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Geology of 1:10 000 sheet NY86SW and the southern parts of NY86NW and NY76NE

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BRITISH GEOLOGICAL SURVEY

GEOLOGY AND LANDSCAPE NORTHERN BRITAIN PROGRAMME

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Compiler

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Foreword

This field report is a description of the geology of 1:10 000 sheet NY86SW and the southern parts of NY76NE and NY86NW. Survey was carried out by B Young during 1996 and 2005. Geological mapping of the northern halves of Sheets NY86NW and NY76NE was completed by D V Frost and D W Holliday in 1968 and D V Frost in 1968-69 respectively, as part of the re-survey of BGS 1:50 000 Scale Sheet 13 (Bellingham). The report summarises details of the geology of the area mapped along with key local information. This area forms part of the 1:50 000-scale geological map for Hexham, England and Wales Sheet 19. Completion of this work formed part of the Northern England – Alston Block Project within the Geology and Landscape of Northern Britain Programme. This report has been compiled by K Whitbread from three separate draft documents prepared by the author. The report has been edited by D Millward.

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The author gratefully acknowledges the co-operation of the landowners within the area.

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Summary

This field report provides a summary of geological information to accompany the recently resurveyed 1:10 000 sheets NY86SW and parts of NY86NW and NY76NE.

Previous mapping history and geological background to the area are highlighted in sections 1 and 2. Descriptions of the Carboniferous geology from outcrop and borehole/mining data are covered in sections 4, 5 and 6 for the Alston Formation, Stainmore Formation and Pennine Coal Measures Group respectively. Igneous rocks of the area are described in section 7. Geological structure and mineralisation are covered in sections 8 and 9. Aspects of the Quaternary geology are discussed in section 10. A summary of the economic aspects of the geological resources is made in section 11, and finally environmental issues arising from the nature of the geology or exploitation of the geological resource in the region are noted in section 12.

1 Introduction

This report provides details of the geological features noted during the re-survey of BGS 1:10 000 scale Sheet NY86SW and the southern halves of Sheets NY86NW and NY76NE. The re-survey was undertaken by B Young during 1996 and 2005 as part of the re-survey of BGS 1:50 000 Sheet 19 (Hexham). The original geological survey of the area was carried out by H H Howell and D Burns and published as Old Series 1:63 360 Scale Sheet 106 NE in 1881. This mapping was partially revised by R G Carruthers between 1939-49 and published in 1956 as a 1:63 360 scale Provisional Edition of Sheet 19 (Hexham). The sheet was enlarged to 1:50 000 scale, without amendment, and published in 1975. No Geological Survey Memoir was ever issued for the Hexham Sheet, though important summaries of parts of the area are contained in Smith (1923) and Dunham (1948, 1990) and Chadwick et al. (1995). Detailed revision and re-mapping, at 1:10 000 scale, of the entire Hexham Sheet was begun in 1996.

The account that follows includes observations made during the latest re-survey, and incorporates relevant information and comments derived from previous studies by BGS and other sources.

2 Geological setting

The area surrounds the town of Haydon Bridge, extending south to include the village of Langley and north to Hadrian's Wall.

Geologically, the area lies astride the southern margin of the Northumberland-Solway Trough and the northern edge of the Alston Block. It is crossed by the Stublick Fault system, which forms the structural boundary between these two major areas of Carboniferous sedimentation. The bedrock exposed at the surface are mainly of Dinantian and Namurian age, but two structural inliers of Westphalian rocks occur in the southern part of the area. Two mineshafts penetrate Dinantian rocks beneath those seen at outcrop, however no older rocks have been proved here. The northern parts of the area include several mineralised veins which are generally considered as outlying parts of the Northern Pennine Orefield which coincides closely with the Alston Block, to the south.

3 Carboniferous nomenclature

The succession and stratigraphical classification of the Carboniferous rocks present within the area is shown in Figure 1.

The lithostratigraphical nomenclature used in this report is that of the draft review of the Carboniferous lithostratigraphical nomenclature of northern Britain. All Carboniferous rocks exposed or proved in the area mapped up to and including the Great Limestone are included within the Alston Formation, previously known as the Alston Group. (The equivalent strata on the adjacent 1:50 000 Sheets 13 (Bellingham) and 14 (Morpeth) are assigned to the Liddesdale Group). Carboniferous rocks lying between the top of the Great Limestone and the conjectural base of the Pennine Coal Measures Group which is taken at the Quarterburn Marine Band, are included within the Stainmore Formation, previously called the Stainmore Group. The Alston and Stainmore formations, together with the underlying Tyne Limestone Formation (not proved in the present area) form the middle Dinantian to upper Namurian Yoredale Group of the Northumberland Trough. The Pennine Coal Measures Group is Westphalian in age.

In the descriptions which follow, the long established names for limestones and coal seams, devised by generations of miners and quarrymen, are used. For sheets NY86NW and NY76NE, the northern parts of which are included on 1:50 000 Sheet 13 (Bellingham), several limestones are referred to by different names in the two areas. Although names such as the Eelwell Limestone are widely adopted across Northumberland, a practice followed by Frost and Holliday (1980) in the adjoining Bellingham District, in their descriptions of the metalliferous mineral deposits of the present area authors such as Smith (1923) and Dunham (1948; 1990) have employed the equivalent Northern Pennine nomenclature. Thus, the Eelwell and Redhouse Burn Middle limestones of the Bellingham District are the correlatives of the Scar and Five Yard limestones of the Northern Pennines. In this account the Northumberland nomenclature is adopted, with the equivalent Northern Pennine names included in parentheses.

For convenience the lithostratigraphy is described, so far as possible, in terms of the individual Yoredale cyclothems, beginning with the limestone member and continuing through the overlying beds to the base of the succeeding limestone.

4 Dinantian rocks: Alston Formation

Strata from beneath the Five Yard Limestone up to the top of the Great Limestone crop out at surface within the area north of the Haydon Bridge Dyke on Sheets NY86NW and NY76NE and the very north of Sheet NY86SW. No provings of older strata are known within the area.

4.1 THE SHOTTO WOOD LIMESTONE CYCLOTHEM

Mapping of the land immediately to the north of the present survey area, in the ground covered by Sheet 13 (Bellingham), indicates that a limestone, identified as the Shotto Wood Limestone, lies immediately above the Whin Sill. This limestone outcrop must pass into the present area in the peat covered ground approximately 500 metres north-west of High Shield [7630 6750]. Mapping suggests that, when traced westwards, the limestone may be truncated by the top of the Whin Sill. No exposures of Shotto Wood Limestone, or of the overlying beds within this cyclothem, occur within the present area.

The logs of two trial bores (NY76NE/9 and NY76NE/10) for water at High Shield [7680 6720 and 7680 6710] note the presence of limestone ‘beds’ or ‘partings’ which may correlate with the Shotto Wood Limestone, though the geological details recorded in the logs are difficult to interpret with any precision and may be unreliable.

4.2 THE EELWELL (SCAR) LIMESTONE CYCLOTHEM

The outcrop of the Eelwell Limestone passes into the area of NY76NE approximately 600 m east-north-east of High Shield [7750 6750], though its outcrop is everywhere concealed beneath superficial deposits. Up to 1 m of brownish yellow fine to medium-grained sandstone, exposed in a line of old pits which extend from the Twice Brewed Inn [7510 6689] to approximately 300 m east of Springwell House [7556 6709], are interpreted as belonging to the Eelwell (Scar) Limestone cyclothem. No other exposures of these beds were located during the survey.

A borehole (NY76NE/1) [7623 6676], in the fields north of the Brackies Burn, recorded by the previous survey, penetrated 12 m of beds beneath a limestone assumed to be the Redhouse Burn Middle Limestone. A lower limestone, 0.4 m thick, encountered 6.3 m beneath this, may be the Redhouse Burn Lower Limestone of the Bellingham district. Apart from noting that this borehole terminated at a depth of 29 m in sandstone, no other details of the beds penetrated are recorded.

In the area of Sheet NY86NW, the only proving of beds at this level was in the Joicey Shaft of Langley Barony lead mines [8312 6657] (Figure 2). Here, a total of 45.4 m of beds comprise alternations mainly of sandstone ('*hazle*' in the contemporary shaft log) and mudstone ('*plate*' in the shaft log). A 0.38 m-thick limestone, 4 m beneath the Five Yard Limestone was considered by Frost and Holliday (1980, p38) to be the Redhouse Burn Lower Limestone. Two thin coal seams were encountered 2.7 m beneath this limestone. Though the shaft was not sunk to the Eelwell (Scar) Limestone, comparison with adjacent areas suggests that it must lie within a very few metres of the shaft bottom.

4.3 THE REDHOUSE BURN MIDDLE (FIVE YARD) LIMESTONE CYCLOTHEM

In the area of NY86NW this limestone was recorded as 1.8 m thick in the Joicey Shaft [8312 6657] (Figure 2). It is overlain by 20.4 m of sandstone and mudstone with three coal seams which vary from 0.3 to 0.2 m in thickness. The two upper seams are underlain by prominent mudstone seatearths ('*seggar clay*' in the shaft log). Leadbitter Shaft [8260 6612] terminated in mudstone 42.7 m below the base of the Three Yard Limestone.

To the east, on NY76NE, rocks of this cyclothem, including the Redhouse Burn Middle (Five Yard) Limestone itself, are concealed beneath till, except in the steep sides of the headwaters of Bradley Burn. Here, less than 1 m of dark grey silty mudstone, near the base of the cyclothem, is exposed on the west bank of the burn [7801 6745]. A few metres upstream, on the east bank [7804 6742] approximately 2 m of medium-grained sandstone are overlain by a grey mudstone seatearth, 0.75 m thick, immediately beneath the Four Fathom Limestone. A note on field slip Northumberland 89NE/E (New Series) during the previous survey records the following section, immediately beneath the Three Yard Limestone, at the site of an old trial level, said to have been driven for lead ore. Nothing was seen at this point during the re-survey:

Coal ……..… 0.05 m
Plate [shale]…….1.8
Coal……...0.13
Plate [shale]……..7.6
Coal…….0.025
Ganister

A limestone, almost 2 m thick, was recorded at a depth of 17 m in a borehole [7623 6676], in the fields north of the Brackies Burn. From its position, this could well be the Redhouse Burn Middle Limestone, but if so it seems unusually thin. The record of this borehole, recorded by the previous survey seems very abbreviated, and may be unreliable.

A dark grey limestone, 4 m thick, penetrated at a depth of 20.3 m in a borehole (NY76NE/7) at The Knowe [7815 6738] may be the Redhouse Burn Middle (Five Yard) Limestone, though the reported presence beneath this of a further 5 m of limestone, separated from it by only 0.86 m of sandy shale, suggests an improbably large thickness of limestone at this horizon and casts some doubt on the reliability of the log, or at least the lowermost portion of it. The same borehole log records almost 11 m of shale and sandstone between this limestone and the base of what is almost certainly the Three Yard Limestone.

4.4 THE THREE YARD LIMESTONE CYCLOTHEM

The Three Yard Limestone crops out north of the Haydon Bridge Dyke, on the northern bank of the River South Tyne, west of Haydon Bridge. Though the unit is largely concealed beneath superficial deposits, mainly till, there are small exposures in the steep, overgrown sides of the Honeycrook Burn, and in a small area around Heugh House Lane, Haydon Bridge. During the

survey of the area between 1946-49, R G Carruthers recorded the following composite section beneath the Four Fathom Limestone in the north bank of Honeycrook Burn south-west from the waterfall at the site of Nattrass's Level [8285 6600 to 8265 6586]:

Four Fathom Limestone

Bright coal ……	0.1 m
Dark rooty fireclay…….	0.9 m
Sandstone flags with stigmaria……..	0.76 m
Sandstone fakes [shaly sandstone] and shale…….	0.6 m
Micaceous shale and thin clay band ironstone lenses [clay ironstone nodules]……..	1.2 m
Bright coal……..	12 m
Fireclay…….…….……	0.15 m
Dark micaceous rooty fireclay……..	0.3 m
Hard sandstone rib ……	0.05 m
Soft shaly sandstone (rooty) ……..……	0.38 m
Hard sandstone rib (rooty)……..……...	0.22 m
Shaly sandstone with roots……	0.22 m
Hard sandstone in thin beds……..…….	0.6 m seen

This part of the burn is today heavily overgrown and no clear section remains.

Approximately 1 m of yellowish brown, fine to medium-grained sandstone, is exposed in the bed and east bank of the Honeycrook Burn [8224 6546] 600 m south-west of the site of Langley Barony Mine. Approximately 1 m of grey silty mudstone, dipping gently to the south-west is exposed in the east bank of Honeycrook Burn [8230 6519] to the west of Chesterwood. Similar mudstones, with a 0.18 m-thick bed of dark grey carbonaceous (blackband) ironstone crop out, also in the west bank of the stream, 120 m farther south [8232 6506].

A bed of blackband ironstone was quarried during the 19th century in the east bank of the burn [8246 6503] about 650 m west of Chesterwood. According to Strahan et al. (1920) the bed was between 0.9 and 1.2 m thick and occurred in a limited area "…between two faults which limit the outcrop on the north and south…". Mapping reveals that the outcrop does indeed appear to be confined to a limited area south of the roughly west-north-west-trending fault which crosses Honeycrook Burn at 8260 6584 and a parallel fault which crosses the burn at 8188 5483, approximately 150 m south of the area described in this report. It is not known whether these faults played any part in limiting the deposition of this ironstone to this area, though it is worth noting that no such blackband ironstone was recorded in the section of Joicey Shaft (Figure 2), or in the composite section of strata beneath the Four Fathom Limestone, recorded by Carruthers, higher up the Honeycrook Burn (see above). Little remains exposed in the overgrown and degraded sides of the ironstone quarries today, though the spoil heaps consist mainly of grey shale with a few blocks of fine-grained sandstone. The ironstone, as revealed by a few fragments present in the spoil heaps, comprise a dark grey very fine-grained rock which locally exhibits brown surface weathering crusts.

The previous survey records a small adit, apparently driven northwards to the ironstone in the west bank of the Honeycrook Burn [8239 6524]. No sign of this mine opening can be seen today, though a small spoil heap, no doubt derived from it, consists mainly of grey shale and silty shale with a few blocks of fine-grained sandstone. Another adit, driven north on the outcrop of the ironstone, here concealed by a thin mantle of till, is recorded approximately 430 m to the east [8270 6529]. Here again, nothing can be seen on the ground today, though Mr Wardle who farms this land, recalls filling the site of the adit with soil and rubble several years ago.

In other outcrops, up to 3 m of grey bioclastic limestone, underlain by a mudstone seatearth are exposed in the eastern slopes of the Bradley Burn valley [7804 6742] approximately 250 m north of West Crindledykes. Similar grey bioclastic limestone crops out in the Brackies Burn [7638 6660] and in the fields immediately to the north [7643 6668]. Immediately to the east of these outcrops are old quarries excavated in the mudstones to extract clay ironstone nodules. These beds are not exposed today, though the substantial spoil heaps locally reveal an abundance of dark grey laminated mudstone. A few small, generally less than 10 cm, clay ironstone nodules can be found, though from their scarcity it may be concluded that hand picking of the ironstones was thorough. Sandstone, which appears to form the uppermost portion of this cyclothem, crops out at several places in the steep southern bank of the Bradley Burn, and has been quarried at several places [7723 6651, 7775 6711 and 7759 6696]. At the latter locality up to 5 m of thickly bedded, medium to fine-grained sandstone with low-angled cross-bedding is exposed. Very small exposures of flaggy sandstone, interpreted as lying close to the base of the Four Fathom Limestone are present in the fields about 150 m east-north-east of Chesterwood Villa [8333 6556]. A sandstone, assumed to be at the same stratigraphical horizon, forms a low north-facing scarp feature beneath the outcrop of the Four Fathom Limestone immediately south of Haydon Fell Plantation [8400 6692 to 8450 6704]. Sandstone within the interval between the Three Yard and Four Fathom limestones was formerly worked in shallow quarries about 400 m east-south-east of Chesterwood. Though the sites of these workings may be identified today, nothing is exposed.

Overgrown, and partly obscured pits, to the north and west of Heugh House Lane [8330 6494] worked sandstone. A few fragments of pale brown, medium-grained sandstone may be seen in the soil brash, though no good exposures remain today.

A borehole (NY76NE/7) at The Knowe [7815 6738] penetrated 4.96 m of limestone, interpreted as the Three Yard Limestone, at a depth of 4.37 m, overlain by 0.52 m of dark shale and 2.6 m of weathered yellow sandstone. Another borehole (NY86SW/1) [8214 6461], drilled in 1953 north of Lipwood Well, proved approximately 35 m of mudstone and sandstone overlying a 4.6 m thick limestone, likely to be the Three Yard Limestone. A 0.38 m thick coal was encountered within a succession of grey mudstones at a depth of 44.7 m.

The Joicey Shaft section (Figure 2) records the Three Yard Limestone as 4.2 m thick, immediately overlying the uppermost coal of the underlying cyclothem. The overlying beds comprise 26.4 m of mudstone, sandstone and alternations of mudstone, siltstone and thin silty sandstones (‘*plate and grey beds*’ in the shaft log). A 0.25 m-thick coal was recorded 3.7 m beneath the Four Fathom Limestone, with a 0.2 m-thick coal, immediately beneath that limestone.

4.5 THE FOUR FATHOM LIMESTONE CYCLOTHEM

The Four Fathom Limestone is well exposed in the steep sides and bed of the Honeycrook Burn between Whinnetley [8160 6480] and the River South Tyne [8127 6449]. A total of around 12 m of limestone is exposed in this section. The rock is typically a well-bedded grey bioclastic limestone with scattered small crinoid fragments. A note on the fieldslip from the previous survey (Northumberland 90SW/E (New Series)) refers to the presence here of chert layers, though none was seen during the present survey.

The limestone forms cliffs alongside the Honeycrook Burn in the neighbourhood of Langley Barony Mine [between 8289 6609 and 8261 6586], though the sections are heavily overgrown and difficult to access. During the 1940s survey of the area R G Carruthers recorded more than 6 m of massive dark grey, compact limestone with scattered small crinoid ossicles, with a 0.2 m-thick bed of limy shale containing crinoid and brachiopod fragments at the base, in the bank south-west from the waterfall at the site of Nattrass’s Level [8285 6600]. A small exposure [8270 6590] on the north bank of Honeycrook Burn beneath the site of Langley Barony Mine

reveals grey bioclastic limestone with a distinctive pale brown weathering. This colour may reflect weathering of dolomitised or ankeritised rock associated with a nearby fault, though similar brown weathering of this limestone is also present in the small exposures in the fields south of Haydon Fell Plantation [8400 6692 to 8450 6704] which are remote from any known faulting or mineralisation.

North of West Crindledykes [7830 6735], the drift-free outcrop of the Four Fathom Limestone forms a well-marked north-facing scarp feature. An old quarry [7836 6744] exposes up to 6 m of grey bioclastic limestone, in wavy-beds up to 0.75 m thick separated by mudstone partings a few millimetres thick, dipping south at 14°.

West of the Bradley Burn, the Four Fathom Limestone is everywhere concealed beneath till. A borehole (NY76NE/2) at Seatsides [7502 6615], although drilled to a total depth of 113 m, did not record the Four Fathom limestone.

The bed of the Bradley Burn immediately south of Chesterholme [7719 6625] exposes large bedding plane surfaces of similar grey, massive, well jointed, bioclastic limestone. In the steep river bank, immediately to the east, the limestone is overlain by up to 6 m of grey silty mudstone, above which occurs up to 5 m of pale fawn, medium-grained sandstone in beds up to 0.4 m thick. Approximately 50 m upstream, also in the east bank [7724 6625], the same sandstone is well exposed, here with a few shaly partings up to 0.05 m thick separating sandstone beds up to 0.75 m thick.

Between Haydonfell Plantation [8400 6700] and New Alston [8409 6619] a substantial drift-free outcrop of beds lying between the Four Fathom and Great limestones has been mapped, though exposures are few and the detailed stratigraphy and structure are difficult to interpret. Topographical features suggest the presence of at least two substantial sandstone units. The remains of overgrown shallow pits may be seen locally [8427 6669, 8385 6635, 8440 6653], though there are no good exposures of the sandstone. South and south-west of New Alston one sandstone bed forms a prominent low south-facing scarp in which may be seen exposed [8366 6595] up to 1.5 m of massive, pale grey-weathered, fine to medium-grained sandstone. Numerous rootlet traces and a few stigmaria are conspicuous.

Greyish fawn, bioturbated fine to medium-grained sandstone is exposed in the field immediately east of East Haydon Farm [8460 6567] where there are signs of small-scale quarrying.

Strata between the Four Fathom and Great limestones crop out in Cruel Sike, south of Page Croft [8445 6531 to 8453 6505]. Though heavily overgrown and difficult to access today, R G Carruthers recorded the following section during his re-survey of the area in 1940:

Great Limestone	
Hard rooty sandstone, some beds of brachiopods…….	about 1.8 m
Unexposed…….	1.2 m
Hard rooty sandstone…….	0.6 m
Unexposed……..	1.8 m
Rooty sandstone…….	0.6 m
Unexposed (?sandstone quarried out)……	1.8 m
Hard sandstone……..……	0.6 m
Unexposed……..……...	0.9 to 1.2 m
Dark shale……..	1.8 m
Unexposed……..	0.6 m
Pale grey hard sandstone, abundant	
white brachiopod fragments…….……..	0.08 m
Hard pale sandstone……..……..	0.3 m
Unexposed (position of blackband ironstone)…….……	1.2 m
Hard rooty sandstone …….…….	1.8 m

Carruthers also recorded the following section [8479 6601], within a few metres of the base of the Great Limestone, in the stream east-north-east of East Haydon Farm:

Rooty sandstone, often soft and mealy…….……..	2.4 m
Dark shale……..…….	1.8 m
Dark grey sandstone with white shells…….…….	0.22 m
Dark shale ……..……...	1.2 m
Parrot coal…….…..…….	0.025 m
Blackband ironstone ……..	0.12 m
Dark rooty sandstone	

Sandstone appears to comprise much of the interval between the Four Fathom and Great limestones between the Bradley Burn and East Crindledykes [7870 6740]. A well marked scarp feature defines the outcrop in most of this area, even where till cover conceals the outcrop immediately east of the Bradley Burn. Small pits [7811 6713 and 7824 6725] expose up to 1 m of rather flaggy, pale grey to fawn, fine to medium-grained sandstone.

Several metres of mudstone, siltstone and sandstone above the Four Fathom Limestone are exposed in the cutting on the north side of the A69 road west of Minnow Bridge [8105 6472 to 8125 6455].

A section recorded on field slip Northumberland 90SW/E (New Series), reveals that the Whinnetley Adit, driven as an exploration for lead ore from the north bank of the Honeycrook Burn [8150 6477], passed through almost the full thickness of the interval between the Four Fathom and Great limestones. According to this section these strata are approximately 20 m thick, in the upper half of which occurs at least one sandstone unit and a coal seam of unrecorded thickness, approximately 7.5 m beneath the Great Limestone. Dunham (1990, p 263) noted that the southern extremity of the Bewick Vein of the Langley Barony mines was encountered here in the 'grey beds above the Four Fathom Limestone', but that the workings were not extensive.

The Four Fathom Limestone is 9.9 m thick at Joicey Shaft [8312 6657] (Figure 2). The Shaft also records 5.84 m of overlying mudstone and siltstone ('*plate*' and '*grey beds*' in the shaft log).

The Four Fathom Limestone was quarried for making burnt lime from outcrops which form a conspicuous drift-free scarp feature approximately 400 m north-west of Chesterwood [8257 6546]. A few metres of grey bioclastic limestone are visible in the remaining overgrown quarry faces.

4.6 GREAT LIMESTONE

In the lithostratigraphical classification adopted in this report, the top of the Great Limestone is taken as the top of the Alston Formation, with the base of the overlying beds marking the base of the Stainmore Formation. For the purposes of this account the Great Limestone is therefore described separately, with the overlying beds of the Great Limestone cyclothem described as components of the Stainmore Group.

The Great Limestone outcrop lies entirely beneath superficial deposits in the area of NY86SW. A rise driven approximately 7.5 m above the foreheads of the Whinnetley Adit [8150 6477] struck the base of the Great Limestone, though there is no record of any driveages or workings in the Bewick, or any other vein, in this limestone.

In the area of NY86NW the Great Limestone occupies two separate outcrops. Of these, the western outcrop, west of the Honeycrook Burn is entirely concealed beneath a mantle of Quaternary deposits, mainly till and the eastern outcrop, between Carrstones Quarries [8485 6660] and Haydonside Plantation [8475 6535] is generally well exposed. No single complete section has been proved through this limestone within the area. However, in the immediately

adjoining Bellingham District (Frost and Holliday, 1980) the limestone is typically around 15 m thick.

Good sections of Great Limestone remain in the rather extensive, comparatively shallow, workings of Carrstones Quarries. Approximately 3.5 m of generally thickly bedded, medium-grey, bioclastic limestone, exhibiting the rather irregular 'wavy' bedding which characterises this limestone in neighbouring areas (Young and Lawrence, 2002) is exposed in the western wall of the quarry [8473 6644] adjoining the track leading to Fell House. A comparable thickness of similar limestone is exposed in the easternmost of the Carrstones Quarries [8490 6645]. Conspicuous in this quarry is a roughly north-east-trending gentle anticlinal fold. Such folds are common in the Great Limestone of the adjoining Bellingham (Frost and Holliday, 1980) and Morpeth (Young and Lawrence, 2002) districts. Known to local quarrymen as 'rolls', these folds are discussed in more detail below.

A few metres of similar 'wavy' bedded limestone, dipping south at 10° are exposed on either side of the waterfall [8490 6592] in the stream approximately 450 m east-north-east of East Haydon Farm. The exposures here appear to have been enlarged by quarrying.

A borehole at Whitechapel Farm (NY86NW/7) [8029 6500] terminated at a depth of 41 m in 0.7 m of limestone, correlated with the Great Limestone.

In the area of NY76NE, a few metres of grey bioclastic limestone, belonging to the Great Limestone, crop out on the downthrow side of the Chesterholme Fault in the Bradley Burn [7718 6612], south of Chesterholme. In places the limestone exhibits a rather broken appearance, and variable dips, due to the proximity of this fault.

The Great Limestone forms an almost continuous, drift-free outcrop eastwards from the old quarries at Crindledykes limekiln [7817 6700]. It has been worked hereabouts in several substantial quarries [7805 6695, 7815 6705 and 7845 6725]. The southern face of the westernmost of these [7805 6695] exposes the following section:

Mudstone, grey, silty, brown-weathering……..	0.75
Mudstone, grey, calcareous……	0.6
<u>Great Limestone ('Tumbler Beds')</u>	
Limestone, grey, bioclastic, bituminous, in posts up to 0.5 separated by mudstone beds up to 0.45 m…….	5.5
<u>Great Limestone ('Main Posts')</u>	
Limestone, grey, bioclastic, bituminous, thickly-bedded……	1.8 seen

As in adjoining parts of Northumberland, the Great Limestone here may be divided readily into an upper division with abundant mudstone interbeds, known collectively as the 'Tumbler Beds', overlying more thickly bedded limestone with mudstone partings only a few millimetres thick, collectively known as the 'Main Posts' (Young and Lawrence, 2002).

The quarries east of Crindledykes limekiln [7815 6705] expose similar sections through the limestone, though without the overlying mudstones.

The easternmost of the Crindledykes quarries [7845 6725] also exposes a similar range of beds. A feature of this quarry is a conspicuous north-east – south-west asymmetrical anticlinal flexure. Though most prominently exposed in the western face, this can be traced across the full width of the quarry. Dips are steepest on the southern limb of this fold, commonly reaching 60°, with a small area in the western face inverted. Such small-scale folds, or 'rolls', have long been known in the Great Limestone of Northumberland (Lebour, 1875; Frost and Holliday, 1980). Shiells (1964) described various folds in the Great and lower limestones throughout Northumberland. In the nearby Morpeth district, Young and Lawrence (2002) demonstrated that these folds typically

occur as groups of *en echelon* periclines, most commonly aligned between north-south and north-east – south-west. Whereas the overlying beds are not generally seen, in one example the overlying mudstone was observed to be virtually unaffected by a sharp synclinal fold within the limestone. The folds may result from minor movements during early Namurian times, perhaps related to tectonic activity associated with continuing development of the Northumberland – Solway Basin.

5 Namurian rocks: Stainmore Formation

Strata belonging to the Stainmore Formation comprise the most extensive surface outcrops of bedrock within the area. However, only to the north of the Haydon Bridge Dyke can the stratigraphical position of these beds be determined with confidence. South of this, a widespread cover of superficial deposits renders the identification, correlation and structural interpretation of the very few exposures of these beds at best highly conjectural.

5.1 STRATA BETWEEN THE GREAT AND LITTLE LIMESTONES, INCLUDING THE LITTLE LIMESTONE COAL

Because they are almost everywhere concealed beneath Quaternary deposits, little is known of the nature of these beds, which comprise the clastic sedimentary rocks of the Great Limestone cyclothem. However, this interval includes the Little Limestone coal, one of the most important and formerly extensively worked coal seams of south Northumberland. This seam has been worked at several places in the eastern half of the present district, the main workings comprising those of the Whinnetley and Whitechapel collieries.

Whinnetley Colliery was worked from at least four adits [81386579, 8167 6603, 8181 6615 and 8206 6640] driven roughly north-westwards from near the seam outcrop, and a shaft [8176 6622] on the hill slope south of Haresby Road. Information from contemporary mine plans, included a mining slip (Northumberland New Series 90 NW(E)), prepared during the 1940s revision mapping, indicates a seam thickness of 0.5 m at [8167 6660], increasing to 0.9 m at the northernmost extremity of the recorded workings [8168 6682]. The mine plans indicate minor disruption of the seam by several small faults.

Whitechapel Colliery was worked from an adit driven north-west from close to the seam outcrop, east of Blackhall Plantation [8095 6521] and from an adit driven north to the seam from the north bank of the South Tyne [8051 6485], a short distance south of the present area. An airshaft [8052 6508] was sunk approximately 450 m west of Blackhall Plantation. A note, presumably derived from a contemporary mine plan, included on a field slip (Northumberland New Series 90SW(E)), indicates that the seam averaged 0.6 m thick underlain by a 0.38 m-thick ‘seggar’, or fireclay seatearth. The mine plans indicate minor disruption of the seam by several small faults.

A borehole at Whitechapel Farm (NY86NW/7) [8029 6500] penetrated 13.4 m of mudstone and sandstone between the Great and Little limestones.

In the mapped area of NY76NE, except for a small exposure in the bed of Kingcairn Burn, close to its confluence with Bradley Burn [7707 6574] near Low Fogrigg, the outcrop of these beds west of Bradley Burn is everywhere concealed beneath till. In this small exposure, approximately 1 m of rather slabby, micaceous, fine to medium-grained sandstone lies immediately beneath the Little Limestone. No exposures of these beds are seen elsewhere in the burn.

The exposure of grey silty and calcareous mudstones, immediately above the Great Limestone in the westernmost quarry at Crindledykes [7805 6695] has been mentioned above (see Section 4.6). East of here, though mapping suggests that significant portions of the outcrop of these beds are essentially drift-free, there are no exposures, though fragments of, flaggy, pale fawn, fine-

grained sandstone were seen in the spoil from a pole foundation at East Crindledykes [7871 6715].

The Little Limestone Coal is nowhere exposed at the surface within the mapped area of NY76NE. It has been extensively worked on both sides of the Bradley Burn. Traces of what may have been small opencast workings on the seam outcrop were noted between East Crindledykes [7865 6702] and East Morwood [7930 6727]. The coal was extracted from extensive underground workings on both sides of Bradley Burn. The workings were accessed mainly from several cross-measures drifts driven from near the outcrop at the former Shaw Head Drift [7587 6541], the former Barcombe Colliery in the Bradley Burn valley [e.g. 7723 6581 and 77126561], near Crindledykes [7831 6692] and at the former Morwood Colliery [7962 6736]. Contemporary records from these workings, noted by the previous survey, suggest that the Little Limestone Coal comprised a single workable seam between 0.45 and 0.5 m thick in the Crindledykes and Morwood area. A borehole (NY76NE/3) drilled in 1939 at Barcombe Colliery, recorded the seam to be 0.53 m thick, underlain by a grey fireclay. A log of 'Mr Addison's Shaft' at Birkshaw Colliery (NY76NE/4), the precise site of which is not known, but is close to [7745 6555], records the seam as 0.6 m thick.

No surface exposures of the beds above the Little Limestone Coal are known in the area. However, the borehole (NY76NE/3) at Barcombe Colliery, mentioned above, penetrated 3.9 m of measures, mainly comprising mudstone and siltstone, between the base of the Little Limestone and the roof of the Little Limestone Coal. Included in these beds is a coal, 0.12 m thick, resting on a grey fireclay, 0.8 m thick, immediately beneath the limestone.

South of the Haydon Bridge Dyke correlation of Stainmore Formation strata is generally uncertain and often, at best, conjectural. However, if the correlation of the limestone exposed [8282 6321] in the un-named stream west of West Lane Ends is the Oakwood, as proposed by the previous survey, it is possible that the limestone exposed on the north bank of the River South Tyne at West Rattenraw [8285 6406] could be the Little Limestone. If so, strata between the Great and Little limestones must crop out on the downthrow side of the fault which hosts the Haydon Bridge Dyke, beneath the valley floor around Lipwood Well [8210 6405]. A small, and normally inaccessible, exposure of sandstone at, or just below river level, on the south bank of the river at Lees Haugh [8177 6360] almost certainly belongs to these beds.

If the 3.6 m-thick limestone, proved at a depth of 42 m in a borehole (NY86SW/2) [8392 6395] on the south side of the River South Tyne is the Little Limestone, a 0.38 metre-thick coal, encountered at a depth of 47.9 m, is likely to be the Little Limestone Coal.

The previous survey recognised the outcrop of a limestone up to 4.6 m thick in Morralee Wood [centred around 8015 6352]. Though not named on either the field slip or Standard from the previous survey (Northumberland 90SW/W) this limestone was identified on the published 1:50 000 Sheet 19 as the Little Limestone. If correct, a coal, of unknown thickness, worked from shallow shafts and surface excavations in the wood is likely to be the Little Limestone coal. In his description of the nearby Morralee lead workings, Dunham (1990, p 263) appears not to accept this correlation and refers to the strata hereabouts as belonging to the 'upper part of the Namurian'. The correlation of this limestone, and thus the underlying beds, cannot therefore be regarded as certain, and must await the results of mapping of the area to the west.

5.2 THE LITTLE LIMESTONE CYCLOTHEM

As outlined above (Section 5.1), a case can be made for considering the limestone exposed on the north bank of the River South Tyne at West Rattenraw [8285 6406] to be the Little Limestone. A total of 2 m of grey bioclastic limestone, in beds up to 0.75 m thick, is exposed here, dipping south-south-east at 12°. A depression [8285 6410], immediately north of the railway appears to mark the site of an old quarry, though it is today completely overgrown and no bedrock is exposed.

A grey limestone, 3.6 m thick, at a depth of 42 m in a borehole (NY86SW/2) [8392 6395] at East Lane Ends may be the Little Limestone. The log records alternations of mudstone and sandstone overlying the limestone.

No exposures were seen during the present survey of the limestone outcrop, mapped by the previous survey, in Morralee Wood (see above, Section **5.1**).

The Little Limestone is nowhere exposed at the surface within the area of NY86NW. Its outcrop position in the west of the area is inferred from information recorded in the workings of Whinnetley and Whitechapel collieries. Fragments of grey bioclastic limestone on the spoil heap from the southernmost adit [81386579] of Whinnetley Colliery are almost certainly derived from the Little Limestone. In the extreme east of the area, its position east of Haydonside Plantation is inferred from observations recorded in the adjoining area to the east.

In the area mapped for sheet NY76NE, the lowest 0.5 m of the Little Limestone, here comprising a massive grey bioclastic limestone, is exposed in the bed of Kingcairn Burn, close to its confluence with Bradley Burn [7707 6574] near Low Fogrigg. No other surface exposures of the limestone are known, though east of Bradley Burn its outcrop must lie near the foot of the steep north-west face of Thorngrafton Common. East of East Crindledykes [7870 6700], its outcrop is marked by a low north-facing scarp feature.

If the limestone in the stream at Robbs Dene [8282 6322] is the Oakwood, as suggested by the previous survey, the few metres of sandstone formerly exposed in the lower reaches of the stream must belong to the upper part of the Little Limestone cyclothem. A coal, almost certainly the Oakwood coal, was mapped by the previous survey, in this stream. The sandstones and sandy mudstones, poorly exposed in the un-named stream south of Lees [8238 6337], are also likely to be at a similar stratigraphical position.

In the area of sheet NY86NW, the outcrop of a sandstone body, several metres above the Little Limestone horizon, has been mapped on the hillside west of Whinnetley Colliery. A number of long-abandoned quarries here expose pale fawn, fine to medium-grained sandstone. Up to 2 m of this rock, in beds up to 0.75 m thick, are present in a small pit [8107 6588] south of High Prior House Wood. Rather flaggy fine-grained sandstone occurs in an old pit [8087 6606] north of the wood.

Exposures of beds above the Little Limestone, in the area of NY76NE, are confined to the area east of Bradley Burn where they form the prominent heather-clad hilly country of Thorngrafton Common. Well marked scarp and dip features, with linear belts of sandstone crags, characterise this country. Sandstone occupies much of the Stainmore Formation succession up to near the assumed horizon of the Oakwood Limestone (see below). Mapping suggests that several sand bodies are present here, perhaps stacked directly one upon another. Locally, well marked belts of ‘slack’ ground suggest the presence of thin and almost certainly impersistent mudstone or siltstone units. The numerous natural crags and abandoned stone quarries mostly reveal pale fawn to brown, sub-arkosic, medium-grained sandstone with conspicuous kaolinised feldspar grains. Much of the sandstone is thickly bedded, especially in the old quarries, said to be of Roman origin, on the hillside above Vindolanda [7754 6609 and 7761 6621] where massive beds over 1 m thick may be seen. Low-angle tabular cross-bedding is seen locally [e.g. 7810 6563]. Rootlet traces, including stigmarian roots, are common in places [e.g. between 7885 6635 and 8000 6680]. *Zoophycos* traces are present on the upper surface of the sandstone bed exposed on the low crags west of West Morwood [7900 6696]. Coarser-grained, rather ‘gritty’ sandstone occurs locally [e.g. 7785 6615 and 7776 6580] but no readily mappable gritty units have been identified.

5.3 THE OAKWOOD LIMESTONE CYCLOTHEM

Only two very small exposures of limestone, correlated by the previous survey with the Oakwood Limestone, occur within the area of sheet NY86SW. The previous survey identified a limestone in the stream at Robbs Dene [8282 6322] as the Oakwood. However, brief notes by R G Carruthers on the field slip (Northumberland 90SE (New Series)) only state "limestone seen". The absence of any other lithological description, or comments on thickness, suggest that exposure was then very poor. No limestone was seen during the present survey. The presence beneath this limestone of a workable coal, of unknown thickness, correlated by Carruthers with the Oakwood Coal, lends support to the identification of this limestone as the Oakwood.

A small exposure of limestone in the stream in Vauce Wood [8016 6254], high on the eastern bank of the Allen gorge, was correlated by Carruthers (Northumberland 90SW (New Series)) with the Oakwood. The exposure was not found during the present survey.

A coal of unrecorded thickness was mapped by Carruthers a few metres above the supposed Oakwood Limestone both in the stream at Vauce Wood and at Robbs Dene. Carruthers noted (Northumberland 90SE (New Series)) "*Lingula* shale on top" of this coal at the latter locality, though neither the coal nor the overlying *Lingula*-bearing bed was seen during the present survey.

In the area of sheet NY76NE, the correlation of certain fossiliferous horizons, then exposed in two streams east of Thorngrafton village, with the Plankey Shell Beds, led the surveyors at the time of the previous survey, to infer the presence of the Oakwood Limestone in the Thorngrafton area. Though these stratigraphically significant exposures could not be located during the recent survey, it is accepted that, in common with adjoining areas, the Oakwood Limestone is indeed very likely to be present here. Accordingly, this admittedly conjectural position of the Oakwood Limestone has been incorporated into the revised version of Sheet NY76NE.

Beds above the assumed position of the Oakwood Limestone crop out in two parallel streams which drain south from near Eastend Town [7895 6547]. It is clear from notes included on the field slip (Northumberland 90SW/W (New Series)), dating from the previous survey, that these streams then provided significant, and almost continuous sections through Stainmore Formation strata. At the time of the present survey (2005), these streams were substantially overgrown with few meaningful exposures. Pale fawn, medium-grained sandstone was observed in the streambeds at 7899 6531 and 7924 6531. A small ferruginous spring today issues from the streambed at the latter position. Summarising the observations of the previous survey, the streams exposed interbedded sandstone, siltstone and mudstone, locally with thin unit of coal. The positions of two coal seams, possibly the correlatives of the Crowhall Coals, the northernmost 0.13 m thick, the southernmost 0.3 m thick, have been included on the revised map. The previous surveyors correlated a sandstone with large *Productus* casts, formerly exposed in each stream [7897 6526 and 7926 6526], with the Plankey Shell Beds.

Neither the Oakwood Limestone nor any of the overlying beds are exposed at the surface in the area of sheet NY86NW. Their position, on the downthrow side of the Grindon Hill Fault, is inferred from the mapping of the adjoining area to the west (NY76NE).

5.4 BEDS BETWEEN THE OAKWOOD AND BELSAY DENE LIMESTONES

Strata of the Stainmore Formation above the Oakwood Limestone are known only from the area of sheet NY86SW. Because of an extensive cover of superficial deposits, exposures of beds between the Oakwood and Belsay Dene Limestones are limited to stream sections at Lees [8230 6317], Robbs Dene [8275 6305] and the lower reaches of the Langley Burn in Gees Wood [8465 6421 to 8480 6391].

Two thin coal seams of unknown thickness crop out in the lower reaches of the Langley Burn [8467 6415]. If Carruthers' (Northumberland 90SE (New Series) identification of the Plankey

Shell Beds, a few metres upstream is correct, these may be the local equivalent of the Crowhall Coals.

Fine to medium-grained micaceous sandstone with shell debris, exposed in the streams south of Lees [8230 6317] and at Robbs Dene [8275 6305], may be correlated with the Plankey Shell Beds. Carruthers (Northumberland 90SE (New Series)), recorded an outcrop of the Plankey Shell Beds "at the foot of the cliff" in the west bank of the Langley Burn [8467 6414], though without any description of the lithology or fauna. The present survey noted only about 0.75 m of rooty sandstone at this point.

Further south in the Langley Burn, Carruthers also recorded the presence of two separate shell beds, possibly the equivalent of the Aydon Shell Beds [8484 6411 and 8485 6408], but again without any description of the lithologies or the fauna. The present survey found approximately 2 m of apparently un-fossiliferous, medium-grained sandstone in two massive beds at the former location. At the second locality a brown medium-grained sandstone was seen to contain casts of poorly preserved shells, probably brachiopods and bivalves, together with a few crinoid ossicles.

5.5 BELSAY DENE LIMESTONE CYCLOTHEM

Grey bioclastic limestone, typically with scattered crinoid fragments, crops out in the bed of the Langley Burn east and north-east of Esp Hill [between 8455 6359 and 8485 6402]. The presence of shell beds, likely to correlate with the Aydon Shell Beds, a few metres downstream, suggests that this may be the Belsay Dene Limestone. The full thickness of the limestone is not seen, though it is unlikely to exceed two to three metres.

Approximately 2 m of fine-grained sandstone and silty mudstone, in indistinct beds up to 0.15 m thick, overlie the limestone in the east bank of the burn [8450 6377], though the junction with the limestone is not seen. Cross-bedded, fine to medium-grained sandstone, slightly higher in the succession, is exposed a few metres to the east [8455 6378].

South of Crook Hill [8455 6360], rather siliceous, fine- to medium-grained sandstone, locally flaggy and with rootlet traces, along with a few thin mudstone and siltstone partings, forms the beds and east bank of the Langley Burn.

5.6 CORBRIDGE LIMESTONE CYCLOTHEM

In this account, the use of the name Corbridge Limestone is retained for this limestone in the area north of the Stublick Fault. It is almost certainly the correlative of the Lower Felltop Limestone of the northern Pennine succession, seen south of the Stublick Fault.

The Corbridge Limestone forms a prominent 4 m high waterfall in the Langley Burn adjacent to the monument, east of Lights Birks [8447 6326]. The rock is here a grey, well-bedded, bioclastic limestone in which crinoid fragments are commonly visible, accompanied locally by concentrations of large productid brachiopod shells. These are especially conspicuous on the weathered surfaces of a very large detached block a few metres downstream from the waterfall [8447 6330]. The limestone forms the bed of the stream for almost 150 m upstream from the waterfall.

The east bank of the burn, approximately 75 m upstream from the waterfall [8444 6317], exposes the top of the limestone overlain by 0.8 m of laminated grey mudstone with layers of clay ironstone nodules, above which lies 0.7 m of fine- to medium-grained sandstone.

Grey limestone, likely to be the Corbridge Limestone, crops out in the bed of the Langley Burn between Langley Castle [8360 6242] and Lintle Hill Plantation [8310 6200]. Extensive excavations in the woodland north of the A686 road [8335 6210] may be old limestone quarries, though no limestone is visible here today. The overgrown faces locally expose medium-grained sandstone which almost certainly overlies the limestone. Sandstone and siltstone are exposed

locally in the thickly wooded slopes south and east of the burn. The previous survey identified a thin coal seam, a few metres above the limestone, though no sign of this was seen during the recent survey.

Overgrown, shallow quarries mark the outcrop of the Corbridge Limestone east of Lough Green [8090 6230], though there are no good permanent exposures of the limestone. However, a small section at the extreme north of the old workings [8105 6243] revealed almost 2 m of dark grey laminated mudstone overlying brown weathering limestone.

A small, long-abandoned quarry [8025 6120], west of Harsondale, exposes about 2.5 m of grey bioclastic limestone in beds up to 0.7 m thick, separated by very thin grey marly partings.

Similar grey limestone, tentatively correlated with the Corbridge Limestone, has been worked in small quarries [8160 6218 and 8160 6219] west of West Deanraw. The northernmost of these workings is today overgrown, though the southern quarry still exposes up to 1.7 m of grey bioclastic limestone with conspicuous crinoid ossicles, in beds between 0.15 and 0.3 m thick separated by grey mudstone partings up to a few centimetres thick. Though the top of the limestone is not exposed here today, exposures of silty mudstone, overlain by fine- to medium-grained sandstone, may be seen a few metres east of the southernmost limestone quarry [8172 6220].

5.7 THORNBROUGH LIMESTONE CYCLOTHEM

A note on the fieldslip from the previous survey (Northumberland 99NW (New Series)) [8116 6162] suggested that grey limestone brash in the fields south-west of Harlow Field Cottage [8130 6183] may indicate an outcrop of the Newton Limestone. The recent survey suggests that this is much more likely to be the Thornbrough Limestone. Its identification is based solely on a few fragments of soil brash and it has not been possible to trace the outcrop beyond the immediate vicinity of Harlow Hill Cottage. Mapping of the ground to the east and south-east reveals the presence of at least two prominent sandstone units above the horizon of this limestone.

Up to 1 m of brown-weathered, grey limestone, exposed in the un-named stream on the south side of the Langley Burn, approximately 550 m south of Langley Castle [8355 6192] may be the Thornbrough Limestone. It has not been possible to trace this outcrop beyond the stream across this densely wooded hillside with any confidence.

5.8 UPPER FELLTOP LIMESTONE CYCLOTHEM AND OVERLYING BEDS

Approximately 1 m of grey sandy limestone, with scattered shell debris, is exposed resting upon sandstone, in the un-named stream on the south side of the Langley Burn, approximately 700 m south of Langley Castle [8360 6177]. Though this bed cannot be traced beyond the stream, 0.8 m of grey bioclastic limestone at the same, or very similar, stratigraphical horizon, is exposed in an old quarry [8438 6265] on the hillside approximately 500 m south of Light Birks. These limestones are tentatively identified here as the Upper Felltop Limestone.

At the second named exposure, the limestone is overlain directly by about 4 m of feldspathic, coarse-grained sandstone. Though no clear evidence of erosion can be determined in this exposure, the texture of this sandstone is reminiscent of similar Namurian sandstones which occupy erosive channels, such as those at Shafto Crags in central Northumberland (Young and Lawrence, 2002). It is possible that the apparently intermittent presence of certain limestones in this area may, in part, be due to ‘wash outs’ by similar sandstones. However, such features are difficult or impossible to recognise in the Haydon Bridge area because of the extensive cover of superficial deposits.

A substantial thickness of Stainmore Formation rocks above the horizon of the Upper Felltop Limestone occur within the area, but the precise stratigraphical position cannot be determined.

6 Westphalian rocks: Pennine Coal Measures Group

Coal Measures rocks crop out as a series of fault-bounded inliers within the Stublick Fault Zone, near the southern margin of the area. Exposures are very few, and details of the stratigraphy and structure, as depicted on the 1:10 000 scale map, are derived almost entirely from contemporary deep mine plans, exploration boreholes and the results of exploration for opencast coal reserves.

The only permanent exposures of Coal Measures rocks within this area occur in the headwaters of the Harsondale Burn, between 200 and 400 m west of Carts Bog Inn [8145 6065 to 8165 6065]. Here, a few metres of silty mudstone, with an unidentified 0.3 m thick coal, crop out on the banks of the burn.

7 Intrusive igneous rocks

Dolerite of the Late Carboniferous Great Whin Sill crops out in the extreme north-west of the area, north of East Twice Brewed. It is well exposed in west facing crags in the sides of a glacial drainage channel to the east of Peel [7540 6745]. Much of the exposed outcrop comprises part of the south-facing dip slope on the top of the intrusion. The top contact of the sill is everywhere concealed beneath superficial deposits.

The northern part of the area is crossed by the Haydon Bridge Dyke, a member of the Northern England Late-Carboniferous tholeiitic Dyke-swarm, emplaced contemporaneously with the Whin Sill-complex. The dyke occupies a roughly east-north-east-trending fault which throws down to the south. There are no exposures of the dyke within the area today though it was formerly quarried for roadstone east of West Mill Hills [8490 6495]. Its width in the eastern part of this quarry was recorded as between 1.5 and 1.8 m at the time of the previous survey. Dunham (1990, p 263) noted that, according to the primary survey, the dyke was cut in an adit [8042 6368] though he gave no description of the dyke rock or of its thickness. However, the previous survey (Northumberland 90SW (New Series)) depicts the outcrop of the dyke north of this adit. No dolerite has been found in the small spoil heap from this adit and, in the absence of any other information, the precise position of the dyke remains unresolved.

8 Structure

Major faults, or groups of faults, naturally divide the geology into a number of discrete areas. The Stublick Fault Zone crosses the southern part of the area between the Allen valley [8000 6115] and Stublick Hill [8500 6110]. Evidence for the nature of this important structural belt is derived mainly from contemporary plans of underground workings in the faulted inliers of Coal Measures rocks within the fault zone. No exposures of the fault zone were seen in the area.

Stainmore Formation rocks south of the Stublick Fault Zone are also poorly exposed, though mudstone and sandstone, of unknown stratigraphical horizon, exposed south of Stublick Syke [8420 6035 and 8429 6028] dip northwards towards the fault at 20°.

The Haydon Bridge Dyke occupies a substantial east-north-east-trending fault to the north of the Stublick Fault Zone. Precise evidence for the amount of throw is wanting in this area though, if the limestone exposed in the banks of the River South Tyne south of West Rattenraw [8285

6406] is the Little Limestone as suggested in section 5.1, the throw must be at least 100 m. This structure may be viewed as an antithetic fault in the hanging wall of the Stublick Fault Zone.

Exposure is limited in the ground between the Haydon Bridge Dyke and the Stublick Fault Zone, though the Stainmore Formation rocks which crop out here appear to be inclined generally to the south-east, typically with dips of 10 to 15° in the exposures in the Langley Burn south of Haydon Bridge. The continuity of this south-easterly dip is interrupted by several north-west and west-trending faults.

Across much of the area north of the Haydon Bridge Dyke, the Carboniferous rocks dip to the south mostly at between 8 and 14°; in the area of NY86NW few dip measurements are available, but where visible, the strata exhibit dips of 10° or less.

The general southerly dip of the Carboniferous rocks on the northern side of the South Tyne valley, to the north of the Haydon Bridge Dyke, is interrupted in the neighbourhood of the Honeycrook Burn by a gentle roughly north-easterly trending anticlinal flexure, the axis of which coincides approximately with the course of the Honeycrook valley.

An another asymmetrical anticlinal flexure, aligned north-east – south-west, within the Great Limestone at the easternmost quarry at Crindledykes [7845 6725] has been noted in section 4.6. This appears to be a very local feature which has not been traced beyond the boundaries of the quarry. It appears to be a representative of a suite of exactly comparable structures, possibly of Namurian age, described from the Great Limestone and other limestones of Northumberland by Lebour (1875), Shiells (1964) Frost and Holliday (1980) and Young and Lawrence (2002).

The north-east-trending fracture, known as the Grindon Hill Fault in the adjoining Bellingham District, where it exhibits a north-westerly throw of at least 70 m, passes into the mapped area west of Hindshield Dam [approximately 8250 6750]. Here it has no surface expression and its position cannot be precisely determined. However, mine plans reveal that it was not cut in the workings of either Whinnetley Colliery or in the most north-westerly driveages from Langley Barony Mine. It is not known to have been cut in the workings of Whitechapel Colliery. Mapping indicates that a fault of this trend and magnitude must intervene between the western parts of the present area and the area of Sheet NY76NE. The course of the Grindon Hill Fault must lie to the north-west of the workings of Whinnetley and Whitechapel collieries.

Prominent NE – SW faults are those which carry lead – zinc – baryte – witherite mineralisation at the Langley Barony mines. Here, north-westerly throws of 12.8 m and 10.4 m were recorded at the Joicey [8312 6657] and Leadbitter [8260 6612] shafts respectively. A north-east-trending fault, almost certainly the southern extension of the Bewick Vein of the Langley Barony mines of the area to the north (NY86NW) has been explored from an adit driven along it from the north bank of the River South Tyne at Waterhouse Mine [8102 6469]. Small parallel fractures, named the Dixon-Brown and St Andrews vein, lie in the hanging-wall block of the Bewick Vein, though the amounts and direction of throw on these is not known.

In the eastern part of the area, the outcrop of the Great Limestone is displaced by two parallel north-east-trending faults, both of which throw down to the south-east. Lead and baryte mineralisation is locally associated with these fractures which are known as the Haydon Fell and Sillyburn veins.

Several north-west-trending faults, of small throw, displace the outcrop of the Four Fathom Limestone in the Honeycrook Burn immediately south of Langley Barony Mine [8260 6584 and 8269 6581]. The former fault is almost certainly the ‘cross vein’ upon which a trial crosscut from the Langley Barony mines is known to have been driven approximately 300 m north-west of the St Andrews Vein, to a point [8188 6629] close the surface position of Whinnetley Colliery. A fault of this trend was identified in the workings of Whinnetley Colliery, though the amount of throw is unknown. The plans of Langley Barony Mine suggest that this fault may be displaced by a few metres (north-west side west) by the north-east-trending Bewick Vein. In the neighbourhood of the Joicey Shaft, records of the workings suggest that locally the Bewick Vein

may be displaced a few metres by small north-west-trending cross veins [8302 6645, 8308 6650 and 8325 6676].

At least two roughly west-north-west-trending faults are recorded in the Little Limestone Coal workings at Whitechapel Colliery, but the amounts of throw, though clearly small, are not clear. These faults may represent continuations of small fractures of this trend, mapped in the lower reaches of the Honeycrook Burn between Whinnetley Farm and Lipwood Hall, in the adjoining areas to the south. A sub-parallel fault, also identified in the Honeycrook Burn [8189 6438] must continue into the present area to the north-east of Prior House [6140 6528], where it must connect with the south-westerly continuation of the Bewick Vein. Its relationship with this vein is not clear from mining records.

A prominent roughly east – west fault with a southerly downthrow, named the Chesterholme Fault in this survey, crosses the Bradley Burn at Chesterholme [7717 6619], east of which it assumes a north-east – south-west course.

Branching from the Chesterholme Fault, immediately east of the Bradley Burn, is a roughly north-north-west-trending fault with a westerly downthrow. Approximately 400 m south of this point the fault branches in the neighbourhood of Birkshaw [7744 6564]. Mine plans of workings in the Little Limestone Coal indicate that the easterly branch has a maximum throw to the west of 36.6 m near Birkshaw [surface position 7762 6565]: the western branch has a maximum throw to the east of 15.2 m south of Birkshaw [surface position 7769 6540].

Minor faults, of unknown throw, and trending west-north-west, west and west-south-west are recorded on plans of underground coal workings beneath Thorngrafton Common. The surface position of these faults is locally reflected in the abrupt end to several prominent sandstone ridges.

9 Mineralisation

The area contains several mineralised veins which, from their general similarity to those of the outer parts of the main Northern Pennine Orefield to the south, have customarily been regarded as comprising an outlying portion of that orefield (Dunham, 1948,1990). However, the deposits are separated by more than 10 km from the nearest significant mineralisation in that area. Moreover, they lie outside of the Alston Block, hosted by Carboniferous rocks belonging to the southern part of the Northumberland – Solway Trough. As the veins of the Haydon Bridge area lie within the hanging wall of the Stublick Fault system, commonly in faults which are sub-parallel and antithetic to that fault, a case may therefore be made to view these deposits as discrete from the main Northern Pennine field. Young et al. (1992) have speculated that these veins may be high level expressions of substantial, possibly syngenetic, base-metal mineralisation concealed at depth in Lower Carboniferous rocks genetically associated with the basin margin.

The area of Sheet NY86NW includes one of the largest of the lead mines of the Haydon Bridge area. Dunham (1990) gave a detailed description of the geology and mineralisation of the veins worked at the Langley Barony mines and Harley (1999) has produced a detailed account of their history. Originally worked for lead ore during the 19th century, the spoil heaps from both the Leadbitter [8260 6612] and Joicey [8312 6657] shafts were re-processed to recover sphalerite concentrates during the 1950s. Substantial tonnages of barium minerals, mainly baryte with smaller quantities of witherite, remain in the large tailings heaps adjacent to Leadbitter Shaft. Proposals were made to recover baryte from these in the 1980s but were not proceeded with. Minerals remaining on the extensive dumps around Leadbitter Shaft include baryte and ankerite, with smaller amounts of galena, sphalerite (much of it in the form of coarsely crystalline ‘schalenblende’, and locally a little witherite. The latter mineral is especially common on a small

overgrown dump, apparently derived from the Honeycrook Adit, adjacent to the Honeycrook Burn [8260 6585].

The southernmost extension of the Bewick Vein of the Langley Barony mines was worked on a small scale for lead ore from Waterhouse Mine, the adit of which was driven as a crosscut through strata beneath the Great Limestone, from the north bank of the South Tyne [8102 6471], west of Minnow Bridge. Dunham (1990, p263) recorded that workings extended 290 m along the vein, probably in sandstone and mudstone above the Four Fathom Limestone. He further noted that the workings cut at least three cross veins, though no indication is given of any mineralisation on these. Small dumps on the riverbank near the adit include brown, possibly dolomitised or ankeritised, limestone together with white and pale pink compact crystalline baryte, some galena and rare witherite. Output for the years 1861-65, and 1880-81, which included a small tonnage from Morralee Mine (see below), amounted to 572 tons of galena, which carried 7 oz silver per ton of lead.

The Bewick Vein was also worked at the Whinnetley Mine, which was accessed through an adit [8153 6478] driven in the Four Fathom Limestone from the north bank of Honeycrook Burn, south of Whinnetley Farm. Mineralisation in the Bewick Vein was worked from 'grey beds' (probably mudstone and siltstone) above the Four Fathom Limestone. Little remains to mark this working today, though the remains of an old dressing place, described by Dunham (1990, p263) in the woods near Lipwood House [8135 6460], can still be located. Compact crystalline pale pink to off-white baryte is abundant here, commonly veining pale brown, probably dolomitised or ankeritised, limestone. A little galena is present and a few very small crystals of chalcopyrite occur scattered through some of the baryte.

Dunham (1990, p. 269) recorded baryte mineralisation along the north-east – south-west fault, known as the Haydon Fell Vein, in the area immediately east of NY86NW, and as thin coatings on joints in the Great Limestone exposed in Carrstones Quarries. Pale pink crystalline baryte, apparently unaccompanied by any other mineral, may be seen locally in these quarries [e.g. at 8476 6648 and 8496 6644]. Notes on the field slip from the previous survey (Northumberland New Series 90NE), refer to trial excavations along the course of the Haydon Fell Vein [8463 6654 and 8442 6652] though with no records of any mineralisation. Similarly, the small spoil heaps from an old shaft, apparently sunk on the course of the vein [8470 6668] shows only limestone and shale spoil.

Also described by Dunham (1990, p263) are several small east-north-east-trending veins in the area of Allen Banks, on the west side of the River Allen. One of these veins occurs in the present area. Its position is taken from the primary survey mapping: little remains to mark its outcrop today. Dunham (1990) noted that none of the veins were mineralised at outcrop, but that a crosscut adit [8042 6350] proved lead ore, presumably in strata above the Little Limestone. This adit cannot be located today, though very small, overgrown spoil heaps mark the site of shallow shafts sunk on, or close to, the vein nearby [8045 6358 and 8049 6354]. Another crosscut adit [8042 6368] is known to have been driven to the vein from the hillside approximately 100 m north of these shafts. According to Dunham (1990, p 263) this adit cuts the Haydon Bridge Dyke though, as noted above (Section 7) the previous survey (Northumberland 90SW (New Series)), depicts the outcrop of the dyke north of this adit. The spoil heap contains much grey limestone, presumably from the Little Limestone, together with fragments of white calcite, traces of pyrite and galena, and rare malachite stains. A shaft [8050 6367] about 100 m east of this adit may be that referred to by Dunham (1990, p263) as having been sunk to test the possibilities of mineralisation along the course of the Haydon Bridge Dyke. No mineralisation is today visible in the remaining spoil and the reasons for this, presumably unsuccessful, trial are not known.

The north-east-trending Sillyburn Vein, is known to have been mineralised in the Great Limestone near the eastern margin of the area. A small amount of spoil in the overgrown field edge [8500 6606] is all that remains of the spoil heap from the uppermost of two trial levels described by Dunham (1990, p. 269). Small amounts of pale brown ankeritised or dolomitised

limestone, together with some pink baryte and galena were seen during the present survey. A little white baryte exhibiting the sharply terminated crystal morphology characteristic of baryte developed secondarily after a barium carbonate mineral (Dunham, 1990) were observed, though no barium carbonate mineral was found.

The purpose of an adit [8442 6538] driven north from Cruel Sike, approximately 100 m west of Page Croft, is unknown. The adit offered no realistic prospects for coal or ironstone, though it may have been an attempt to test the Sillyburn Vein, the surface outcrop of which lies about 250 m north of the adit portal. Fragments of galena, reported from the garden of Page Croft by the owner, Mr Smith, may possibly have been derived from this adit.

No mineral veins are known within the area of sheet NY76NE, however, the Ordnance Survey base map for Northumberland 89NE (New Series) refers to 'Old lead mines' in the Brackies Burn [7650 6664]. In addition, a note on the fieldslip from the previous survey refers to an old lead level apparently driven into the southern bank of the burn here, though makes no mention of any vein or associated mineralisation. No sign of the level, and no evidence for any mineralisation, or of any fault which might host mineralisation, was detected during the present survey.

10 Quaternary and Artificial deposits

There is evidence for glacial erosion within the area and deposits from the ice-sheets form an extensive mantle of variable thickness across the area. Deposits of the River Tyne and its tributary valleys are also significant. Some areas of man-made deposits have been mapped.

10.1 GLACIAL EROSION FEATURES AND MELTWATER CHANNELS

Scouring by eastward moving ice is likely to have created, or at least enhanced, the elongate basins between sandstone ridges on Thorngrafton Common, especially those today occupied by peat south of East Morwood.

The Whin Sill crags immediately east of Peel [7540 6745] mark the eastern side of one of a number of a glacial drainage channels which cut the Whin Sill escarpment in the Hadrian's Wall area.

A prominent gully-like feature north of Carts Bog Inn [8180 6067] may be a channel through which glacial melt waters flowed into the Allen Valley via the Harsondale Burn, from a former lake within the wide basin between Carts Bog Inn and Nilston Rigg [8260 6080].

A conspicuous valley without a modern stream, and which runs eastwards from Langley Moss [8250 6133] may be a glacial drainage channel.

The B6295 road, south of Stublick [8355 6015] runs in a prominent valley, interpreted during the previous survey as a glacial drainage channel cut through till. A roughly parallel channel, approximately 300 m further east, may also be a glacial drainage channel.

10.2 TILL OR BOULDER CLAY

Most widespread is an almost continuous mantle of till or boulder clay which typically gives rise to rather smooth topography. In the area of sheet NY86NW, crude, smooth, rounded ridges aligned roughly ENE-WSW are common and may be poorly developed drumlins. On sheet NY76NE till is generally confined to a few comparatively restricted patches east of the Bradley Burn, but in the west of the area it comprises an almost complete cover, with bedrock exposed at only a handful of places. West of Bradley Burn, and south of Brackies Burn, the till-covered country exhibits a number of large well rounded roughly east – west orientated drumlin-like

ridges. Viewed from the highest points of Thorngrafton Common, these contrast markedly with the characteristic 'cuesta' landscape of the Carboniferous rocks and Whin Sill country north of the Brackies Burn.

Much of the area's till comprises clay or sandy clay with a variable stone content comprising mainly locally-derived Carboniferous sandstones and smaller amounts of limestone, together with some Whin Sill dolerite and, more rarely, volcanic lithologies from the Lake District, and greywacke sandstones and granitic rocks from south-west Scotland. A single small pebble of Shap Granite was identified in soil derived from till north-east of Esp Hill, Haydon Bridge [8470 6405].

Till thickness clearly varies considerably across the area. Up to 49 m of till, including some gravel, were recorded in an air shaft [8052 6508] at Whitechapel Colliery, according to a note, attributed to Lebour, on field slip Northumberland New Series 90SW(E). The log of the Joicey Shaft [8312 6657] at Langley Barony records 10.5 m of till. Boreholes at Muckle Moss (NY86NW/18) [8069 6669] and Whinnetley Moss (NY86NW/19) [8193 6662] were both drilled to 18 m without bottoming stony clay with cobbles of limestone, sandstone and mudstone. The log of the former hole records the presence of cobbles of pink granite. Two closely spaced boreholes at Whitechapel Farm (NY86NW/7) and (NY86NW/80) [8029 6500 and 8030 6501] record stony and gravely clay between 16 and 21 m thick, overlying Stainmore Formation bedrock. At least 8.5 m of till, with large limestone and sandstone boulders, were recorded in a borehole (NY86SW/3) [8287 6380] on the southern side of the River South Tyne. The borehole (NY76NE/1) [7623 6676] on the north side of Brackies Burn, proved 6.2 m of stony and sandy clay. A borehole at Seatsides (NY76NE/2) [7502 6615] recorded 70 m of brown and grey boulder clay, with a 0.6 m thick bed of sand 40 m above the base.

10.3 GLACIOFLUVIAL DEPOSITS

Small areas of glaciofluvial sand and gravel form conspicuous mounds at Chesterwood [around 8285 6515], on the upper slopes of the east bank of the Honeycrook Burn [around 8250 6520]. Glaciofluvial sand and gravel are also found on the higher ground north of Lipwood Hall [8175 6470] and west of Whinnetley Farm [8120 6490]. Much smaller patches of these deposits have been mapped around Haydon Bridge and at several places on the south side of the South Tyne around Morralee Wood [8040 6380] and Tedcastle [8100 6385], near Lees [8245 6335], and in a linear belt [8380 6315 to 8485 6415] between Light Birks and Haydon Bridge. The only evidence of any working of these deposits is an overgrown sand pit [8382 6320] west of Light Birks.

Though no deposits of this type have been mapped at the surface in the area of NY76NE, a 0.6 m thick bed of sand within the till in the borehole (NY76NE/2) at Seatsides, may have be of glaciofluvial origin.

10.4 ALLUVIUM, RIVER TERRACE AND ALLUVIAL FAN DEPOSITS

Flat, low-lying areas of alluvium up to 300 m wide flank the River South Tyne and extend upstream into the River Allen in the extreme west of the area and up to two well marked terraces may be traced on both sides of the River South Tyne. Much smaller areas of alluvium occur elsewhere adjacent to small streams. Prominent terrace features around East and West Morralee [8055 6425 and 8080 6435] may represent deltaic deposits formed at the mouth of the Allen gorge, possibly during early post glacial times.

Small alluvial fans have been mapped in the lower reaches of several streams, for example between Lees [8235 6360] and East Lane Ends [8340 6370] and at West Mill Hills [8460 6485]. There are few good permanent sections through any of these deposits, though they appear to consist mainly of silt, sand and gravel.

A temporary section, exposed during July 2005, in the hillside immediately north of Alexandra Terrace, Haydon Bridge [8431 6467], revealed up to 4 m of coarse gravel belonging to the Second Terrace of the South Tyne, resting directly upon a roughly horizontal surface of grey stony till.

A borehole on West Lane Ends Farm (NY86SW/3) [8287 6380] proved approximately 3.3 m of alluvial gravels overlying till. At East Lane Ends, another borehole (NY86SW/2) [8397 6395] proved 2.9 m of alluvial deposits, comprising gravel and clay, overlying bedrock.

Several site investigation boreholes (NY86SW/10) [centred around 8440 6435] indicated the presence of superficial deposits, comprising alluvial silts and gravels and till, to depths of around 8.2 m. The logs do not readily enable the alluvial deposits to be distinguished from till.

A borehole (NY86SW/11) [8341 6415] proved sands and clays to at least 18.2 m.

A number of boreholes (NY86SW/26 – NY86SW/34) drilled along the floor of the South Tyne valley as part of an investigation of sand and gravel resources in 1975, revealed alluvial sands and gravels up to 19 m thick locally, e.g. in borehole NY86SW/28 [8099 6433].

In the areas of Sheets NY76NE and NY86NW small areas of alluvium flank some streams, including the Brackies [7558 6664 to 7600 6653] and Bradley [7720 6500] burns and comprise variable mixtures of clay, silt, sand and gravel of local derivation.

10.5 PEAT

Peat occupies hollows within the till or bedrock surface in several locations in the mapped area. Small accumulations of peat occur in the Langley Moss [8200 6125], Carts Bog [8220 6070] and Langley [8360 6060] areas. The thickness of peat is unknown, though a single ditch section in the former area [8217 6076] revealed up to 1.5 m of peat resting on gravel.

Peat is present to the north and north-west of the area mapped for sheet NY86NW. Though in places over 1 m thick, little is known of the thickness of these deposits. The roughly circular, isolated area of peat north-west of Whinnetley Moss [centred around 8115 6665] exhibits a well developed convex rounded upper surface, typical of raised bogs.

Extensive expanses of peat occur in two places within the area of NY76NE. In both instances the depressions are elongated along the strike of the underlying strata and are clearly the result of glacial scouring. One area of peat lies at the foot of the Whin Sill dip slope between Peel [7550 6730] and High Shield [7700 6745]. The other area occupies a hollow between the prominent sandstone ridges of Thorngrafton Common, south and east of East Morwood centred around 7970 6690]. At the western end of the latter area, lobate extensions of the peat extend westwards between small sandstone ridges. The maximum thickness of peat is unknown.

These peat areas have considerable conservation importance as examples of the fragile ‘border mire’ habitat.

10.6 LANDSLIP

Substantial areas of landslipped till have been mapped on sheet NY86SW, on the upper slopes of the Allen gorge at Sillywrea and Staward Peel woods [8010 6200 and 8040 6030]. Whereas slipping here may result merely from the over-steepening of the till-covered slopes adjacent to the steep gorge sides, lenses or beds of water-bearing sands, gravels or laminated clays, which may be present within the Quaternary sequence, may also be a causative factor. Smaller areas of landslipped till also occur on the steep south side of the Langley Burn [8440 6300] and on the north face of Humbleton Hill [8405 6220 and 8435 6230].

In the area of NY86NW, a small area of landslip has been mapped on the south bank of the Honeycrook Burn upstream from the site of Nattrass’s Level [centred around 8290 6606]. The

slipped material comprises strata above the Four Fathom Limestone, which here consist mainly of mudstones and siltstones. The slip probably results from over-steepening of the valley.

Two areas of landslip occur in the valley of Bradley Burn on Sheet NY76NE, downstream from Chesterholme [centred around 7725 6610 and 7715 6550]. Both occur on outcrops of till and appear to result from undercutting of the slope by the stream.

10.7 ARTIFICIAL GROUND

On Sheet NY76NE small areas of colliery spoil, mainly comprising waste mudstone, though with smaller amounts of sandstone, limestone and ironstone fragments, occur adjacent to former coal workings at Barcombe [7718 6576] and Morwood [7965 6740] collieries. In addition, colliery spoil has been used to infill part of the group of quarries at Crindledykes, east of the limekilns [7830 6715].

Much of the Roman site at Vindolanda is founded on artificial deposits, mainly composed of earth from levelling of the site and demolition and re-use of previous buildings. Part of this site is noteworthy for the deposits of Roman waste which, because of unusual anaerobic ground conditions, have proved to be a prolific source of otherwise ephemeral artefacts such as leather, fabric and wooden writing tablets.

In the area of Sheet NY86NW substantial areas of artificial ground occur adjacent to the two main shafts of Langley Barony mines. Though much of the spoil from the Joicey Shaft [8312 6657] was removed to the site of Leadbitter Shaft [8260 6612] during the 1950s for the extraction of sphalerite, spreads of mine waste still remain here. The mine spoil at Leadbitter Shaft includes both coarse rock from the original mining operations, as well as large heaps of sand-grade tailings remaining from the sphalerite extraction. A very small area of spoil, consisting mainly of mudstone with a few blocks of baryte-rich veinstone, is present adjacent to Brigden Shaft [8225 6580].

Small areas of colliery waste, mainly mudstone, too small to depict on a 1:10 000 scale map, remain adjacent to coal workings at Whinnetley Colliery, though one larger accumulation has been mapped adjacent to the southern-most adit.

Mappable areas of artificial ground on Sheet NY86SW are confined to very small areas of spoil from blackband ironstone workings at Honeycrook Burn [8235 6500], an earth bank forming part of a school playing field at Haydon Bridge High School [8375 6440], domestic waste in a former land-fill site at the old whinstone quarry at West Mill Hills [8495 6495] and a small accumulation of quarry spoil adjacent to the old limestone quarry at West Deanraw [8153 6220]. Substantial quantities of colliery spoil, associated with numerous coal workings across the outcrops of Westphalian Coal Measures strata, and slag and other waste from the former lead smelting works at Langley [8300 6155] are too dispersed to be mapped separately.

11 Economic geology

11.1 SANDSTONE

Wherever drift-free, most of the outcrops of sandstones, both of the Alston and Stainmore formations have been worked on a very small scale, probably mainly to supply stone for walling and local farm buildings.

Rather larger quarries may be seen in the thickly bedded sandstones which lie above the Little Limestone on Thorngrafton Common, especially on the steep hill slopes to the east of Vindolanda [7762 6620 and 7785 6608]. The presence of interesting Roman graffiti on the wall

of the first of these quarries has been taken as evidence of Roman working, possibly to supply stone for the construction of Vindolanda and parts of Hadrian's Wall.

Local tradition claims that the standing stone, known as the Long Stone [7786 6641], is a monument to quarrymen killed in the nearby sandstone pits.

Further working of sandstone, except for very small-scale local use, is extremely unlikely.

11.2 LIMESTONE

The Great Limestone has been worked on a substantial scale in several shallow pits at Carrstones Quarries [centred on 8485 6640]. The Great Limestone has also been worked in the Crindledykes neighbourhood. Several quarries here extracted stone which was burnt in kilns by the roadside south of West Crindledykes [7808 6700]. These kilns were recently restored by the Northumberland National Park Authority and an interpretation panel erected.

The Four Fathom Limestone has been worked in a small quarry [8255 6545] north-west of Chesterwood. It is likely that most of the stone quarried was burnt for use as quicklime and slaked lime. This unit has also been worked on a small scale in the steep sides of Honeycrook Burn south of Whinnetley Farm [around 815 6480].

A depression [8285 6410], immediately north of the railway near West Rattenraw [8285 6406] appears to mark the site of an old quarry, possibly in the Little Limestone, though it is today completely overgrown and no bedrock is exposed.

Completely overgrown excavations on the north side of the A686 road between Lintle Hill Plantation [8310 6200] and Langley Castle [8360 6242] may mark long-abandoned quarries in the Corbridge Limestone, though no limestone is visible here today. The Corbridge Limestone has also been worked in small quarries east of Lough Green [8090 6230], west of Deanraw [8160 6218 and 8160 6219] and west of Harsondale [8025 6120].

Further commercial interest in limestone is extremely unlikely.

11.3 COAL

Coal has been worked underground from the Little Limestone Coal at Whitechapel and Whinnetley collieries [8051 6485] and in the vicinity of Morralee Wood [centred around 8015 6352]. The Little Limestone Coal has also been extensively worked, mainly by underground mining, on both sides of the Bradley Burn. Although significant reserves may remain, it is unlikely that a single seam of such small thickness would attract further economic interest.

A coal, correlated with the Oakwood Coal, which crops out in Robbs Dene [8282 6322] has been worked from an adit [8295 6345] driven from the east bank of Robbs Dene, though the extent of the workings is unknown. A note by Carruthers on the field slip (Northumberland 90SE (New Series)) suggests that working may have taken place in the late 19th century.

A pair of coal seams which lie between the Oakwood and Belsay Dene limestones, which may correlate with the Crowhall Coals were worked on a small scale in the lower reaches of the Langley Burn, near Haydon Bridge [8467 6415].

The faulted inliers of Coal Measures rocks, associated with the Stublick Fault System, have been extensively worked from innumerable small shafts and several adits. Particularly striking are the closely spaced shafts with their circular mounds of spoil in the neighbourhood of Stublick Bog [centred around 8380 6080]. The fine pit-head buildings, including the pumping engine house and chimney of the long-disused Stublick Colliery [8332 6040] are listed historic buildings and prominent landscape features. During the early 1980s exploration identified coal reserves suitable for opencast working in the Stublick area, though planning consent for extraction was not granted and the remaining reserves remain intact.

Future economic interest in coal in the area is unlikely.

11.4 FIRECLAY AND BRICK CLAY

Seatearth mudstones, associated with the Westphalian coal seams of the Stublick area provided the raw materials for the manufacture of fireclay products at Langley Fireclay Works [8280 6115]. Products included refractory goods and sanitary wares. Further commercial interest in fire and brick clay is possible as by products of opencast coal mining, should this ever be undertaken in the area.

11.5 SAND AND GRAVEL

Deposits of glaciofluvial sand and gravel are very small, though small amounts have been worked for local use near Light Birks [83906320] and possibly west of Whinnetley Farm [8105 6489]. Further commercial interest in sand and gravel is extremely unlikely. The very small deposits near Chesterwood have not been worked and are of no commercial interest.

11.6 PEAT

There is no evidence of peat extraction in the area, either as a fuel or soil improver. Commercial interest is unlikely, especially as such peat deposits in this part of Northumberland are of very high conservation value.

11.7 IRON ORE

Blackband ironstone in the strata beneath the Four Fathom Limestone was formerly worked on the eastern side of the Honeycrook Burn [8235 6500].

Clay ironstone nodules were formerly worked from the mudstones overlying the Three Yard Limestone in a quarry on the north bank of Brackies Burn [7670 6668]. This working forms part of a 4 mile strike length of workings for clay ironstone ‘ballstones’, from the beds above the Three Yard Limestone, exploited during the mid 19th century, referred to by Strahan et al. (1920). The tonnage raised is unknown, though from the extent of the workings this cannot have been large. It is not known where the ore was smelted.

Further commercial interest in iron ores in the area is improbable.

11.8 NON-FERROUS ORES

Substantial tonnages of lead ore were raised in the 19th century from the Langley Barony mines (Dunham, 1990). Some lead ore was also raised from Alston Formation strata at Waterhouse Mine [8102 6471] and Whinnetley Mine [8153 6478]. Lead ore was also worked from veins which cut Stainmore Formation strata in Morralee Wood [between 8042 6350 and 8050 6367]. No complete production figures are available, but the amounts raised are likely to have been very small.

The area included one of the largest and most productive lead smelting mills of the Northern Pennine Orefield. Langley Smelt Mill [8300 6155] was built by the Commissioners of Greenwich Hospital to smelt duty ore from mines on their Alston Moor estates. Some zinc ore was also smelted here in the early years of the 19th century. Little remains to mark the site of the smelting works, though the reservoirs built to supply water to power the works survive [8310 6145 and 8275 6095] and the smelt mill chimney [8405 6109] and its associated system of flues leading from the mill, remain conspicuous landscape features.

Further commercial interest in non-ferrous ores is extremely unlikely.

11.9 BARYTES

Although an abundant gangue in the Langley Barony veins, baryte was never recovered either during lead mining or during the later re-working of the spoil for zinc ore. Substantial tonnages remain in the tailings heaps at Leadbitter Shaft, though they remain unworked.

12 Environmental issues

12.1 LANDSLIPPING

There is evidence of intermittent movement on the substantial areas of landslipped till at Sillywrea and Staward Pell woods [8010 6200 and 8040 6030], high on the eastern side of the Allen valley. This may influence land management of the valley slopes and adjoining land. In the area of sheet NY76SE, the presence of small areas of landslip on till, in the valley of the Brackies Burn [7725 6610 and 7715 6550] demonstrates the potential for instability, at least locally, of this deposit.

12.2 COAL MINING

Although comparatively shallow underground coal workings are present beneath significant parts of the area, little evidence of subsidence or other environmental problems typically associated with such long-abandoned workings has been identified.

Some small seepages of ferruginous water were observed. In the ditch immediately south of the southern-most adit of Whinnetley Colliery [8140 6568] a minor seepage is almost certainly formed as a leachate from adjoining colliery waste. An intermittent discharge of iron-rich water, derived either from abandoned underground workings, or from leachates originating in colliery spoil, is conspicuous on the east of the road a few metres south of Crindledykes lime kilns [7809 6667]. The discharge has produced small deposits of bright orange-brown ochre at the roadside and in the fields immediately to the west. A small discharge of ferruginous water [7924 6531] which issues from the bed of the un-named stream south-east of Eastend Town is likely to be a natural spring. Small encrustations of white, possibly aluminium-rich deposits are associated with a small discharge of water in the Langley Burn [8471 6415], south of Haydon Bridge. The discharge here takes the form of a roughly 1 m long, horizontal very narrow jet of water issuing from the west bank of the burn, immediately above the normal stream level.

Small accumulations of colliery spoil remain at the former Barcombe [7723 6581 and 77126561 and Morwood [7962 6736] collieries, though there is currently no evidence of any contamination derived from these affecting the adjoining ground or water bodies.

Numerous closely spaced shafts, with associated circular mounds of spoil, mark the outcrop of the Coal Measures rocks in the neighbourhood of Stublick Bog [centred around 8380 6080] and to the west of Carts Bog [centred around 8150 6090]. There is evidence in these areas of subsidence over underground workings. No evidence of surface discharges of mine water or gas are known to be associated with these workings. Discharges of ferruginous water at two places in Langley Wood [8303 6167 and 8329 6151] may be natural springs associated with Stainmore Formation rocks: they are likely to be too distant from any known workings to have an origin as mine water.

12.3 METALLIFEROUS CONTAMINATION

Spoil heaps associated with metalliferous workings are almost certainly too small, and with such low mineral contents, to present a significant contamination threat. However, contamination of

the Honeycrook Burn from fine-grained zinc- and lead-bearing tailings from the large spoil heaps at Langley Barony Mine, in the adjoining area to the north (Sheet NY86NW) is possible.

Substantial areas of smelt mill waste, including slags from lead and zinc smelting and processing remain in the vicinity of the former Langley Smelt Mill [8300 6155]. In addition, small areas of potentially high lead and other heavy metal contamination are almost certainly associated with much of the system of flues leading from the smelt mill to Langley Chimney. During the present survey small areas of pale grey soil, barren of any vegetation, were noted along the course of the collapsed flue [8338 6126 and 8351 6111] and in the neighbourhood of the chimney [8400 6109 and 8405 6109].

Substantial volumes of mine waste, including large amounts of sand to silt-grade tailings, are present adjacent to Leadbitter Shaft at Langley Barony mines. Although this is waste remaining after the commercial extraction of lead and zinc minerals, small but significant amounts of heavy metals remain in these deposits. Substantial areas of this spoil remain un-vegetated today. These accumulations of spoil have the potential to contaminate streams, most notably the upper reaches of the Honeycrook Burn. Because of the fine-grained nature of the tailings, there is some potential for air-borne contamination.

12.4 CONSERVATION

Part of the area lies within the North Pennines Area of Outstanding Natural Beauty (AONB) which now enjoys the designation of a European Geopark. Conservation, management and interpretation of features of geological interest within the Geopark are addressed within a comprehensive Geodiversity Audit and Action Plan (North Pennines AONB Partnership, 2004).

The remaining buildings of Stublick Colliery are understood to be protected as a Scheduled Ancient Monument.

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Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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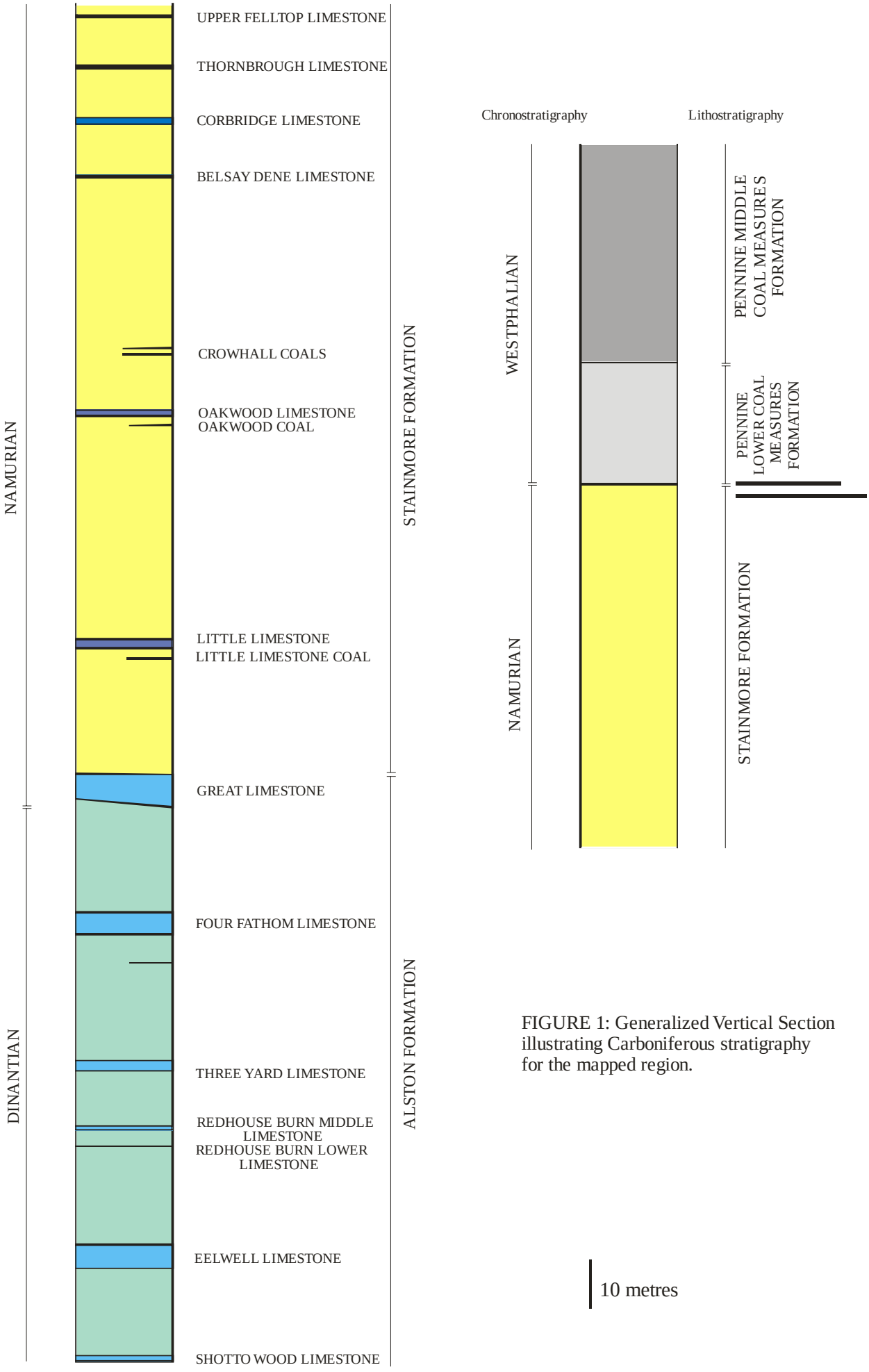

FIGURE 1: Generalized Vertical Section illustrating Carboniferous stratigraphy for the mapped region.

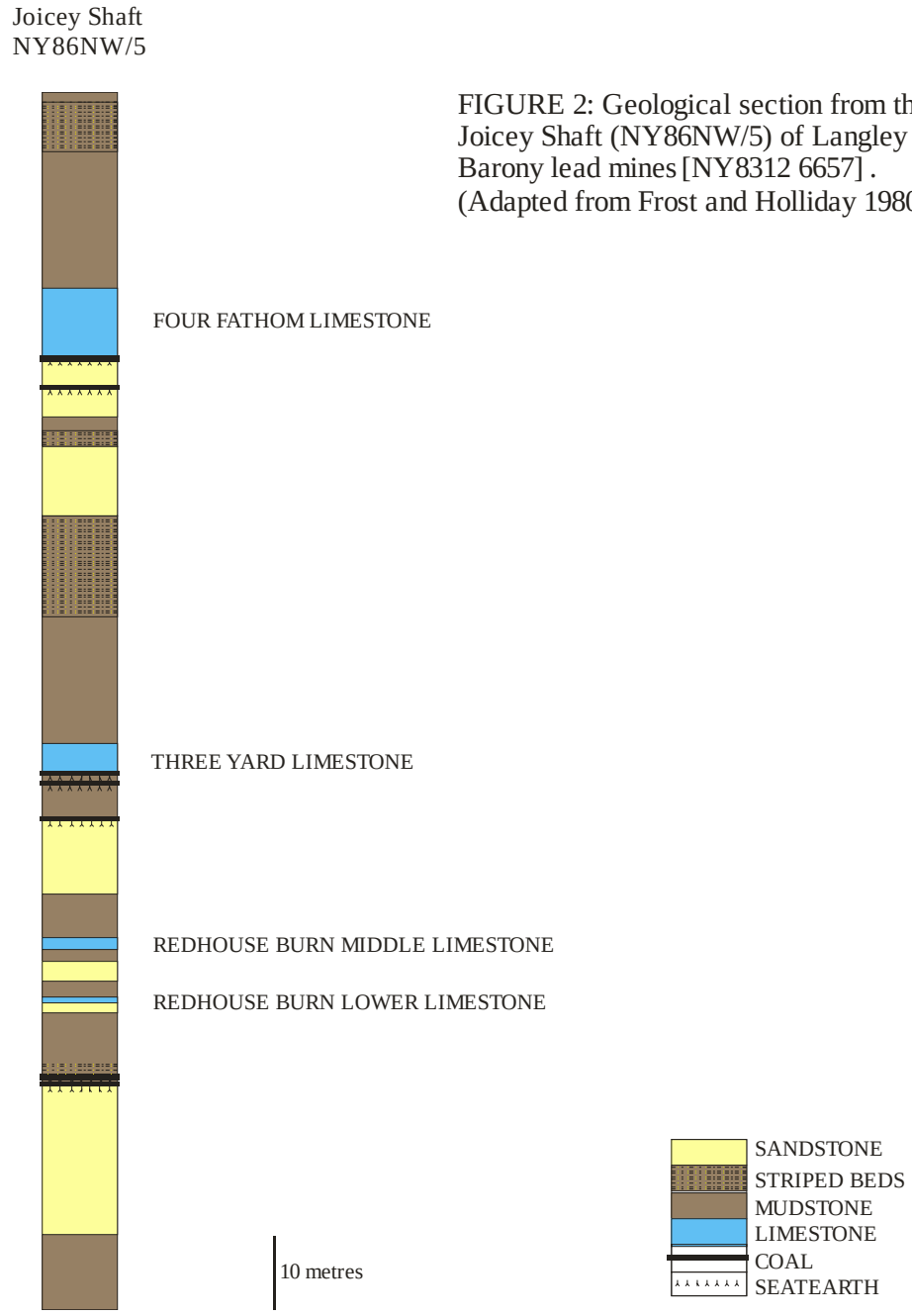

FIGURE 2: Geological section from the Joicey Shaft (NY86NW/5) of Langley Barony lead mines [NY8312 6657] . (Adapted from Frost and Holliday 1980)