agricultural land, as well as providing high quality building sand (when washed). Of particular note are the various sand pits in the dune system between Hayle and Gwithian.

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Appendix 1

The number of types of components found in the National Thesaurus of Site Types (maintained by English Heritage) are very limited at present. Below is a more complete list of the principal components found at quarries and pits or other sites associated with the industry. The list is arranged roughly in process order:

1. Ownership

Boundary stones *(sett boundstones, boundary marks)*

2. Site Preparation

- **Overburden dumps**

- removal of soil and subsoil to reveal the rock to be extracted

3. Drainage

- **Leat(s)**

4. Extraction

- **Quarry, pit, mine**

- the area from which the raw material has been removed. Often filled with water following abandonment. In the case of quarries there will be ***floor(s)****,* ***face(s)*** *and* ***entrance(s)****.*

5. Waste storage

- **Primary waste**

- waste produced from extracting the desired dimension stone. ***Waste dump(s)*** *when undifferentiated;* ***finger dump(s)*** *when trammed from the quarry.*

- **Secondary waste**

- produced when shaping dimension stone into a finished product eg: ashlar blocks, roofing slates. ***Scabbling dumps*** *for granite.*

6. Moving stone around the quarry

Cranes and winches used to move the stone from the working face to the dumps and dressing floors. As a general rule cranes lifted blocks of stone and winches dragged blocks of stone.

- **crane** - hand, compressed air, steam, electric, mobile; **poppet head; winch; derrick; mast crane; guys; guy anchor point(s); strongpoints; capstans; horse whim**.

7. Breaking stone

- **wedge and groove** hand breaking with chisel; **plug(tare) and feathers** boring by drill.

- **Drilling; blasting; thermal lance/jet-channelling.**

8. Transport

- **Tramways; railways; loading ramps; railway/tramway inclines; cart roads; quays; wharfs**

9. Dressing/crushing

- **Dressing sheds/bankers; splitting sheds;**

- **Blacksmith's shop; carpenters shop; smithy/smiths shop; powderhouse /magazine; sawing shed/works; polishing shed/works; fitters shop.**

- **Crushing plant; screening plant; Compressor house;**

Administration

- **Offices; managers houses; quarryman's houses/cottages**

CHAPTER *Three*: THE NATURE CONSERVATION VALUE OF ABANDONED PITS AND QUARRIES

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1. Introduction

Derelict pits and quarries are largely an unrecognised resource for nature conservation in Cornwall. Natural colonisation by plants and animals has followed the abandonment of these sites (Plate 14) often leading to the presence of rare or locally important species (Coppin & Bradshaw, 1982). Some of these quarries (e.g. Newmill Quarry and Sheffield Quarry in West Penwith) have been well surveyed for wildlife and others such as Rosemanowas Quarry near Penryn are known to be important for wildlife despite being still used for a variety of industrial purposes. However, there are large numbers of quarries and pits (many on private land) for which the wildlife is yet to be documented but which may be important because they contain one or more of the following:

- refuges of habitats formerly common in the surrounding agricultural landscape
- open exposures with early successional stage plants and animals
- standing water buffered from the surrounding landscape
- key species such as birds, bats, mosses and liverworts and dragonflies

Many sites of wildlife value in Cornwall have been designated either as Sites of Special Scientific Interest or as County Wildlife Sites. Many quarries have been designated as SSSIs because of their geological interest, although some (e.g. Stepper Point and De Lank) are also important for wildlife. County Wildlife Sites are also important in this context and it has been estimated by the Environmental Records Centre for Cornwall and the Isles of Scilly that about 29% (179) of the County Wildlife Sites in Cornwall contain at least one (often more) disused quarry, ranging from 10 metres to over 300 metres wide. In addition to these sites, a large number of non-designated areas of wildlife value centre on former quarries because these have often been too difficult or hazardous to reclaim for agricultural land.

A review for English Nature of the importance of the mineral extraction industries for biodiversity in different Natural Areas in Britain (English Nature Research Report 279) omits the Natural Areas which occur in Cornwall (Bodmin Moor, Cornish Killas and Granite, The Lizard, West Penwith, The Culm and the coastal fringes). This illustrates the point that the importance of quarries for wildlife may be largely overlooked because many of the quarries are very small and widely scattered throughout the region.

2. Key Habitats

2.1. Habitat types

A range of habitats occur in quarries, depending on a variety of factors including:

- the underlying geology (e.g. granite, slate, serpentine or sand dune)
- the pre-industrial wildlife
- the industrial history

- the sequence and pace of colonisation (often slow on thin acid soils)

Figure 1: *Sand pit on the north Cornwall coast (c. A. Spalding)*

2.2. Woodland and scrub

The flat land on the quarry floor and associated areas has often been colonised by woodland. In Cornwall, early colonisation of these thin acid soils is often characterised by European Gorse (*Ulex europaeus*) scrub, or Willow (*Salix species*) and Birch (*Betula pubescens*) scrub, sometimes with Sycamore (*Acer pseudoplatanus*) and Elder (*Sambucus nigra*). Ruderal species such as the Butterfly Bush (*Buddleia davidii*) are often present. These early colonisers may be followed by thin oak woodland over a typical acid flora of Bilberry (*Vaccinium myrtillus*), Bramble (*Rubus fruticosus agg*), Great Wood-rush (*Luzula sylvatica*) and Heather (*Calluna vulgaris*). Bracken scrub may be abundant on adjacent slopes where the soil is deeper.

Figure 2: *Kennal Quarry (c. A. Spalding)*

Flooded quarries are often fringed by Willow scrub, with abundant Grey Willow (*Salix cinerea*) and a ground flora of typical species such as Cock's-foot (*Dactylis glomerata*), Hemlock Water Dropwort (*Oenanthe crocata*), Marsh Bedstraw (*Galium palustre*), Red Campion (*Silene dioica*), Yorkshire Fog (*Holcus mollis*) and Wild Angelica (*Angelica sylvestris*).

2.3. Unimproved grassland

The thin soils that accumulate on quarry floors may be colonised by short grassland, often grazed by rabbits; in some areas the thin soil is enriched by rabbit droppings. These areas of short rabbit-grazed vegetation often support a good variety of plant species, with a range of typical grasses such as Bent (*Agrostis species*), Crested Dog's tail (*Cynosurus cristatus*), Red Fescue (*Festuca rubra*), Sweet Vernal-grass *Anthoxanthum odoratum* and Yorkshire Fog (*Holcus lanatus*). A large number of other plant species are often present, mainly typical grassland species but including less widespread plants such as Yellow Bartsia (*Parentucellia viscosa*) (often associated with poor stony soils), Heath Spotted Orchid (*Dactylorhiza maculata*) (on poor damp soils) and Lesser Skullcap (*Scutellaria minor*) (on wet soils).

Common and widespread species include Buck's-horn Plantain (*Plantago coronopus*), Common Centuary (*Centaurea erythraea*), Common Field Speedwell (*Veronica persica*), Common Ragwort (*Senecio jacobaea*), Daisy (*Bellis perennis*), Procumbent Pearlwort (*Sagina procumbens*), Scarlet Pimpernel (*Anagallis arvensis*) and Selfheal (*Prunella vulgaris*). Mosses and lichens may be abundant in places.

2.4. Disturbed and open ground

Areas of stone rubble associated with quarry workings may support a range of plant species associated with early successional stage habitats. These generally form a sparse vegetation and may include Common cat's-ear (*Hypochaeris radicata*), English Stonecrop (*Sedum anglicum*) (Plate 15), Foxglove (*Digitalis purpurea*), Sheep's-bit (*Jasione montanum*), Silverweed (*Potentilla anserina*) and Sweet Vernal Grass (*Anthoxanthum odoratum*). Non-native garden plants may be present in quarries where the dumping of garden waste has occurred.

The bare rock exposures of quarries may be colonised by plants such as English Stonecrop (*Sedum anglicum*), Silver Hair Grass (*Aira caryophyllea*) and Wall Pennywort (*Umbilicus rupestris*). Rock ledges may hold small clumps of Heather (*Calluna vulgaris*) and Bilberry (*Vaccinium myrtillus*). Ferns such as Common Polypody (*Polypodium vulgare*) and Broad Buckler (*Dryopteris dilatata*) are often present.

2.5. Wetland

Many hard rock quarries are poorly drained and contain extensive areas of wetland. Typical habitats include Purple Moor Grass (*Molinia caerulea*) grassland, rush meadow and wet heathland. Purple Moor Grass grassland is usually species poor and is often associated with wet Willow woodland. Rush meadow may be dominated by species such as Soft Rush (*Juncus effusus*) and Jointed Rush (*Juncus articulatus*), with associated grassland species. Wet heathland may contain stands of Heather (*Calluna vulgaris*) and Cross-leaved Heath (*Erica tetralix*), in addition to Bog Asphodel (*Narthecium ossifragum*), Tormentil (*Potentilla erecta*) and Sphagnum mosses.

2.6. Freshwater

In many cases, previous industrial activity has created deep pools in abandoned quarries which provide rare examples of deep oligotrophic or mesotrophic pools. The stable weed communities associated with these habitats often possess large areas of clear water, fringed by a diversity of aquatic plants such as Gypsywort (*Lycopus europaeus*), Water Mint (*Mentha aquatica*) and Marsh St John's-wort (*Hypericum elodes*). This creates ideal habitat for invertebrates that use the open water for predation and the plant cover for refuge and breeding.

Pools are generally surrounded by a margin of derelict land, providing a buffer zone from agricultural fertilisers, pesticides and soil erosion. Previous industrial activity has usually created a deep pool, which also allows nutrients to become bound and lost in sediments with minimal risk of recycling or disturbance by the weather. Many such areas will have elevated levels of metals, such as iron

and manganese, which bind phosphate and suppress algal blooms. Previous activity can also create unusual pH and conductivity values, potentially providing a niche for plants and animals with particular requirements. Depth also controls weed populations, any depth greater than 80 cm tending to discourage the establishment of rooted macrophytes. Quarry pools often have a low surface area to volume ratio, creating deep pools that are good at buffering extremes of temperature. This type of pool provides a valuable contrast to the vast majority of man-made pools - 63% of surveyed ponds were identified in the DETR lowland pond survey of 1996 to be either very shallow or seasonally dry.

3. Key Species

3.1. Priority species

As part of the national Biodiversity Initiative, a large number of species have been listed as Priority Species for which costed action plans have been prepared. Those species which may be associated with abandoned pits and quarries are listed in Table 1. and illustratedin Plates 16, 17 and 23.

Table 1: Priority Species possibly associated with abandoned pits and quarries in Cornwall

Common name	Scientific name
Western Ramping Fumitory	*Fumaria occidentalis*
Greater Horseshoe Bat	*Rhinolophus ferrum-equinum*
Lesser Horseshoe Bat	*Rhinolophus hipposideros*
Sand Martin	*Riparia riparia*
Silver-studded Blue	*Plebejus argus*
Double Line Moth	*Mythimna turca*

Figure 3: *Double Line moth associated with bracken slopes on abandoned moorland quarries (c. A. Spalding)*

Figure 4: *Bearah Tor, habitat for Double Line moth (c. Historic Environment Service, Cornwall County Council)*

3.2. Stoneworts

Quarry pools on the Lizard Peninsula are important for stoneworts (*charophytes*) because they may provide:

- clean unpolluted water, isolated from main water courses (stoneworts are especially sensitive to nitrates and phosphates)
- magnesium (many stoneworts secrete calcium carbonate onto their outer surfaces and therefore are often associated with chalk/limestone areas; on the Lizard, magnesium substitutes for the required calcium).

South-west Cornwall has been listed by Stewart (1996) as one of the key areas of

Britain for stoneworts, with 14 species present, many of which are associated with the magnesium-rich serpentine quarry pools on the Lizard (Gainey, 1997). Stoneworts are generally early colonisers and may be threatened by natural succession, pollution and eutrophication.

3.3. Bryophytes

Over 230 mosses out of 425 species in Cornwall occur on mines and quarry sites (including china clay) - these areas provide a range of habitats, from very dry to aquatic, from acidic to basic. A number of nationally rare and nationally scarce mosses and liverworts have been recorded in quarries in Cornwall (Table 2).

Table 2: Examples of important bryophytes associated with quarries in Cornwall

Scientific name	Status
Barbula acuta	nationally scarce
Brachydontium trichodes	nationally scarce
Bryum pallescens	nationally scarce
Cephaloziella turneri	nationally scarce
Cephaloziella integerrima	nationally rare
Cratoneuron commutatum	locally scarce
Fissidens algarvicus	nationally rare
Fossombronia maritima	nationally rare
Grimmia decipiens	nationally scarce
Grimmia laevigata	nationally scarce
Oligotrichum hercynicum	locally scarce
Philonotis rigida	nationally scarce
Pogonatum aloides	nationally scarce
Tortula canescens	nationally scarce
Tortula cuneifolia	nationally rare

Several quarries have been listed by English Nature as important for bryophytes, e.g. Withiel Quarry (117 bryophytes listed), Bodieve slate quarry, Straverpark Quarry and Trevorrick Slate quarries. The old limestone quarry at Southdown near Millbrook in south east Cornwall contains 64 species, although no rare species are known.

3.4. Vascular plants

Vascular plants typically associated with abandoned quarries are ruderal species such as Bramble (*Rubus fruticosus agg*)., Common Nettle (*Urtica dioica*), Creeping Buttercup (*Ranunculus repens*), Foxglove (*Digitalis purpurea*) and Rosebay Willowherb (*Chamerion angustifolium*). Royal Fern (*Osmunda regalis*) (Plate 18) is often found in quarries, for example at Maen Pern, Sheffield Quarry and Newmill Quarry (French *et al*. 1999) . However, a number of rare species also occur in quarries (Table 3).

Table 3: Important vascular plants associated with quarries in Cornwall

Common name	Scientific name	Status
Balm-leaved Figwort	*Scrophularia scorodonia*	nationally scarce
Cornish Moneywort	*Sibthorpia europaea*	nationally scarce
Little Robin	*Geranium purpureum*	nationally scarce
Sharp Rush	*Juncus acutus*	nationally scarce
Western Ramping Fumitory	*Fumaria occidentalis*	nationally rare

3.5. Invertebrates

Quarries are important for invertebrates because they may provide:

- a varied topography with a variety of habitats
- shelter from climate (wind, rain and cold)

- bare surfaces for sun-basking, predation and ground nesting
- ruderal plant communities, often with abundant nectar and pollen
- pollution-free pools for freshwater species
- a variety of seasonal pools and wet bare ground

Quarries with pools are especially important for dragonflies and damselflies (*Odonata*). For example, the nationally scarce Scarce Blue-tailed Damselfly (*Ischnura pumilio*) is often associated with shallow pools with scant emergent vegetation and is found at Stepper Point Quarry. The locally scarce Black-tailed Skimmer (*Orthetrum cancellatum*) is especially associated with old quarries for serpentine, gabbro and hornblende schist on the Lizard where it colonises large areas of open water. The nationally rare Red-veined Darter (*Sympetrum fonscolombei*) has been recorded in large shallow pools in old quarries on the Lizard. Several sites with quarries in Cornwall have been classed by the Cornwall Wildlife Trust as Key Odonata Sites, e.g. Porthoustock Quarry.

Many quarries will contain areas of bare ground, especially old sand quarries. Bare ground is especially important for invertebrates, which use the bare areas for thermo-regulation, burrowing and predation (e.g. Key, 2000). (Plate 19) Sand quarries (e.g. at Gwithian and Godrevy) will often contain important populations of those species more generally associated with the adjacent dune systems, where important invertebrate habitat may have been lost due to increased stabilisation with scrub and Marram grass (*Arenophila arenaria*). Similarly, important invertebrate habitat on coastal cliffs may have been lost following encroachment by Bramble and Blackthorn so that the only warm exposures remaining are on the thin soils of disused slate quarries. These areas can be important for warmth-loving species such as Grey Bush-cricket (*Platycleis albopunctata*) (Plate 20).

3.6. Reptiles

Quarries are important for reptiles because they may contain one or more of the following:

- warm sheltered basking areas
- abundant prey items
- abundant cover for concealment from predators

In particular, quarries provide an important resource for Adder (*Vipera berus*) (Plate 21) and Common Lizard (*Lacerta vivipara*) (Plate 22).

3.7. Birds

Breeding birds associated with quarries in Cornwall include Buzzard (*Buteo buteo)*, Kestrel (*Falco tinnunculus)*, Peregrine (*Falco peregrinus)*, Raven (*Corvus corax)* and Stock Dove (*Columba oenas)*. The Cornwall Wildlife Trust defended the quarry site at Mabe against development because of its birds interest, especially the presence of Stock Dove. Peregrines nest mainly on the coast but also use one or two inland quarries (Madge, 1997). These species are of nature conservation importance within Cornwall since they all

have breeding populations of less than 1000 pairs.

3.8. Mammals

Abandoned quarries may be of special importance for bats. Many quarries are important as feeding sites, especially where they contain water and deciduous trees, as the warm humid climate is ideal for insects. Although bare rock faces are of little value for bats, rock exposures with ivy and other vegetation provide suitable summer roost habitat for bats. The associated disused quarry buildings may also provide important summer roosts.

Quarries with adits where minerals have been extracted may also be important as hibernation sites. This is especially true where the adits are sheltered and well-ventilated. Two quarry sites in Cornwall host important colonies of the nationally rare Greater Horseshoe Bat (*Rhinolophus ferrum-equinum)* and some sites host the nationally rare Lesser Horseshoe Bat (*Rhinolophus hipposideros)* (Plate 23) in addition to other species.

4. Conservation

4.1. Designated sites

The statutory notification of international (Special Areas of Conservation) and national sites (Sites of Special Scientific Interest) requires local authorities and the landowners or occupiers to take into account the special interest of the site should any development plans or changes in land management be proposed, with English Nature as the Government's Agency providing the formal advice on such matters.

4.2. Non-designated sites

Many quarries and pits lie outside designated sites and these have an important role to play for wildlife by providing valuable stepping stones or corridors for plant and animal dispersal and so sustaining the overall fabric of the countryside. Their wildlife is also protected to varying degrees by a variety of statutory measures, depending on the species and habitats present. These include:

- The Wildlife & Countryside Act 1981 and the Conservation (Natural Habitats etc) Regulations 1994 - provides basic protection for the majority of British wildlife species and special protection to those listed in the Schedules.
- The Protection of Badgers Act 1992 - provides protection to badgers and their setts.
- EC Habitats and Species Directive - Member States are required to maintain habitats at favourable conservation status in their natural range. The Directive also requires Member States to endeavour to use planning and development policies to maintain features of importance for wildlife as corridors or stepping stones 'for the migration, dispersal and genetic exchange of wild species' .

4.3. Key issues

The biodiversity of abandoned pits and quarries is being affected by a range of factors, including the following:

- landfill e.g. the disposal of dead animals and agricultural waste
- fly tipping e.g. of garden waste

- disturbance e.g. of nesting birds
- creation of fisheries
- invasive freshwater and terrestrial plants
- quarry face stabilisation damaging early successional stages
- Scrub encroachment e.g. by European Gorse
- Landscaping e.g. reforming and reseeding
- Tree planting

These factors may often result in the loss of valuable wildlife habitat, including the loss of bare ground and disturbance to early successional stage habitat. Increasing costs for general waste disposal (e.g. the landfill tax) have increased pressure on such sites. There is a risk that some of the quarry ponds will become dominated by exotic invasive weeds (Plates 24 and 25); as an increasing number of managed ponds become infested, the risk of cross-contamination increases, e.g. by birds (Plate 24). In addition, many landowners have attempted to create fisheries from pools, usually coarse fisheries which tend to result in an increasing trend towards eutrophic conditions. (There have also been cases of unscrupulous owners killing otters to protect their stock). Disturbance may be detrimental for bats and birds, although in some cases it may be beneficial by preventing succession to scrub and woodland and helping maintain bare ground suitable for a wide range of warmth-loving invertebrates. Monitoring the effects of disturbance and the rate of succession to scrub and woodland on these sites would provide useful information to inform future management decisions.

4.4. Management

Management recommendations for enhancing the nature conservation value of abandoned pits and quarries should only be made after a full site assessment. Site survey work should include habitat mapping and the assessment of the site for key species (especially stoneworts, bryophytes, vascular plants, invertebrates, reptiles and amphibians, birds and mammals). However, generic management recommendations might include the following:

- wetland recreation - restoration of pools and wetland habitat
- maintenance of early successional stage habitat
- retention of bare rock exposures
- retention of undisturbed habitat for nesting birds
- maintenance of abandoned buildings for roosting bats
- management of open woodland to maintain structural diversity
- maintenance of warm sheltered areas for reptiles and invertebrates
- removal of invasive alien plants

Management could be achieved by a range of measures including grazing, mowing, tree clearance and the use of herbicides (e.g. for the removal of Japanese Knotweed). However, continuing neglect may be beneficial for some quarries, especially for quarry pools. Management recommendations for bare ground are detailed in an English Nature booklet published as part of their National Lowland Heathland Programme.

5. Survey Procedures

Before any survey is performed, a suitable risk assessment should be carried out. Whilst sites may be derelict, many of the hazards of their former industry may remain. Foliage may conceal steep quarry edges, glass and sharp metal, fly-tipped asbestos, and many other hazards. Pools also tend to have steep edges.

The habitats of each quarry should be assessed and appropriate targeted methods used for each site, rather than approaching each site with a rigid approach to monitoring. For example, aquatic plants can be surveyed using grapples and algae from hauls with plankton nets. Freshwater invertebrates may be caught in marginal sweeps or from dredge sampling. Other invertebrates may be surveyed with light traps, sweep nets and beating trays. Bat detectors are an important aid in bat surveys.

It is important that ecological fieldwork is undertaken at the appropriate season to ensure consistent quality of results. For example, it is not possible to identify many of the more important bryophyte species in the dry summer months and many higher plants, invertebrate groups, reptiles and hibernating mammals are not visible in winter. The most appropriate times of year for undertaking specific group surveys are detailed in Table 1 (reproduced from Spalding & Dinsdale, 2000).

Table 1: The most appropriate season for undertaking species surveys

Species group	spring	summer	autumn	winter
Mammals except bats	Appropriate	Appropriate	Appropriate	Acceptable
Bats	Acceptable	Appropriate	Acceptable	Appropriate
Birds	Appropriate	Appropriate	Inappropriate	Inappropriate
Reptiles and Amphibians	Appropriate	Acceptable	Appropriate	Inappropriate
Invertebrates	Appropriate	Appropriate	Appropriate	Inappropriate
Flowering plants and ferns	Appropriate	Appropriate	Acceptable	Inappropriate
Lower plants	Acceptable	Inappropriate	Inappropriate	Appropriate

Appropriate Acceptable Inappropriate

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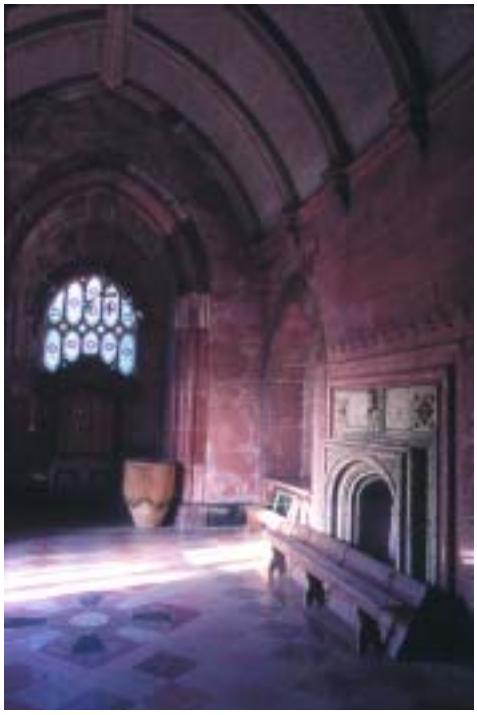
1. *Tregarden quarry at Luxulyan; this was the last active quarry in the once intensely quarried Luxulyan valley area. It is currently worked as a source of aggregate. The rare ornamental stone 'luxullianite' can be found in this quarry (bottom centre). (c. Colin Bristow)*



2. *The interior of Porphyry Hall, Place, Fowey, lined with polished slabs of luxullianite and polished elvan. The skirting is composed of schorl and the central floor rose incorporated polished panels of topazfels from St Mewan Beacon, described by Collins in the last paper he wrote (Collins and Coon, 1914). (c. Colin Bristow)*

5. *Withnoe quarry, above Whitsand Bay, which shows an early Permian volcanic neck. This occurrence, together with the lava at Kingsand, are the only ones which show volcanic rocks corresponding in their chemistry with the granites. (c. Colin Bristow)*

3. *15th century carvings in Pentewan stone on the tower of St Austell Parish church - a sermon in stone. For a description of what the carvings represent, see Rowse, 1960. (c. Colin Bristow)*

4. *The exterior of Place, Fowey, faced with Pentewan Stone. Much of the stone was renewed in the early 19th century by Joseph Treffry, the famous mid-Cornwall quarrymaster, who lived at Place. The most likely source for this stone was a quarry inland from Pentewan village (SX 022479). (c. Colin Bristow)*

6. *15th Century font in St Petroc's church, Padstow, carved in Cataclews stone (a dolerite) by the 'Master of St Endellion'. (c. Colin Bristow)*

7. *Carving in Polyphant stone forming part of the Boer War Memorial in Truro Cathedral. Polyphant stone is composed of talc, chlorite and Ca/Mg carbonates and workings date back to Norman times. (c. Colin Bristow)*

8. *Old slate quarry at Gerran's Point, which worked slates of the Meadfoot Group (Lower Devonian) in the early 19th century, on the west side of St Austell Bay. Important fossils have come from the vicinity of this locality, including an Orthoceratid which can be seen in the Rashleigh Gallery of the Royal Cornwall Museum. (c. Colin Bristow)*

9. *Gew-graze talc working on the west side of the Lizard. The talc occurred as a vein in the serpentine and the working forms an irregular scar extending from the shoreline up the hillside in the centre of the picture to the quarry at the top. The working is of considerable historical interest as talc from here was used by Lund in Bristol around 1850 for the manufacture of some of the earliest porcelain made in this country, before the technology of using china clay was developed by William Cookworthy. (c. Colin Bristow)*

10. *An arch built of Quaternary sandrock in St Carantoc's church at Crantock. A tower built of this sandrock in the 14th century fell down shortly after it was built, suggesting that there are structural limitations with this type of stone. (c. Colin Bristow)*

11. *De Lank Granite Quarry, St Breward. A dimension stone and aggregates quarry that has eaten into a low ridge. On the left is Eddystone Quarry which provided the stone for the lighthouse. A railway incline took stone down to the Bodmin and Wadebridge Railway terminus at Wenford (in the valley at the top of the photo). Site survey: Cornwall Archaeological Unit 1993 published in Herring et al. (forthcoming). (c. Historic Environment Service, Cornwall County Council)*

12. *Carbilly Tor Granite Quarry, Blisland, Bodmin Moor. Good example of abandoned dimension quarry with finger (waste) dumps. On the right is the flooded quarry with crane base. Survey by Cornwall Archaeological Unit 1993 and, published in Herring, et al. (forthcoming). (c. Historic Environment Service, Cornwall County Council)*

13. *Prince of Wales Quarry, near Tintagel. Prince of Wales (west) at the top, Bowithick Quarry is on the right. The main Prince of Wales Quarry with its winding engine house is in the centre. (c. Historic Environment Service, Cornwall County Council)*

14. *Pentewan Quarry, 100 years after quarrying ceased (c. C. Bristow)*

15. *English Stonecrop (c. Coast and Countryside Service, NCDC)*

16. *Western Ramping Fumitory (c. E.C.M. Haes)*

17. *Silver-studded Blue associated with warm sand dunes and quarries (c. A. Spalding)*

18. *Royal Fern (c. Coast and Countryside Service, NCDC)*

19. *Digger Wasp Mellinus arvenis in sand pit (c. A. Spalding)*

20. *Grey Bush-cricket (c. E.C.M. Haes)*

21. *Adder (c. A. Spalding)*

22. *Common Lizard (c. A. Spalding)*

23. *Lesser Horsehoe Bats (c. Fiona Gwynne-James)*

24. *Quarry pool, infested with Parrot's Feather after inappropriate disposal from a garden pond (c. T. Renals)*

25. *Flooded serpentine quarry with goldfish and water lily (c. A. Spalding)*

26. *Casts of Toarcian ammonites illustrating the stratigraphy of an abandoned quarry at Thouars. (c. Kevin Page)*

27. *'Rock Route' panel, funded by the Geologists' Association, at Northmoor Hill Woods reserve. (c. John Macadam)*

29. *Climbers in Cligga Quarry, Perranporth. (c. John Macadam)*

28. *Aerial view of the National Stone Centre. (c. NSC)*

30. *Carn Marth and Lanner village (c. Kerrier District Council)*

31. *View of the Theatre quarry*
(c. Kerrier District Council)

32. *Drill holes in quarry wall, Holman's Quarry*
(c. Kerrier District Council)

33. *Japanese Knotweed infestation at Holman's Quarry*
(c. Kerrier District Council)

34. *Abseiling and de-scaling loose granite at Holman's Quarry*
(c. Kerrier District Council)

35. *Pedestrian access ramp, Holman's Quarry*
(c. Kerrier District Council)

36. *Installation of Kestrel's nest box, Holman's Quarry (c. Kerrier District Council)*

37. *The Cheesewring in early February, 1984 (c. Historic Environment Service, Cornwall County Council)*

38. *The Cheesewring in late February, 1984 (c. Historic Environment Service, Cornwall County Council)*

39. *Colonising vegetation at Prince of Wales Quarry (c. Coast and Countryside Service, NCDC)*

40. *Tip requiring continuing monitoring (c. Coast and Countryside Service, NCDC)*

CHAPTER *Four*: THE LAND USE PLANNING CONTEXT FOR ABANDONED PITS AND QUARRIES.

David Owens (Principal Planner, Planning Directorate, Cornwall County Council)

1. Introduction

It has been estimated that there maybe 4 - 5,000 examples of disused mineral extraction sites in Cornwall. These range from the numerous small rab pits of no more than 10 cubic metres from where material was used for building or hedging purposes up to and including the substantial voidspaces remaining from the activities of the modern minerals industry.

This plethora of abandoned pits and quarries in Cornwall raises a complex range of issues which need to be considered, not only by the planning authorities but by a much wider range of statutory agencies and non statutory organisations. It is essential that the conference, the resultant papers and subsequent actions of this range of bodies begins to address the challenges and opportunities presented by these sites.

2. The Issues

Quite simply we do not know enough about the abandoned pits and quarries on our doorstep in Cornwall. I do not think that we are alone in this state of affairs but by having set up the Derelict Land Advisory Group and by holding this conference we are attempting to take those first essential steps.

The following questions have had to be asked at the outset of the process :-

- how many abandoned pits and quarries are there in Cornwall?
- where are they ?
- what is their history ?
- what is their value ?
- what are the opportunities ?
- what are the threats ?

It has gradually become apparent during the early stages of this Project that there do exist several unrelated sources of specialist information and indeed knowledge of a number of individual sites. But until more is known and the answers to these questions have been realised, it is not possible to begin to build up an accurate or effective overall picture of the resource nor begin to assess either the scale of threats both to the individual sites or their collective value.

3. The Two Ages of Mineral Extraction

From a planning perspective there are two distinct "ages" of minerals extraction which require a fundamentally different planning response. These ages can be briefly outlined as follows :-

- **Pre-War Quarries and Pits**

  Undoubtedly the majority of abandoned pits and quarries in Cornwall fall into this classification. They represent key components of the landscape character of Cornwall and are principally constituted of small sites used for local building and hedging purposes and were excavated to minimise the transport of relatively low grade materials over significant distances. Because of their age they have the potential to have assumed

considerable conservation and historical value but arguably are those most under threat because of their compactness, perceived nuisance value and lack of recording.

- **Post War Permissions**

Sites granted planning permission for mineral extraction and associated activities since the introduction of the Town and Country Planning Act 1947 have enjoyed gradually increasing levels of planning control. Today "active" mineral workings have, under the new requirements of the Environment Act 1995, reviews of their planning consents undertaken every 15 years in order to modernise the level of environmental control exercised over such sites.

4. The Planning Context

Where development proposals emerge which would be located in either abandoned or current mineral workings the planning system comes into effect.

The planning context for abandoned pits and quarries is set by the legislative framework of the Town and Country Planning Act 1990 as amended by the Planning and Compensation Act 1991. This is both reinforced and complemented by the requirements of legislation such as the Wildlife and Countryside Act, the Water Resources Act and the Quarries Act. This legal context is further developed by a comprehensive range of regulations and formal advice including, for example, the Department of the Environment Transport and the Regions series of minerals planning guidance (MPGs) notes. This complex of advice is further supported by a vast range of Government sponsored research which, it should be noted, is predominantly based upon the presumption for the infilling/restoration of mineral workings.

The general policy approach set out in Government advice is a presumption in favour of the restoration of mineral workings. MPG 1 states :-

> "Land taken for mineral extraction or the depositing of mineral wastes should be reclaimed to a standard suitable for a beneficial after-use as soon as possible."

There are a number of reasons for this policy:-

- To prevent dereliction
- Minimising the environmental effects of mineral working
- Safety
- Opportunity for achieving some of the targets set in the UK Biodiversity Action Plan
- Magnets for fly-tipping

The planning approach to abandoned pits and quarries is determined to a significant extent by whether planning consent for minerals extraction exists for a particular "hole in the ground." The introduction of the planning system after the second world war required all working extraction sites to obtain planning consent. Therefore the Study to date has concentrated on the predominant proportion of abandoned mineral workings in Cornwall which do not have formal planning consent. These sites therefore only become of interest to the

planning authorities if there is a proposal (or threat) to develop such a site.

The Derelict Land Advisory Group has however not tasked itself to give consideration to those sites which enjoy the benefit of planning consent. The operational planning control and after-use of such sites is the concern of the relevant planning authorities through the planning legislation.

5. The Development Plan Context

Development decisions must be taken by the relevant authorities within the context of the Development Plan. The development plan in a two tier system of local government, such as Cornwall, is composed of the Structure Plan, district wide local plans and minerals and waste local plans. Much work is still necessary to reach the stage of having up to date adopted plans in the County. However two significant elements of the development plan have been formally adopted in Cornwall.

- **Cornwall Structure Plan, 1997**

  The Structure Plan provides the broad strategic context within which the rest of the development plan resides. The Plan sets out policies covering a wide range of matters from housing and retail development, through maritime, minerals, waste and environmental matters. The approach recognises the importance of facilitating appropriate development while being sympathetic to the inherent value of the unique environment of Cornwall.

- **Cornwall Minerals Local Plan, 1997**

  The County Council adopted in 1997 the Cornwall Minerals Local Plan which sets out the policy context for the development of the minerals industry in Cornwall over the period to 2011. Whilst seeking to control and direct the development of the industry, the Plan also provides wider contextual guidance which is relevant to abandoned pits and quarries particularly where there are proposals to re-open former or redundant workings. Particular encouragement is given to enable the re-opening of closed mineral workings where there is a need for obtaining material for restoration/conservation projects. The Plan also contains a Chapter on the educational value of mineral workings in the County.

6. Conclusions

This conference has already succeeded in that it has brought the issue of the conservation value of abandoned pits and quarries to a new audience and indeed a much wider level of awareness within Cornwall. Looking just at the work of the Derelict Land Advisory Group has drawn together a range of interests including geologists, ecologists, educators and even planners - success in itself !

It is apparent from the work that has led to this conference and listening to the speakers that this diverse Cornish resource is something that needs to be studied, understood, valued and utilised, where it would not harm the very value of the particular resource.

It is also essential that work must not stop here. There is an urgent need to scope the nature and value of this resource. It is the next steps which will be of fundamental importance to the understanding and conservation of this stunning resource.

CHAPTER *Five*: THE WASTE MANAGEMENT LICENSING ASPECTS

Ralph Seymour (Principal Solicitor, South West Region, Environment Agency)

1. Introduction

A paper such as this can only be an outline guide to the legal position and not an in depth one. Its aim is to give you an overview to how Waste Management Licensing applies to the filling of old quarries and pits.[1]

The Environmental Protection Act 1990 seeks to implement the Waste Framework Directive into national law. The starting point for our regulatory regime is to be found in Section 33. Section 33(1)(a) & (b) make it an offence to deposit, treat, keep or dispose of controlled waste except under and in accordance with a Waste Management Licence. Section 33(1)(c) makes it an offence to treat, keep or dispose of controlled waste in a manner likely to cause pollution of the environment or harm to human health. The latter applies whether or not something is done under and in accordance with a waste management licence - although if the conditions of a licence are being complied with then pollution or harm should not arise. Section 33(3) provides that sub-sections (1)(a), (b) or (c) do not apply in cases prescribed in Regulations made by the Secretary of State.

Such Regulations seek to exclude from the licensing system:

- Any deposits that are small enough or of such a temporary nature that they may be excluded
- Any means of treatment or disposal which are innocuous enough to be excluded
- Or where adequate controls are provided by another statutory regime.

Controlled waste is defined in Section 75. It is a complicated topic in its own right. It is not always straight forward to determine whether something is waste. As a working definition for the purposes of this paper, it can be taken as being a substance which the holder or producer discards, intends to discard or is required to discard, but not any waste from any mine or quarry or waste from premises used for agriculture.

At one extreme it is easy to determine that the contents of a domestic dustbin are waste. At the other extreme, you have chemicals used in industry which periodically lose their effectiveness. Some of these can simply be cleaned or re-generated. Others have to go through a waste treatment or recovery process to reclaim useful material from them. It is not always easy to distinguish between these different types of operation.

The exclusions relating to wastes from mines and quarries or waste from agricultural premises are wider than those in the Directive. The exclusions from the Directive are limited to situations where other regulatory controls apply and in the case of agricultural waste to specified types of agricultural wastes. Section 75 will be amended to bring it in line with the Directive and consultation papers are

[1] All new landfills now require a Pollution Prevention Control (PPC) permit rather than a waste management licence. They also need to meet the requirements of the Landfill Directive. Transitional provisions will bring existing landfills into this regime. The exemptions can still be relied in in appropriate cases.

expected shortly on how this will be achieved.

The Waste Management Licensing Regulations 1994

Regulation 17 provides that Section 33(1)(a) & (b) do not apply to the carrying out of the activities set out in Schedule 3 (subject to any conditions in the Schedule). [Note S33(1)(c) does still apply].

It follows that if any conditions relating to a particular exemption are not met then an offence is committed under Section 33(1)(a) or (b).

Even if the conditions are met, if the activity gives rise to pollution of the environment or harm to human health then there is an offence under Section 33(1)(c).

Regulation 17(4) provides that the exemptions only apply in so far as the operations meet the `relevant objectives' which are that they :-

do not endanger human health

do not use processes or methods, which could harm the environment and in particular without:-

(i) risk to water, air, soil, plants or animals; or

(ii) causing nuisance through noise or odours; or

(iii) adversely affecting the countryside or places of special interest

If the 'relevant objectives' are not met then an activity will not be exempt from the need for a waste management licence.

The 'relevant objectives' apply to all exemptions and appear at first glance to be self-explanatory. The reference to places of special interest may be of particular relevance to some quarries. Unfortunately, it is not defined in the Regulations which leaves its meaning open to interpretation. It would also be dependent on the Agency being aware or being made aware of the special interest when it was determining whether a particular proposal met the 'relevant objectives'.

Schedule 3 to the 1994 Regulations contain 45 exemptions ranging from the burial of dead domestic pets to metal recycling. They are primarily aimed at recovery/re-use.

Where an exemption does allow for the disposal rather than re-use of a waste to satisfy Article 11 of the Directive, the disposal should be at the place of production of the waste and be by the establishment or undertaking that produced it.

Regulation 18 requires any undertaking or establishment carrying out an exempt activity to be registered with the Agency.

Hence the Agency should get to know about any proposals relating to exempt activities. If it is not satisfied that the terms of the exemption are met it can refuse to register it.

The onus is on the person claiming the benefit of an exemption to satisfy the Agency that they meet its terms. The need to register does not apply to individuals carrying out an operation in a private capacity but for example sole traders would be an undertaking or establishment. The two most relevant exemptions for pits &

quarries are those in paragraphs 9 & 19 of schedule 3:

"9(1) subject to sub-paragraph (3) below, the spreading of waste consisting of soil, rock, ash or sludge, or of waste from dredging any inland waters or arising from constriction or demolition work, on any land in connection with the reclamation or improvement of that land if

(a) by reason of industrial or other development the land is incapable of beneficial use without treatment;

(b) the spreading is carried out in accordance with a planning permission for the reclamation or improvement of land and results in benefit to agriculture or ecological improvement; and

(c) no more than 20,000 cubic metres of such waste is spread on the land

(2) [prior storage of waste before spreading]

(3) sub-paragraph (1) above does not apply to the disposal of waste at a site designed or adapted for the final disposal of waste by landfill."

You can see that paragraph 9 sets out the types of waste that can be utilised and then there are 3 criteria all of which must be met. Criteria (a) is self-explanatory, for (b) the planning permission must be for reclamation or improvement of the land. It is not sufficient for the activity to be incidental to a planning permission for another purpose or for it to be covered by permitted development rights. In (c) the fact that the exemption refers to spreading and the exemption limit should be taken together. The material does not have to be exactly the same depth all over so you can take out any slight uneveness in the original surface but you cannot put 90% in a hole in the middle of the site and the remaining 10% round the edge. The maximum permitted quantity would give a depth of approximately 6 feet when spread. (It would not apply where the primary purpose of the activity was disposal but given the quantity limits and need to be beneficial this should not be the case anyway.)

Paragraph 19 covers the storage and use of waste which arises from demolition or construction work or tunnelling or other excavation or which consists of ash, slag, clinker, rock, wood or gypsum.

The waste must be suitable for purpose and it can be used for construction work, including the deposit of waste on land in connection with:

(a) the provision of recreational facilities on that land; or

(b) the construction, maintenance or improvement of a building, highway, railway, airport, dock or other transport facility on that land, but not including either any deposit of waste in any other circumstances or any work involving land reclamation.

There are no quantity limits which can be a problem. However, the quantity of waste used must be reasonable in relation to the proposal. Otherwise it will be considered that the primary purpose of the activity is

disposal rather than re-use and so the exemption will not apply (as it is intended to provide for the beneficial use of wastes and not their disposal). Recreational uses can include golf courses or ski slopes.

There was an application for registration of an exemption under this paragraph recently where the proposal was in practical terms to fill a quarry to put a golf course over the top of it. The facts of that proposal were such that they went beyond what was necessary and appeared to amount to a back door method of disposal rather than being a genuine re-use of waste. Registration was refused. Had the proposal been limited to the deposit of material to create a golf course within the confines of the quarry void (rather than filling the entire quarry) a different decision may well have been reached.

2. Licensing Issues

The filling of quarries and pits with bio-degradable waste will be licensable as that is clearly a waste disposal operation. A licence will also be required where the waste types are inert if the primary purpose of the activity is waste disposal.

If a licence is granted, it will contain detailed conditions controlling how the activity is to be undertaken. Where planning permission is required for the use of the land for the proposed operations, a licence will not be issued unless either an appropriate planning permission is in force or there is an established use certificate.

Engineering problems - depending on the waste types the site may need lining to prevent the escape of pollutants.

Gas migration can be a problem - it is less predictable than for above ground disposal as it can travel through fissures in the rock.

As one licensing officer put it, it can cost a lot to fill a quarry and even more if anything goes wrong.

Landfill tax is payable in respect of waste deposited at licensed sites. It is not payable in respect of wastes deposited at exempt sites. It has just been raised in the recent budget and will continue to rise at £1 per tonne for the next 5 years (currently £10 per tonne for degradable).

The EU Landfill Directive restricts the types of waste which can go to landfill, requires the pre-treatment of waste which is to be landfilled, prevents the disposal of household and industrial waste in the same site, and seeks to reduce the amount of bio-degradable municipal (i.e. household) waste going to landfill progressively so that by 2010 it will only be 25% of that landfilled in 1995.

In terms of filling a void as opposed to landraising (i.e. above ground deposits), personal experience is that at the planning stage the former is preferred. It is seen as less intrusive during the majority of the operational phase and is less likely to be objected to on landscape grounds. The point about visual intrusion has led to at least 2 civic amenity sites being established in old quarries where they can not be seen. Above ground tipping may require less complicated engineering works.

Unlicensed operations fall into 2 camps. There are those activities which are exempt from the need for a licence. As mentioned,

these benefit from not being liable for landfill tax. The impact of this has been that some licensed facilities are having trouble obtaining inert material which can lead to them having to buy in material to finish off the site. The other category is operations not involving controlled waste which therefore fall outside of the regulatory regime.

Some operations will clearly be genuine and others clearly disposal operations with a grey area in between. It is an issue that may well lead to litigation in the future.

3. Enforcement Issues

Subject to the usual criteria for deciding whether a prosecution is appropriate, the Agency can prosecute where an offence has been committed. This of itself does not achieve the removal of any unlawfully deposited waste.

Section 59 gives the Agency the power to require the removal of waste deposited in contravention of Section 33, or to require steps to be taken to eliminate or reduce the consequences of such a deposit. Any notice must be served on the occupier who can appeal against it on the grounds that they did not deposit the waste nor knowingly permitted or knowingly caused its deposit. In such cases the Agency can remove the waste [or take other steps to eliminate/reduce its consequences] and recover its costs from the person responsible for the deposit - where that person is known.

Before exercising these powers the Agency will have to consider whether it is appropriate to take action. For example, can the Agency show that the waste is controlled waste, and that it was deposited illegally, what are the benefits and dis-benefits of taking action?

Whilst only being a quick run through a very complicated subject, hopefully I have given you some idea of the regulatory controls that may be relevant to the filling of pits or quarries and made you aware of some of the major issues.

(Prepared in connection with the conference given on 22nd March 1999; whilst it has been updated to include references to the PPC regime and the adoption of the Landfill Directive, it has not been fully updated to reflect all developments that have occurred since that time).

CHAPTER *Six*:

ABANDONED PITS AND QUARRIES: A RESOURCE FOR RESEARCH, EDUCATION, LEISURE AND TOURISM

John Macadam (Earthwords) and Robin Shail (Camborne School of Mines, University of Exeter)

1. Introduction

Pits and quarries are regarded by many as environmentally unacceptable 'blots on the landscape', to be filled in as soon as possible when they are abandoned. They are an increasingly valuable commodity as waste receptacles, and have been used as such for centuries. Even when not formally designated and engineered as waste sites, they are still seen by many people as convenient places to dump their domestic, agricultural and trade refuse. The aim of this short paper is to identify some alternative uses of abandoned pits and quarries so that communities, and individuals, can see the potential and often unrecognised value of this resource.

Examples of diverse uses are provided from Cornwall, the rest of the United Kingdom and the European Union. Many of these pits and quarries are being valued by different sections of the community, for a range of activities, so strengthening the case against infilling. It is regrettable that geological features do not at present explicitly come within the Countryside Stewardship scheme, thus landowners have no financial incentive for preservation and often regard old pits and quarries as private landfill sites. (But it is sometimes possible for Stewardship schemes to include such works as scrub clearance on access routes, if the project officer is sympathetic).

2. Abandoned pits and quarries for research

Quarries often provide exposures of geological importance that cannot be seen elsewhere. Cornwall has excellent outcrops along its coast but the geology is generally poorly exposed inland where abandoned quarries may also provide important ecological habitats that support a diverse flora and fauna. As a consequence many pits and quarries, both active and abandoned, have a statutory designation as a Site of Special Scientific Interest (SSSI), and are thus protected by the Countryside and Rights of Way Act, 2000.

An early selection of important sites in the West Country by the Nature Conservancy Council's then Chief Geologist was published in 1970 (Macfayden, 1970): six out of the fifteen sites in Cornwall were pits or quarries, and at least three more included pits or quarries. Between 1970 and 1990 the Geological Conservation Review (GCR) process was a rigorous re-evaluation of the scientific importance of all the SSSIs designated for geology and geomorphology (Ellis et al., 1996). Since the early 1990s the Joint Nature Conservation Committee has been publishing individual GCR volumes. The Igneous Rocks of South-West England volume (Floyd et al., 1993) includes fourteen abandoned pits and quarries, plus five active ones.

Site of Special Scientific Interest is a statutory designation but many other sites have a non-statutory designation, also on scientific grounds, as Regionally Important Geological/geomorphological Sites (RIGS). Other grounds for RIGS designation are educational, historic (e.g. a site where an important scientific principle was first

demonstrated) and cultural or aesthetic (possibly because the site was an important source of building stone or is a well-known landmark) (Nature Conservancy Council, 1990). Some pits and quarries have a non-statutory designation for their wildlife importance: in Cornwall these are designated as 'County Wildlife Sites', in other counties the designation is different. Likewise in some counties RIGS are also known as 'County Geological Sites' (e.g. in Devon), and in places all geological and wildlife sites come under one umbrella, possibly as a SINC, a Site of Importance for Nature Conservation. Non-statutory sites have a measure of protection under the planning process.

Designation is an on-going process, but advances in science are rather faster so the scientific importance of any natural or man-made rock exposure, designated or not, will vary over time

Research does not just take place at designated sites so it was instructive to scan a couple of major international research journals for papers about the geology of the south-west and, in particular, Cornwall. Two topics of current research interest are the geology of The Lizard and the origins of the granites and the mineralisation, and both draw research workers from abroad. The Lizard was the subject of a paper by a Canadian-British research team in the Journal of the Geological Society in 1998 (Clark et al., 1998): the locality sampled was the edge of a quarry at Porthkerris, within an SSSI. Research on granites and mineralisation was published in 1993 (Chen et al., 1993) again by a Canadian-British team in the Journal of the Geological Society: localities sampled were a mix of designated and undesignated sites. Work by an American-German-British team was published the same year (Chesley et al., 1993) in Geochimica et Cosmochimica Acta: again the localities used were a mix of designated sites and undesignated sites, including quarries.

Some sites are the focus of repeated research as new techniques and understanding are developed. An example is St. Erth Pits (Millett, 1886; Mitchell et al., 1973; Jenkins, 1982; Roe et al., 1999) and the subject of a case study in this volume (Macadam, 2002a).

Some sites are reference localities for geology. Of particular note are sites important for stratigraphy, illustrating a tiny portion of the immensity of geological time. An example here is the 'abandoned' quarry at Thouars, in France, with the historical type section for the Toarcian Stage of the Jurassic. The quarry face is not of immediate interest to the layman - indeed it is a rather monotonous, layered, brownish rock - but innovative interpretation involving placing casts of the significant ammonite fossils at the relevant levels (Plate 26), as well as an information panel (Figure 1) alongside has turned a research site into an educational site as well. This excellent example of promoting PUS (Public Understanding of Science - or 'Vulgarisation …' in French) has, hopefully, sown the seed that many other 'old quarries' could be of scientific importance. The site is protected as part of the French national suite of Réserves Naturelles.

Figure. 1: *Information panel in the quarry at Thouars. (c. Kevin Page)*

A major importance of pits, quarries and other man-made exposures of rock (such as mines and road cuttings) is that they give geologists rock to study where the only other option would be a borehole, with its very restricted size and often prohibitive cost. Cornwall does of course have a wealth of disused mines and the unflooded sections above adit level provide a so-far under-used resource: it is important to design access into shaft caps when safety work on mine sites is planned (Cornwall Underground Access Advisory Group, 2001).

3. Abandoned pits and quarries for education

Pits and quarries can be used for many subjects in the National Curriculum: science, geography and physical education are three obvious ones. Geology is not a separate subject, but elements appear in both science and geography: most of the geology is taught within the 'Materials and their properties' strand of the science curriculum. A few schools offer GCSE Geology, as a separate subject and in 1999 there were about 1,600 candidates (in England, Wales and Northern Ireland), compared with 257,000 for Geography. At Advanced Level the contrast is not quite so great: 2,000 candidates compared to 42,000 for Geography. Undergraduate and post-graduate courses have a need for field sites too (Figure 2) and Cornwall is an important location for Advanced Level and undergraduate residential field classes in geology and geography. Continuing education courses also need sites to visit.

Figure. 2: *CSM student in quarry at Cligga Point, Perranporth. (c. John Macadam)*

Attempts have been made to establish criteria for assessing the educational potential of sites (Wilson, 1994 p. 219; Reynolds et al., 1997). Both Dorset (Thomas, 1996, 1998) and Devon (Page & Chamberlain, 1999) have registers of educational sites for school use, with the suitability of sites for different age groups assessed. Devon's register is available both on the county's intranet and on the world-wide web.

Certainly all attempts to develop abandoned pits and quarries for school use should be made in consultation with teachers, and it may well be that the local cemetery, with a diversity of stone, will be the best teaching tool. Where old pits and quarries can be of wider value than just for their rock there is more chance they will be used: useful features would be interesting wildlife, evidence of ancient working - especially for

locally used stone giving a tie-in to local history, and use for physical education, but the limit will be the ingenuity and enthusiasm of the teachers. An outline of how a proposal to infill a disused quarry could be the basis for work across the (Welsh) curriculum was developed by Macadam (Curriculum Council for Wales, 1993) and is illustrated in figure 3.

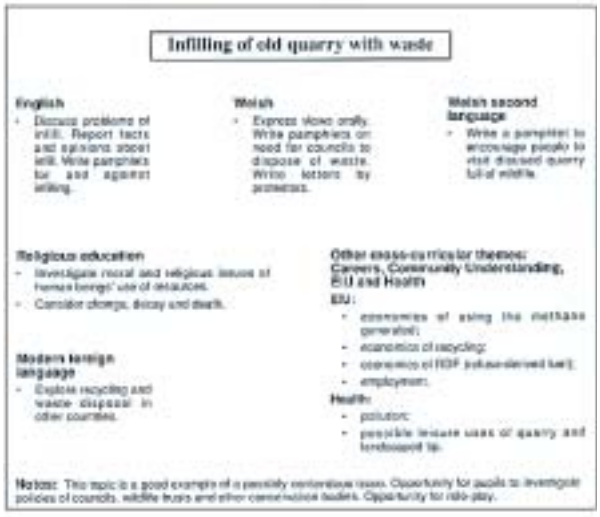


Figure. 3: *Cross-curricular (environmental education) work plan for a quarry in Wales.*

Locally in Cornwall, Cornwall Outdoors is developing Hendra Pit, a disused clay pit owned by IMERYS, for education. Initially the use has been of the flooded part for sailing, kayaking and canoeing, but there are plans to develop other aspects - history, art and science. One of the developing Cornwall Heathland Project sites is close by so providing a semi-natural laboratory for longitudinal ecological studies.

An interesting example of a quarry being used for combined geology and ecology was the use by the Open University's Discovering Science (S103) summer school of Northmoor Hill Woods reserve (Plate 27) in Buckinghamshire. The area included a chalk pit (also used by youthful motorbike scramblers) as well as sandy and clayey soils. Consequently there was a wide range of habitats, even if the accidentally simultaneous use of the quarry by OU students and scramblers was not ideal (though accident-free): at least this illustrates the potential conflicts inherent in multiple use of an abandoned pit. In this case the scramblers had negotiated use of the quarry prior to its designation as a reserve.

The two 'abandoned' quarry sites in the UK with the greatest educational use are the Wren's Nest in Dudley (West Midlands) and the National Stone Centre near Matlock in Derbyshire. As well as their educational value (Cutler et al., 1990) the Silurian limestones of the Wren's Nest are also of international historical and scientific importance, and the site was declared the first National Nature Reserve solely for geology in 1956. The National Stone Centre (Thomas & Prentice, 1994) occupies a 50 acre site and comprises several limestone quarries and purpose-designed buildings (Plate 28). The Centre is an educational charity, supported by over 80 public, industrial and academic organisations. Derelict Land Grants funded much of the

Figure. 4: *School party at the National Stone Centre. (c. NSC)*

original set-up costs. The Centre attracts around 400 groups plus thousands of individuals each year, and informs them not only about the geological heritage but the present day importance of the extractive industries. As well as attracting school groups (Figure 4) the Centre also markets itself as a geotourism provider: “the Centre is a place for both serious learning and fun" (NSC promotional leaflet).

Figure. 5: *Tresayes Quarry, a Cornwall Wildlife Trust reserve, leased from Goonvean Ltd. (c. John Macadam)*

Overgrown pits and quarries need a certain amount of clearance work before educational parties can use them, and this is usually seen as a conflict between geological conservation and wildlife conservation. But clearing an overgrown quarry face and adjacent area will also provide a glade for butterflies and so may increase the biodiversity of the site. Work by the Cornwall Wildlife Trust at Tresayes Quarry (Figure 5), leased to the Trust (for one peppercorn a year) by Goonvean in 2001, is intended to preserve most of the natural colonisation of this quarry as well as clean a few rock faces to expose the spectacular geology, a very coarse-grained granite (a 'pegmatite') with feldspar crystals up to 80 cm long.

4. Abandoned pits and quarries for leisure

Many pits and quarries have been used for leisure. Quarries in granite, such as Cligga (Plate 29), Kit Hill and Cheesewring (Eddy, 2002, this volume) are popular with climbers (e.g. Peters, 1988). The flooded clay pit at Hendra has already been mentioned for its school use but community use for watersports is also developing. Many flooded gravel pits in the Home Counties now have their own sailing or waterski-ing club. Northmoor Hill Woods chalk pit provides a safe venue for young scramblers, and the noise is contained. The same point could be made about clay pigeon shooting, which was a former use of Helsbury Quarry in north Cornwall.

Many flooded pits and quarries have been stocked with fish. Carn Grey granite quarry, a geological SSSI and the main source of building stone for St. Austell, provides a place for fishing, picnicking and dog walking just beyond the edge of the town. IMERYS lease the quarry to Restormel Borough Council, which intends to designate the site as a Local Nature Reserve (LNR), under Section 21 of the National Parks and Access to the Countryside Act, 1949, and utilise available grants for management and interpretation. Currently there are over 600 LNRs in England, but few have been designated for their geological interest. One exception is

Cowraik Quarry, a source of the red sandstone used for many of Penrith's Victorian houses. The quarry was designated by Eden District Council which has also published a trail leaflet (Eden District Council, n.d.). Several wildlife trusts (e.g. Brecknock, Lancashire, Manchester and Merseyside, Shropshire, Staffordshire, Sussex, Ulster, Yorkshire, and Cornwall) manage geological reserves with varying importance for research, education and leisure. As ideas on interpretation for the public have evolved only rarely has a second generation of interpretation been produced: one such example is Staffordshire Wildlife Trust's Brown End Quarry (Cossey et al., 1995; Macadam, 2001a).

Some pits and quarries have more unusual roles. Carn Marth granite quarry near Redruth is used as a theatre, and in summer 2000 Hendra Pit found yet another use as the spectacular setting for Kneehigh Theatre's site-specific community production of Hell's Mouth, by Nick Darke. Líthica, a charity conserving abandoned quarries on the island of Menorca, holds jazz concerts and other events in some of their quarries.

5. Abandoned pits and quarries for tourism

Tourism where the interest is geology has, not surprisingly, been termed 'geotourism'. This is a small niche market. The market leader in the British Isles is the 'Landscapes from Stone' project based in Belfast and Dublin. As a result of market research the project team do not use the term 'geotourism', referring instead to 'landscape tourism', and of course adding a large quantity of culture to their popular products (e.g. McKeever, 1999).

Whatever tourists interested in geology and landscape are called there is a growing market in providing popular trails and guides for them, and this niche is being developed in Cornwall (Goode, 1995a; Goode, 1995b; Macadam, 1995; Goode et al., 1996; Macadam, 1997; Macadam, 1998; Goode, 1998; Goode, 1999; Marks, 2000; Bates & Scolding, 2000; Macadam, 2001b, Macadam, 2001c). Many of these products feature abandoned quarries. Some quarry trails are written from a holistic viewpoint (e.g. David, 1991 and David, 2002, this volume).

The more specialist end of the market, basically amateur geologists and geologists and geology students on holiday, is catered for principally by the guides produced by the Geologists' Association. Only two of these are based solely on quarries, that for the Salthill Quarry Geology Trail (Bowden et al, 1997) and Ercall Quarries in Shropshire (Toghill & Beale, 1994). The latter has sold just under one thousand copies in seven years, far fewer than the guides to the Isle of Wight, the Costa Blanca, Majorca or Tenerife, which may reflect the fact that geologists can take their partners to enjoy a holiday in these places whereas the joys of the Ercall Quarries are probably not obvious to all. Back in Cornwall the GA Guide to West Cornwall (Hall, 1974, 1994) includes several abandoned quarries.

In addition to the Geologists' Association, many publishers both in the UK (e.g.

Unwin) and abroad (e.g. Mountain Press in the USA), have published series of geological and landscape guides. In nearly all these abandoned quarries figure prominently. For south west England, Perkins wrote two volumes in the "Geology Explained …" series published by David & Charles in the 1970s (e.g. Perkins, 1971; Perkins, 1972). Local government (notably Cornwall County Council but also e.g. South Somerset: Prudden, 1995), small presses, local geological societies and RIGS Groups (e.g. Cumbria RIGS: Skipsey, 1994) have published many more, often restricted to their local quarry or quarries. Some, such as the Ketton Geology Trail (Dawn, n.d.), have been part-funded by industry, in this case Castle Cement.

The potential market for geotourism - or landscape tourism - is likely to expand when an area gains a European or global designation. Several of the quarries in the south west will be mentioned in moves to gain European Geopark status, a new designation (under UNESCO auspices) of areas where exceptional geology is linked with sustainable development policies. Both Cornwall (Macadam, 2002b) and Torbay are potential candidates. Thus selected 'holes in the ground' will have an economic value as a resource for developing green tourism based on an internationally, rather than just a nationally, designated area.

6. Afterword

Finally, infilling of the void left by quarrying does not necessarily preclude some of uses mentioned above. In some quarries important faces have been preserved, for research or education or both. With some, interpretation has been provided as part of the package. A particularly noteworthy example is Craigleith Quarry in Edinburgh, the source of much of the building stone for the New Town. After infilling, the site was used for a retail development. Alongside their superstore Sainsbury's preserved (and floodlit!) part of a face, and also commissioned an artist, Reinhard Behrens, to engrave leaves on some of the facing stones of their new building. Around the walls of the coffee shop are prints of the quarry in its heyday, and for the opening a high quality leaflet was produced. Dr Chris Page from the Royal Botanical Gardens in Edinburgh was consulted and Dawn Redwoods (Metasequoia glyptostroboides), the nearest living relative to the fossil trees found in the quarry, were planted in front of the shop. More people now know about the quarry and its importance - and Carboniferous Edinburgh - than would have been the case with most other potential end-uses.

7. Summary

Abandoned quarries provide a rich range of opportunities for after-use. Cornwall already provides some imaginative schemes, and elsewhere there are many others. It is even possible in some cases to use quarries as landfill sites and then have long-term community after-use: a case of having your cake and eating it.

This paper also provides a range of uses that can be considered during the ROMP (Review of Mineral Planning Permissions) process under the Environment Act 1995, and, indeed, before planning applications

are made for new quarries or extensions to quarries. It is no longer acceptable for quarries to be just 'abandoned'.

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CASE STUDY *One*: BURRATOR QUARRIES

Peter Keene (Fellow of Oxford Brookes University; Director of Thematic Trails)

1. Location and Description

The Burrator Quarries lie on the south-western flank of Dartmoor where the River Meavy, leaving the high granite moorland, has cut a steep-sided gorge into the Devonian country rock. On the northern side of this small but deep valley, two quarries span this geological boundary (SX 549677). The older, southern quarry, consists mainly of grey, locally slatey, altered mudstones but its northern end features a rare and classic exposure of the contact between the Dartmoor granite and the upper Devonian country rocks into which the granite was emplaced. This junction is sharp but highly irregular. It has been the site of several classic and pioneering studies investigating compositional exchanges between granite magma and country rock and is of historical importance in understanding the genesis of granitic rocks.

When, in the late nineteenth century, a more dependable source of water was needed to supply the growing needs of nearby Plymouth, the upper part of the Meavy gorge, in sound granite, provided an attractive site for a dam creating the Burrator Reservoir. The Burrator dam, built between 1893 and 1898, was of gravity construction, depending for its strength on the mass of the granite from which it was built. Six thousand tonnes of granite, including many 8 tonne blocks, were quarried from what was to become the floor of the new reservoir. Within 25 years the capacity of the reservoir needed to be augmented. Between 1923 and 1927 the dam was raised by three metres, increasing the volume of the reservoir by 65%. A new quarry was necessary, to replace the now inaccessible reservoir floor site. Abutting the southern Burrator quarry, a second road-side site immediately to the north of the first was opened, this one developed in typical coarsely-jointed Dartmoor granite. Together the two quarries provided a complete exposure from sound granite through to the altered country rock. Eventually, after being abandoned the two quarries were infilled to road level, providing easy access to the still-exposed contact zone.

Figure 1: *The northern end of the quarry, showing the line of a large vein of fine-grained granite (c. P. Keene)*

2. Conservation and Management

The 0.5 hectare site provides an interesting example of the changing perspectives and priorities in the conservation and management of abandoned quarries.

Clearly this site was, geologically, of considerable historical importance and it was acknowledged that, because of its unique accessibility, the exposure should be protected to allow specialist access for further studies. It was registered as a Site of Special Scientific Interest (SSSI) in 1976 and this was reaffirmed (under the 1981 act) in 1986. The need for conservation and management was recognised.

Effective management needs interpretation to justify conservation and to enable competent and reliable decisions to be made on the priorities and quality of management to be provided. At this stage the management of the Burrator Quarries could be described as passive, the interpretation, which had led to its designation as an SSSI in the first place, was largely the preserve of formal academic literature.

However, in the 1980s there was a ground swell in support of a wider interpretation of sites or landscapes of scientific interest. There was active encouragement to provide on-site geological explanation and discussion, which would reach a broader public audience, albeit, still largely an educational one. In the long term, the protection of sites was seen as being enhanced by encouraging a fuller understanding and therefore appreciation of valued environments. Understanding reinforces protection by creating a body of opinion aware and supportive of the conservation value of sites.

The policy of the Nature Conservancy Council (NCC), responsible for the administration of SSSIs, reflected this change of emphasis. My involvement in the interpretation of the Burrator Quarries dates from 1986 when I was asked by the NCC to write a landscape trail to include the Burrator Quarries and what they could tell us of the evolution of Tors and the Dartmoor landscape. Interestingly, the justification for the trail included its function as a useful diversion from heavily used honeypot sites on Dartmoor such as Hay Tor and Two Bridges. The resulting trail (Keene & Harley, 1987) was typical of the period in that, although it paid lip service to the seriously interested non-specialist member of the general public, its main audience was clearly educational groups. The majority of the general public was specifically excluded from the planned target audience. This is not an implied criticism of the trail but simply to point out that, like most trails of the period, its assumed target audience was a very small section of the community. The Burrator Dartmoor Landscape Trail achieved its 'academic depth' by an unblinking concentration on geomorphological and geological aspects of the landscape. Today, I walk the same trail with Environmental Science students. Our pause at Burrator Quarries initiates wide-ranging discussion of landscape management including aspects of engineering, ecology, economics, a sense of place, tourism, romanticism and usually culminating with cultural issues and its central role in management and conservation decisions.

This shift in emphasis, towards what is regarded as a more holistic approach, is again reflected by the most recent plans to manage the old Burrator Quarries. Under

the current Devonshire Roadside Geology Initiative, the quarry faces will be cleaned, an interpretative board erected and parking will be improved. The provision of a short 'family walk' leading across the hillside towards the reservoir will provide a useful social service by enriching the recreational choices. This is another step towards the recognition that most people who park their cars at the Burrator site have little knowledge, or indeed interest, in geology as they understand it. And yet their experience of the location, perhaps on the safe family trail, can add to the protection of the site by creating a body of opinion more aware and supportive of the conservation value of the quarry than it was before, whether that concern is for its geological conservation value or simply as a valued scenic and recreational venue.

I have stressed that interpretation is essential for effective conservation management but I would end on a note of caution. The educated have a compulsive desire to explain. Someone said to me, "Interpreters are very good at providing answers to questions that nobody asked." Interpretation is now a large industry with its own agenda. I fear the time when some sites I know and love are festooned with inescapable interpretations which intrude upon my private sense of that place. Please consider leaving some sites as they are.

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Burrator Dartmoor landform trail. N.C.C. Peterborough.

CASE STUDY *Two*:
THE RECLAMATION OF HOLMAN'S QUARRY, CARN MARTH, LANNER

Jon Mitchell (Landscape Architect, Kerrier District Council)

1. Introduction

Carn Marth is a granite outcrop which lies approximately one mile to the south east of Redruth and directly north of the mining village of Lanner. The Carn is designated as an Area of Great Landscape Value and is an important site for recreation, offering good all round hilltop views in a peaceful setting, yet close to an urban centre (Plate 30).

In total there are five former granite quarries found on the Carn. Three quarries are owned or leased to the Carn Marth Protection Group. This is a community lead group which was set up in 1992 in direct response to a planning application for the installation of a crushing plant within one of the quarries upon the Carn. The quarries under the care of the Protection Group are used for amenity and nature conservation purposes. On the southern side of the Carn is a quarry which has had an amphitheatre produced from the loose material barred off the quarry face and this site is used in the summer for local theatrical productions (Plate 31). The group also own a flooded quarry which is well known and used locally for coarse fishing.

To the north of the summit is Holman's Quarry, the largest quarry on the Carn, which has an area of almost two hectares. Unlike the surrounding landscape it was neglected and had become an eyesore. Illegal tipping was abundant, and only poor quality fencing separated the site from a public bridleway, which at certain locations, ran immediately next to the sheer quarry face (Figure 1). Other problems at the site included scrambling by motorbikes and derelict buildings. Overall the quarry presented many hazards to visitors.

Figure 1: *Holman's Quarry showing the extent of fly tipping (c. Kerrier District Council)*

This report summarises the approach taken by Kerrier District Council to reclaim Holman's quarry during winter 1997. The reclamation works were intended to convert the derelict quarry into an area that was safe for public use whilst remaining sympathetic to the archaeology and ecology of the site. It also aimed to link the site to other initiatives on the Carn and the unique surrounding mining landscape.

2. Brief History

Although the 1880 Ordnance Survey maps show that some quarrying had taken place upon the Carn, the principle period of quarrying at the Holman's site was post World War Two. The site became abandoned in the 1960's as a quarry and was purchased by Holman's of Cornwall in

1968 to test pneumatic and hydraulic drilling equipment. Activity ceased at the quarry in 1976 and since then it has had a series of owners. Unfortunately it became a well known spot for illegal fly tipping, being close to urban areas yet slightly off the beaten track.

Figure 2: *Remains of stone bases with loose blocks and dangerous metal work, Holman's Quarry (c. Kerrier District Council)*

The old quarry buildings had become abandoned and partially demolished and large unstable concrete blocks and metal tram rails stuck precariously out of ground from these structures (Figure 2). However the quarry does hold many interesting features. The stone shutes which once served the quarry are still visible and remnants from when the site was used as a test mine make an unusual feature, as hundreds of drill holes can be seen within the quarry walls (Plate 32). The shear quarry faces are also safe havens for a variety of nesting birds.

3. Vegetation

The quarry floor supports limited plant growth due to the compact and regularly disturbed nature of the ground. Grasses are slowly colonising the site although it is mainly barren, apart from one area which has ground water springs with water edge vegetation including rushes. Ferns can also be found growing from the drill holes in the quarry wall. Japanese Knotweed infestations are found on the site, especially where fly tipping had imported contaminated material (Plate 33). Due to the exposed hilltop location the characteristic vegetation type is Heather, Gorse, Bracken and Willow.

4. Grant Availability

The site was classed as derelict under the 1993 Derelict Land Survey prepared by Kerrier District Council. The neglected site is of interest forming part of Cornwall's industrial heritage and its geology is of county importance in that it has the potential to become a Regionally Important Geological Site (RIGS). It links into the Mineral Tramways Project and also forms one of the visitor attractions within Kerrier District Council's Mining Village Regeneration Strategy. Due to the significance of the site and its great potential, Lanner Parish Council and Kerrier District Council, with assistance from Barclays Bank, purchased the quarry to safeguard it in the long term.

An application was subsequently submitted to English Partnerships for grant assistance to reclaim the site using the Land Reclamation Fund. This application formed part of the overall Mining Village Regeneration Strategy and the quarry acted as a matched funding site which drew in further money from a number of funding bodies to implement other works in the Lanner, Carharrack and St Day area. These projects included environmental improvements to the Market Square in St

Day, stabilisation of Pennance Engine House in Lanner and the Mills Hall building improvements at Carharrack.

5. Surveys

On completion of the acquisition of the site the following surveys were carried out:

- Management/Ecological Survey of the site on behalf of the Carn Marth Protection Group
- Desk Study/ Industrial History Report of the site
- On site Structural Assessment Survey of the quarry face
- An 'In house' site appraisal after on-site discussions with the Cornwall Archaeological Unit and Cornwall RIGS group

6. Consultation

A wide interest was shown in the quarry by the local community and ward members felt that it was extremely important and beneficial to advise the local community of any proposals for the site. This was carried out through public meetings in the villages of Lanner and St. Day. A fact sheet was prepared and distributed to neighbouring properties that were directly affected by the proposed works and to local shops and post offices. Copies were also forwarded to special interest groups for feedback. A partnership approach was stressed and various contacts were provided at end of the fact sheet.

From the 150 sheets distributed most responses were extremely positive, concerned with either when the works were to commence or wishing to express a greater interest in the Carn through joining the Carn Marth Protection Group, which had been closely involved in the preparation of the scheme. The consultations were carried out prior to the planning application submission in order to gauge public support for the works. Planning permission to change the use of the site from a derelict quarry to an informal public open space was subsequently submitted and granted.

7. Reclamation

Due to the differing nature of the proposed works the Contract was split into two distinct phases; phase one, a quarry stabilisation contract followed by phase two, a clearance and environmental improvement scheme.

A specialist rope access company carried out the first phase of the works, the stabilisation of quarry face. It was intended to keep works at an environmental and economically acceptable level whilst making the quarry safe for public use (Plate 34).

The works involved:

- Abseiling down the quarry face and carefully de-scaling all loose granite. A total of 47m3 of granite was removed manually from the quarry face from this operation
- Trimming back unstable overburden, due to erosion, from the top of the quarry face to reduce the risk of future failure
- Rock anchoring of loose boulders which, due to their size, could not be manually removed from the quarry face
- Drilling into the granite face and fixing

a steel rock stabilisation mesh on to overhangs and large areas of potential instability (Figure 3). A total of 125m^2 of quarry face was fitted with the mesh. The existing vegetation is already growing through and hiding the mesh from the users of the site.

Figure 3: *Phase 1: Drilling to erect steel stabilisation mesh at Holman's Quarry (c. Kerrier District Council)*

Phase two of the reclamation works involved site clearance and environmental improvements.

All works at the site were intended to enhance the profile of the quarry and show it as an important asset to the community, rather than detracting from the overall appearance of the Carn. It was felt that the unsightly entrance had lead to many of the social problems at the site such as the large scale fly-tipping. It was important to give the quarry an appearance of ownership rather than neglect. The Japanese Knotweed infested bund at the entrance was removed, and the boundary delineated by the construction of a dry stone wall along the northern edge of the site. The dry stone wall boundary matched the local wall type at this rocky, exposed and shallow soiled location. A lockable metal gate was erected at the entrance which prevented motorcycle scramblers from accessing the site yet did not restrict pedestrians due to the provision of a kissing gate. Adjacent to the public highway a lay-by was constructed to regularise car parking at the site for four to five vehicles. At other access points around the quarry pedestrian access was improved by the installation of kissing gates, which prevented motorcycles gaining access into the quarry.

Removal of the fly tipping was problematic due to the narrowness of the lanes leading up to the quarry and the cost implications of removing such a large amount of construction waste to a licensed tip. In accordance with the Cornwall County Council Waste Local Plan, which encourages the reuse of construction and demolition waste, it was decided to recycle the materials. Reusable waste was stockpiled on site and crushed down and used to create a pedestrian access ramp from the quarry floor to the top of the quarry. The ramp was constructed at the lowest point of the quarry face, where the overburden was particularly unstable (Plate 35). The crushed inert waste was then capped with a subsoil layer and lightly seeded with an acidic grass mix to prevent erosion and allow the local seed bank to colonise. At areas where pedestrian short-cutting may have occurred gorse plugs were planted. The ramp was an essential feature as it formed a footpath link from the quarry floor up to the public bridleway which skirts around the edge of the quarry. This enabled a link between the site and the rest of Carn Marth.

Areas which had had large amounts of refuse cleared and which would take a time to revegetate naturally were assisted in the recolonisation process through the seeding of an acidic grass mix (*Festuca rubra, Agrostis capillaris, Agrostis stolenifera* and *Cynosurus cristatus*) at 8 grammes per metre square. At this low density a grass sward would establish, yet would still be light enough to allow the local seed bank to encroach naturally.

The public bridleway runs immediately alongside the quarry face for 90 metres on the southern side of the quarry. When the quarry was purchased the fence around the edge was less that one metre in height and of poor construction, being loose scaffold poles and chicken wire mesh. A new fence was required to allow the bridleway to be used safely. Problems occurred as at many locations the quarry was worked up to the boundary of the bridleway. Where this shortage of space occurred the existing fence was simply replaced with a more robust fence. At certain locations there was space to move the fence back away from the quarry face after negotiation with the Carn Marth Protection Group who allowed the fence to be erected on their land. This allowed safe views of the quarry from the bridleway which was set back two to three metres from the quarry edge. Two styles of fence design were used. Away from the bridleway where public access is limited due to uneven and overgrown ground, simple reinforced concrete posts were used. Where the fence ran close to the bridleway and would be visible to site users, granite posts were used (Figure 4). It was felt this was less visually intrusive than the concrete posts but was as robust. The height of the fence was raised to 1.2 metres. The lower section of the fence is black heavy duty chainlink which restricts animal access and the top section of the fence is 8mm thick wire cable to reduce the visual impact of the fence from the quarry floor. The fence design is considered to be of low long term maintenance and reasonably unobtrusive, whilst making a suitable boundary between the public bridleway and the shear drop. The archaeologically sensitive finger dumps were avoided by the new fence alignment and where possible European Gorse (*Ulex europaeus*) plugs were planted between the fence and the quarry face as a further deterrent.

Figure 4: *Granite fence posts between Holman's quarry and the public bridleway (c. Kerrier District Council)*

The entire scheme was put on hold until the end of the bird nesting season to ensure that no disturbance occurred to the various species which used the quarry. Consultation with the Cornwall Bird Preservation Society showed that one area of steel mesh, erected to stabilise the quarry face, would directly affected a Kestrel's nest site. After further consultation with the group, a timber kestrel's nest box was designed and constructed. A rope access group

subsequently installed it on the quarry face (Plate 36).

On the eastern side of the quarry the face was classed as potentially unstable in the long term. An earth bund was constructed along the base of the quarry face to prevent pedestrian access directly up to the quarry wall. This was then planted with gorse plugs as a deterrent.

Vegetation management works were also implemented within the site. All stands of Japanese Knotweed were treated with the herbicide 'Glyphosate' in an attempt to prevent it spreading on to the valuable ecological habitats within the quarry. In accordance with the Cornwall Wildlife Trust's Management Plan for the Carn, an area of Bracken is to be treated with 'Asulam' to allow the Heathland vegetation to regenerate at the site.

Figure 5: *General view of the springs after reclamation work, Holman's Quarry (c. Kerrier District Council)*

All archaeological features were consolidated in order to prevent them from becoming a hazard to the site users. Loose concrete blocks and protruding metalwork were removed from the top of the structures and all voids which could create a trip hazard were filled with granular material. The setting of the buildings has also been improved by the removal of refuse.

8. The Future

In the future it is intended to investigate the leasing of Holman's quarry to the Carn Marth Protection Group on a long term basis. The Group's objective is to conserve and enhance Carn Marth for its recreational use and nature conservation interest. The reclamation works implemented by Kerrier District Council link in with the Protection Group's objectives. Overall the scheme has been a success and this has partly been due to the close working relationship between district and parish councils, and the Carn Marth Protection Group before and throughout the duration of the project.

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CASE STUDY *Three*:
CHEESEWRING QUARRY, BOLTS, BLACKFACES AND BERTRANDITE

Martin Eddy (Caradon Countryside Service, Caradon District Council)

1. Introduction

The Cheesewring Quarry is a disused quarry on the south-eastern edge of Bodmin Moor, 1.5 kilometres north of the former mining village of Minions. The quarry worked the silver-grey granite of Stowe's Hill, cutting deep into the hillside but stopping short of the famous Cheesewring stones. The hill is surmounted by a Neolithic hillfort, demonstrating the earliest identifiable use of granite as a building material.

Figure 1: *The Cheesewring at Sunset*
(c. Caradon District Council)

2. Setting

The quarry is on the open moor adjacent to the Stowe's Hill Scheduled Monument. The area is part of the Bodmin Moor section of the Cornwall Area of Outstanding Natural Beauty (AONB) and lies within Areas of Great Historic Value and Scientific Value (AGHV, AGSV). It is part of a Cornwall Nature Conservation Site and is a Regionally Important Geological/ Geomorphological Site, the Cheesewring being the Cornish RIGS Group logo.

3. History of the quarry

The quarry is surrounded by extensive evidence of moorstone workings which would have been familiar to the famous stonecutter-mathematician Daniel Gumb. In 1845 a lease was granted by the Duchy of Cornwall to Trethewey, Clogg & Co., who, in 1851 trading as the Cheesewring Granite Co., produced the 9.1 metre Ionic column for the Great Exhibition at Crystal Palace. The arrival of the Liskeard and Caradon Railway in 1844 greatly facilitated the transport of granite to sea at Looe and production rose to 3,364 tons in 1854 (Messenger, 1978) rising to 11,274 in 1858 (Sharpe, 1989). The Duchy of Cornwall had placed restrictions on the 1845 lease to protect the "Druidical remains or natural curiosities" and this restricted the expansion of the quarry to the north.

Figure 2: *Daniel Gumb's Cave with the Cheesewring in the background*
(c. Caradon District Council)

In 1863 John and William Freeman formed a new company, the Freeman and Cheesewring Granite Co. Ltd. and work expanded with stone being supplied to Tower Bridge and the Albert Memorial. There was general decline in the granite quarrying in the early part of the 20th century and the quarry had largely ceased working in 1934.

4. Present management and issues

The quarry is owned by the Duchy of Cornwall and it forms part of a popular destination for walkers and a permissive route has been agreed with the Duchy of Cornwall for access to the Cheesewring (Macadam, 1998). During the 1999 total solar eclipse a chain barrier was erected at the bottom of the access track to regulate vehicular access to the quarry. There are a number of activities that take place in the quarry:

Figure 3: *The Cheesewring (c. Caradon District Council)*

- **Educational visits** - school visits combine climbing in the quarry with a package of orienteering, letter boxing, archaeology and history tours on the open moor. This use is mostly by primary schools. Visits have reduced recently due to the weight of regulation now associated with outdoor activity and reducing school budgets. Groups visiting the quarry require extra interpretation to understand the site; there are no toilet facilities and large parties can disturb "the peace" of the moor.

- **Climbing** - the quarry face offers one of the premiere inland climbing sites in Cornwall. Many modern routes were first described in the 1960's (Stanier, 1996) and recently publicised in a new climbers guide (Hawken, 1998). Climbing tends to take place informally in small groups. Issues associated with climbing include the use of bolts to aid climbing, a practise which may be more acceptable on an artificial cliff, but high quality bolts need to be used to avoid having to re-bolt. Other issues include disturbance of nesting birds, access for emergency vehicles, climbing for the less able and access for specialist vehicles, and the concentration of people along the cliff top fence line, damaging the scheduled monument. A new fence was recently erected using funding from the South West Regional Development Agency's Environmental Improvement Fund and gate positions were arrived at in consultation with climbers.

- **Informal recreation** - large number of people use the area, principally for walking where the quarry forms a convenient target as it can be accessed along an unmetalled track. Some mineral hunting takes place in the quarry, and more extensively at the nearby Stowe's Mine. The first recorded phenacite was discovered here in 1905 (Stanier, 1990).

- **Animal grazing** - the quarry offers limited grazing for moorland animals, as

well as water and shelter. There is an issue of the safety of sheep, chiefly agile Scottish Blackface crosses, becoming stuck on quarry face shelves, and the safety of people rescuing them.

Figure 4: *Belted Galloway grazing in the quarry (c. Caradon District Council)*

- **Industrial Archaeology** - the archaeology of the quarry was largely lost during the removal of stone in 1984 (Sharpe, 1998) but what remains is reasonably robust (Plates 37 and 38).
- **Wildlife** - the area is part of a Cornwall Nature Conservation Site and the quarry pond is a breeding site for newts and common toads

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CASE STUDY *Four*:
PRINCE OF WALES QUARRY, TREWARMETT, NORTH CORNWALL - REUSE OF AN ABANDONED SLATE QUARRY AS A RECREATIONAL AND EDUCATIONAL SITE.

Charlie David (Coast and Countryside Officer, North Cornwall District Council)

1. Introduction

The disused Prince of Wales Quarry lies between Tintagel and Camelford just off the B3263 (SX0786). It forms a part of a series of small quarries which dot the landscape in this area and which dominate the coastal scenery between Trebarwith and Tintagel. These quarries, the most famous of all being the 600ft deep Delabole Slate quarry which is still in operation, produced many tons of slate from the medieval period; it is from these measures that the fossils of the Delabole butterfly *Cyrtospirifer verneuili* have been found.

Figure 1: *Prince of Wales Quarry*
(c. Coast and Countryside Service, NCDC)

The Prince of Wales Quarry is owned by the Duchy of Cornwall and is currently leased to the North Cornwall District Council. The Council have developed an access route around the quarry and there is interpretation material on site and in leaflet form which is available from nearby Visitor Centres.

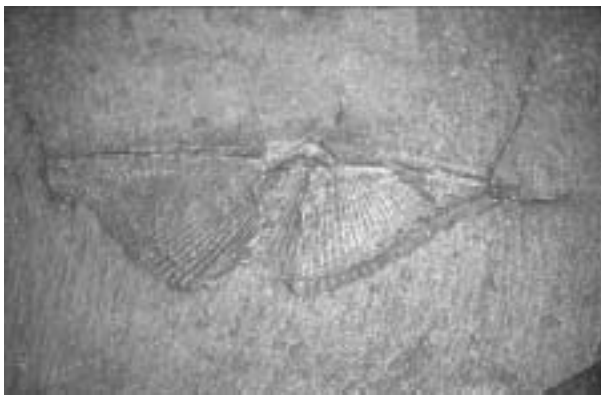

Figure 2: *Delabole Butterfly*
(c. Coast and Countryside Service, NCDC)

2. History of the Prince of Wales Quarry

The Prince of Wales Quarry was probably in the height of its production from the early to the mid 19th century. Records suggest that the quarry had closed by the 1880s. The nearby cliff quarries date from the late medieval period and were still in use during the 1930's.

Figure 3: *Quarry tips*
(c. Coast and Countryside Service, NCDC)

In 1986, the District Council extended its lease on the quarry area and applied for a Derelict Land Grant from English Partnerships in order to allow for safe public access to the site which was being used primarily for unauthorised motorbike scrambling, but which had the potential for

an interesting environmental and recreational site. The grant was subsequently obtained and work completed in 1987.

3. Scientific interest

The quarry has proved to be of considerable environmental interest, there being a number of different habitats within a relatively small area of land. The bare rock and waste dump sites are ideal for drought resistant plants, the pond (and waterfall) now occupying the quarry pit are ideal habitats for aquatic insects and plants such as ferns, Southern Aeshna and Golden-ringed Dragonfly being frequently recorded together with waterside birds such as Gray Wagtail. The undulating nature of the site provides a range of sheltered areas ideal for insect and numerous butterfly species have been recorded, including recently the relatively unusual Grayling.

Figure 4: *Heath-spotted Orchid*
(c. Coast and Countryside Service, NCDC)

Gorse had been the dominant vegetation until a vegetation management programme was introduced a few years ago. Since clearance of gorse, there has been an increased amount of Heather (*Calluna vulgaris*) and Heath-spotted Orchid (*Dactylorhiza maculata*) (Plate 39). There are also recorded two stands of Japanese Knotweed.

4. Historical interest

The quarries are integrally linked to the history of the local communities as they provided local employment and required particular skills. The Prince of Wales Quarry probably had a fairly short life span being worked during the 19th century. Of particular note though is the presence of a beam engine house which housed a Wolf Compound Beam Engine. This provided power for the operation of an aerial ropeway that hauled large blocks of slate from the depths of the quarry workings to the headframe where it was sorted ready for splitting. The existence of an engine house provides a particular local focus. In 1976 a group of local people formed themselves into a Prince of Wales Engine House Society and, using available grant, undertook a restoration programme.

As part of the restoration work undertaken by the District Council, the Cornwall Archaeological Unit did some research work to assist with the production of onsite interpretation. The resulting information board and leaflet shows a diagram of the beam engine and how it operated.

5. Present management

The District Council's Coast and Countryside Service are currently

responsible for managing the site. This involves the implementation of a vegetation management plan geared towards habitat management. There is ongoing management to the structures within the quarry, the engine house, viewing platform and fencing. (Plate 40) In addition there is a requirement to undertake a geotechnical survey of the quarry, particular the waste dumps, to ensure public safety and safety of nearby dwellings.

Acknowledgements

The Prince of Wales Engine House Society, whilst now no longer a going concern, nevertheless provided considerable assistance with the background to the engine house and of course provided the wherewithal to restore it in the first place. The Coast and Countryside Service undertakes management tasks ably assisted by numerous volunteers without whose help work could not proceed so well.

Figure 5: *Clearing up fly tipping at Prince of Wales Quarry (c. Coast and Countryside Service, NCDC)*

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CASE STUDY *Five*: ST ERTH PITS - CORNWALL WILDLIFE TRUST'S FIRST GEOLOGICAL NATURE RESERVE

J.D. Macadam (Cornwall RIGS Group)

1. Introduction

The village of St Erth lies 2 km south-west of Hayle in west Cornwall. On the east side of the village sand deposits have been worked from about 1834 through to the twentieth century for building sands and moulding sands, with associated clays being used for pottery, puddling and pigment. Several pits are known only from historical records but Harvey's Pit and the adjoining Vicarage Pit, owned by Church Commissioners, are still pronounced features even if overgrown.

2. History of the sand pit

Harvey's Pit was worked from the 1890s to the 1950s. The main product was moulding sand for Harvey's foundry in Hayle. Harvey's was famous for making beam engines ('Cornish engines') for the mines, but the firm also met other requirements including pumping engines for Holland with a cylinder diameter of 144 inches, the largest ever made. The equally famous foundry firm of Holman's of Camborne also owned the pit at one time.

Records of sand pit production are not known, but the moulding sand is known to have been exported from Cornwall: the sand was reputed to be one of the three best in the country (Boswell, 1918). Final discontinuous working was for building sand before the sand pit and adjacent land was sold to a developer. The latter offered the sand pit to the Royal Geological Society of Cornwall (RGSC) for £1 as a geological reserve. The RGSC had no experience in managing reserves so generously arranged for the Cornwall Wildlife Trust to buy it on the same terms after the geological group in the Trust (the Cornwall RIGS Group) had been set up.

3. Scientific interest

The sands and clays are part of the St Erth Beds. Most of the research has been carried out on the adjacent Vicarage Pit, initiated after fossiliferous clays were discovered and worked in the last century for puddling clay for Penzance harbour. Many of the papers were published in the *Transactions of the Royal Geological Society of Cornwall* between about 1880 and 1903. The main modern research was carried out by Mitchell and co-workers (Mitchell *et al*., 1973). Rowe (Rowe *et al*., 1999) and Scourse and Furze (1999) provide useful lists of references. In addition to a famous, well preserved, diverse macrofauna (notably gastropods, bivalves and crustaceans) there is a very diverse microfauna. The beds are believed to be of late Pliocene age and are either the only deposit, or one of two or three deposits, of that age onshore in the UK: they are thus of at least national importance, if not international importance.

4. Historical interest

In addition to the major importance of the sand pit as the source of moulding sand for Harvey's, sand and clay from the pits were used locally for other purposes (Webber, 1997; Herring, 1998). Bernard Leach experimented with the clays in about 1920 when he set up his pottery in nearby St Ives (Leach, 1977). Local residents can still

remember active working and they provided material for the information board (Fig. 1) which was erected on the wall of the Star Inn, the village pub, at the invitation of the landlord and with aid of children from the local primary school (Fig. 2). Another valuable source of information was two photographs of the active pit c. 1905-10, held in the Royal Institution of Cornwall's archives.

Figure 1: *Information board on the wall of the Star Inn, St Erth.*

5. Present management

Despite heavy colonisation by sycamore and scrub the sand pit appears to be little changed from its last operational condition, with working faces, benches, loading points and spoil tips all identifiable. The management plan (Ealey & Adams, 2000) drawn up by the Cornwall Wildlife Trust envisages some clearance of vegetation (which is of low conservation value) to enhance the industrial archaeological interest. This then might be linked to the interpretation which is proposed for Hayle, probably as part of a heritage trail: the reserve would add tourism to its current value as an educational and recreational resource for the local community as well as being of specialised interest to a small band of geologists and industrial archaeologists. Management to date has consisted mostly of fencing, and the removal of fly tipped material.

Figure 2: *The visit by the local primary school*

6. Acknowledgements

Work on the reserve has been financed under English Nature's Reserves Enhancement Scheme; future work will also benefit from English Nature's Facelift programme. Technical support from Camborne School of Mines (University of Exeter) is acknowledged, as is the technical knowledge and historical research of Russell Webber. Peter Ealey, of Cornwall RIGS Group, kindly suggested improvements to this short note.

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THE WAY FORWARD

Stephen Hartgroves, David Owens and Adrian Spalding

1. The resource

As we have seen in the previous chapters, abandoned pits and quarries represent a major asset in terms of their historic, geological and biodiversity value and for their potential as small-scale sources of local building stones. With an estimated total of 3-4000 small pits and quarries in Cornwall, they also make a significant contribution to local distinctiveness as features in the wild Cornish landscape of cliffs and moorland, and add a hard edge to the more gentle farmed landscape.

Although abandoned, many quarries represent an economic resource which should not be sterilised in the interests of conservation. Today's active quarry is tomorrow's site for special conservation value; conversely, today's conservation site might become tomorrow's active quarry. In particular, it is important to maintain the viability of those quarries which provided distinctive stone for the construction of historic buildings; these quarries should be maintained in a viable state so that they can be exploited for repairs and for future conservation needs.

All those involved in quarries (whether because of ownership, scientific and research interest, or recreational value) should be encouraged to engage in a creative and flexible way with the management of the resource so that the abandoned quarries have a sustainable future

2. Issues

Existing frameworks for the management and protection of quarries include the strategic plans produced by local authorities (e.g. structure, waste and mineral plans and the local area plans) and the regulatory mechanisms maintained by the Environment Agency. These plans tend to focus on regulating the work of active quarries to minimise or mitigate environmental impacts and on restoration and after-use of sites once production has ceased. Government guidance (MPG7) indicates that the aim of reclamation should be to ensure that the site can support "an acceptable after-use" but too often there seems to be a presumption that the quarry void will be re-filled to produce land with added value. It should be stressed that maintaining or enhancing conservation value is an acceptable after- use with significant and wide ranging environmental benefits.

Some quarries are protected because they lie within designated areas such as AONBs, SACs, SSSS's and Areas of Scientific or Historic Value - these afford some measure of protection through relevant legislation and the planning system. However, many of the threats to the resource fall outside these, or any other, regulatory mechanisms. This report forms the first steps towards the formulation of a strategic non-statutory approach to secure long-term sustainable conservation. This will mean resolving potential conflicts through an integrated holistic approach, bringing together the elements of biodiversity, geology, history,

landscape character, education and amenity to provide a framework for decisions about the management, protection, conservation and interpretation of this resource.

However, the conservation value of dormant quarries cannot at present be fully recognised in these strategies because of the lack of information about the location, condition and conservation value of quarries. For example, only 569 excavations and pits have been mapped in the Cornwall Land Reclamation Strategy 1997-2000. What is lacking in the current management framework is a consistent level of up-to-date information on the whole resource, and until this is achieved it will not be possible to make valid assessments of the conservation value of particular sites, nor to indicate the relative importance of any individual quarry.

3. The way forward

To enhance our understanding of the geological, ecological and historical value of abandoned or dormant quarries in Cornwall, and to provide the basic information to guide management and conservation, an audit of quarries is needed. The aims of the audit will be to gather an agreed data set for each site and to record this information in a systematic and consistent way. The proposed audit should proceed through a number of steps:

- A Desk Assessment, which will examine historic maps, aerial photos, habitat maps and the County Historic Environment Record. Results should be recorded in a simple database linked to a GIS which will display the location and extents of quarries and illustrate their development through time
- Field visits to sites with evident conservation potential to record the essential conservation characteristics of each quarry. Site surveys must be carried out by specialists and results will be used to update the database and GIS
- Production of a report outlining the results of the Audit, assesing the state of the resource, and proposing management guidelines to form the basis for dialogue with local authorities, landowners and other interested parties

Apart from the immediate value of a project to identify and describe the conservation value of this potentially rich resource, the audit will be useful in a number of ways:

- It will introduce clarity and objectivity into systems for assessing mineral extraction and development proposals
- It will indicate opportunities for landowners to exploit the conservation interests of quarries in their ownership
- It will provide the basis for management recommendations to enhance the geological, ecological and historical value of active quarries.
- Non-important sites will be recognised, which will make their ongoing development more straightforward
- Grant aid and funding for quarries of high conservation value should be improved
- The Audit will inform future strategic planning and flag up quarries that need to be further surveyed prior to

permissions being obtained.

The audit will greatly enhance the future management of abandoned quarries and bring this into line with conservation and sustainability guidelines. It will of course be necessary to recognise that some sites will have residual economic potential and could be brought back into use to generate income for landowners. However, the audit should also indicate sites where there may well be alternative uses which would be equally beneficial. For the most part though, the management of the resource will be geared towards securing the preservation of each site's particular range of flora, fauna, rocks and minerals, the remains and traces of past technologies and that particular 'spirit of place' which infuses those sites that, though now silent, once hummed with noise and activity.

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the conservation value of

bandoned pits and Quarries

in

CORNWALL

A report of the conference in Truro, Cornwall on 22nd March 1999

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Abandoned pits and quarries represent a major asset in terms of their historic, geological and biodiversity value and for their potential as small-scale sources of local building stones. With an estimated total of 3-4000 small pits and quarries in Cornwall, they also make a significant contribution to local distinctiveness as features in the wild Cornish landscape of cliffs and moorland, and add a hard edge to the more gentle farmed landscape.

This report encourages all those involved in quarries (whether because of ownership, scientific and research interest, or recreational value) to engage in a creative and flexible way with the management of the resource so that the abandoned quarries have a sustainable future.

This report is based on the papers presented at the conference on abandoned pits and quarries held at County Hall, Truro on 22nd March 1999, sponsored by the University of Exeter and Cornwall County Council. Subjects include: geology and building stone, wildlife, history, planning issues and waste management.

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