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A GUIDE TO THE HISTORY AND GEOLOGY OF QUARRYING AT LOCALITIES ALONG THE NATURAL HISTORY TRAIL IN CORBET WOOD, GRINSHILL, NORTH SHROPSHIRE

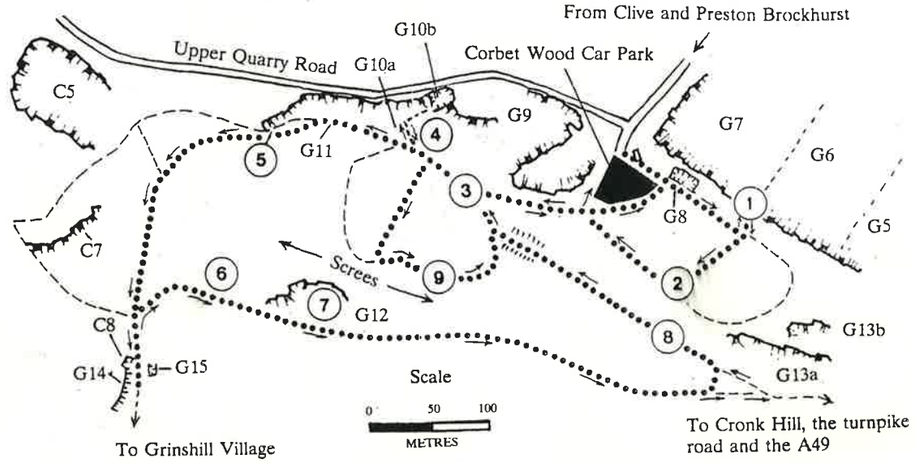
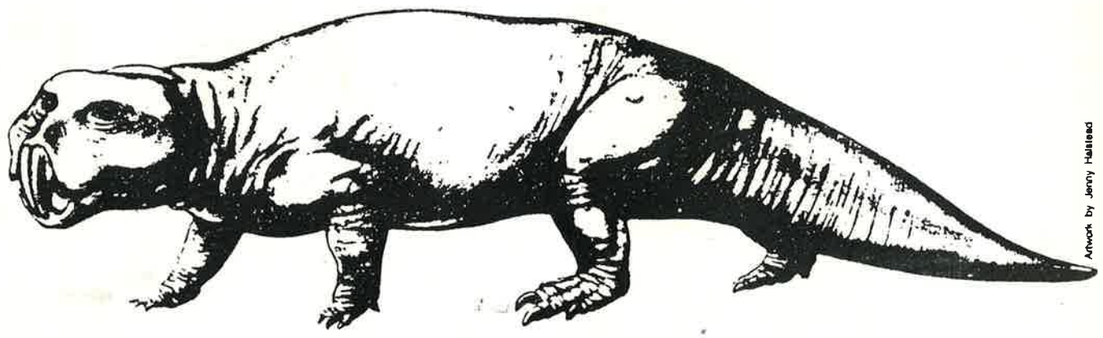


Figure 2 The natural history trail and its waymarked route in and around Corbet Wood (Anon 1975).



Artwork by Jenny Halstead

The age of the rhynchosaur

CLIVE AND GRINSHILL CONSERVATION COMMITTEE JANUARY 1995
CHAIRMAN: PROFESSOR MARK ROBERTS SECRETARY: DAVID B THOMPSON

D. B. Thompson to [illegible] N3GUA 1995

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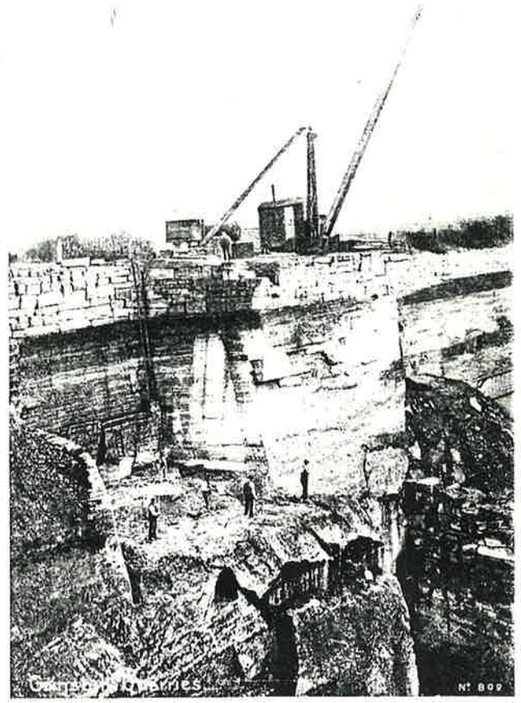
DAVID B THOMPSON



CLIVE AND GRINSHILL CONSERVATION COMMITTEE JANUARY 1995

ENGLISH NATURE

Both the author and the chairman of the Clive and Grinshill Conservation Committee, Professor Mark Roberts, on behalf of the Committee, are pleased to thank the following people and organisations for their support and sponsorship of this booklet over the period 1989-1994:

English Nature, Attingham Park, Shropshire.	Mrs K.A. Everitt (Executive Officer) and Mr Anthony Hearle (Conservation Officer)
Shropshire County Council, Leisure Services Department, Shrewsbury.	Councillor Don Maybury, Mr J. Hirst, Mr. Nigel Jones.
North Shropshire District Council, Wem.	Councillor Sybil Lewis, David Wallace and Sylvester Swaffield.
CAMAS Aggregates (Quarries Division) PLC (formerly English China Clays Construction Materials Quarries Division) Grinshill, Shropshire.	Mr Andy Hunter (Manager) and Mrs J. Maybury.
Clive Parish Council, Clive, North Shropshire.	Mr Don Binks, Mr Richard Farmer and Bert Fowles (successive chairpersons).
Grinshill Parish Council, Grinshill, North Shropshire.	Mr Jim Good (chairperson)

THE COVER PHOTOGRAPH. A working face of one of the Grinshill Quarries sometime close to 1905. A stable platform 3-5 metres (10-18ft) deep has been built above the quarry in order to locate a large steam crane whose driver peers down at those working 10-15 metres (up to 50ft) below. The platform is underlain by a metre-thick bed of dark red mudstones and siltstones at the base of the Bollin Mudstone Formation (showing darker grey). The base of this rock unit shows that the original horizontal of the Earth's surface upon which these rocks were deposited has been gently tilted subsequently by earth forces so that it is now inclined gently (i.e. dips) to the north or NNE. The view is therefore towards the ENE. Beneath the latter unit for 10m lie the flat-bedded, gently dipping, buff to off-white Grinshill Flagstones of the Tarporley Siltstone Formation, at the base of which rock unit a single quarryman is working. The flagstones are the main source of the fossil footprints and bones of extinct reptiles, especially the small lizard-like Rhynchosaurus but also occasionally the larger predecessor of the dinosaurs known as Chirotherium (the hand beast). The flagstones were deposited on intertidal sand and mud flats interpersed with salt lagoons across which intermittent rivers flowed - all this in a desert area c.20 degrees north of the equator c. 245-240 million years ago. Underneath the flagstones, four quarrymen contemplate the top 1-2m of the Grinshill Sandstone which they have just lifted; they are thinking how they will quarry the next 15 m (50ft) of first-class building stone beneath their feet. Faint signs of bedding planes in the sandstones, down to the front left, may be an expression of the cross-bedded frontal slopes of former fossil sand dunes developed by an easterly trade wind. Daily access to the working face was by the wooden ladders. Mrs Kathleen Godfrey of Wem still recalls her horror as a young girl of seeing her grandfather James Phillips, and later her father Harry Higginson, noncholantly throw their legs over the ladder top each morning prior to making a rapid and intrepid 50-foot descent. The location is likely to be the north face of either the Bridge Quarries G9-11 of the Bridge and Cureton Company or the Mount Pleasant Quarries G6-7 of John M. Kilvert. Source: postcard No. 809, dated late 1905, of Messrs Wildings, Printers and Publishers (1875-198?), 33 Castle Street, Shrewsbury, courtesy of Mr Derek M. Walley of Bayston Hill, near Shrewsbury.

A GUIDE TO THE HISTORY AND GEOLOGY OF QUARRYING AT LOCALITIES ALONG THE NATURAL HISTORY TRAIL IN CORBET WOOD, GRINSHILL, NORTH SHROPSHIRE

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Bibliography

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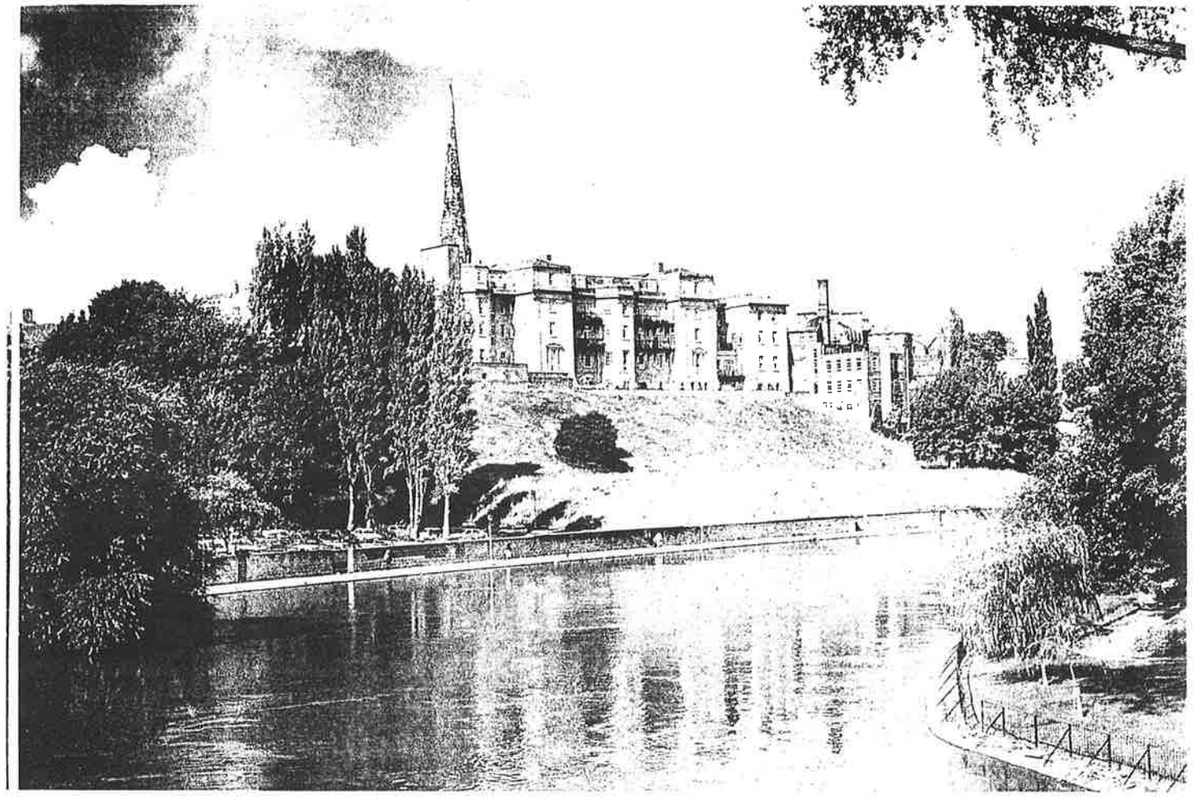
Shrewsbury Station, built largely of the best off-white Grinshill Sandstone in 1848 to the design of Thomas Penson of Oswestry. Between 1899 and 1903 a third storey was inserted below the others, resulting in the lowering of the forecourt. Shrewsbury Castle is on the right.



Arguably the most famous view across Shrewsbury is from the English Bridge (by William Gwynn 1773, widened and lowered by Arthur Ward 1927) to the 15thC spire of St Mary's Church with, in the foreground, the former Royal Salop Infirmary (1826-1830 by Edward Haycock) now the Parade Shopping Centre and The Court apartments - all three buildings constructed of, or faced with, Grinshill Sandstone.

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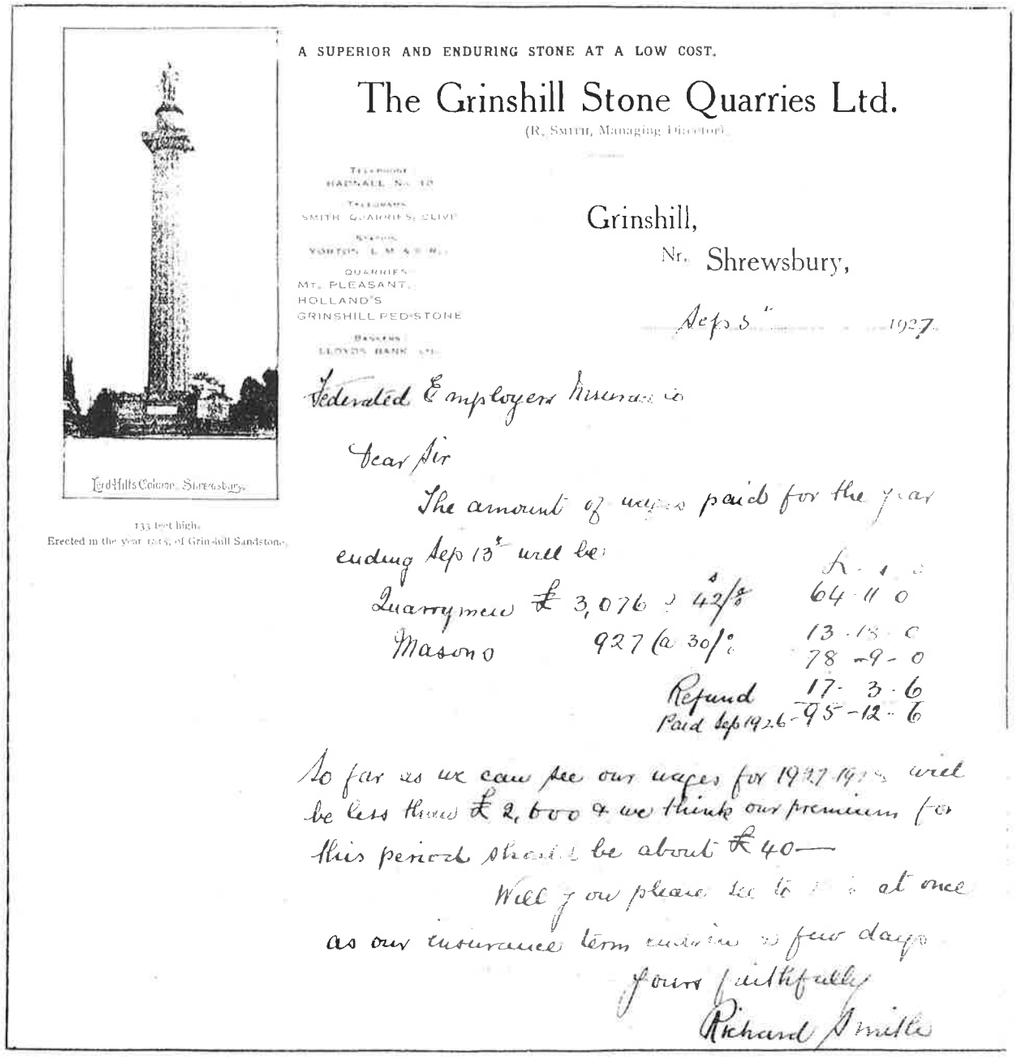

A SUPERIOR AND ENDURING STONE AT A LOW COST.

The Grinshill Stone Quarries Ltd.

(R. Smith, Managing Director).

TELEPHONE HADNALL No. 10
TELEGRAMS SMITH, QUARRIES, CLIVE
STATION YORTON, L.M.& S.R.
QUARRIES MT. PLEASANT, HOLLAND'S GRINSHILL RED-STONE
BANKERS LLOYDS BANK LTD.

Grinshill,
Nr. Shrewsbury,

Sept 5th 1927.

Federated Employers Insurance Co

Dear Sir

The amount of wages paid for the year ending Sept 13th will be:

		£ s d
Quarrymen	£ 3,076 @ 42/8	64 11 0
Masons	927 @ 30/-	13 13 0
		78 -9- 0
Refund		17- 3- 6
Paid Sept 1926		-95-12- 6

So far as we can see our wages for 1927 1928 will be less than £2,600 & we think our premium for this period should be about £40—

Will you please let us have it at once as our insurance term expires in few days

Yours faithfully
Richard Smith

Lord Hill's Column, Shrewsbury.

133 feet high.
Erected in the year 1815, of Grinshill Sandstone.

THE HEADED NOTEPAPER OF THE GRINSHILL STONE QUARRIES LTD, PROPRIETOR CHARLES P. THURSBY, IN 1927.Top left is Lord Hill's Column, the tallest Doric column in the world, constructed in 1814-1816 out of subscriptions offered by the grateful people of Shrewsbury. The Grinshill Stone weighs c. 1000 tonnes and is likely to have come from Quarry G9 (see Figs 1 & 3), since later in 1821-2 this quarry was leased by John Carline II, Richard Matthews and John Straphen from Sir Andrew Corbet. To show his own gratitude John Straphen designed and constructed the inner staircase of the column at his own expense. The huge basal pedestal, 4m high, is guarded by four lions carved by John Carline II. The overall design was by Ed. Haycock of Shrewsbury and Thomas Harrison of Chester. The statue of Lord Hill was modelled by Panzetta of artificial white stone and was executed by Messrs Coade and Sealey of London. The letter alongside is written by Richard Smith, formerly chief mason, now managing director, and it records the total amount of wages paid out on behalf of the quarrymen and masons (some 42 men) from September 1926 to September 1927: a mere £4003. Notice that the quarries owned by this company are the Mount Pleasant Quarry (G6 & G7), Holland's Quarries (C3 & C4, possibly C5 & 6 as well) and the Grinshill Red-stone Quarries (probably G12, possibly G14 & G15 as well).

LIST OF FIGURES AND THEIR CAPTIONS

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Figure 2 The natural history trail and its waymarked route around Corbet Wood (Anon 1975).

Figure 3 The Acton Reynald Estate Map for 1835. The faces of working or abandoned quarries are marked by dotted lines. Quarries in Shawbury Parish (Acton Reynald Township) and Clive Parish are not marked on the map. This extract from the estate map is published with the kind permission of the Shropshire Record Office.

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Figures 11-13 Typical Triassic fossil footprints comparable with some of those from the bedding planes of the Grinshill Flagstones of the Tarporley Siltstone Formation:

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Figure 14 The earliest reconstruction of the skeleton of *Rhynchosaurus*, the herbivorous lizard-like reptile (after A. S. Woodward 1907, p. 294).

Figure 15 A modern reconstruction of the skeleton of *Rhynchosaurus articeps* (after Benton 1990, Fig.38 with the author's permission and that of the Royal Society).

Figure 16 Modern comparative reconstructions of the skeletons of the three main British species of *Rhynchosaurus*: *R. articeps* (below), *R. brodei* from Warwickshire (middle) and *R. spenceri* from Dorset (top) (after Benton 1990, Fig.39 with the kind permission of the Librarian of the Royal Society of London). The fossil bones available to make the reconstructions are shown in black.

Figure 17 A full-bodied reconstruction of one of the larger species of *Rhynchosaurus* in order to show the barrel-shaped body enclosing a large alimentary system capable of digesting large quantities of coarse plant material of the *Dicroidium* flora (after Benton 1983; drawn by Jenny Halstead).

Figure 18 Reconstructions of the animal which may have made the *Chirotherium* footprints (after Tresise 1989):

(i)Owen's chirothere *Labyrinthodon* giving rise to cross-legged footprints so that the large digit (actually the outside "little toe") appears in the manner of our thumb on the inside of the track (after Lyell 1841). Notice the very few bones (dotted) upon which this false reconstruction is based: the bones are now known not to belong to the producer of the *Chirotherium* prints.

(ii) A hypothetical reconstruction of the animal which made the *Chirotherium* footprints based on the pseudosuchian (=false crocodile) reptile bones found in Triassic rocks in South Africa. The hypothetical animal is 3m long (after Soergel 1925).

(iii) The nearest fossil skeleton capable of making chirotheroid-like footprints: *Ticinosuchus ferox* an early carnivorous rauisuchian archosaur (prior to the dinosaurs proper) which was found in 1965 washed out to sea into marine limestone deposits of Triassic age at Monte San Giorgio in the Swiss Alps. The skeleton is 2.5 m long (after Krebs 1966, with permission).

Figure 19 Scanning electron microscope photographs of the Grinshill White Sandstones of Quarries G5-7, especially Cureton's Quarry G5 (by kind permission of Dr John Cubitt, Technical Director, and Dr Mike Love of the Geochem Group Ltd, Chester). The instrument allows the observer to peer between the individual sand grains of this fine to coarse sandstone to see the detailed world of the grain surfaces, pore spaces, overgrowths by quartz and feldspar crystals, the dissolution of certain grains, and the growth of finer, pore-filling illitic clay-mineral cements on the grain surfaces and between the points of contact of the grains. The units on the scale bar are in tenths of a millimetre.

a. Core 1 Plug 12 Photo 0005/20. Grinshill Sandstone, Grinshill Quarry. A poorly sorted laminated fine to coarse sandstone extracted from only 10 cm away from the igneous dolerite dykes which cross the quarry. On the one hand there is much pore space but it is diminished by pyramid quartz overgrowths (centre right) and feldspar overgrowths (top left) and grain-rimming clay minerals of smectite composition (everywhere). On the other hand pore space is increased by the chemical dissolution of feldspars (e.g., at the bottom end of the large feldspar grain – top centre). The coherence, hence the durability of the rock as a building stone, is mainly due to the points of contact but is enhanced by the many overgrowths of all kinds. Pore-space 24.9%; permeability 1912 millidarcies.

b. Core 2 Plug 14 Photo 0008/20 Grinshill Sandstone, c. 70m (230 ft) from the dykes in the southeast of Grinshill Quarry. A moderate to well sorted fine to medium sandstone with subrounded but mostly rounded grains due to aeolian abrasion (and deposition). Coherence is due to grain contacts and in part to small feldspar overgrowths. As a result of the good sorting, the roundness of the grains, the lack of compaction and lack of great amounts of secondary cementing minerals, the pore space is high (26.2%), the permeability high (3255 millidarcies) and the density of the rock relatively low for a first class building stone.

c. Core 2 Plug 14 Photo 0009/20. Grinshill Sandstone from the same plug as in Photo b above, but at higher magnification in order to show the nature of the clay minerals (largely smectite but also with minor amounts of illite and kaolinite) on the surface of the grains and the points of contact of the grains which 'cement' the rock and contribute to its coherence and durability.

Figure 20 The geological structure of North Shropshire (after the mapping of the Geological Survey in the 1920s on the 1: 10,560 six-inch scale; see Pocock and Wray 1925).

Figure 21 The distant landscape features seen from the Greensward (Locality 9 of the Nature Trail) and the Clive or High Scaur (after Anon 1975).

Further un-numbered illustrations are added in places where space permits. These are referred to by an asterisk * in the text.

1. INTRODUCTION

Anyone who has sat upon the Cliff or High Scaur above both Clive and Grinshill and marvelled at the harmony and beauty of the north Shropshire landscape all round will have spared a thought for the contribution of the treescapes of the escarpment and dip slope nearby. Even a short foray into this area will reveal the presence of rock faces and former quarries, as many as 30 of the latter in area of only threequarters of a kilometre square. At the present day only one quarry - of CAMAS Aggregates (Quarries Division) Plc (formerly English China Clays Ltd) – is working and that is on the top of Grinshill (**Fig.1**) in an area once known as Mount Pleasant up to at least 1870.

Even the least curious may wonder about this abnormal incidence of quarrying in the area:

- When and where did it first start?
- Who carried it out? Who was the first quarryman? Who owned, leased and worked the quarries at various times? Who were the famous? Who were the villains? What were their names; to which families did they belong; did they go through hard times?
- What were the materials produced; how were they worked? Where did they go? How far did they go and when? How were they transported to distant places?
- To which buildings, by which mastermasons, architects and contractors, did the Grinshill Sandstones contribute?

Some visitors will ponder further and ask:

- How are these most valuable rock types distributed? How far do they extend both at depth and at the surface?
- How did the rock get there in the first place?
- By what means and how long ago did it arise?
- What properties make the Grinshill White Sandstones so famous as a building stone?
- Will supplies of Grinshill Stone and the Grinshill Flagstones last for ever?

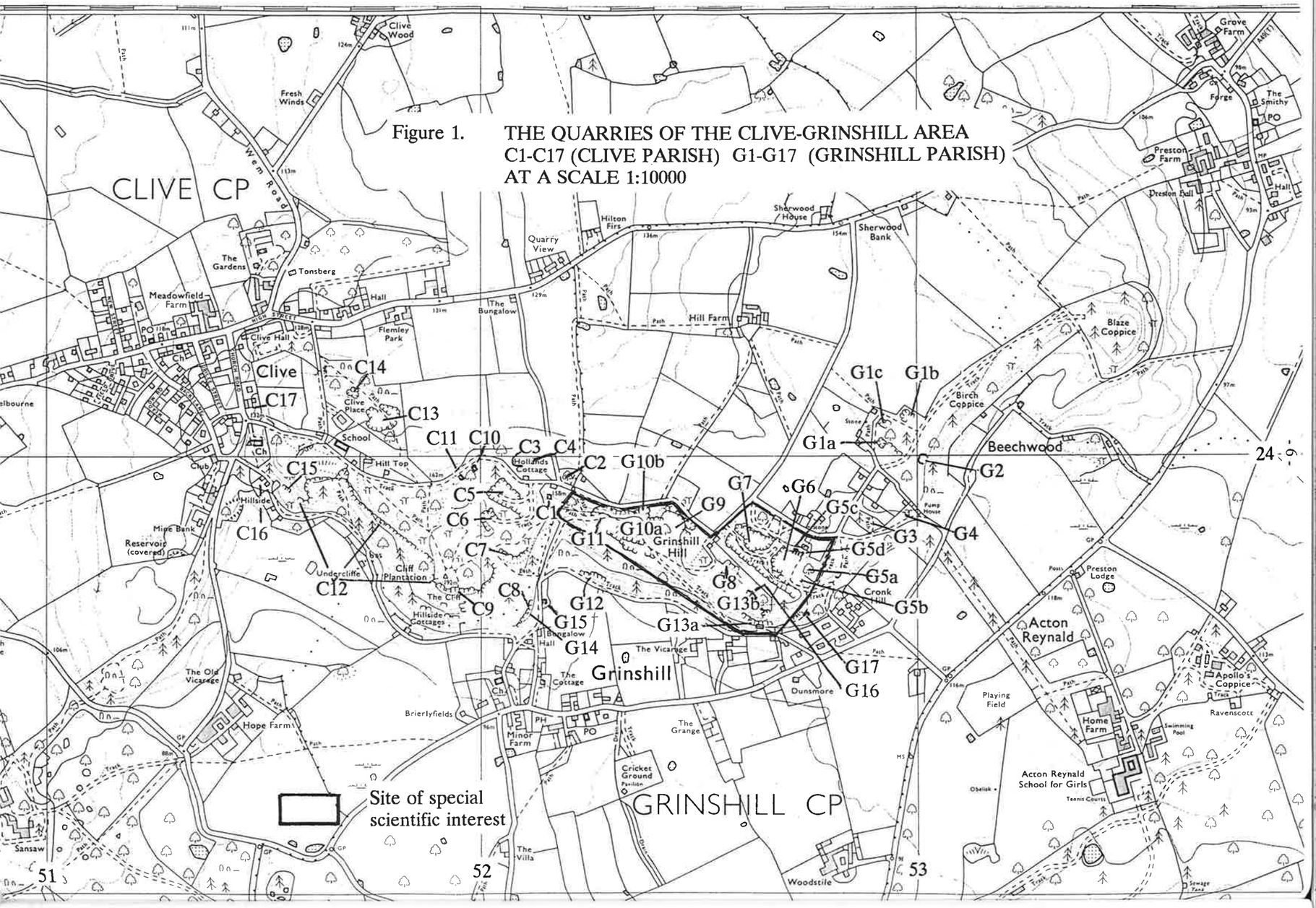
This pamphlet sets out to answer some, but alas not all, of these questions by guiding the visitor along the natural history trail developed in the grounds of Corbet Wood which was generously donated by Sir John Corbet to Shropshire County Council in 1971. With luck, the guide will provide a starting point through which the visitors will observe and understand these natural and man-made features more closely, and will eventually frame and answer their own questions. Ultimately, perhaps after several visits, it is hoped that a considerable respect will emerge for the immense labours of our forebears and a determination to help to conserve and cherish this sublime landscape which has been passed down to us as a common heritage.

The walk starts in the Corbet Wood Car Park, Grinshill (SJ 525238), and visits are made to but a small sample of the quarries and outcrops of the area, notably those waymarked for the natural history trail (**Fig.2**).

2. THE DERELICT COTTAGE AND ANDREW DOWNES' QUARRY

The derelict cottage and garden at the north end of the car park lie c.30m west of a disused quarry, Downes' Quarry, which is designated as Quarry G8 on the map (**Fig.1**). The quarry was marked on the Acton Reynald Estate Map of 1835 (1) (**Fig.3**) and was leased by Andrew Downes from Sir Andrew Corbet at the time of the Tithe Apportionment in 1838 (2). The Downes family will later be shown to be a

Figure 1. THE QUARRIES OF THE CLIVE-GRINSHILL AREA
C1-C17 (CLIVE PARISH) G1-G17 (GRINSHILL PARISH)
AT A SCALE 1:10000



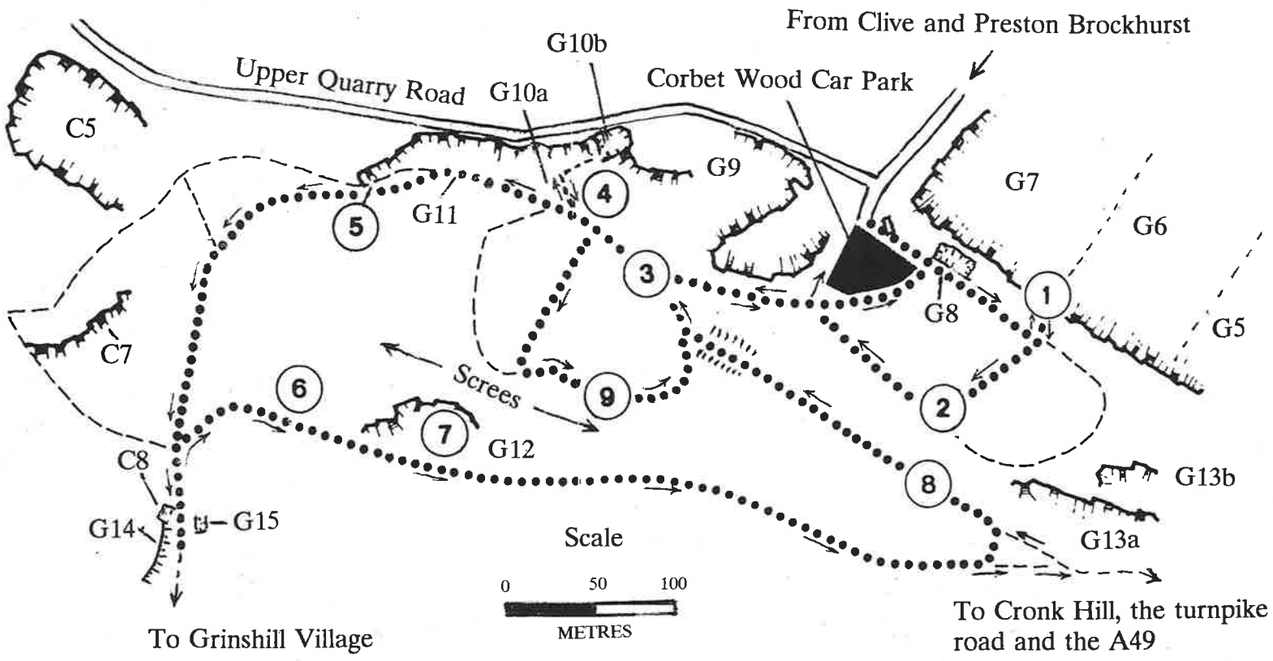


Figure 2 The natural history trail and its waymarked route in and around Corbet Wood (Anon 1975).

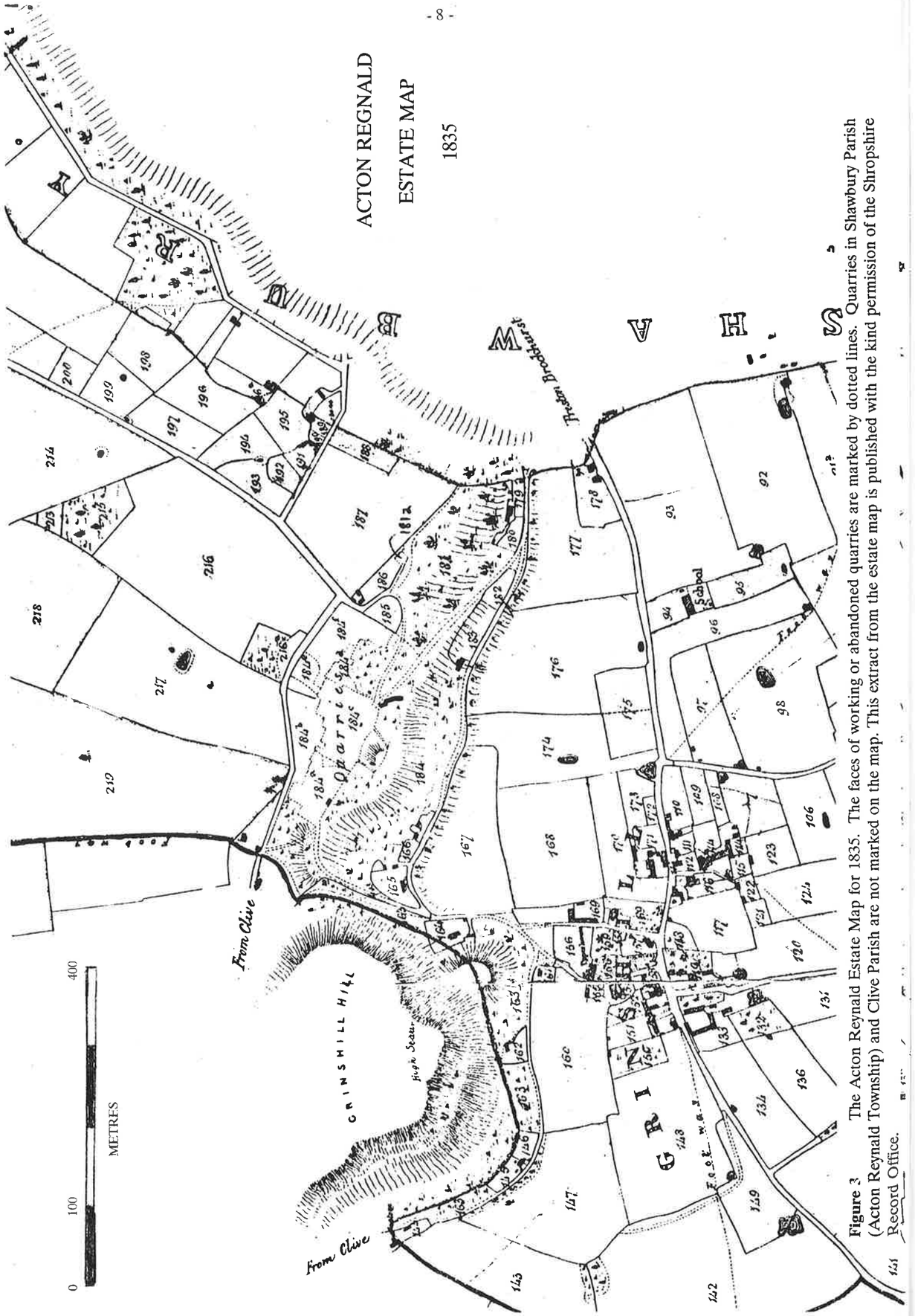


Figure 3 The Acton Reynald Estate Map for 1835. The faces of working or abandoned quarries are marked by dotted lines. Quarries in Shawbury Parish (Acton Reynald Township) and Clive Parish are not marked on the map. This extract from the estate map is published with the kind permission of the Shropshire Record Office.

famous quarrying family, which until recently, lived at a house on the hill to the north of the present quarry. The Tithe document reveals that the cottage alongside the quarry to the west was leased to Benjamin Hassal by Sir Andrew, but it is not known whether Benjamin was a quarryman. What is certain is that the cottage and quarry (G8) are older in origin than the present quarries (G6-7) to the immediate north. Oral accounts of local people suggest that quarry G8 ceased working prior to 1914 but that ashes derived from the fire-box of the steam crane were still visible in the 1920s. In view of these possible connections with quarrying, it is most appropriate that there are hopes eventually to reconstruct and adapt the derelict cottage, in part as an information centre and a local museum displaying both the products and the history and geology of the quarrying industry hereabouts.

3. THE WORKING QUARRIES ON MOUNT PLEASANT - LOCALITY 1 OF THE WAYMARKED TRAIL

A short diversion ESE for 70 m will bring the visitor to **locality 1** of the nature trail and will provide a preliminary panoramic view northwards over a huge working quarry, until recently belonging to Grinshill Stone Quarries (1982) Ltd, a company owned and managed largely by two local men, John O'Hare and Jim Thursby. From 1989-1994 Grinshill Quarry was part of English China Clays Construction Materials (Quarries Division) Ltd, but this business activity has now been hived off as a separate arm of ECC known as CAMAS Aggregates (Quarries Division) Plc.

3.1 The first records of quarrying....the myth of quarrying in Roman times

It is well to note that, despite the frequent trumpeting of the idea that the quarries at Grinshill - even the present working quarries (G5-7) – were first worked by the Romans in order to furnish stone for parts of their city of Uriconium (3), no remains or artefacts support this idea (4). So far as the present author is concerned the quarries in the area have been worked only for ten centuries, but that is surely a proud enough record!

3.2 Cureton's Quarries

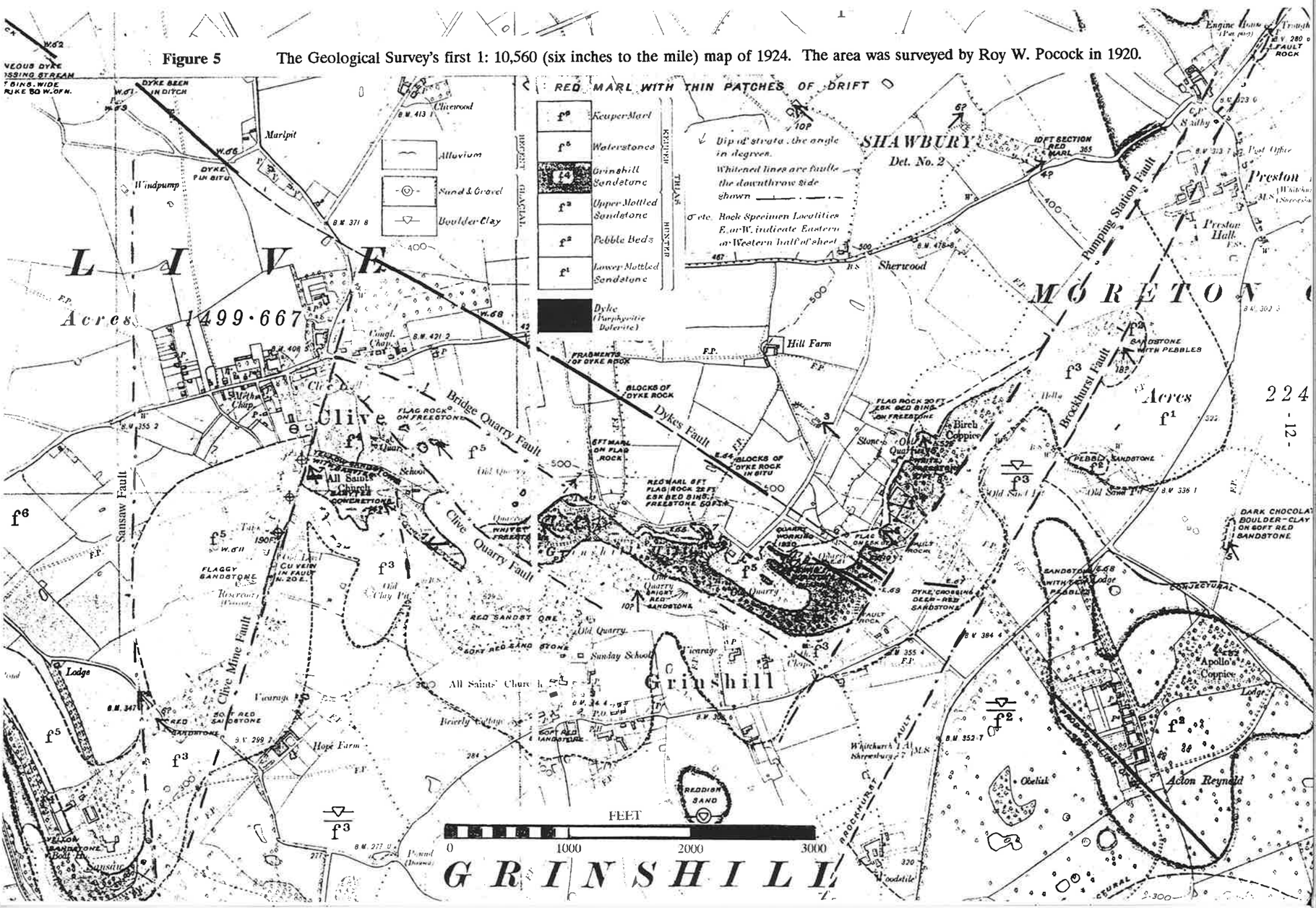
Historically, it is helpful to think of two, or even three, quarries hereabouts which have combined to form the large one which you now see. On the far right, to the east of the north-south parish boundary dividing Grinshill from Shawbury (Acton Reynald Township) **(see Fig.1)** lies quarry G5, Cureton's Quarry, the quarry leased by the Cureton family from the Corbet family (or possibly owned outright by the Curetons) since the Middle Ages until the death of the last Edward Cureton (1806-1884) and his wife Elizabeth (died 1897). A prominent descendant and genealogist of this family, Professor Thomas Cureton, lived until recently in Urbana, Illinois, USA – the result of migrations by members of this quarrying family which were occasioned by religious intolerance in the mid-1600s. In the 1950s and 1960s he often visited the area in search of his roots and he claimed that he could trace the origins of his family to an abbey in Aquitaine in SW France, which was connected with quarrying the local limestone building stones at least as far back as the 12th century (5).

By the time of the Ordnance Survey map on a scale 1:2500 (25 inches to the mile) in 1880 (6), Cureton's Quarry possessed a crane and was working the squarish headings (G5c and G5d), which we now see, abandoned and partially infilled, on the far right (the northeast) of the quarry **(Fig.4)**. Until 1960 or so, Cureton's cottage stood in the worked-out, northern part of his original holding (G5a). Descendant Professor Thomas Cureton has attributed a date of 1540 to it (7), though no local inhabitants can confirm that this date mark appeared on any building stones. Other descendants of the Cureton family still live in the area, notably in Prees village.

3.3 The Mount Pleasant Quarries owned successively by J.M. Kilvert, George and John Hancock and Charles Thursby & Co.

On the Tithe Map of 1838, not very different than that of **Fig.3** (8), the western and central parts of the present quarry were still arable land, known as Mount Pleasant, and were owned by Richard Kilvert.

Figure 5 The Geological Survey's first 1: 10,560 (six inches to the mile) map of 1924. The area was surveyed by Roy W. Pocock in 1920.



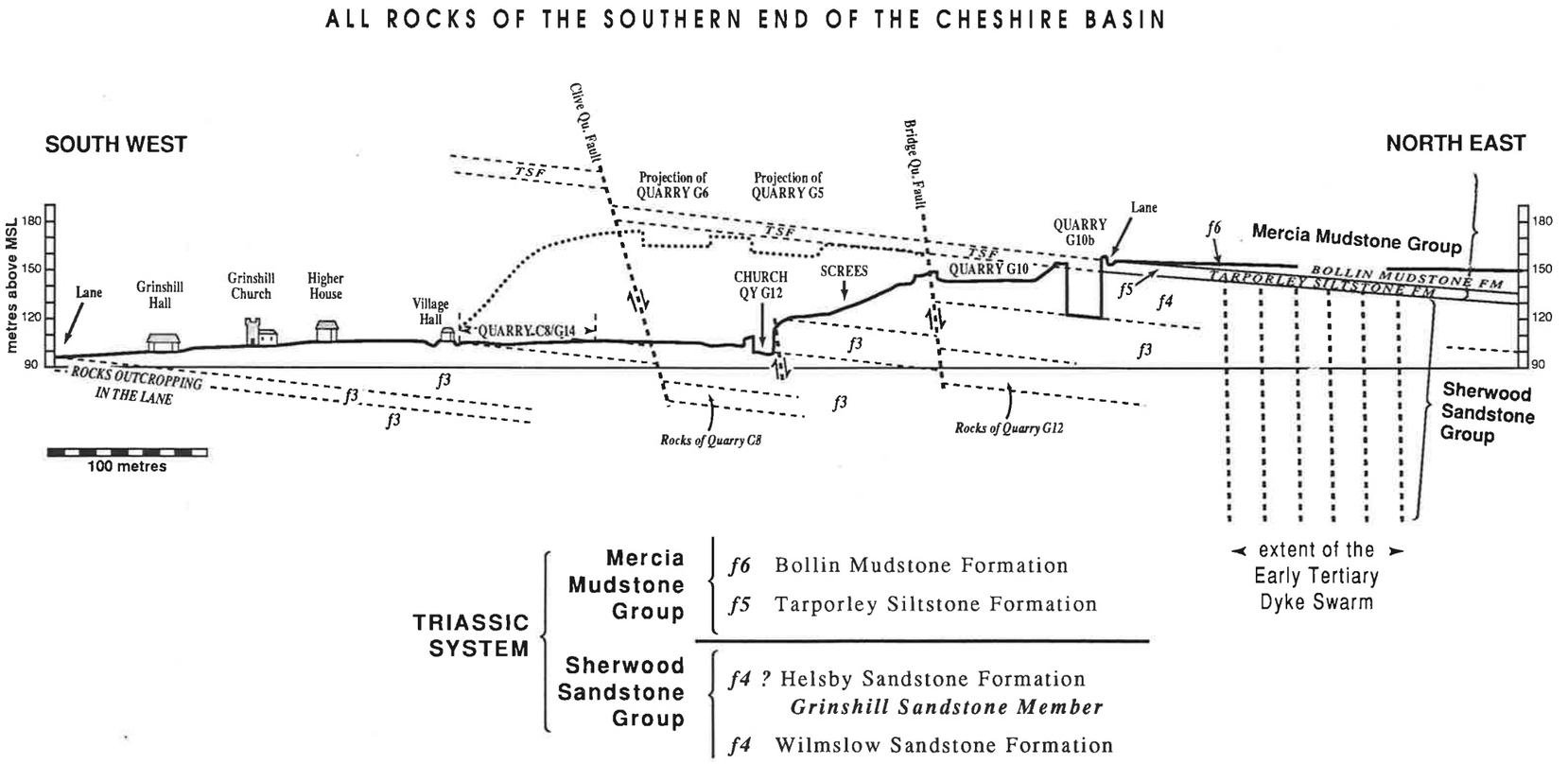
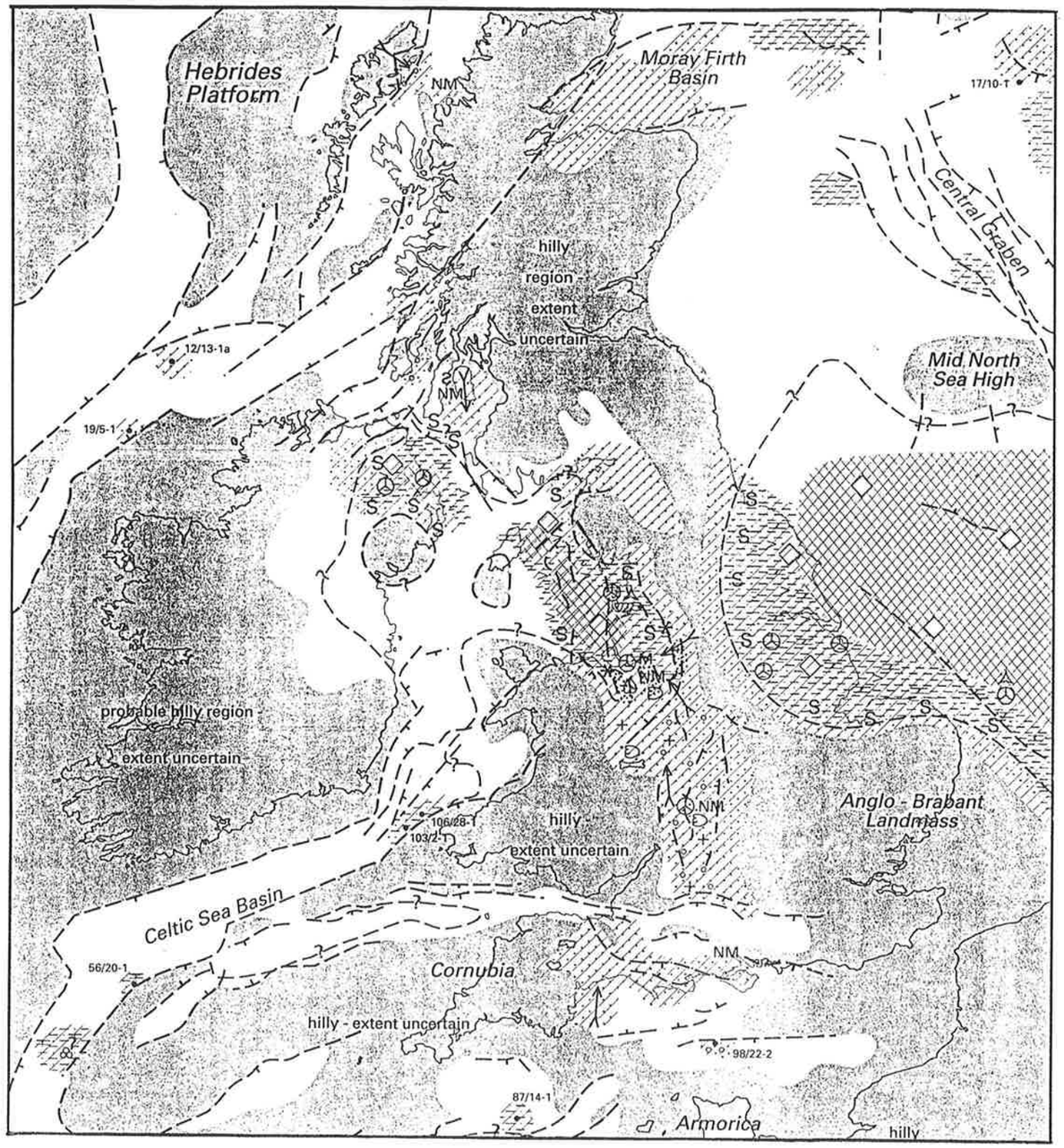


Figure 6 A geological cross-section of the Grinshill-Clive area from the centre of Grinshill village to the Bridge Quarries and the Deep Quarry G10b to illustrate the simple layer-cake structure of the area.

Figure 7a A generalised palaeogeography of the British Isles at a time (242 million years ago) soon after the deposition of the Wilmslow Sandstone Formation and the Helsby Sandstone Formation and during the deposition of the Tarporley Siltstone Formation, including the Grinshill Flagstones [after G. Warrington and H.C. Ivimey-Cook in Cope, J.C.W. *et al.* (editors) 1992 with the kind permission of the Geological Society of London].



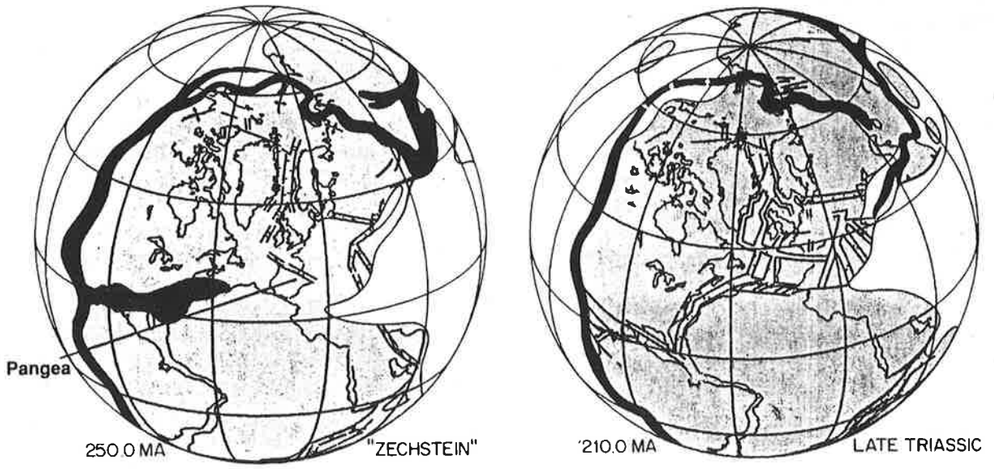
low-lying land
higher, hilly or mountainous terrain
red beds (original or subsequently reddened)
dunefields
shoreline, where known with reasonable precision
shoreline, whose general position is known
shoreline, whose position is only suspected
direction of sediment derivation and bottom currents
prevailing wind direction
sabkhas
active faults, tick on downthrow side, half arrow showing sense of lateral movement, if any

sand
silt
clay, mud (shale) incl. black shale
modern coastline
St Erth□ named locality
• B • 72/10-1A named borehole
+ fresh water
* brackish water
◇ hypersaline water

Evaporites
gypsum
anhydrite
halite
potassium and magnesium salts (usually with halite)

Fossil symbols
acritarchs
sporomorphs
plant remains
branchiopods/ conchostracans
vertebrates other than fish
footprints
M marine indicators
NM non-marine indicators

Figure 7b The general disposition of the fragments of our present landmasses at 250 and 210 mya, showing that there was then only one continent - Pangea (after P.A. Ziegler 1993 with the kind permission of the Geological Society of London).



Notice, however, that parts of the backwall of the quarry on the northern side are different. Some parts weather brown and orange and are distinctly broken into rounded spheroidally weathered blocks, especially towards the top of the quarry. This backwall exposes thin (up to 75 cm thick) sheets of a dark-grey igneous rock known as dolerite or basalt (dependent on the grainsize, medium or fine respectively) (21) which have been age-dated somewhat insecurely (for the rock is badly mineralised and weathered) as only 50 ± 13 million years (22) i.e. from the Eocene (= dawn of the recent) part of the Cainozoic Era (recent-life period). Other less direct measures of dating by the apatite fission track method (on the grains of the sandstones between the dykes) give ages of 69 and 63 mya (22). This igneous rock was once molten magma and originated in the mantle of the Earth many tens of kilometres down and rose up, at 1200 degrees C or so, along brittle fracture lines (called faults) into the earth's crust. Such thin vertical sheets of rock are called dykes and, where several are present, they constitute a dyke swarm. In this case the magma rose up the Dykes Fault Zone (see **Fig.5**) which is aligned WNW-ESE, before cooling slightly and crystallising 2-3 km beneath the earth's surface, well before a temperature of 1100 degrees C was reached. Had it reached the surface, the magma would have formed a lava flow and a series of lava fountains and would have looked like the yellow to red-hot basic (iron and magnesium-rich) silicate magma which is often seen on television issuing from lines of vents across Hawaii or Iceland today.

The intrusion of this dyke swarm was related to the opening of the North Atlantic between Greenland and Norway. Indeed it may have been a precursor of, or have been associated with, the early through to late phases of the of the emplacement 65-50 mya of the 2000 km-wide mushroom shaped "Icelandic" plume of magma. This arose from deep in the mantle of the Earth to impinge on the base of the outer more solid and brittle exterior shell of the Earth circa 62 mya. Iceland is still subject to igneous activity along its central rift as the Atlantic continues to widen and the North American and Eurasian plates drift away westwards and eastwards respectively at a few centimetres per year.

The branches of the Grinshill Dyke Swarm - possibly 7 or 8 in number - head off towards Anglesey, on and around which island several similar dykes have been found which appear to be aligned with centres of volcanic activity associated with the Giant's Causeway in Northern Ireland (24). At a late stage - probably 50 million years ago – these igneous rocks were mineralised by hot watery solutions bearing abnormal elements including lead (Pb) and zinc (Zn) (25). This mineralisation may relate to the copper (Cu), cobalt (Co), zinc and lead mineralisation at Clive Mine nearby to the west.

All these geological events are mentioned because the particular qualities of the Grinshill White Sandstones and Flagstones, which make them so admired and so saleable as building stones, are likely to depend uniquely upon the originally red Triassic sediments of some 240 million years ago being favourably altered by the high temperatures and access of mineralising solutions associated with the intrusion of this dyke swarm (see Section 3.10)(26).

3.5 The quarrying companies and their personnel in the 1920s

Before leaving this vantage point, it is worth reiterating that in the early 1900s Kilvert's quarries G5-7 were amalgamated with the Bridge and Cureton Company's Quarries and were managed first by George Hancock of Shrewsbury and then later by his son John Lewington Hancock (**Fig.9**) of Clive. These quarries were sold in 1923 to the Grinshill Stone Quarries Ltd (1923) led by Charles P. Thursby, Jim Thursby's father, a company which struggled to survive in the late 1920s and late 1930s, ceased to trade during the second world war, and was but a shadow of its former self from 1950 to 1980. It was reorganised and saved from extinction by John O'Hare in 1980 and traded as Grinshill Stone Quarries (1982) Ltd, before being taken over by the present owners, English China Clays-CAMAS Plc, in 1989 (26).

Now is the time, perhaps, to try to imagine the workings and the personnel of these quarries in the first half of the nineteenth century, particularly the 1920s and 1930s.

Locate the remnant walls of former headings G5c and G5d, developed between 1870 and 1939, on the far right of the present quarry. It will be seen that the walls were 1-2 m wide, just sufficient for the running of wheelbarrows or steam-haulage cranes loaded with stone. Envisage the site of the stone masons' sheds of the 1920s and 1930s on the far left i.e. the northwest side of the quarry. Imagine a steady workforce

of about 20 people assembling there: Charles Thursby (owner), Richard Smith of The Knoll, Clive, managing director on a salary of £6, the chief mason Freddie Downes on 1s 10d (=9p) an hour, 4-5 masons like Harry Jones (on 8p per hour), 5-6 skilled quarrymen like Freddie Forgham and Joe 'Capsey' Walford (6p), and the rest labourers like Richard Dytor (at 5p) or apprentices like Stan Austin (at 40p a week!). Freddie Forgham, a skilled quarryman, also manoeuvred the fixed crane until he left the quarries, whereupon the duty fell upon Bill Reeves, an unskilled quarryman. Harry Price was the driver of the travelling steam crane named "Captain" which had once on test-trial lifted and carried a 10-ton block of white sandstone. Later Herbert Smith of New Street, Clive (a favourite abode of quarrymen) drove a steam crane though it is not known whether it was of the fixed or travelling variety. Harry Price was father-in-law to George Smith the lorry driver who was first person to drive a Peerless lorry. Holidays were taken with no pay at Christmas, Easter and Midsummer (27). The workforce rose to c.40 persons only during the rebuilding of the English Bridge in Shrewsbury in 1925-7, for the lowering of its hump and the doubling of its width brought much work to the quarries (28). Alas! the quarries could not supply a keystone for the centre arch comparable to that of 1773 and a substitute material, Portland Stone (of Upper Jurassic age), had to be imported from the south of England.

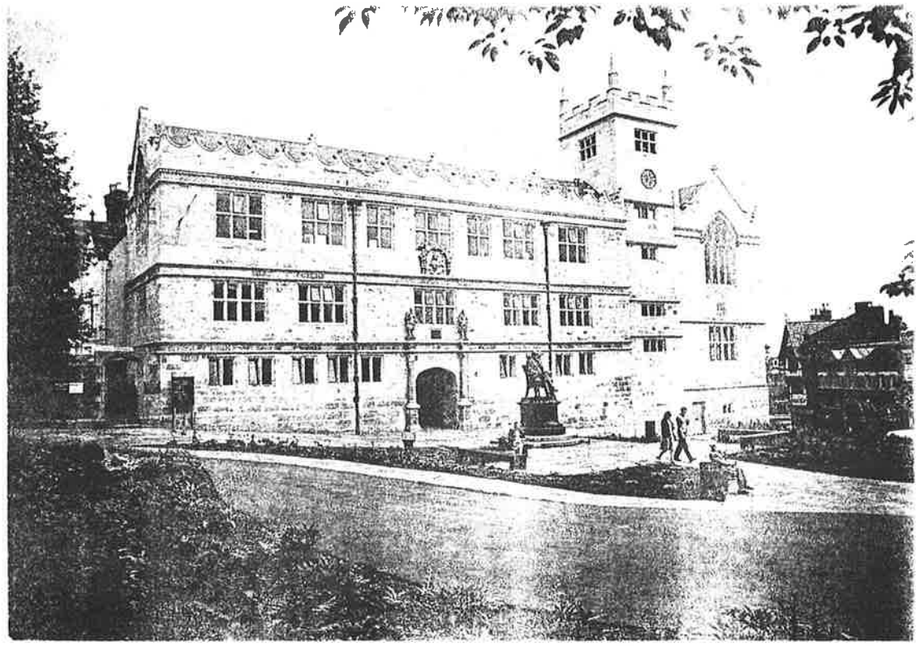
3.6 The quarries and the Second World War

Realise that during the last war the local homeguard led by Mr Fenn-Wigin, head brewer of the famous plant at Wem, used to assemble on the quarryside where you are standing and, for practice, fire phosphorous bombs at the northern wall of the quarry. Until 1990, the dark green marks were still be seen on the face of the wall where the bombs had burst into flames. Local hearsay suggests that it was from that wall that stone for Liverpool's Anglican Cathedral was being won just prior to 1939, but this author has looked in vain for the use of Grinshill stone in that place. John O'Hare maintains that many of the blocks destined for the cathedral lie quarried but untransported in the depths of the present quarry G6. Realise, also, that the foundations of airfield runways at Shawbury and Tern Hill were fashioned from the waste rock kept in the bottoms of the quarry headings of this quarry and G9 – in the years immediately prior to the war. During the years 1940-1943, much rubble was taken from this quarry and G9 to form the bases of army and airforce huts prior to the invasion of Europe in 1944. After the war, the quarry waste of former years provided the main supplies of stone for a modest market; but few faces were quarried, and little masoning took place (29). Many a carpark of Greenall Whitley's public houses have been floored by rubble from the quarries which was provided and transported by Parry's of Shawbury using a fleet of their own lorries between 1950 and the early 1960s.

3.7 The processing of the stone and its transportation

Locate the dimension-stone cutting facilities of the present quarry. They are sited on the southwestern side of the quarry, where the sheds are now present, but for many years they were on the northwestern side of the quarry. A considerable amount of masoning of the stone takes place now, but try to imagine in the past the large amounts of stone which were neatly cut, squared and roughly-dressed or finely dressed (for ashlar), or carved (for delicate window tracery) from the Grinshill White Sandstones (**Fig.10**). Sense the many hearths, mantlepieces, fireplaces, flagstones, engine beds, tombstones, gravestones, memorial tablets, and even occasionally roofing stones, that were fashioned from the Grinshill Flagstones. Picture the carrier Mr Haynes and the heavily-loaded waggons drawn by teams of shire horses which sweated and frothed their way downhill to Yorton Stoneyard by Yorton Station from 1858 onwards. Later in the day of your visit you may be moved to trace the carters' route to Yorton Station and follow the trail of a weary waggoner into the Railway Inn and so satiate your imagined thirst with foaming ale. Alas! Adie Robinson, who until 1990 had been serving at the bar for 50+ years, will not any more look after your needs, or tell you a tale or two the prolonged carousels of 'Capsey' Walford and Joe Chettoe as they tottered on their way home to Myddle. With luck you may be served just as cheerily by her niece.

From 1925 or so, transportation was increasingly effected by George Smith of Holland's Cottage (SJ 521239), who drove a sturdy Peerless motor lorry and later, in the 1930s, a Fordson truck. After the war much of this function was taken over by Parry's of Shawbury whose lorries worked in tandem with Charles Thursby's workforce and took stone from both these quarries and the Bridge Quarries especially G9 (**Fig.1**) (30).



Shrewsbury Library (1983-), formerly Shrewsbury Free Grammar School (built 1627-1630) in the most pleasing Grinshill Sandstone possibly by the son of Walter Hancock of Shrewsbury), together with the school library/chapel/gallery (on the right of the tower; built in 1594-1612 by John Richardson). In 1815 the attic gallery was removed by John H. Haycock and a matching parapet was added, together with gothic windows, to the library. The dark statue in front of the school gate (cut from black Norwegian larvikite, an intermediate syenitic rock now unobtainable) is of Charles Darwin (1809-1882). He was a reluctant scholar of modest achievements who, with his brother Erasmus was publicly and privately derided by his headmaster, Archdeacon Samuel Butler, because of his interests in natural history and chemistry (the latter generating his nickname "Gas").

3.8 The destinations of dressed stone from Grinshill Stone Quarries (1982) Ltd

Where has the stone from the revitalised quarries (G5-7) been sold in recent years? An analysis of the company's invoices (1980-85) revealed that the following were the main customers and that a notable array of buildings were served by the quarries (31):

1. **R. Bridgeman, Cathedral Works, Lichfield:** St Chad's, Shrewsbury; St. Mary Magdalene, Battlefield; St. Andrew's, Wroxeter; Tern Bridge, Atcham; Maxstoke, Tamworth, Dudley and Kirby - Muxloe Castles; Attingham and Shugborough Halls.

2. **Will. Sapcote & Sons, Birmingham:** Madeley Court, Telford; Whitehall Buildings, Shrewsbury.

3. **Staffordshire Stone (Hollington) Ltd:** Trench Lock, Telford.

4. **Frank Galliers Ltd, Shrewsbury:** Shrewsbury Library (once Shrewsbury Free Grammar School) using white sandstone*; Riggs Hall (adjacent) using red sandstone; the Roman Catholic Cathedral, Shrewsbury.

5. **The South-Western Stone Cleaning and Restoration Co Ltd, Bristol:** The Library, Shrewsbury*; the Museum (formerly Rowley's Mansion), Shrewsbury; Cleobury Mortimer School; Wolverhampton Law Courts.

6. **E. Rogers, Monumental Masons, Nantwich:** Crewe Hall, near Crewe, Cheshire.

7. **John Laing Construction Ltd, Carlisle:** The Buttercross, Ludlow.

8. **Shropshire County Council:** Bridges at Lee Brockhurst and Platt Mill, Ruyton of XI Towns.

9. **John Uddall, Landscape Gardener, in conjunction with Bridgemere Nurseries, Woore:** the National Garden Festivals at Liverpool and Stoke, and many other contracts.

* = illustrated.

3.9 Grinshill Quarries; Conservation and Planning

In the late 1970s it was realised by the County Planning Department that Charles Thursby's quarries G5-7 had not been registered under the Town and County Planning Act of 1947! The Nature Conservancy Council had first designated the quarries as a Site of Special Scientific Interest (SSSI) in 1972 and the processing of this decision above all should have alerted the authorities to the quarries' existence, but somehow that had not happened. It was not until 1979 that a planning application was submitted with respect to the continuation of an activity, quarrying, which had been going on for roughly 1000 years in the area!

At first the planners treated the quarries as aggregate quarries, suggesting that working faces were to be benched and stepped; unused or worked areas were to be graded and grassed. The periphery of the quarry was to be banked and planted with a screen of trees, so as to hide the "unsightly" workings from the eyes of local people and visitors who were using the local roads.

The quarry owners were willing to comply with the latter request but were very resistant to grassing over large parts of the working quarry. To them this was simply a practical matter. Pause to reflect that in the present quarry, such a large, seemingly untidy, area of rock needs to remain exposed and open to the elements because the slight variations of colour and texture requested in customers' restoration contracts require the matching of these features in sandstone blocks which may be located in small quantities in virtually any part of the quarry. Note also that few stone blocks can be left exposed and have their quarry

water evaporate; they must remain buried in easily accessible sandy waste so as to retain their natural ground waters. These very practical considerations led to many misunderstandings and some acrimony; the owners were unwilling to jeopardise their livelihoods; the planners appeared to think that they were stubborn. In the end in 1979 permission for the continuation of working was given until 1994 (32), subject to stringent conditions. Recently a 15 year extension of quarrying has been requested by ECC-CAMAS and has been granted by the Planning Committee of the County Council.

3.10 The properties of the Grinshill Sandstones and Flagstones which have made them pre-eminent as building stones

Building stones are natural raw materials; they inherit features which have been developed over long periods, in this case 250 million years. Apart from sawing and masoning, no manufacturing processes ancient or modern will change their properties. Over eight and a half centuries the Grinshill Sandstones and Flagstones have been tested by trial and error on innumerable construction sites and subsequently in use they have withstood weathering and erosion better than other local rocks of similar age and outwardly comparable appearance.

Ever since the enquiry in 1839 by the Parliamentary Commissioners into the building stones which might be suitable to withstand the increasingly smoke-ridden, acidic atmospheres typical of inner cities in general and the buildings at Westminster in particular (33), an effort has been made to use science and technology to isolate the factors which make a stone pre-eminent. This kind of assessment was extensively undertaken in the early 1890s (34), but recently the Building Research Establishment (BRE) has attempted to design tests which will be applicable in terms of British Standards and will show up the features which make a stone of high quality (35).

Colour is an important factor. The original redness of the Grinshill Sandstones was due to the presence of a thin film of hematite (Fe_2O_3) around every aeolian sand grain. This is still present in the Red Sandstones, but it has been dissolved away in the case of the 'White' Sandstones, probably by acidic and/or reducing solutions accompanying igneous intrusion and mineralisation. The Flagstones may never have possessed any original redness because of their very different, chemically reducing, environment of deposition. Not every architect and owner takes to the colour of the Grinshill "Red", and many prefer the pink-tinged, buff, honey-coloured, yellowish varieties of the Grinshill "White" Sandstones. These latter variations are caused by the presence of small amounts of secondarily redistributed hematite (pink-tinged varieties), or iron hydroxide (the rusting of rare pyrite grains producing the limonite or goethite of the yellow-buff-brown-orange varieties). For long periods, however, architects and owners have preferred the simplicity, and particularly the classical 'purity', of the whitish stone (36).

Weatherability and durability are equally important. These attributes stem from a combination of factors: mineral and chemical composition, degree of porosity and permeability, types of cement and resistance to natural acids and crystallising forces provided by rainwater, sea spray, road spray and freeze-thaw cycles.

The Grinshill Sandstones are composed of quartz (c.70%), feldspars (c.10%), rock fragments (c.9%) and clay minerals leaving less than 2% for cementing materials which have grown in the pore spaces and so bind the sand grains together. The cementing materials are of quartz and feldspar "overgrowths" (37) (**Fig.19**). No calcium-carbonate grains or cements are present which could be attacked and dissolved, so the rock does not weather when subjected to acid rainwaters and it easily passes the acid immersion test of the BRE (38). The silica and feldspar overgrowths, though small in amount, are quite vital, for it is their very secure cementing of the sand grains which renders the white rock so coherent; it is their lesser presence which renders the 'red' sandstones slightly less serviceable (39).

The pore space of the sandstone is about 25% and the rock is very permeable so that solutions bearing sea-spray and road-spray salts (with NaCl) readily enter the rock and evaporate. As they do so, they exert very considerable forces of crystallisation which tend to prise the sand grains apart. The BRE crystallisation test replicates such a happening rather severely across 15 cycles of crystallisation of a standard salt. The results of the tests are expressed either in terms of failure after a number of cycles, or in terms of loss of weight after 15 cycles. The different samples of Grinshill Red Stone disintegrated

completely after 5-12 cycles, but the samples of White Sandstone survived the whole test and lost between 50 and 60% of their weight at the end of 15 cycles - a better-than-most, and a very acceptable result (40). These results do not mean that the Red Sandstones are not serviceable for most purposes; by the test of time they clearly *are* serviceable for most purposes but do not possess the added durability of the white stone which makes it pre-eminent for delicate ornamental work and so good for engineering purposes.

The compressive strength of the White Sandstone was long ago shown to be slightly less than average for most sandstones but more than adequate for all building and almost all engineering purposes (41). Its competitive edge was increased greatly by the fact that it possessed the same strength whichever way it was laid, i.e. parallel to the bedding planes or across them. The Red Stone has not been tested in this regard.

The weight and density of the stone. Grinshill White and Red Stones are lighter than most sandstones when hefted (i.e. weighed comparatively) in the hand. Detailed measurements have yielded a relative density of 1.96 - rather low when compared with most high-quality sandstones and other building stones (42), but one which brings marginal savings in transport costs.

The hardening and workability of the stones. Grinshill White and Red Sandstones and Flagstones are relatively soft when they are quarried. They develop an added patina of hardness when the natural quarry waters slowly work their way, by evaporation and capillarity, to the surface of any block and precipitate (i.e. crystallise) their siliceous burden as a hard outer cover.

There has always been a controversy amongst architects regarding the advisability of masoning the stone either immediately after quarrying or much later after it has been "seasoned" for several years, i.e. had time to develop its external patina. Either way, the Grinshill Stones have always been reckoned to be 'kind', i.e. soft, to the mason's chisel and delicate tracery has often been finely prepared (43) and preserved.

4. THE BRIDGE QUARRIES - LOCALITIES 3, 4 AND 5 OF THE TRAIL

4.1 The origin of the name of the quarries - the 18th century bridge building programme of the County

Walk SSW and then WNW via **Locality 2**, or retrace one's steps to the car park and follow the sunken path through the Tarporley Siltstones southwards down Grinshill Hill towards waymarkers 3 and 4 of the nature trail (**Fig.2**). At this point the former Bridge Quarries (G9-11 on **Fig.1**) are entered. They are so-called because it was from these quarries that the stone for the county bridge-building programme of the late 18th century was won (44). The bridges which were built include:

- The Severn Bridge, Atcham (1768-1771), by John Gwynn of Shrewsbury;
- The English Bridge, Shrewsbury (1769-1774), by John Gwynn; rebuilt (1926-7) by Arthur Ward, Borough Surveyor of Shrewsbury, but an architect by education and training;
- The Tern Bridge, Atcham (1777-1780), by William Hayward at one time Gwynn's Clerk of Works;
- Walcot Mill Bridge (1782), by William Hayward;
- The Welsh Bridge, Shrewsbury (1791-5), by John Carline I and John Tilley, contractors turned architects, both of Shrewsbury;
- The Longdon-Coleham Bridge (over Rea Book) (1795), by Carline and Tilley;
- ? Shawbury Bridge (?1795 but rebuilt 1936); originally possibly by Thomas Telford, part-time highway engineer to Shropshire County Trustees for Bridge Construction.

4.2 Building stone for the churches and chapels of North Shropshire

It is also likely, though not certain, that earlier buildings both in the county and the town were fashioned, at least in part, from stone hewed from these quarries and from adjacent ones in Clive Parish, (e.g. C5, C6, C14: see **Fig.1**). This applies especially to the building of the churches and chapels of the villages of North Shropshire, beginning in the 12th century.

- Haughmond Abbey (from 1135);
- Broughton Monastery and Church (few vestiges remaining);
- Grinshill Chapel (1140: few foundation stones left)
- Edstaston (c.1150)
- Clive Chapel (c.1190);
- High Ercall (c.1190);
- Wem (14thC, 16thC)
- Battlefield (1409)
- Shawbury (12thC);
- Astley (12thC);
- Hadnall (12thC);
- Upton Magna (12thC);
- Moreton Corbet (12thC);
- St Mary's Shrewsbury (13th, 14th, 15thC)*;
- St Julian's, Shrewsbury (15thC);
- Minsterley (1689)

4.3 The mansions, market halls and schools of the late 16th, 17th, 18th and early 19th centuries

By the end of the 16th Century the best mastermasons were turning architect and becoming well known. A host of pleasingly designed fashionable mansions, schools, market halls and churches were constructed in Renaissance and Classical styles in the next three centuries, essentially for members of families which were rich and influential. The stone for these buildings, too, is likely to have come largely from the Bridge and for Cureton Quarries, since the requirement was often for honey-coloured and yellowish freestones:

- Moreton Corbet Mansion (1573-1597) for the Corbet family, especially Robert Corbet;
- Condover Hall (1586-98) by ?Walter Hancock for Justice Thomas Owen;
- The New Market Hall, Shrewbury (1596) by ?Walter Hancock;
- Shrewsbury Free Grammar School (1627-1630) and library/chapel (1594-1612)*; possibly by the son of Walter Hancock, for the sons of the foremost traders in the town;
- Acton Reynald Hall (1601, 1625, 1834) for the Corbet family;
- The Country Schoolhouse, Grinshill (1617-21) – now the Stone Grange – for the masters and boys of Shrewsbury Grammar School in times of plague; could this be by the son of Walter Hancock too?
- Grinshill Manor House (1624) for John Kilvert; another building by the son of Walter Hancock?
- Higher House, Grinshill (?1657) for John Embrey;
- Soulton Hall, Wem (1668) for Thomas Hill;
- Minsterley Church (1689); red brick but with stonework in a distinctive half-classical, half-baroque style;
- Preston Brockhurst Manor House (?1690) for Mr Wingfield of Shrewsbury;
- Wem Market House (1702, 1728);
- Hawkstone Hall (?1700, 1725, 1740) for Richard, and later Rowland, Hill by ?Henry Flitcroft; extensions (1830) by Lewis Wyatt;

- Onslow House (1780) original designs by George Steuart, later designs by John Haycock of Shrewbury; for Col. Wingfield;
- Attingham Hall (1783-5) for Lord Berwick by George Steuart and the lodges etc. by John Nash, much admired for his work in both London and Bath;
- Shrewsbury Castle (1790) and Laura's Tower by Thomas Telford for Sir William Pulteney;
- The New St Chad's Church Shrewsbury (1792) by George Steuart, aided by Carline and Tilley;
- Allatt's School (1798-1800), now Murivance House, Shrewsbury, by E. Haycock of Shrewsbury;
- Cronkhill (1802) in italianate style for Francis Walford, agent of Lord Berwick, by John Nash again;
- Longner Hall (1803) also by John Nash;
- Lord Hill's column (1814-1816) by Edward Haycock and Thomas Harrison (of Chester) for the grateful people of Shrewsbury*. Constructed by John Straphen, but the lions carved by John Carline II. John Carline, Richard Matthews and John Straphen are known to have leased or owned quarry G9 at Grinshill a little later, in 1821-22 (45), so it is likely that the stone came from this quarry alone.

4.4 Municipal, commercial and industrial building of the 19th century

In a later period, much municipal, commercial and industrial building was developed in Shrewsbury, but the stone for this programme is still likely to have emanated from the Bridge Quarries;

- William Hazeldine's Paper Mill (1810?) (no longer standing) (a floor of paving stones provided by the Grinshill Flagstones);
- The Buttermarket, Pride Hill (1819-20);
- The Salop Infirmary, overlooking the River Severn, reconstructed (1826-30) by Edward Haycock (now the Shopping Parade* and the Court Apartments*);
- The Shire Hall (1836-7) by Sir Robert Smirke, no longer standing on the side of the old market square;
- The Music Hall (1839-40) by Ed Haycock;
- The Savings' Bank, College Hill (1839) (46).

Try to imagine all the famous mastermasons, architects and engineers mentioned in Sections 4.1 to 4.4 labouring up the hill at Grinshill in order to inspect the particular beds from which their stone would be quarried - personal control and choice of materials by the project leaders was the rule in those days!

4.5 The volume and value of the stone extracted from the Bridge Quarries

The present extent of the Bridge Quarries is hard to grasp, especially when they are clothed with vegetation in summer, but an effort can be made to see the limits of the quarries through the trees and to estimate their length (250 m), width (130 m down to 70 m; say 100 m on average) and depth (average 25 m). Back at home, or on the spot if you prefer, try calculating the worth of the stone taken from these quarries alone over the centuries, using a round figure of £50 per cubic foot i.e. roughly 30 cubic feet per m^3 ex-quarry as the price of today's best stone (apologies for the imperial units of the quarrying trade!). A truly staggering figure results!

4.6 The working faces of the Bridge Quarries in 1769, 1835 and 1880

The earliest working parts of the Bridge quarries are unknown but they were presumably at outcrop on the former scarp on the southern side. The first dated reference to the quarries is in the late 18th century when Lord Hill of Hardwick Grange owned the estate. In 1769 a woman lessee of a quarry, one Martha Walford (of yet another famous quarrying family), was arraigned before the bailiffs of Shrewsbury because, contrary to normal business practice, she had insisted on prior downpayments on all stone moved from the quarry by John Buddle, contractor, of the Strand, London. This had held up the starting of the English Bridge and the Trustees had had to seek the help of the law (47). Lord Hill, meanwhile, the landowner had offered the Trustees the stone of an adjacent quarry which was not in use at this date.

By the early 19th century, the ownership of the land on which the Bridge Quarries stand had passed to the Corbet family. The location of the working faces of the quarries are first shown on the Acton Reynald Estate Map of 1835 (**Fig.3**) and the names of the individual quarry lessees are set down in the Tithe Apportionment of 1838. Andrew Downes held one plot, John Carline III (architect) and Richard Dobson (contractor), both of Shrewsbury, held another; most of the other plots were in the name of Sir Andrew Corbet and were not therefore leased or likely to be working. The Ordnance Survey map of 1880 at 1:2500 (**Fig.4**) showed that the faces had worked back a good deal but that, surprisingly for the hey-day of victorian quarrying, only one face boasted a crane. This suggests that only one quarry was then working and that this was the western part of quarry G9 (see **Fig.1**).

4.7 Locality 3: the eastern end of the Bridge Quarries

Immediately to the southeast of **locality 3**, the footings of the old stonemasons' and blacksmiths' sheds, well displayed on the 1880 map (**Fig.4**), can be discovered by rooting in the undergrowth. Turning to the southeast, one can see the beginnings of the gentlest down-incline for horse-drawn transportation of large blocks of stone to Shrewsbury. This is probably the only route down which the huge stone for keying the central arch of the English Bridge could have been manoeuvred, by sturdy shire horses and an unknown array of carters, in 1773. The arrival of that tired and sweating party was reported matter-of-factly by the Shrewsbury Chronicle for Saturday 20th March 1773 (48). "On Tuesday laft was brought from Grinfell Quarry, a key stone for the centre arch of the new bridge, which weigh'd ten tons, eight hundred and forty fix pounds, and was drawn by twelve horfes."

As one walks towards **locality 4**, it is just possible in winter, through the trees, to see that the quarry wall on the left, i.e. south side, is a planar fault surface - that of the Bridge Quarries Fault - trending WNW-ESE and bearing tell-tale signs of each episode of earth movement (i.e. slickensides) in a normal extensional sense i.e. with a dip and downthrow to the north (**Fig.5**).

4.8 Locality 4: The geology of the face of quarry G10; quarrying practices from the Middle Ages to 1939

At this locality the view northwards reveals the full extent of the succession (**Fig.8**). Grinshill buff-white sandstones of the Helsby Sandstone Formation lie at the base for c.7 m and bear signs of crossbedding - further evidence which confirms the pattern displayed by the former faces of sand dunes created by an easterly wind. Above these beds lie c.9 m of the Grinshill Flagstones of the Tarporley Siltstone Formation showing several horizons where finer sediment, shales and fine sandstones, predominate. The face is capped by 2 m of red mudstone, siltstone and fine sandstone of the Mercia Mudstone Group. A scramble up to the overhanging cliff on the immediate west will give a close-up view of some of the splendid sedimentary structures in the flagstones, especially wave and current ripple marks, but care needs to be taken in any such ventures in order not to disturb any strata which are overhanging. Hard hats may protect visitors from the fall of any loose debris ... be warned and be safety conscious.

There are several brittle fractures crossing the quarry face (**Fig.8**): a small normal extensional fault appears on the left (west), aligned WNW-ESE and dipping and throwing down to the NNE, and there are several curved joints, all of which are natural post-depositional features which would control the working of the rock face by the quarrymen. In the Grinshill Sandstones, the quarry face shows 5 rectangular holes which suggest that a temporary building was once attached to this wall.

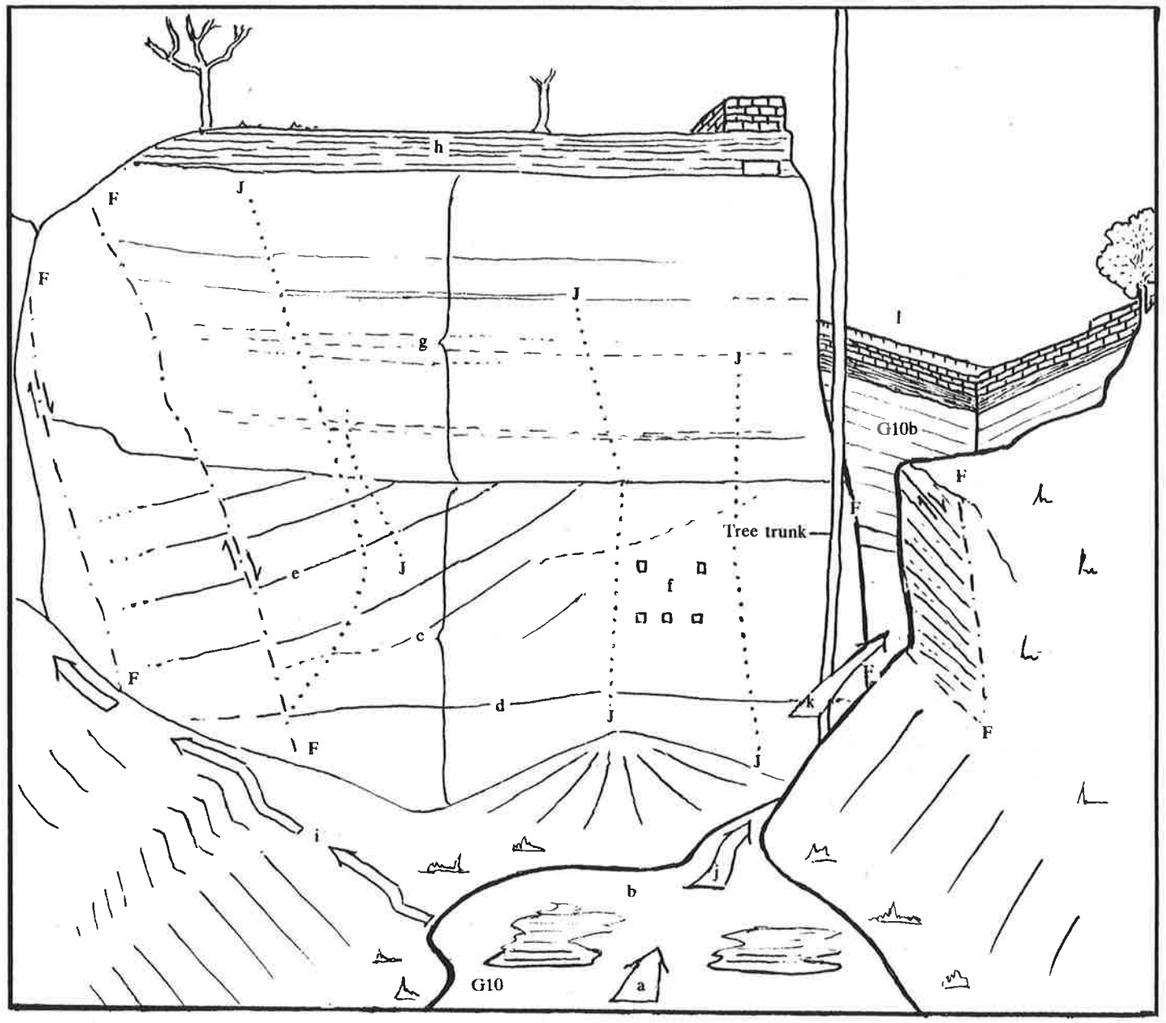


Figure 8 A diagram drawn in the field to show the main features exposed on the north side of the Bridge Quarry G10 .

a. The pathway approach from waymarker 4, all within Quarry G10.
b. The vantage point from which to view the main quarry face to the north.
c. The Grinshill Sandstone (= ?the Helsby Sandstone Formation) with the top 7 metres thickness showing. It displays: a sub-horizontal erosion plane marked (d); cross-bedded foresets (the sloping front of a former sand dune at least 4 metres high advancing from the east) marked (e); square holes to accomodate the former beam ends of a temporary quarry building marked (f).
g. The Grinshill Flagstones (of the Tarporley Siltstone Formation) 8-9 metres thick showing several cycles of fine sediment. The original discoveries of fossil footprints and bones of Rhynchosaurus came from a comparable horizon to this rock unit within these Bridge Quarries G9-11. Both this unit and the sandstone one below display two kinds of brittle fracture: one along which no movement has taken place (the joints marked J) and another kind along which displacement has occurred (the faults marked F). To the west a fault is aligned 296 degrees and dips 68 degrees. The half arrows show the sense of extentsional movement.
h. The Bollin Mudstone Formation, with only its lowest 2 metres uneroded, is surmounted by the remains of a pedestal upon which a steam crane is likely to have been positioned at one time.
i. The rough path and scramble up a quarry waste pile to where the overhang in the Grinshill Flagstones reveals slabs which are wave and current ripple marked. The exercising of extreme caution and the wearing of hard hats is recommended hereabouts.
j. The path to the viewport which reveals quarry G10b. As you walk to the viewport, locate on your right-hand side a fault plane aligned 037 degrees and dipping 85 degrees to the southeast; it bears signs of the oblique rub marks (slickensides) which accompanied its former violent movement(s). These dislocations would have been accompanied by considerable earthquake shocks at some time after 50 million years ago. Note how the limit of working of quarries G10 and G10b was controlled by this fracture.
k. The breathtaking view of Quarry 10b. This large rectangular quarry was obviously worked independently, starting at an unknown time before 1835 (see Fig. 3). The stone was worked and taken from beneath the quarrymen's feet by the processes of channeling and guttering, thus deepening the quarry through the 1800s and the early 1900s. A comparison of the maps (Figs 1, 3 and 4) shows that the quarry was also substantially widened. The limiting depth of the quarry was due either to the weight and tensile capability of the steel ropes of the steam cranes as they hauled heavy loads out of the depths, or to a fall off in the quality of the building stone with increasing depth. The astonishing extent and depth of this quarry may also be seen from the upper quarry road (marked l), but great care must be taken especially where children are involved.

Moving a few metres towards the viewport on the northeast, it will be seen that the northeastern face of the quarry in which you are standing is controlled by a fault plane trending NE, bearing oblique slickensides and dipping at a high angle, 85 degrees, to the SE.

The view northeastwards from the viewport into quarry G10b is breathtaking. It reveals a huge square quarry some 30 m wide and perhaps 50 m deep which was already partly worked by the time of the construction of the Estate Map of 1835 and was owned by Sir Andrew Corbet (see **Fig.6** which is drawn across the quarry). Between 1870 and 1923, it was managed by George and later John Hancock (**Fig.9**) for Sir Walter Corbet.

Of all the quarries (**Fig.10**), this best allows one to imagine the working practices which pertained from the middle ages to the beginning of this century (49). When "ridding" took place i.e. starting work on a new quarry or a new heading, a square area of more of less horizontal natural outcrop was cleared and the size of the potential blocks marked out. At first such a heading would be near the scarp face, as in the remnant areas still seen on the crags beneath the summit of Clive Hill itself, and would be only 10 m or so wide. As confidence in using mechanical aids increased, this width grew to be 30 m. Scratch marks would next be made on the more or less flat surface, marks which would relate to the sizes of the major blocks needed for any particular building (see **Figs.10e,f**). Skilled men like William Quarriator of Grinshill, in the 13th century the first named quarryman of the area, would cut channels 20 cm or more wide around all the blocks and to the depth needed by the masons. The commonest tool was the double headed jad pick (**Fig.10f**). Once cut, these blocks were wedged off their bed and hauled away. The quarrymen then marked out a fresh set of templates on the now lowered surface. By repeating the process 20 times or so, a 20-30 m deep square quarry was developed - of the kind which you see in front of you. To haul stone from the depths of such large quarries, crude cranes made of oak beams were slung across their right-angled corners (triangular niches mark the places where such beam ends were lodged) and pulley systems and winches were developed. It was only in the late 19th century that steam cranes with steel jibs were used (**Figs.10a,b,c,d**). The positions of the major cranes which were in position in 1880 are shown in **Fig.4.**

The effect of the channelling or guttering process was to leave a series of concentric pick marks on the face of the wall of the quarry; the effect of any 180 degree reversal of the direction of working by the skilled quarrymen in a deep gutter was to produce the reversal of the direction of the concentric pick marks so that all the quarry walls end up with the herringbone pattern which we see on the walls of so many abandoned quarries (see **Fig.10g**).

By 1890 some mechanisation had taken place and steam-driven channelling and dressing machines and steam cranes were in use (50), but the first two were never successful.

4.9 The possible finding of the first fossil in the Grinshill Quarries, c.1800

The first mention of the finding of a possible fossil at Grinshill, relating to c.1800, is quite intriguing: "Little more than 20 years ago a toad was found alive in a solid block of stone, hewn out of the quarry at Grinshill. The creature survived its liberation only a few moments - It has been carefully preserved in spirits by Sir Andrew Corbet, Bart., and is now in possession of his son.....of Acton Reynald Hall, the proprietor of the quarry" (Gregory 1824 The Shropshire Gazetteer) (51).

It is just possible that this is a reference to the earliest finding of a small fossil skeleton of a reptile of the kind recovered 15 years later in the quarries (see section 4.11). There is more of a chance, however, that this object may have been a real toad squeezed into an enlarged joint, for around this time there were many stories of toads being found alive in stone. In 1825 William Buckland, Reader in Mineralogy and Geology at Christchurch College, Oxford, began a series of careful experiments relating to such claims. Twelve circular cells were prepared in blocks of sandstone and limestone, to each of which a plate of glass was fitted. Toads were then placed in the cells and buried beneath three feet of earth and left for one year. Every toad encased in sandstone died, but the greater number of those encased in porous limestone survived, though greatly emaciated. At the end of a second year's incarceration in limestone, every toad had died (51). Was the Grinshill Sandstone sufficiently porous for the toad to survive?

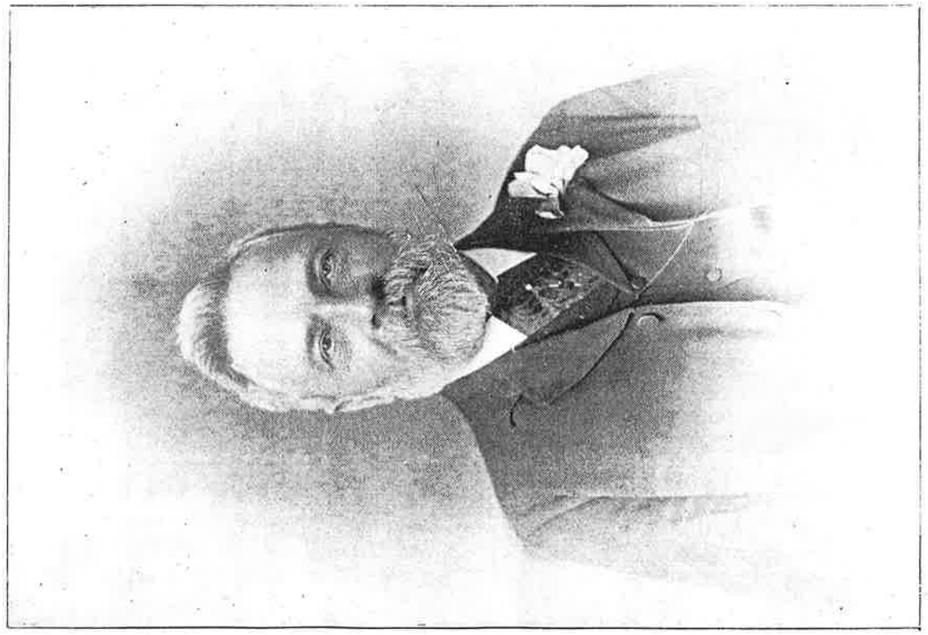
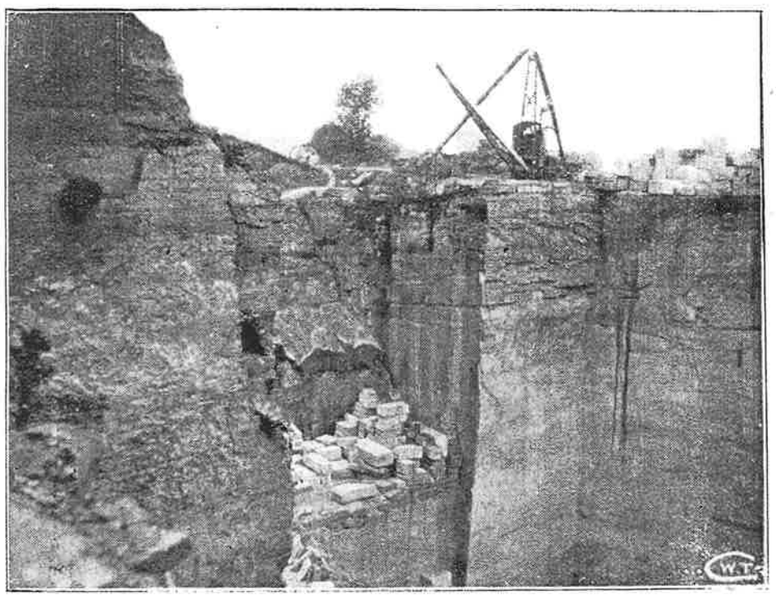


Figure 9 Photographs of George Hancock and his son John Lewington Hancock, joint managers of the Bridge and Cureton Quarries Ltd (from Anon 1898).



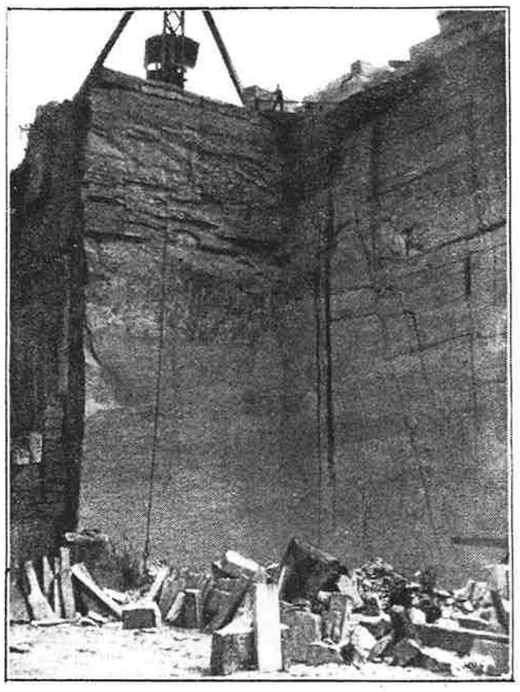
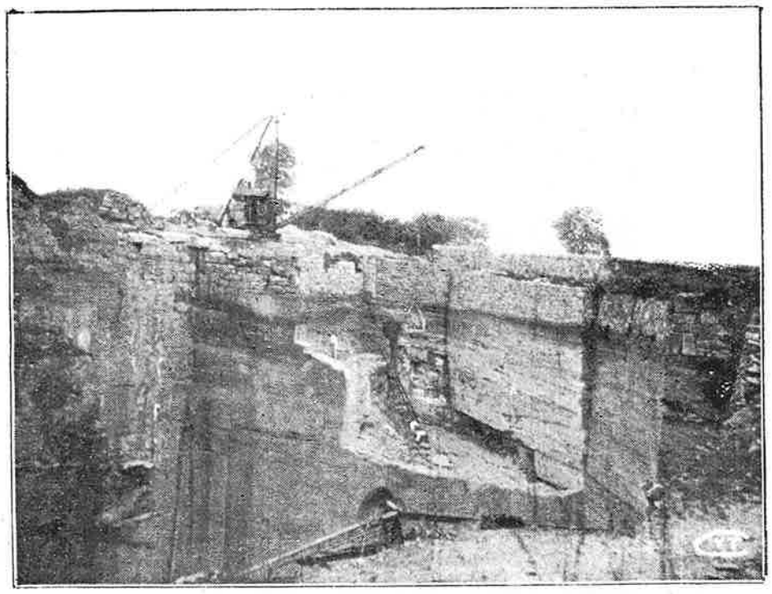
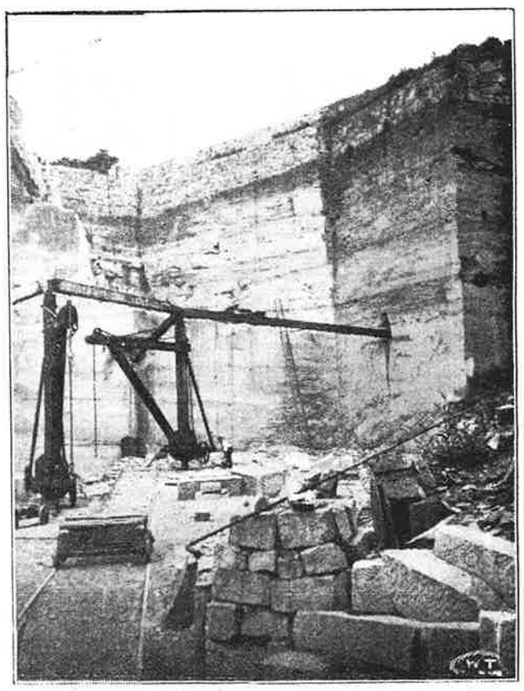


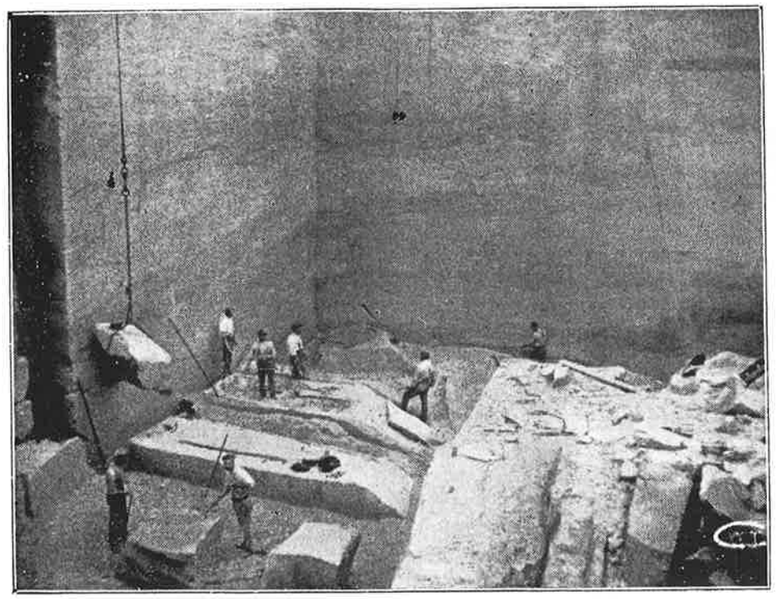
Figure 10 Photographs of the Bridge and Cureton Company's quarries showing their working practices in the late 19th century (from Anon 1898).

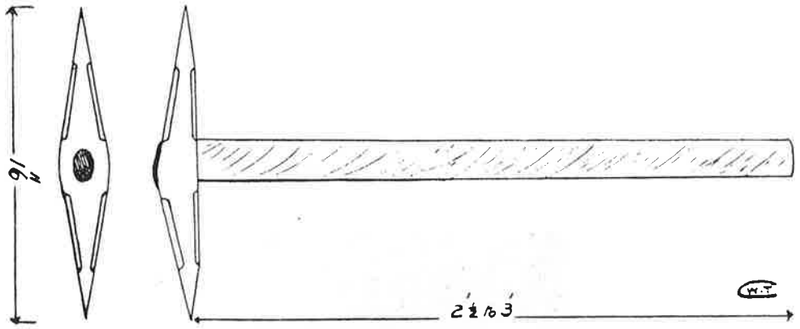
10a,b No. 1 Quarry Face, probably that of the north side of the Bridge Quarries, possibly in the area of quarry G9. The first photograph is taken looking northeastwards and the second one looking northwestwards, since the dip of the strata is gently northwards towards the centre of the Cheshire Basin.

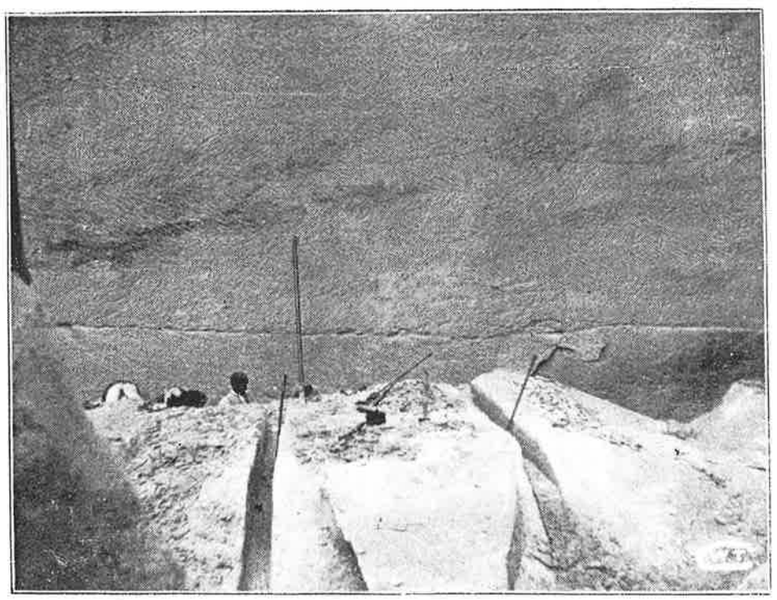




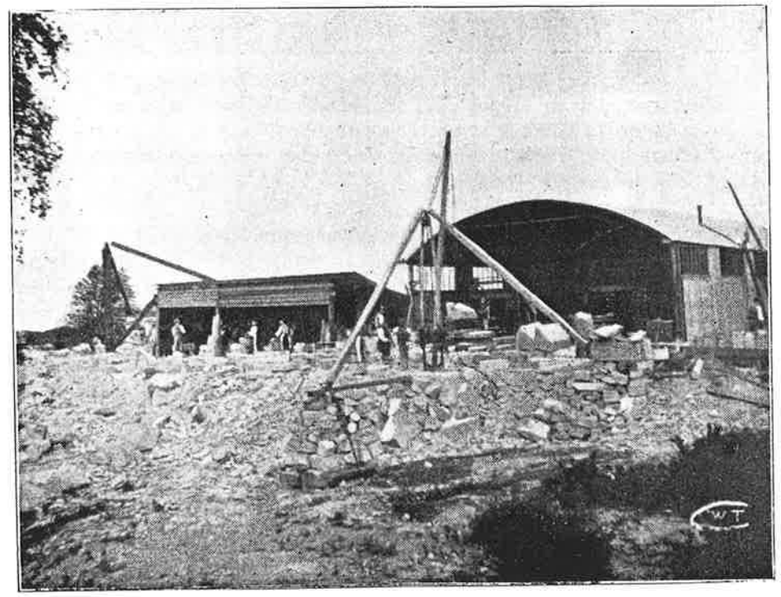
10c,d No. 2 Quarry Face, possibly that of the north side of the Curetons' Quarry, G5, or the Mount Pleasant Quarry G6 (if John Kilvert had sold out to the Hancocks by 1898), or another part of the Bridge Quarries: G9, G10 or G11. The first photograph is taken looking northeastwards, the second looking northwestwards.

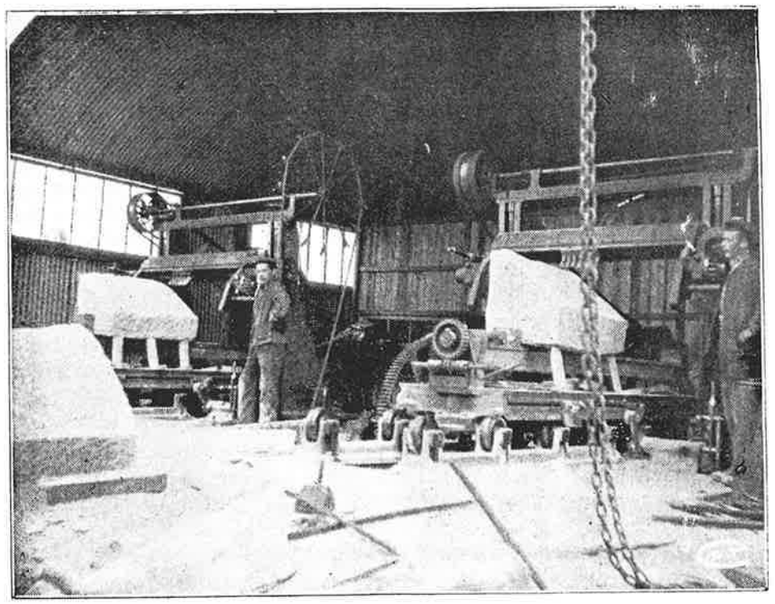






10e,f,g Methods of working the quarries. Photograph 10e shows the process of channeling or guttering using the jad pick seen in photo 10f. The pick is wielded in making the channels between the blocks and at the side of the quarry by the base of its walls. The main and cross channels are 20-30 cm (c.9-12 inches) wide and 1 metre (3-4 feet) deep. The herringbone pattern of pick marks seen on the quarry walls is the result of the quarrymen alternating the facing direction of their working by 180 degrees. The pattern is seen in the close-up photograph 10g. The double-headed jad pick was made by the Hardy Patent Pick Co.





10h,i A general view of the dressing sheds and the interior of the machine shed of the Bridge and Cureton Co. shortly before 1898.

Only the Esk Bed (c. 50cm thick) at the junction of the Grinshill Sandstones and Flagstones appears to be porous enough to allow this to happen. Was the finding of a small fossil reptile confused with the discovery of a modern toad? There is just a chance that the find was the head and body of a small *Rhynchosaurus*, the fossil lizard whose presence was detected at the commencement of Queen Victoria's reign – as recounted in the next two sections.

4.10 The discovery of fossil footprints, ripplemarks and rainprints in 1838

It was from these quarries, probably G10, which was leased by John Carline III from Sir Andrew Corbet, that the first recorded footprints (much later named *Rhynchosauroides*) of a lizard-like creature (later named *Rhynchosaurus*) were found in the Tarporley Siltstones in 1838. It is hard, at this distance from the events, to imagine the cultural context in which such finds were made and to realise the excitement, fear and religious intolerance with which the interpretations of the former existence of these fossils were received.

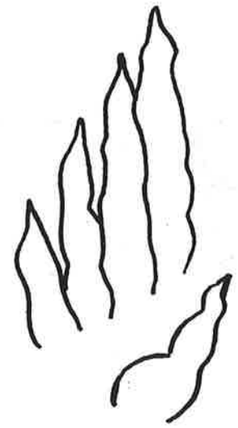
Strange markings like these had been first found in 1824 in Triassic rocks near Tarporley and in Permian rocks in Dumfreesshire. The latter were sent to Reverend William Buckland at Oxford in 1827*. At first greatly baffled, he then had the bright idea that they might be footprints, so he made a pet crocodile walk over a soft piecrust prepared by his wife. He took casts of the marks and decided that crocodiles could not have been responsible. Early in 1828, however, he tried again with tortoises and in public in both Oxford and London. This time fellow "philosophers" were more than satisfied with the tests and henceforth many persons were convinced that prehistoric animals, like tortoises, had made the marks (52). Comparable prints of several kinds were found in Triassic rocks at Storeton in the Wirral in June 1838 (**Fig.11**) and on November 1st 1838, Dr Thomas Ogier Ward, a doctor of medicine in Shrewsbury, presented "4 slabs of freestone from Grinsel (sic) containing impressions of the foot of some animal & impressions of drops of rain" to the Museum of the then-recently-formed Shropshire and North Wales Natural History Society (1835) (S & NWNHS) (52). He was soon to become the curator of geology and conchology in the Museum (1839-1842). Dr Ward sent these or other similar prints to his old mentor and tutor at Oxford, the eccentric Dr Buckland. These slabs are still preserved in Oxford University Museum. The word of the finds rapidly spread. On the 4th December 1838 Roderick Impey Murchison, soon to publish "The Silurian System" (1839), wrote to ask if Dr Ward "could ... be empowered to lend the Geological Society of London slabs of Grinshill Sandstone with impression of feet of extinct animals" (54). Murchison was sufficiently excited to mention the finds, before he had seen them, in an addendum to his eagerly awaited and widely admired book (55). The slabs were thereafter displayed and interpreted by Buckland at the Ashmolean Society, a general "philosophical" society, in Oxford on 11th March 1839 (56) and at the Geological Society in London on February 21st 1840 (57). Ward, meanwhile, in June 1839, amidst fears of Chartist riots had travelled to the Birmingham Meeting of the British Association for the Advancement of Science, then a relatively new forum (founded in 1831) but soon to become accepted as the "parliament of science", and had presented a very lively interpretation of "the Footprints and Ripple-marks of the New Red Sandstone of Grinshill Hill, Shropshire" (58).

Dr Ward made it clear that the specimens with the sedimentary structures came from the Grinshill Flagstones and he compared them, by present-day analogy, with ripple marks caused by waves and marks due to streams. He interpreted small round depressions in terms of raindrops which had struck forcibly against the side of the dried-out ripples. Thereafter, he argued, animals had walked over the area, so making the three-toed footprints, which differed in size and shape from those of the *Chirotherium* (i.e. the larger "hand beast") which had been found at Storeton and was later to be discovered at Grinshill (see below and **Fig.13**). The identity of the Grinshill animal was not suggested and only later, after bones were found and interpreted in 1842, did a likely organism become apparent. Specimens were despatched to Oxford, Warwick and other museums and Ward briefly mentioned the prints in his book on the Medical Topography of Shropshire of 1841 (59). Further specimens of the footprints (*Rhynchosauroides*) of this reptile were later found in Kilvert's Mount Pleasant Quarry (later named the Grinshill Quarries in 1923), as they are down to the present day (59) (**Fig.12**).

Less well known and very infrequently, footprints of the larger reptile *Chirotherium* were found (**Fig.13**), though from which quarries in the area is uncertain. A Mr W. Phillips, presumably the historian, donated a specimen to the Shrewsbury Museum in 1896 and it is still on display there (60).

TYPE D 1 Scale x1.
Right foot (pes). Location: Storeton (c.120 ft above the base of the Lower Keuper Sandstone, now the Helsby Sandstone Formation) and ?Grinshill (in the Grinshill Flagstones, now the Tarporley Siltstone Formation). Name: Rhynchosauroides articeps. Producer:?Rhynchosaurus articeps Owen according to Beasley 1905 p. 276.

TYPE D2 Scale x1.
Right pes. Location: Storeton and Runcorn (c.120ft above the base of the LKS). Name: Rhynchosauroides rectipes. Producer: ?R. articeps Owen according to Beasley 1905 p. 277.



TYPE D3 Scale x1.
Left pes. Location: South Staffs (from a horizon high in the LKS). Un-named. Producer: ?Rhynchosaurus according to Woodward in Beasley 1905 p. 277.

TYPE D4 Scale x1.
Left pes. Location:Shrewley, Warwickshire (in the Arden Sandstone). Name: Rhynchosauroides sp. Producer: a rhynchosauroid according to Beasley 1905 p. 278 and Kuhn 1963.

TYPE D5 Scale x1.
Possible forefoot (manus). No location or horizon cited. Name: Rhynchosauroides sp. Producer: a rhynchosauroid according to Beasley 1905 p.279 and Haubold 1969.

TYPE D6 Scale x0.5.
Manus (top) and pes (below). Location: Shrewley. Warwickshire (in the Arden Sandstone). Name: Rhynchosauroides sp. Producer: a rhynchosauroid according to Beasley 1907 p. 300 and Haubold 1969.

TYPE D7 Scale x0.5.
?Left pes or manus. Location: Storeton (c.120 ft above the base of the LKS). Name: Rhynchosauroides beasleyi. Producer: a rhynchosauroid according to Beasley 1908 p. 302.

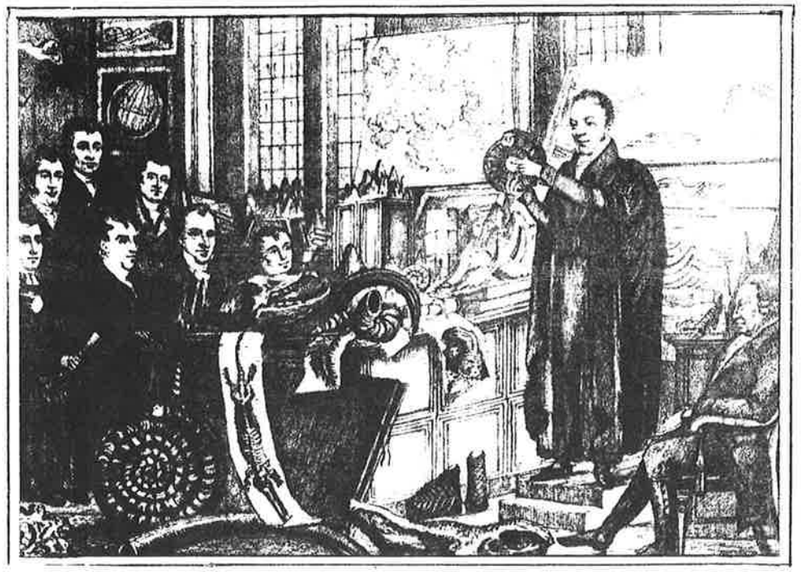
TYPE E Scale: two thirds.
Left pes. Location: Storeton and Runcorn (c.120 ft above the base of the LKS). Un-named. Producer: A rhynchosaurus (R. minimus) according to Morton in Beasley 1905 p. 279.

TYPE I Scale x1.
?Left pes. Location: Storeton and Runcorn in the LKS and Hilton Beck (Cumbria) in the St Bees Sandstone. Un-named. Producer: a rhynchosaurus (R. tumidus) according to Morton in Beasley 1905 p. 281.

TYPE O Scale x1
A pes. Location: Hollington, Staffordshire (in the LKS). Un-named. Producer: possibly a rhynchosauroid according to Beasley 1907 p. 302.

Figures 11-13 Typical Triassic fossil footprints comparable with some of those from the bedding planes of the Grinshill Flagstones of the Tarporley Siltstone Formation:

Figure 11 *Rhynchosauroides* of several types found in Storeton Quarry, Wirral and other places, and described largely by Henry Beasley of Liverpool between 1890 and 1914. Types D_1 and D_2 were attributed to the Grinshill Flagstones, but on very shaky grounds.



Dr William Buckland (1784-1856), the brilliant but eccentric Reader in Mineralogy (1813) and Reader in Geology (1818) at Christchurch College, Oxford University, lecturing in the Ashmolean Museum to senior members of the University in 1823. Soon after 1838 he received a flagstone specimen bearing footprints sent by a former pupil, Dr Thomas Ogier Ward, a medical doctor recently moved to Shrewsbury. Buckland identified the prints as the same as those which had been seen by him in the Liverpool area in 1838 (letter Buckland to Ward 5-6th April 1841; not preserved). On 18th October 1841 Buckland was in Shrewsbury viewing the head of the recently named Rhynchosaurus articeps Owen in the museum of the Shropshire and North Wales Natural History Society (founded 1835) where Ward was one of the curators.

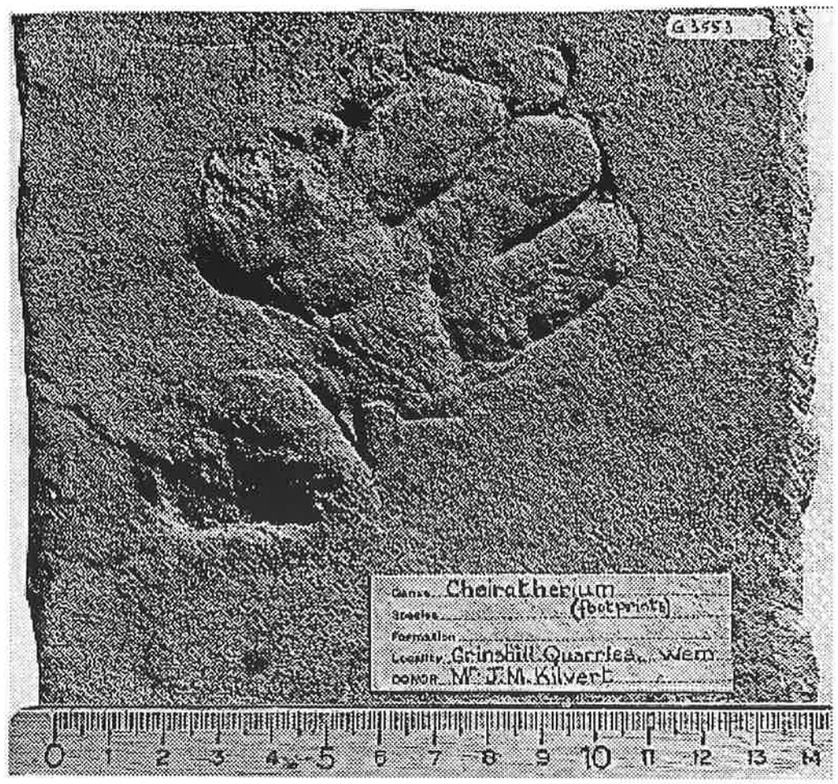
a. Two variants of a clawed four-digit print with double or single heel, or an opposing, backward-pointing digit. The prints may make a track 6 or possibly 7 prints long.

b. A three-digit print and pad from a block with 10 or 11 such prints, 3 with claws twisted sideways, none making a trackway.

All drawings are from specimens found in the Grinshill Flagstones (Tarporley Siltstone Formation; Anisian, middle Triassic) of quarry G7, Grinshill.

c. A slightly curved arc composed of four claw marks, made when the digits and heel were raised and therefore not making a trace.

Figure 12 The smaller kinds of footprints of rhynchosauroid type from Quarry G7, part of the present working quarry, as drawn by Dr John Stanley of Keele University (from Delair and Sarjeant 1985);



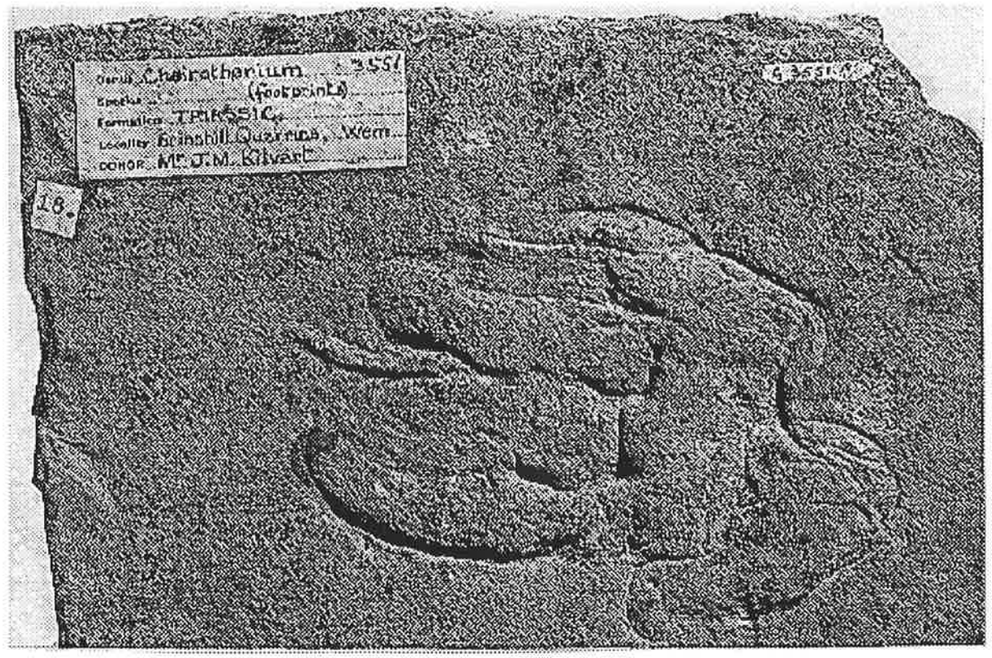


Figure 13 Two separate specimens of *Chirotherium* footprints from the Grinshill Flagstones at Grinshill donated by John M. Kilvert to the Ludlow Museum prior to 1898. Photographs by courtesy of John Norton, for many years the distinguished curator of Ludlow Museum, now retired, Dr Jane Mee and the Shropshire County Museum Service.

Two further examples, collected by J.M. Kilvert (see **Fig.13**), are lodged in Ludlow Museum (61). We know that they were collected from Grinshill Quarries, Wem, prior to 1898 because copies of the prints were sent to Henry C. Beasley of Liverpool, doyen investigator of trace fossil footprints, in that year (62). It is possible that they came from Kilvert's own quarries (G6, G7), but he may have discovered them anywhere in the area. It is very probable that they came from the Tarporley Siltstone Formation. These prints are now regarded as the traces of early carnivors which were the precursors of the dinosaurs (the "terrible lizards" named by Owen in 1842) which evidently roamed the stream courses crossing the sand and mud flats marginal to the salty lagoons which then filled the Cheshire Basin (63) (**see Fig.7**).

As the word of the finds of the earliest footprints in 1838 was spread far and wide, people began to marvel at the evidence of "the first rain showers the world had ever known", and the stories of "the inhabitants of former worlds" which had walked the area "at.....a time incalculably remote" (64). The concept geological time, measured in millions of years, was just beginning to be glimpsed if not understood. Many feared that the evidence from Grinshill and elsewhere would undermine the account of Creation given in Genesis which was passed on literally and weekly to the general public by most clerics of the Established Church. Either way, the rocks and quarries at Clive and Grinshill were beginning to develop a reputation for matters other than their building stones.....but much more was to come.

4.11 The discovery of the bones of fossil reptiles, "inhabitants of former worlds" in 1840

The first fossil bones, even parts of whole skeletons, were found in the Tarporley Siltstone Formation, and possibly in the Grinshill Sandstone Member, in 1840, though the date is not exactly certain. In 1875, in old age at Eastbourne, Dr Thomas Ogier Ward claimed that he personally found the *Rhynchosaurus* at Grinshill in 1838-9 (65), but he probably did not distinguish between footprints and bones as we do today. It is safer, therefore, to rely on the evidence from two sources: the letters which he wrote to Richard Owen (of the Royal College of Surgeons in London, the foremost comparative anatomist in Europe) (66), and the acquisitions register of the museum of the S & NWNHS. The first letter to mention the finding of bones is dated 6th August and by analysis of the context was probably written in 1840; the first donation, of 7 bones, to the museum was on April 24th 1841. The bones were presented jointly "by Dr Ward and Mr John Carline of Shrewsbury" (67). This associates the fossils with quarry G10 (see **Fig.1**) which was leased by John Carline III (1792-1862), architect, of Shrewsbury, and Richard Dobson, a contractor from the same town, from Sir Andrew Corbet. Further specimens were presented separately, on one occasion by John Carline in 1841 and twice by Dr Ward in 1841-2 (including a head) (68). A further head was purchased "from Grinshill Quarry" in February 1842, after which there was a long interval before Mr Richard Marston of Clive presented a skeleton in 1859 (69). This last mentioned specimen may be the one whose existence was described so vividly by the Rev. W. S. Symonds, President of the Malvern National History Field Club, who was visiting the Grinshill area in 1857 (69b). How well the passage captures the sustained excitement of the fossil hunts of mid-victorian times!

> "Apropos of fossils in these strata, I shall not forget a hunt at Grinshill last autumn (i.e. 1856 DBT). I was examining those magnificent quarries and the surrounding geology under the guidance of the well known naturalist T. C. Eyton, Esq. of Eyton Hall, when we heard from some quarrymen of certain curious remains of "something like a fossil bird", in the possession of Mrs ---- at a distant village. Away we went, up the hill and down dale, first to one cottage, then another, and I doubt very much whether the keenest fox-hunter could be more excited than we geologists after the fossil bird, which we ran into at the village of Clive. The fossil was a most valuable specimen of the *Rhynchosaurus* (a lizard with a beak). The animal was lying on its back in the slab of stone, the parrot-like beak, and a considerable portion of the skeleton, being in an excellent state of preservation; indeed it was far superior to the specimen in the Shrewsbury Museum. Mr Eyton offered a considerable sum for the *Rhynchosaurus*, which as a valuable local fossil should be in his excellent museum, but the owner declined parting with it, as her husband had found and valued the specimen, and she was a widow! We could not but respect the feelings which gave such value to the stone, and only trust that care will be taken that this valuable relic of the Waterstones, may not be tossed aside when time shall have summoned its present possessor to join him whose memory she now holds so dear."

It is well to note that this specimen is specifically said to have been found in the Waterstones (now the Tarporley Siltstone Formation), the only one of the early specimens to be attributed clearly to a geological rock formation. Since 1859 other specimens of *Rhynchosaurus* have been found (but in the Mount Pleasant Quarry as related earlier) so that in 1994 there are now about 18 known hand specimens; the minimum number of individuals, based on the number of skulls, being eight (70).

It is worthwhile, however, returning to Dr Ward's letters to Richard Owen in 1840-1, for they contain many details which are of interest. Dr Ward's first letter in 1840 (71) reveals that some of the first set of bones came from a different quarry from the Bridge Quarry which was leased by John Carline III. The possible locations of such a second quarry could be Andrew Downes' first quarry (G8) or his second one (now in the area designated G9 on **Fig.1**), or Cureton's Quarry (G5). Alternatively the quarries in Clive Parish C1-6, C13 and C14 are possibilities. Ward also reveals in the same letter that "he had offended the quarryman, so now he will not part with any of them, or I should have been enabled to send almost an entire skeleton except the head". He reminds Owen that, as a result, the specimens are only on loan to the two of them. Indeed, he had to write again begging their return (72). In doing so he revealed that he had procured some bones for Dr Buckland of the Oxford Museum and that the specimens were exciting interest in the Midland Counties especially in Warwickshire, where related bones, jaws and teeth had been found by Dr Lloyd of Leamington.

There then followed a year, 1841-2, in which the specialist vertebrate palaeontologists tried to determine the proper affinities of the footprints and bones in rocks of similar age in England and on the continent. The nature of the debate is beautifully captured and summarised in Charles Lyell's popular textbook of 1841 (73), but was also reported in the local newspapers in Shropshire, the Salopian Journal for Wednesday 28th April (74) and the Shrewsbury Chronicle for Friday April 30th 1841 (75).

At first Owen had given the bones and the large chirotheroid footprints the name *Labyrinthodon* (Owen 1841), from the peculiarly convoluted arrangement of the enamel lamellae of the teeth of some of the Warwickshire specimens. He had also used the name *Anisopous scutulatus*, the first word being derived from the unequal size of the feet and the second from the animals being covered, like the recent crocodile, with long plates or scales. The *Labyrinthodon*, an air-breathing reptile, was believed to be "an animal partaking of the characteristics of the frog and lizard or crocodile tribes ....one of the earliest, if not the first, of created beings possessed of four extremities", perhaps closer to the "frog tribe than to the family of lizards", its extremities almost equalling the "lightness of a bird" (75). At first Owen drew his reconstruction of the *Labyrinthodon* so as to have it walk cross-footed...but much later it was realised the fifth digit was largest, not the first, and the reconstruction of the chirothere had to be amended by a German palaeontologist (see **Fig.18**).

Eventually, however, by the British Association meeting at Plymouth in August 1841, Owen had cleared up much of the confusion and certain of the bones were designated as the type specimen of *Rhynchosaurus articeps* Owen 1842 (76), a separate and new species and nothing to do with the larger *Chirotherium* or the *Labyrinthodon*. *Rhynchosaurus* was described as a lacertian reptile, i.e. a lizard having no teeth but bearing a parrot-like beak capable of piercing its prey. These animals were said by Owen (probably erroneously we now know) to be capable of making the smaller kind of footprints found by Ward at Grinshill in 1838. Around Liverpool, where these small prints were commonly found, they were closely studied by Henry Beasley (77) and by the turn of the century they were described as prints of type D (**see Fig.11**). It was only in 1914 that they were given the name *Rhynchosauroides* by Maidwell (78). Owen (1842) finally described the nature and place of origin (i.e. provenance) of the bones which constituted his *Rhynchosaurus* as follows: "They occur at Grinsill (sic) quarries, in a fine grained sandstone, and also in a coarse burr-stone: in the latter are imbedded some vertebrae, portions of the lower jaw, a nearly entire skull, fragments of the pelvis and of two femora; in the fine-grained sandstone, vertebrae, ribs, and some bones of scapular and pelvic arches". Strangely, no teeth were apparent but later they were recognised in the specimens (Huxley 1887, p.690). The beak was then thought to be a means of piercing its prey (Owen 1863). The remnants of some of the original specimens which Owen described are to be found in Shrewsbury Museum (79), where you may ask to see them. Owen eventually included a general description of the Grinshill specimens of *Rhynchosaurus* in his general textbook on palaeontology in 1860 (80).

Further descriptions of *Rhynchosaurus* bones from Grinshill and elsewhere have been given over the years by Huxley, Woodward (who included the first reconstruction of the whole skeleton: see **Fig.14**), Watson, Huene, Hughes, Walker and particularly Benton (81) (**Figs.15,16,17**).

Rather amazingly, the original specimens of *Rhynchosaurus articeps* (17 in number and from at least 7 individuals according to the number of skulls) were never fully described by Richard Owen. This task has been accomplished very recently, and quite brilliantly, by Dr Mike Benton (of, successively, Newcastle, Queen's Belfast and Bristol Universities) (Benton 1990). It is rather odd to think that the people of the county and the two parishes have waited 150 years to have their most famous fossils in Shrewsbury Museum properly identified and interpreted!

The rhynchosaurs are now regarded as a once successful group of early lizard-like reptiles which 'ruled' part of the Triassic world from 245 to 213 million years ago. At the beginning of this period 248 mya, the dominant plant-eating animals were the mammal-like reptiles but they declined rapidly as the *Glossopteris Flora* (named after a seed-fern) disappeared. The rhynchosaurs took over the land areas which now constitute Tanzania, Brazil, Argentina, North America, Britain and Germany. At that time all the continents were closed together and formed one landmass called Pangea (**Fig.7**).

The rhynchosaurs possessed teeth which continued to grow throughout life and were arranged to give a precision bite. The jaw action was pivoted and resembled the folding of two powerful penknives. Older ideas, that they used their beaks and dug for mollusc shells have faded, and it is now agreed that they were plant eaters like the 30-40 cm, long, thick-set, barrel-shaped, stumpy-tailed lizard *Uromastix* which lives in North Africa today (**cf. Fig.17**). This herbivore efficiently crops leaves, flowers, shoots and fruit. It is now believed that the rhynchosaurs dug up tubers and roots with their beak-like premaxillae, manipulated their plant food with a large tongue and chopped it efficiently with their relatively large jaws. Their diet consisted of the leaves, stems, fruit and seeds of conifers, gingkos, horsetails, ferns and particularly the family of seed ferns known as *Dicroidium* which gives its name to the flora of the time. The barrel-shaped body was needed to accommodate the large gut for the slow digestion of plant material (see **Fig.17**), little of which is likely to be preserved in fossil form either at Grinshill or elsewhere due to subsequent oxidation in these desert-like environments.

In 1983 it was suggested by Benton that the rhynchosaurs became extinct at the end of the Triassic period (213 million years ago) because the seed ferns declined as the conifers competed effectively and spread worldwide. Thereafter the dinosaurs were the best-equipped reptiles to cope with these new environmental conditions and food supplies, and it is suggested that they radiated into the ecological niches which had been vacated by the declining rhynchosaurs.

Despite the interest which comes with such a wider, modern conspectus, it can truthfully be claimed that there has been no period so exciting as the late 1830s and early 1840s when Grinshill helped to provide the evidence upon which momentous shifts in man's thinking about the evolution of life were beginning to take place.

Charles Darwin is not recorded as visiting the Bridge or Cureton's quarries but there is circumstantial evidence that it is likely that he did so. He wrote in his autobiography that in 1842 (82), during his stay at Maer and Shrewsbury (83), 5 years after the commencement of his notebooks on transmutation, he wrote a pencil sketch of his species theory i.e. the basis of his famous book "Origin of Species", which was published in 1859 (84). During the preceding period 1837-42, immediately after his return from his five-year voyage round the world as a naturalist on HMS Beagle, he had frequently travelled on horseback or in a carriage between his parents' home, The Mount, Shrewsbury (now the Land Valuation Office), his friends the Owens at Woodhouse, near Pradoe, northwest Shropshire, and his cousins the Wedgwoods at Maer Hall in North Staffordshire (85). Hence he knew the countryside well. He was also a member of the S & NWNHS from November 1836 onwards (86). In addition during this period, he was based in London and acted for 3 years (1838-1841) as secretary of the Geological Society, where he organised and administered the meetings to which the reptilian footprints and bones from Grinshill and other places were taken to be worked on, displayed and argued over by Buckland, Murchison and Owen in terms of the nature and origins of past life on our planet (87).

Figures 14-18 Reconstructions of the skeletons, appearance and mode of locomotion of the fossils, "the inhabitants of former worlds", found at Grinshill 1838-1900.

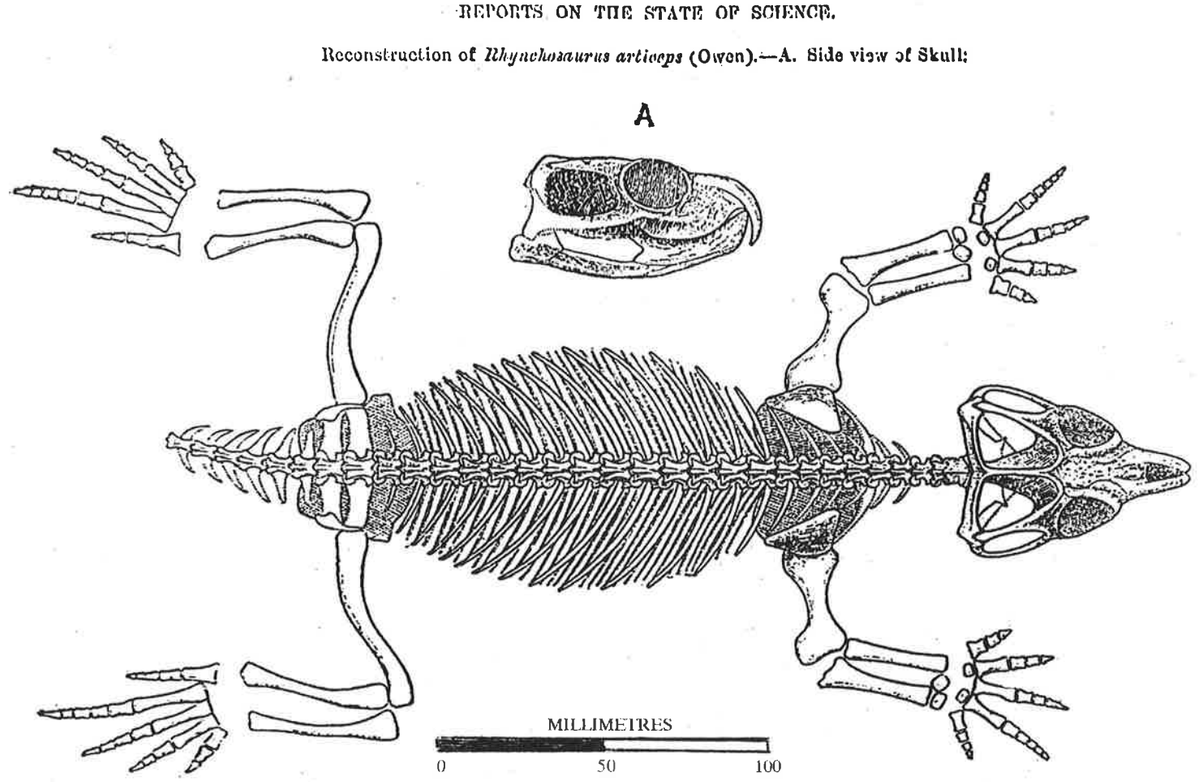


Figure 14 The earliest reconstruction of the skeleton of *Rhynchosaurus*, the herbivorous lizard-like reptile (after A. S. Woodward 1907, p. 294).

Charles Darwin in 1840 at the age of 31, lately returned from the famous voyage of HMS Beagle (1831-36) and newly married to his cousin Emma Wedgwood (1839). He was then hard at work as the unpaid full-time secretary of the Geological Society of London (1838-1841), during which time he was very conversant with the exciting discoveries and discussions which were taking place on the origins of the fossil footprints and reptile bones from the Liverpool-Grinshill-Warwickshire areas. They were being interpreted as components of a wondrous prehistoric world which greatly fired the imaginations of the general public.

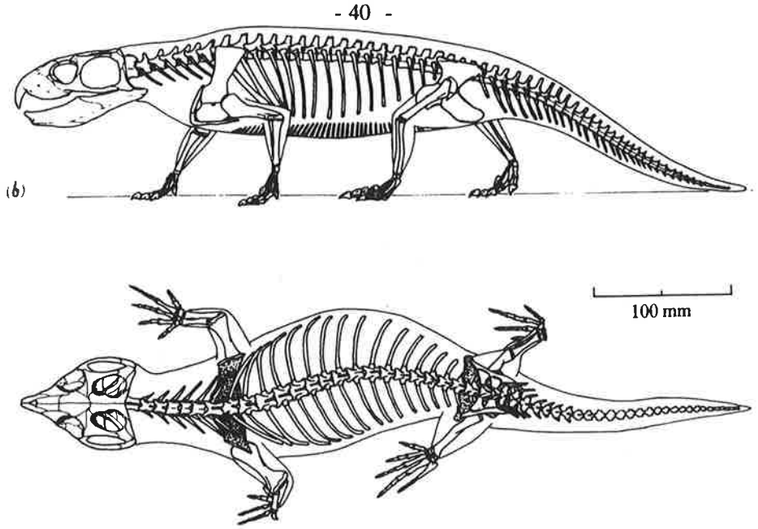


Figure 15 A modern reconstruction of the skeleton of *Rhynchosaurus articeps* (after Benton 1990, Fig.38).

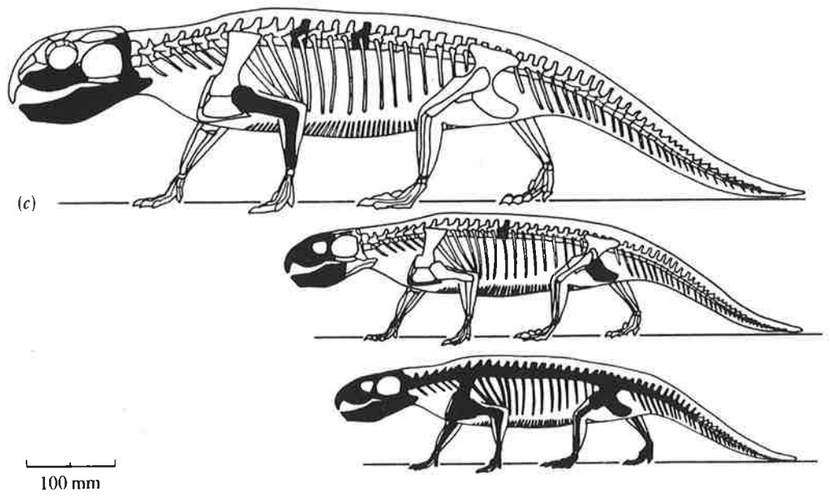


Figure 16 Modern comparative reconstructions of the skeletons of the three main British species of *Rhynchosaurus*: *R. articeps* (below), *R. brodei* from Warwickshire (middle) and *R. spenceri* from Dorset (top) (after Benton 1990, Fig.39 with the kind permission of the Librarian of the Royal Society of London). The fossil bones available to make the reconstructions are shown in black.

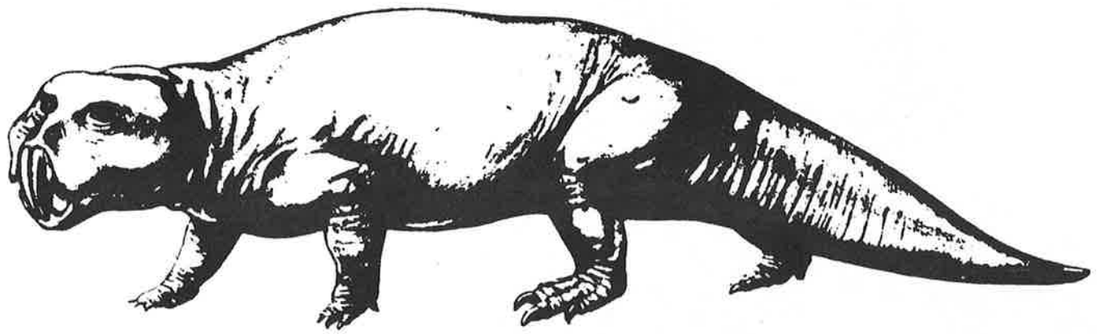
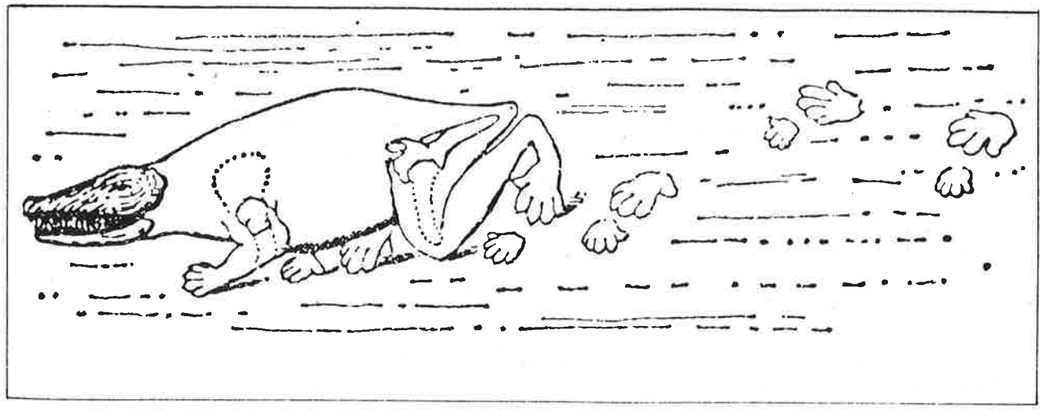
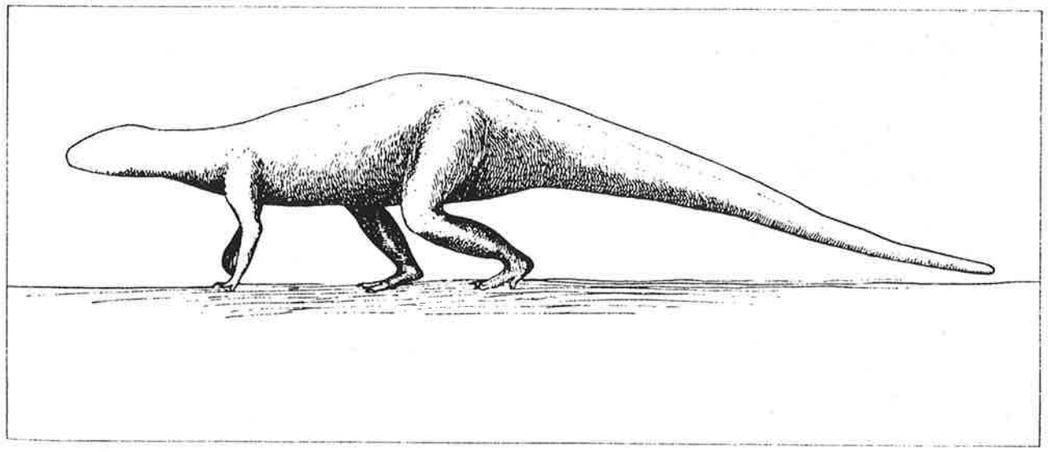


Figure 17 A full-bodied reconstruction of one of the larger species of *Rhynchosaurus* in order to show the barrel-shaped body enclosing a large alimentary system capable of digesting large quantities of coarse plant material of the *Dicroidium* flora (after Benton 1983; drawn by Jenny Halstead).

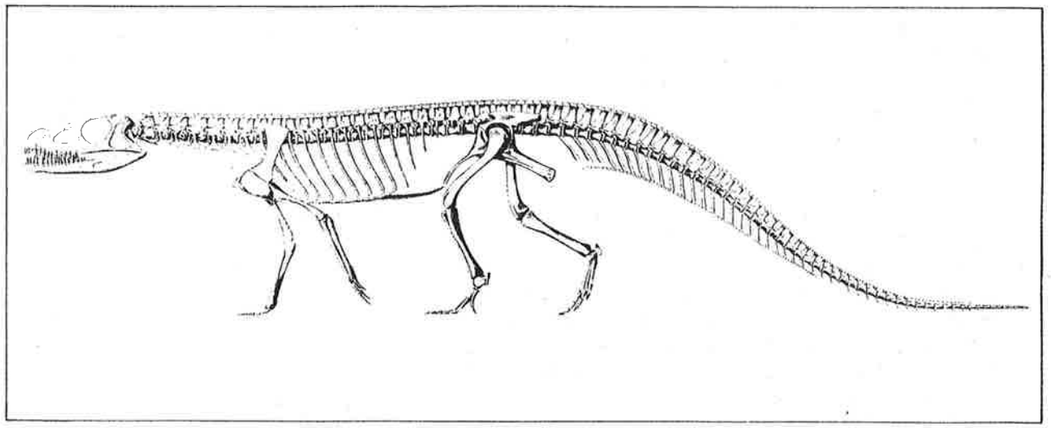
Figure 18 Reconstructions of the animal which may have made the *Chirotherium* footprints (after Tresise 1989):



(i)Owen's chirothere *Labyrinthodon* giving rise to cross-legged footprints so that the large digit (actually the outside "little toe") appears in the manner of our thumb on the inside of the track (after Lyell 1841). Notice the very few bones (dotted) upon which this false reconstruction is based: the bones are now known not to belong to the producer of the *Chirotherium* prints.



(ii) A hypothetical reconstruction of the animal which made the *Chirotherium* footprints based on the pseudosuchian (=false crocodile) reptile bones found in Triassic rocks in South Africa. The hypothetical animal is 3m long (after Soergel 1925).



(iii) The nearest fossil skeleton capable of making chirotheroid-like footprints: *Ticinosuchus ferox* an early carnivorous rauisuchian archosaur (prior to the dinosaurs proper) which was found in 1965 washed out to sea into marine limestone deposits of Triassic age at Monte San Giorgio in the Swiss Alps. The skeleton is 2.5 m long (after Krebs 1966).

In more ways than one, therefore, Darwin was conversant with the startling finds made in the quarries at Grinshill in his home county and he must have incorporated the implications of their study in his writings. Indeed he was present at the British Association meeting at Birmingham in 1839 when Dr Ward first informed the world of the presence of footprints at Grinshill.

It has been said that palaeontology was the radio astronomy of the 19th century - a science at the edge of knowledge, trying to interpret signals from the remote past; Grinshill and Storeton, further north in the Cheshire Basin, were but two of the galaxies in middle-distant space which were providing signals for metropolitan scientists and local amateurs to decipher.

It is salutary to realise that in 1840 the word "scientist" had been coined less than a decade before by William Whewell (in 1833) and that the embryo scientific profession was small and very ill-rewarded; even tyros like Richard Owen and his great rival Thomas Huxley could hardly make a decent living. Fortunately Charles Darwin did not need to, for he was more than adequately provided for by his father Robert Wareing Darwin (1766-1848) who was a very successful medical doctor still living at the Mount, the house he had built alongside the Welshpool Road, in Shrewsbury. Whilst we acknowledge that the scientists and the quarrymen at Grinshill were not the only persons who were poorly rewarded, let us remember that the latter were paid almost twice as much as the agricultural labourers who worked the fields around Clive and Grinshill. Indeed a quarryman at one season would become the agricultural labourer of the next, whenever a seasonal decline in orders for stone became established.

4.12 Locality 5: the western end of the Bridge Quarries

Retrace one's steps a little and walk westwards to **locality 5** at the western end of the Bridge Quarries. Locate the 3 m wide fracture zone of the **Bridge Quarries Fault** where it crosses the gulley in a WNW-ESE direction (see **Fig.5**) and walk up the well-tooled steps on the left of the gulley until you reach a flat platform upon which a former building must have stood, perhaps the wooden office of a busy quarry manager.

4.13 Changes of management of the Bridge Quarries and their amalgamation to form the Bridge and Cureton Company Ltd

As one leaves the Bridge Quarries, realise that the lessees and managers of the quarries changed frequently in the hey-day of quarrying in the mid-Victorian period. The following persons are recorded as lessees or managers at various times: John Carline III 1851; Richard Dobson of Shrewsbury 1861-1879; D. & W. Wylie 1861-70; T.C. Townsend 1870-1871; George Clarke (of Wootton Wawm, Warwickshire, but a lodger at the Elephant and Castle Inn at Grinshill) in 1881. By 1882-3 certain of the quarries must have changed hands again, for Sir Walter Corbet amalgamated several quarries as the Bridge, Cureton and Red Quarries (presumably a reference to quarries G9-11; G5; G8, G12 respectively). These quarries were managed in 1882-3 by Luke Mather and Samuel Trickett, the latter giving an address at the Victoria Wharf at Millwall on the Thames in London, a sure sign that the market place of the Grinshill Stone had become truly national after the coming of the stoneyard and the LNWR railway to Yorton Station in 1858. Indeed, the Grinshill Stone was advertised countrywide in trade journals and was on display at the building exhibition in Islington, London, in 1883 (88).

By 1890, at least, this progression had been taken a stage further, for Sir Walter leased the Bridge and Cureton Quarries to George Hancock of Shrewsbury (89) (**Fig.9**). He is known to have been a former managing director of the Bath Stone Firms Ltd, the major company which quarried and mined the Bath Stone, the famous Middle Jurassic (169-175 million years old) oolitic limestone and freestone of the Cotswolds. He was presumably enticed to north Shropshire by the long established reputation of the Grinshill White Sandstone, the lure of favourable conditions of lease, a large salary and the hope of considerable profits. George was soon joined, and eventually succeeded, by his son John Lewington Hancock, who later on resided locally at Fernleigh in Clive Village. The present Fernleigh may not, however, be the original one, for it was not constructed until 1928. The Hancocks' company traded from at least 1890 to 1923, whereupon it was sold to Charles Thursby & Co., just in time to benefit from the vast contract for the lowering, but doubling in width, of the English Bridge in Shrewsbury in 1925-1927 (47).

5. THE LOWER PARTS OF THE ESCARPMENT TO THE SOUTH

5.1 Grinshill Village Quarry

Regain the path and walk down the gulley for 300 m, formerly a possible exit route for the products of the Bridge Quarries, but one which would have been too steep for many of the heavier horse-drawn loads; hence, no doubt, the building of the gentler incline leading ESE from **locality 3**. Continue down the track and pass the large boulder of red sandstone which has at some time in the distant past rolled down the slope form the west so as partially to block the pathway. Pass the y-junction of the paths and bridle ways. Recognise that Grinshill village lies a short distance to the south. Detect that a former house, occupied by John Deakin and owned by Richard Gardner in 1838 (90), and well depicted on the both Estate Map of 1835 (**Fig.3**) and the OS map of 1880 (**Fig.4**), used to nestle against the old quarry wall on the right. Indeed this quarry (G14/C8 on **Fig.1**) was faintly marked on the map of 1835, so it is of considerable antiquity. The occupant of this cottage was probably at one time (?prior to 1838) associated with the quarrying of the poor quality Grinshill Red Sandstones in this area. A small quarry G15 lies to the east of the path hereabouts and is of later date.

Since this quarry, G14, lacks a name on Ordnance Survey maps, it is here named Grinshill Village Quarry. Its stone may have been used to construct many of the walls of the lanes around the village and perhaps the lower parts of the large barn 100 m to the south down the lane. Another fault, here named **The Village Quarry Fault**, its surface aligned NE-SW and, in 1993, bearing a small amount of copper mineralisation and horizontal slickensides indicative of horizontal tear motions in the earth's crust, is well seen where it is associated with the white patches on the main wall of the quarry. Since the dip of the rocks is still to the north, these red soft sandstones of the Wilmslow Sandstone Formation must lie below the White Grinshill Sandstones of the Bridge Quarries and the Mount Pleasant Quarries (see the geological cross section, **Fig.6**).

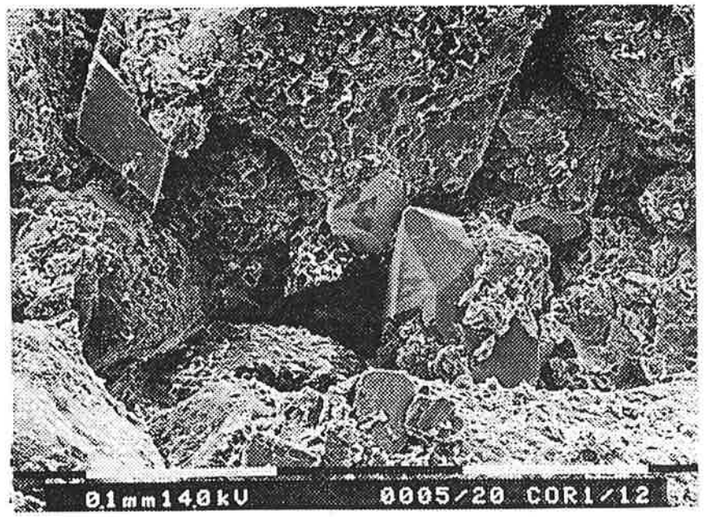
5.2 Church Quarry - localities 6 and 7

Return northwards to the y-junction of the paths and take the right turn eastwards, passing **locality 6** of the trail and the remnants of an old cottage and garden once occupied (in 1838) by George Oswell, yet another quarryman (91). Notice that the bridleway has large stone sets on either side, a sure sign that heavy-wheeled wagons were once drawn along here. In a short distance one sees the reason for the road sets - a small red sandstone quarry with several re-entrant faces: quarry G12 (**locality 7**). On the left as one approaches are signs that a former cottage was attached to the quarry wall: the beam holes are still apparent in the rock face. This was the house of Thomas Harris in 1838 (92) and it is assumed that he was a quarryman. It is believed that stone from this quarry was provided free and used by John Carline III, architect of Shrewsbury, to service the needs of the quaint, somewhat Italianate Neo-Norman red sandstone Church of All Saints which he designed and built 300 m away to the southwest in Grinshill Village in 1839-1840. This church succeeded the Norman Chapel of c.1140. With this likely history in mind, this quarry may best be named **Church Quarry**.

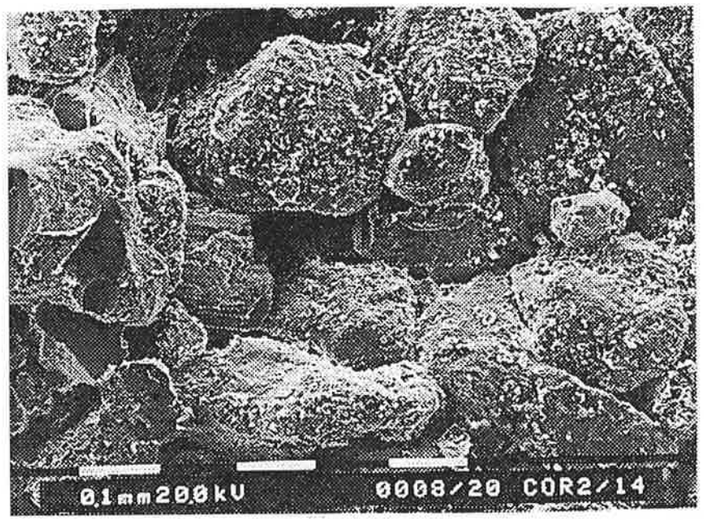
By the time of the OS maps of 1880 (see **Fig.4**), this quarry was still active and was served by a crane which was working its eastern parts. Signs of two rock houses (i.e. shelters cut out of the solid rock) are apparent. It is not known at what date this quarry ceased working, but has already been explained that in 1882-3 a company existed which was called the Bridge, Cureton and Red Quarries Ltd and this company almost certainly worked this quarry, if not G14/C8 as well.

Clearly Church Quarry provided the best Grinshill Red Sandstone of the area, for the rock is considerably harder, more coherent, takes a mason's tool more easily and weathers better than the rock of quarry G14. This is a function of the slightly greater amount of secondary silica cement - probably in the form of quartz overgrowths - developed between the sand grains (see **Fig.19**).

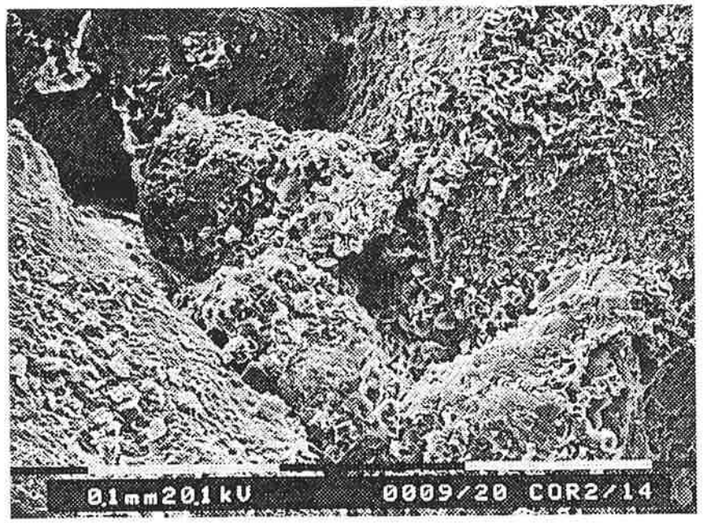
Geologically one cannot help noticing in the many of the recesses of the quarry that the original horizontal of deposition has been tilted by subsequent earth forces so that it now dips between 5 and 10 degrees to the north, as in the other localities visited.



a. Core 1 Plug 12 Photo 0005/20. Grinshill Sandstone, Grinshill Quarry. A poorly sorted laminated fine to coarse sandstone extracted from only 10 cm away from the igneous dolerite dykes which cross the quarry. On the one hand there is much pore space but it is diminished by pyramid quartz overgrowths (centre right) and feldspar overgrowths (top left) and grain-rimming clay minerals of smectite composition (everywhere). On the other hand pore space is increased by the chemical dissolution of feldspars (e.g., at the bottom end of the large feldspar grain - top centre). The coherence, hence the durability of the rock as a building stone, is mainly due to the points of contact but is enhanced by the many overgrowths of all kinds. Pore-space 24.9%; permeability 1912 millidarcies.



b. Core 2 Plug 14 Photo 0008/20 Grinshill Sandstone, c. 70m (230 ft) from the dykes in the southeast of Grinshill Quarry. A moderate to well sorted fine to medium sandstone with subrounded but mostly rounded grains due to aeolian abrasion (and deposition). Coherence is due to grain contacts and in part to small feldspar overgrowths. As a result of the good sorting, the roundness of the grains, the lack of compaction and lack of great amounts of secondary cementing minerals, the pore space is high (26.2%), the permeability high (3255 millidarcies) and the density of the rock relatively low for a first class building stone.



c. Core 2 Plug 14 Photo 0009/20. Grinshill Sandstone from the same plug as in Photo b above, but at higher magnification in order to show the nature of the clay minerals (largely smectite but also with minor amounts of illite and kaolinite) on the surface of the grains and the points of contact of the grains which 'cement' the rock and contribute to its coherence and durability.

Hence the strata exposed in this quarry lie between those of quarry G14 (lowest) and those of the Bridge Quarries (G9-11) (highest) (see the geological cross-section: **Fig.6**). Any boundary between the Red and White Grinshill Sandstones must lie above this locality in the middle part of the scarp face which has been largely covered by the huge screes developed from the waste of working the Bridge Quarries probably in relation to the contracts for the reconstruction of the English Bridge 1925-7 (see **Fig.2**). These Grinshill Red Sandstones are referred to the Wilmslow Sandstone Formation of the Cheshire Basin.

Observe the perfect development of a large cross-bedded rock unit c.7.5 m (25 ft) thick in the upper part of the westernmost outcrops of quarry G12; it is a cross section of yet another very large aeolian sand dune produced by a very steady east wind. This feature, plus other units of similar type in the quarry, raise the possibility that most of the sandstones of the Wilmslow and Helsby Sandstones Formations hereabouts are, apart from their colour, comparable in terms of grain size, sedimentary structures and palaeocurrents and hence yield a series of patterns which are regionally meaningful in terms of a long-lasting sand-sea in a hot desert in the trade-wind belt north of the equator (93). The fossil magnetism of red sandstones of comparable ages elsewhere in the basin tend to confirm a tropical latitude (94) (see **Fig.7**).

Several slightly mineralised white joints cut the face of the quarry and three small normal extensional faults aligned WNW-ESE are developed, the two which traverse the rock houses dipping and throwing only 10 cm to the south, but sufficient to be utilised by the quarrymen in exploiting the faces.

Pause to look southeastwards across the field known as Broomy Corner to the relatively unchanging village of Grinshill: the church on the site of the former chapel (c.1140); the churchyard where so many quarry owners (the Kilverts, the Embreys) and quarrying families (the Downes, the Curetons) are buried; the elegant Manor House (?1624) and Hall (?1850) once the homes of the Kilverts; the Cottage (?1603) once owned by the Canks (another quarrying family): Higher House (1657) built by John Embrey; Minor Farm, Thomas Kilvert's place (1819), the Elephant and Castle (?1820) whose owner (John Matthews) or lodgers (William Clarke) may have had a connection with the quarries, the latter certainly, as a manager, in 1881 (96).

5.3 The lower bridleway: a derelict cottage and views to the south between localities 7 and 8

Continue eastwards for 150 m at the foot of the vast scree slope to SJ 5244 2368 where there are the remnants of yet another quarryman's cottage. This was owned by Thomas Davies in 1838 (97). At a later time, this house has been claimed to be occupied by the Crowther family which is said to have embraced 11 children (98). In 1987 a descendant of this quarrying family, now residing in New Zealand, visited the area in order to seek his "roots". In 1992, it appears more likely that the Crowthers occupied the house known as "Underhill", half way along the unpaved east-west road between Grinshill Village Hall and Clive Church.

Look SSW across School House Field (99) and see in your mind's eye the former 'railway' track which was laid during the first world war in order to transport vast amounts of rubble for the building of army camps nearby. It ran across the field known as Lower Croft, from the foot of the screes to where the sewage pumping station now lies by the lane, at SJ 523 234. Next let the eye swing round southwards to view the Vicarage (1878) and the Vineyard (18??), the latter now the home of the Wycherleys, descendants of the famous playwright William, whose family formerly lived at Clive Hall. Encompassed in the same view, but to the south of the east-west road through the village, lies the Stone Grange (1617-1621), the former country schoolhouse to which the masters and boys of Shrewsbury Free Grammar School retreated (only twice, in 1631 and 1649) in times of plague in the town (100). At other times, the house was rented out, for example to Richard Cureton, owner or lessee of quarry G5, and his family, in the years around 1672 (101).

5.4 Cliff Cottages and the former Methodist Chapel near locality 8

A short walk eastwards brings one to the junction of the tracks at SJ 526 236, near to **locality 8** of the trail. Here there is a good view of the rock outcrops behind the house. One can see early rock houses cut of the outcrop, one with a date 1790, and signs of minor quarrying, hence the designation G13 on

Figure 19 Scanning electron microscope photographs of the Grinshill White Sandstones of Quarries G5-7, especially Cureton's Quarry G5 (by kind permission Dr John Cubitt, Technical Director, and Dr Mike Love of the Geochem Group Ltd, Chester). The instrument allows the observer to peer between the individual sand grains of this fine to coarse sandstone to see the detailed world of the grain surfaces, pore spaces, overgrowths by quartz and feldspar crystals, the dissolution of certain grains, and the growth of finer, pore-filling illitic clay-mineral cements on the grain surfaces and between the points of contact of the grains. The units on the scale bar are in tenths of a millimetre.

Fig.1. Originally there were three separate cottages in a terrace - the Cliff Cottages. In 1838, these plots were held by Richard Davies and Mary Davies (102). The site is reputed to have been a favourite but illegal drinking place of the quarryman in past times. Indeed the present owners, whilst converting the cottages to modern standards, found evidence of ale-making facilities and utensils. It may not have been a coincidence, therefore, that the Methodist Bethesda sect chose to erect their new chapel across the lane, almost opposite this "den of iniquity", in 1843. The stone for this chapel, a sturdy red sandstone, was no doubt obtained from Church Quarry (G12) only 350 m to the west. At the end of the village the normal drinking place for the quarrymen of bygone days was the "Royal Oak", now the Vineyard Cottages, which stand on the north side of the road through the village and on the Grinshill-Shawbury parish boundary (at SJ 527 235) (103). Was this site (or the Elephant and Castle?) the place where the members of the Grinshill lodge of the Rock of Refuge Friendly Society - the self-help "insurance" Society for the quarrymen - met in the 19th century?

From a vantage point on the lane in front of Cliff Cottages, it is possible to observe that the junction between the Grinshill White Sandstones above (the Helsby Sandstone Formation) and the Grinshill Red Sandstones below (the Wilmslow Sandstone Formation) is an irregular horizon at which the normally red sandstones below become mottled, blotchy and then patchily red upwards - a transition recognized repeatedly long ago by Murchison (1839), Hull (1869) and Pocock and Wray (1925). This transition is hardly the basis upon which to draw a proper geological boundary in the modern sense between the WSF and the HSF, and hence the naming of the sequence of rocks in the area is badly in need of revision.

5.5 The bridle path and the main track to and from the Bridge Quarries

Visitors should now retrace their steps to the junction of the tracks and climb steadily up the incline and pathway towards the northwest past **waymarker 8** (see **Fig.2**). Try to imagine the vast amounts of stone which must have been carried down this track by horse and waggon since at least 1769. Take in the many splendid views southwestwards across Schoolhouse Field to Grinshill Village which are afforded by the gaps in the trees. The summit of the Cliff, pronounced Clive, at 630 ft (c.200 m) may be glimpsed to the west. This eminence is often called Grinshill Hill, as on the 1835 estate map (**Fig.3**), and local people, especially in Clive, greatly resent what they claim is a misrepresentation.

5.6 The southern side of the Bridge Quarries; the waste slopes and screes of the Quarries near locality 9

At **locality 3**, turn left, i.e. southwestwards, locating and crossing the slickensided Bridge Quarries Fault (**Figs. 5 and 6**) and entering a 2.5 m wide man-made gulley which cuts at right angles through the Grinshill White Sandstone. This gulley displays large-scale crossbedding (of aeolian dune sandstones) and many joints and small faults separated by only a few metres: two throwing to the north, one to the south. This gulley, cut at so much cost, must have afforded a direct route from the Bridge Quarries to its waste tips i.e. the scree slopes which are now clothed by invading sycamore and planted larch and beech trees (Anon. 1975) (104). The gulley is wide enough to allow a horse and cart to pass through, whereas a similar gulley 30 m to the east will allow only a labourer or apprentice with a wheelbarrow to squeeze by. As might be expected the size and length of the screes to the west, at least 200 m long and 30 m high, suggests that as late as 1950 they formed a considerable eyesore. From map evidence, the most westerly screes are known to be later than the easterly ones beneath the Greensward and the former are likely to relate partly to the fulfilling of the English Bridge contracts between 1st February 1926, when the foundation stone was laid to the 14th May 1927 when the bridge was finished.

5.7 The Greensward: panoramic views to the southwest and southeast from locality 9

A walk through either or both of these gulleys allows one to turn left and pass eastwards along the track to **locality 9**, the Greensward (**Fig.2**). This is a small area of grass, overhung by trees, which is kept trim by the activity of rabbits. It is developed on the top of the earliest screes and its forward, i.e. southern, edge is limited by a tree, the roots of which are surrounded by large blocks of white sandstone and flagstone with their bedding planes aligned in all directions. They are the last pieces of "waste" laid at the edge of the scree and they tend to slip down-slope by degrees, especially during winters in which much freeze-thaw takes place.

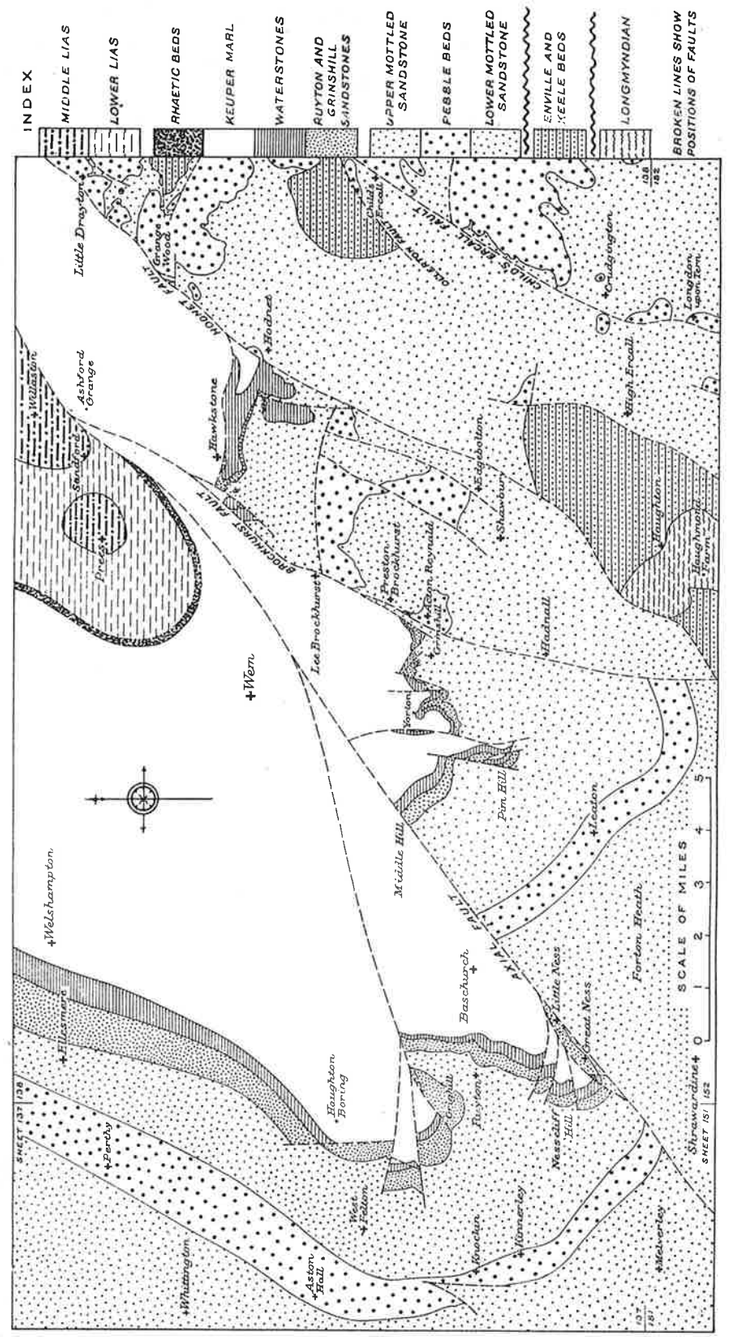


Figure 20 The geological structure of North Shropshire (after the mapping of the Geological Survey in the 1920s on the 1: 10,560 six-inch scale).

(After Pocock and Wray 1925). The up to date names and ages of the rock units need to be explained. The Longmyndian rocks are PRECAMBRIAN (i.e. prior to ?550mya); the Enville and Keele Beds are Upper CARBONIFEROUS (circa. 300-290mya); the Lower Mottled Sandstone is now known as the Kinnerton Sandstone Formation and is likely to be of PERMIAN age (somewhere between 286-248mya. The following rock units belong to the TRIASSIC system. The lowest set of units belong to the Sherwood Sandstone Group: the Pebble Beds are now known as the Chester Pebble Beds Formation (?248-?245mya); the Upper Mottled Sandstone is known as the Wilmslow Sandstone Formation (245-244mya); the Ruyton and Grinshill Sandstone is possibly equivalent to the Helsby Sandstone Formation in the new classification (?244-?243mya). The following rock units belong to the Mercian Mudstone Group of the Trias: the Waterstones which are now known as the Tarporley Siltstone Formation (?243-?242mya: see Fig.7); the Keuper Marl is now divided into three mudstone formations (the lowest of which is the Bollin Mudstone Formation ?242-240mya) and two rock salt formations, the whole group occupying a time span 242-219mya). The Rhaetic Beds now belong to the Penarth Group (219-213mya). The lower and middle Liassic rocks belong to the JURASSIC system and are aged circa 213-200 mya.

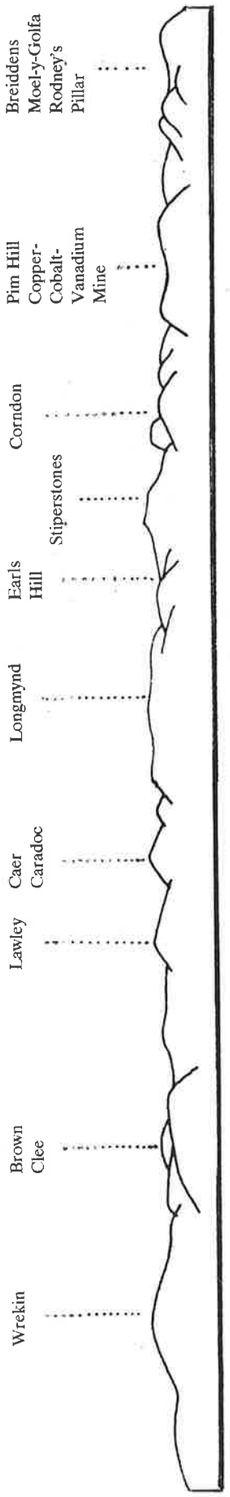
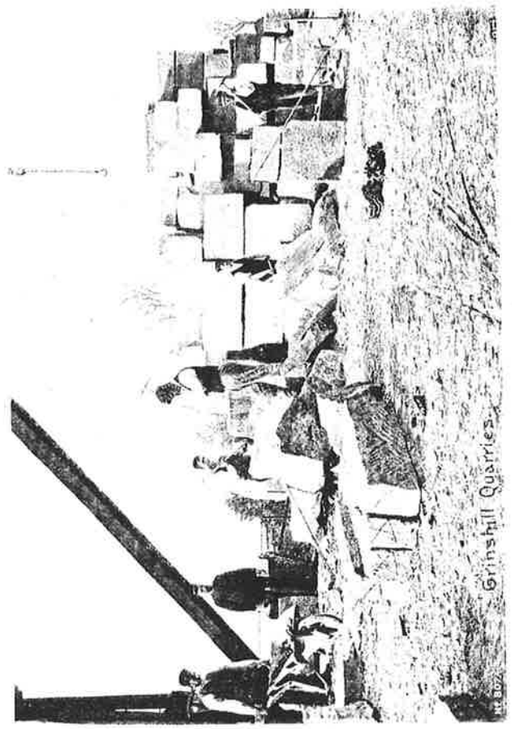


Figure 21 The distant landscape features seen from the Greensward (Locality 9 of the Nature Trail) and the Clive or High Scaur.



(RIGHT) THE FURTHER DRESSING OF THE BLOCKS RAISED BY STEAM CRANES FROM THE DEEP HEADINGS OF THE QUARRIES. The blocks make a pile or bank of roughly dressed sandstone blocks on the flat land atop the quarries and often alongside the final dressing and machine sheds. The four skilled and semi-skilled men working here were sometimes known as banker hands. Note the different attire of the boiler-suited steam crane driver (second left). Photos from postcards 807 and 808 of Wilding and Sons Ltd, Shrewsbury, dated 1905, presented here through the courtesy of Derek M. Walley of Bayston Hill.

(LEFT) THE INTERIOR AND DEPTHS OF AN UN-NAMED QUARRY HEADING PRIOR TO 1905. The base of the Grinshill Flagstones (Tarporley Siltstone Formation) can be seen just over half way up the face. The nine skilled quarrymen are working to free large blocks of sandstone from the underlying Grinshill Sandstone Member (Helsby Sandstone Formation) which displays a good many joints. Note the man on the far right who is cutting a channel or gutter along the length of the base of the quarry wall.

The panorama afforded by this location is exceeded in magnificence only by that from the top of the Clive (see **Fig.21**). In the immediate distance the view across Broomy Corner reveals quarry G8 and the northeast side of the village, with the large barn, the Church, The Cottage and the Elephant and Castle pub being prominent. In the middle distance on the right lie Pim Hill and Harmer Hill, which are composed of similar rocks to those exposed here, but are faulted southwards on the far side of the Shotton Hall Fault. Both this fault and the fault which cuts Pim Hill in a north-south direction are copper mineralised (105). The relationship between geological structure and landscape can easily be seen by reference to the smaller scale geological map (**Fig.20**) (106). The features in the far distance are identified in **Fig.21**.

This is the end of the guided walk and readers are invited to return to the Corbet Wood Car Park by using the maps provided (**Figs.1 and 2**).

6. WILL THE SUPPLY OF THE GRINSHILL SANDSTONES AND FLAGSTONES LAST FOR EVER?

The first point to emerge from the experiences of this excursion is that the supplies of building stones have already been made by Nature over 250 million years - Nature will not "make" any more natural resources like these in the Grinshill area.

The supply therefore, is finite but it is very large to judge by the outcrops and the extensions underground depicted on the geological maps and cross sections (**Figs.5, 6** and **21**). Some supplies still remain at outcrop around the unworked parts of abandoned quarries but most of the latter are of such scenic beauty these days that it would not be wise to work them further. Considerable reserves lie to the north of the scarp and are buried under a thickening amount of overburden - the "Fee" - which would be costly to remove, store and replace.

Since no definitive studies have been made on exactly where and how the best White Sandstones and Flagstones occur, it is hard to say where the best supplies for the future lie.

7. EPILOGUE

It is hoped that the perusal and use of this pamphlet outdoors will have introduced visitors to many places of historical, industrial-archaeological and geological interest. It will have raised issues of amenity v. exploitation, preservation and conservation v. the continued working of wealth from the ground. Readers will make up their own minds on these complex issues and will hopefully contribute their penniesworth to 'public opinion' whenever such issues arise in connection with planning applications in the future, as they surely must.

If there are any points of interest or further information which readers wish to raise with the author, they are invited to get in touch with him at the address given at the end of this pamphlet.

8. REFERENCES IN THE TEXT

1. Acton Reynald Estate Map (1835).

2. The Tithe Apportionment (1838).

3. The idea that the Romans worked quarries at Grinshill – even the present ones G5-7! – is commonly held locally, both in the villages and in the county. This supposed fact has been repeated in c.20 books and articles, some by nationally respected TV personalities like Alec Clifton-Taylor. As far as the author has been able to discern, the idea was first broadcast on field excursions led by Mr H.E. Forrest from 1936 onwards (Anon 1937), appeared in a book by Vale (1949) and has been reported uncritically ever since.

4. See Cantrill, T.C. (1931), the District Geological Survey Officer in Shropshire, for a very careful analysis of where the materials for the building of Uriconium really originated. The author confirms the conclusion of this work. No *in situ* remains or artefacts in museums, not even the inscription tablet for the forum, are likely to have come from Grinshill. Having written this, the author is the first to admit that it is surprising that this should be the case, bearing in mind the skill and care with which the Romans scoured the districts

which they commanded in order to seek first-class building materials.

5. See T.K. Cureton (1968) in Boddie, J.B. (ed.); also Cureton, T.K. (1975).

6. Ordnance Survey 1: 2,500 plan (1880): the first survey of the area on this very large scale.

7. T.K. Cureton MS. The family papers include a xerox of his photographs of the former cottage with a caption which dates the cottage as 1540.

8. The Tithe Apportionment Map (1838); see also Foxall's maps (1977) of all field names for that time.

9. W.A.S. Sarjeant (1985).

10. See the gravestones of John and Marianne Kilvert on the west side of the southern churchyard at Grinshill.

11. The share register and minute books of the Grinshill Stone Quarry Co. (1923) held by Hains and Watts & Co. (Solicitors), Murivance House, Town Walls, Shrewsbury.

12. See Pocock and Wray (1925) for the old nomenclature; Warrington *et al.* (1980) for the new. The rock unit was formerly called the "Lower Keuper Sandstone" and was depicted on maps as unit 'f4'.

13. Thompson (1970a, 1970b; 1985).

14. Nature Conservancy Council (1979); letter from regional office to County Planning Officer Shropshire County Council; see also N.C.C. (1984); letters from K. Duff and L. Richards.

15. This rock unit was depicted on old maps and memoirs (e.g. Pocock and Wary 1925) as f5 the "Keuper Waterstones". The new terminology is explained in Warrington *et al.* (1980).

16. Thompson (1970a; 1985).

17. See Ward 1840 (for 1839) with respect to the first public announcement of the interpretation of a few of these structures.

18. *Rhynchosaurus*: see Walker, A.D. (1969, 1970) for a summary of the occurrences of such remains in the Tarporley Siltstones (formerly the Waterstones).

19. Specimens of *Rhynchosauroides* – the casts of footprints – have been found every year recently and have occasionally been reported in the literature in accounts of field excursions to the area (e.g. Anon 1937, Thompson 1985).

20. These rocks are depicted as 'Keuper Marl', division f6, on old maps and in old memoirs e.g. Pocock and Wray (1925). The new nomenclature is due to Warrington *et al.* (1980).

21. The dykes were first described in the area by Murchison (1835, 1839) at Acton Reynald Hall. They were subsequently found near Holbrook, northwest of Clive, by Pocock in 1920 and traced 5 km southeastwards to the Grinshill Quarries (Pocock 1920, 1921; Pocock and Wray 1925). They have recently been re-examined by Thompson and Winchester (1995).

22. Fitch, Miller, Evans, Grasty and Meneisey (1969) were the first workers to produce radiometric age dates of the dykes. Lewis, Green, Carter and Hurford (1992) have recently published the apatite fission-track dates.

23. Morton, A.C. and Parsons, L.M. 1988.

24. Greenly (1919); Morton and Parsons (1988), Thompson and Winchester (1995).

25. Poole and Whiteman (1966); Thompson and Winchester (1995) on the geochemistry of the dykes.

26. D.B. Thompson MS "The Foundation Stones of North Shropshire" (in preparation).

27. The Wages' Ledger of the Grinshill Stone Quarries (1923) Ltd for 1926-1929.

28. See above and also Ward (1935) and Blackwall (1984).

29. D.B. Thompson MS, as above in note 26; and the Minute Book of the Annual General Meeting of the Grinshill Stone Quarries (1923) Ltd, location cited in ref. 11 above.

30. Ibid.
31. Ibid.
32. Ibid.

33. Parliamentary Papers 1839 (574), xxx, p. 27.

34. Professor Hudson Beare (1892).

35. Leary, Mrs E. (1984).

36. D.B. Thompson MS as in note 26.

37. Ibid.

38. Mrs E. Leary in letters to John O' Hare, Quarry Manager, Sept. 1984.

39. D.B. Thompson MS as in note 26.

40. Mrs E. Leary in letters to John O'Hare Quarry Manager 1984; see also Leary (1986) wherein pp. 36-37 relate to Grinshill Red and White Sandstones.

41. Professor Hudson Beare 1892.

42. Ibid.

43. D.B. Thompson MS as in note 26.

44. Ward (1935); Blackwall (1984).

45 D.B. Thompson MS as in note 26.

46. Ibid.

47. Ward (1935).

48. Ibid. and Shrewsbury Chronicle Saturday March 20th 1773 vol.11, no.11, page 3, col. 2.

49. See Anon (1898) and Wheatley (1912, 1914) for the best accounts of the unchanging working practices in Grinshill Quarries.

50. Anon (1898).

51. Gregory, T. (1824) The Shropshire Gazetteer and Mrs E.O. Gordon (1894 p. 89).

52. See Rupke, N. (1983) and Tresise, G. (1989).

53. Page, B. (1979).

54. Minute book of the Shropshire and North Wales Natural History and Archaeological Society (S & NWNHS & AS).

55. Murchison, R. (1839) The Silurian System, London, p. 734. The last page has this exciting addendum, but see pp. 39-41 for a contemporary description of the succession of types of Building Stones, presumably compiled from data available in the Bridge Quarries.

56. Buckland, W. (1844) Proceedings of the Ashmolean Society (see especially pp. 5-7).

57. Buckland, W. (1842) Presidential Address to the Geological Society of London on 21 February 1840; see especially pp. 244-7.

58. Ward, (T).O. (1840).

59. Ward, T.O. (1841), Medical Topography of Shropshire; Anon 1893, pp. 51-3; Anon 1906, pp. 95-6; Pocock and Wray; 1925, p. 40; Harley 1972, p. 31) and the author's experience on every excursion between the years 1950-95.

60. Shrewsbury Museum, now in Rowley's House; the geological galleries display a limited number of footprints and bones.

61. Letter to the author (1985) from John Norton, for many years the devoted and meticulous curator of this museum. The photographs in figure 13 are his work. The specimens of *Chirotherium* are labelled G3551 and 3853, and were accessioned by Charles Fortey who in turn, sent copies to Henry Beasley of Liverpool in 1898 (Sarjeant 1985).

62. Sarjeant W.A.S. (1985); see above.

63. See Thompson (1985), Tresise (1989, p. 29).

64. Buckland in his Presidential Anniversary address to the Geological Society of London, February 21 1840 (see 1842, pp. 244-7).

65. Ward (1875, p. 8) in a letter of Nature shortly before he died.

66. Letters from Dr T. Ogier Ward to Dr Richard Owen at the College of Surgeons, London, now held in the Sherbon Collection of the British Museum of Natural History. They are numbered out of sequence but can be reordered: BMNH 110, 103, 118, 119 (for 1840) 105, 109, 107, 114, 116 (for 1841) on the basis of their internal evidence.

67. See Page, B. (1979).

68. Ibid.

69. Ibid., but see also Symonds, W. S. 1857, pp. 142-144.

70. Dr Mike Benton, now of Bristol University, once of Queen's University, Belfast, and formerly of the Oxford Museum (where the author first saw all these specimens assembled for study) has studied seven heads (see Benton 1990). The eighth head was quarried by John O'Hare and Co. in 1983 and was identified by Dr J.W.Stanley of the Adult Education Department, Keele University, also in 1983.

71. Letter from T.O. Ward to Dr R. Owen; BMNH Sherbon Collection No. 110; see note 66.

72. Ibid. letter No. BMNH 103; see note 66.

73. Lyell (1841) Elements of Geology, pp. 82-90.

74. Anon, Salopian Journal Wednesday 28 April 1841: The Labyrinthodon.

75. Anon, Shrewsbury Chronicle Friday 30 April 1841: Shropshire and North Wales Museum.

76. Owen, R. (1842); the first description of an extinct "Lacertian Reptile".

77. Beasley, H.C. (1890). Grinshill and rhynchosaurs pp. 151-2; Shrewsbury Museum, p. 165.

78. Maidwell, F.T. (1914).

79. Some original specimens are lost. The ones which remain are ShM G 132/1982 (in coarse sandstone, hence possibly from the Grinshill Sandstone Member) and ShM G133/1982, ShM G134/1982, ShM 151/1982 (in fine-grained sandstone, possibly from the Tarporley Siltstone Formation).

80. Owen, R. (1860) Palaeontology (a general textbook).

81. Huxley, T.H. (1887), Woodward A. S. (1907), Watson, D.M.S. (1910, 1938, 1939a and b), Huene, F. (1929, 1938, 1939a and b; including restorations 1938 p. 110, 1939b p. 503), Hughes, B. (1968) and Walker, A.D. (1969, 1970), Benton, M. (1983, 1990). Most recently Dr Mike Benton, who acted on behalf of the Nature Conservancy Council in the redesignation of the Grinshill Quarries G5-G11 as a Site of Special Scientific Interest, has published a wall chart on the Rhynchosaurs (Benton 1983) and has set their evolution in a wide environmental context (see Tucker and Benton 1982).

82. See De Beer, G. (ed.) (1974).

83. See Burkhardt, F. and Smith, S. (eds) (1986) "The correspondence of Charles Darwin", Volume II, for a chronology of Darwin's travels in each year. He is recorded at Shrewsbury from 7-17 March 1842, at Maer 18 March and June 15-18 1842, at which times he wrote his pencil sketch of 35 pp. of the origin and evolution of species.

84. Darwin, C. (1859) Origin of 'Species, first edition. London, John Murray.

85. See Burkhardt and Smith, see note 83.

86. See the Minute Books of the S & NWNHS.

87. See Burkhardt and Smith (eds) (1985, 1986), The Correspondence of Charles Darwin. Vols I and II for a glimpse of Charles Darwin's work as the secretary of the Geological Society of London.

88. Thompson, D.B. MS; see note 26; also Scard (1989).

89. See Anon (1898).

90. See the Tithe Apportionment (1838).

91. Ibid.
92. Ibid.

93. Thompson, D.B. (1985).

94. Clegg, J.A., Almond, M. and Stubbs, P.H.S. (1954) re the fossil magnetism which justifies this interpretation in terms of a northerly tropical latitude.

95. The names of the fields are cited in the Tithe Apportionments of 1838 and 1842, and maps of the field names in Shropshire have been produced by Foxall (1977).

96. See the National Census returns for 1881 for the parishes of Clive and Grinshill.

97. See the Tithe Apportionment (1838).

98. The Crowther family is recorded in the censuses (1881) as living in Clive and Grinshill; see also the parish registers for Grinshill. As a result of conversations with members of the family living in Ross and Cromarty, Scotland, it is more certain that one part of the family once lived at 'Underhill' on the dirt road between Grinshill and Clive.

99. This field name is recorded in the Tithe Apportionment and on Foxall's Maps (1977). It was owned originally by the Trustees of Shrewsbury Free Grammar School and was part of the property relating to the Stone Grange, the "plague house" of the school, which lies a short distance southeast, across the east-west lane through the village.

100. See Rimmer, A. and Adnitt, H.W. 1899; also Fisher, G.W. (1899) and Oldham , J.B. (1952).

101. See the Shropshire Hearth Tax Roll 1672. Richard Cureton was taxed for 11 hearths. See also Watkins-Pitchford (1949).

102. See the Tithe Apportionment 1838.

103 Thompson, D.B. MS; see note 26.

104. See Anon (1975) The Nature Trial leaflet (2nd edition) for details of the floral changes hereabouts.

105. For an understanding of the copper mineralisation of the area see Dewey and Eastwood (1925), Pocock and Wray (1925), Carlon (1981) and Thompson (1992).

106. See Pocock and Wray (1925).

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