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Geological Survey of England and Wales

Geological notes and local details for 1:10000 sheets NZ15NW, NE, SW and SE

Chopwell, Rowlands Gill, Consett and Stanley

Part of 1:50000 Sheet 20 (Newcastle upon Tyne)

D. A. C. Mills

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PREFACE

This account describes the geology of 1:25 000 Sheet NZ 15. The area falls within 1:50 000 Sheet 20 (Newcastle upon Tyne); it was first surveyed by H.H. Howell, the maps being published on the old County meridian six-inch scale between 1868 and 1871. The area was resurveyed between 1923 and 1948 by A. Fowler and W. Anderson, on the new County meridian, some of the maps being published in 1954.

The present maps are based on a full scale revision begun in 1976 by D.A.C. Mills, with J.G.O. Smart and Denys B. Smith as District Geologists.

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SCOPE AND AIM OF REPORT

This report is a summary of the geology of 1:25 000 Sheet NZ 15. Its aim in conjunction with the accompanying 1:10 000 and 1:10 560 maps, is to provide a framework and guide to the main aspects of the geology as they affect the long term planning and development of the area. The more fundamental scientific aspects of the geology will be included in a study of a wider area.

The information and details on which this study is based may be obtained initially by reference to files and documents held at the North of England Office of the Institute of Geological Sciences, Windsor Court, Windsor Terrace, Newcastle upon Tyne NE2 4HE. Any enquiries should be directed to the District Geologist at the above address.

INTRODUCTION

This account outlines the geology of 1:10 000 Sheet NZ 15 NW and 1:10 560 Sheets NZ 15 NE, NZ 15 SW and NZ 15 SE which are available as uncoloured dyeline maps. Details shown on the maps are supplemented by notes on the margins which include information on the more important surface, borehole and shaft sections.

The area (Fig. 1) forms part of Geological Survey of Great Britain (England & Wales) 1:50 000 Sheet 20 (Newcastle upon Tyne) which is currently under survey and approaching completion. It was first geologically surveyed on the six-inch scale by H.H. Howell, the maps being printed between 1868 and 1871 as Six-Inch Northumberland County 'Old Meridian' and Durham County sheets. Subsequently, the area was resurveyed at various times between 1923 and 1948 by A. Fowler and Mr W. Anderson. Some of these maps were published in 1954 as Six-Inch Durham County Quarter sheets, the remainder being issued as manuscript maps for consultation purposes.

A partial revision of the area on Six-Inch National Grid sheets was undertaken in the late sixties by Messrs. P.M. Allen, D.W. Holliday, A. Reedman and G. Richardson and although these maps were not published they provided a valuable temporary coverage.

The present Six-Inch and 1:10 000 maps are based on a full scale revision begun in 1976 by D.A.C. Mills. The generalized data will be included in 1:50 000 Geological Sheet 20 (Newcastle upon Tyne).

Despite the mineral wealth that has been derived from the area largely over the last one and a half centuries no comprehensive account of the geology has ever been published. Only indirect reference has been made to the subject, and much of the information is available only in unpublished maps, plans, borehole records and internal reports, most of the latter relating to the coal mining industry and to a lesser extent to the steel industry. Much of this information will remain unpublished although access to it will generally be available through the Institute of Geological Sciences (Newcastle Office).

Overlays, isolating various aspects of the geology, can be produced if required but they would do little to augment the data already presented on the maps.

GEOGRAPHY, LAND USE AND POPULATION

The area forms part of south-west Tyne & Wear and north-west Co. Durham; two small parts in the north-west notably Hedley Fell, and between the Milkwell Burn and the River Derwent (Fig. 1) are in Northumberland. The main centres of population are Stanley, Consett, Annfield Plain, Chopwell, High Spen, Rowlands Gill and Burnopfield. Most of the ground is of moderate rolling relief whose overall altitude falls from about 260 m A.O.D. in the west to c. 150 m A.O.D. in the east. The highest points are a at Pontop Pike (over 312 m A.O.D.), north of Chopwell and also in the north-west corner of the area near Hedley Fell. The steep-sided valley of the River Derwent forms a pronounced feature crossing the north-western part from Ebchester to below Rowlands Gill; the valley bottom ranges between 21 and 63 m A.O.D. and forms the lowest tract of ground in the area. Most of the drainage is into the Derwent system, the main exceptions being that in the Stanley and Annfield Plain vicinity where water drains into the Causey Burn (and thence into the River Team), and south of Leadgate where drainage is into the Iveston Burn (and thence the River Browney).

Despite the extensive mining that has taken place most of the area retains a largely rural aspect; much of the ground is given over to mixed agriculture although pasture and livestock rearing predominates. A substantial area is woodland, more particularly along the Derwent Valley; Chopwell Wood east of Chopwell is by far the largest. The settlements and smaller townships that grew up largely owe their existance to the sites of former collieries and these include Chopwell, High Spen, Burnopfield, Dipton and Tantobie. The town of Stanley (together with Annfield Plain) chiefly owes its size to what was one of the largest collieries in the district. Consett falls into a slightly different category; its growth largely sprang from the development of the Iron Works sadly closed in 1979. With the run down of the coal industry over the last twenty years and more recently with the closure of BSC Consett the area has been dealt a crippling economic blow only partly cushioned by the incoming of less labour-intensive light industry.

Despite the heavy industry that has played such an important role in its development the bulk of the area is rural; landscaping has removed almost all traces of the former coal mining industry. Much of the wooded Derwent valley here is regarded as a highly desirable residential area and there are many local beauty spots.

GENERAL GEOLOGY

The area is composed of mainly gently dipping Carboniferous Westphalian (Coal Measures) rocks near the western margin of the Northumberland and Durham Coalfield; these are widely overlain by a mantle of drift deposits.

A sketch map of the solid geology of the area and the outcrop of a selection of the coal seams is shown in Fig. 2.

Details of the distribution, nature, conditions of deposition and sedimentology of Carboniferous strata in north-east England are outlined in various I.G.S. publications e.g. Taylor et al. 1971, while detailed consideration is given to Westphalian rocks in memoirs covering the Tynemouth District (Land, 1974) and the Durham and West Hartlepool District (Smith and Francis, 1967).

(a) Exposure of solid rocks and drift deposits

Surface exposure of bedrock is largely confined to man-made excavations such as quarries and cuttings; scattered natural exposures may be seen on some steep hillsides and also in parts of some burns such as Pontop Burn near Hamsterley Hall, Causey Burn below Tanfield, and locally in the Derwent valley. Everywhere else drift deposits of varied character and thickness mantle the rockhead surface. This surface however, with one or two exceptions, broadly parallels the outlines of the present day topography; were the cover of drift deposits to be removed, most of the valley bottoms would be seen to be appreciably lower than now. Areas shown as drift-free on the maps (i.e. the relevant solid symbol is not fractionated) do not necessarily have rock visible at the surface, but may include a drift veneer up to 1.82 m thick.

Good sections and exposures in the drift deposits also are limited: more commonly their character is revealed by the nature of the topography and study of the soil, etc.

(b) Classification and Geological Sequence

The drift (superficial) deposits and solid formations shown on the maps and generalized vertical sections are listed below:

Drift (Superficial) deposits:

- Made Ground
- Landslip
- Alluvium
- River Terrace Deposits
- Boulder Clay
- Glacial Sand & Gravel

Solid Rocks:

CARBONIFEROUS	Upper Carboniferous	Westphalian B (Cb)
		" A (Ca)
		Namurian
	Lower Carboniferous	Viséan

Strata referred to Westphalian B correspond with what was formerly termed Middle Coal Measures whereas middle and upper Westphalian A strata comprise what was formerly termed Lower Coal Measures. The lowest Westphalian A and Namurian strata correspond to the old Millstone Grit and Upper Limestone

Group, and the Viséan to the Middle Limestone Group. Most of the older literature on these rocks uses the former classification. Only Westphalian B and the middle and upper part of Westphalian A strata crop out, the remainder being recorded from a few boreholes.

The details of the solid geological sequence come mainly from shafts, boreholes (e.g. see Fig. 3) and extensive underground mining. The amount of detail and quality of information provided by these sources vary widely.

Mine plans are indexed under the Six-Inch County Map Series and NOT on National Grid Sheets. The key to the Six-Inch County maps contained within the area of the National Grid Sheet is shown on the bottom right hand corner of each map for ease of reference.

For an overall view of the workings in a given seam the Six-Inch National Grid Plans of the N.C.B. may be consulted, but for details the original plans must be researched and in any workings over about 20 years old these will not use the National Grid system.

The drift deposits are less well known, details coming mainly from site investigation studies for County Council schemes for light industrial estates, schools, etc.

(c) Nomenclature

The main coal seams have been assigned an index letter by the N.C.B. mainly for the purposes of uniformity throughout the coalfield, and the names of the coals are now largely standardized. Many of the coals had local names and where possible these have been shown in square brackets on the left hand margin of each map; some of these names were also used on the older geological maps of the area.

SOLID ROCKS

(a) General

Concealed Carboniferous strata i.e. Viséan, Namurian and low Westphalian have been proved only in isolated boreholes.

Westphalian strata consist of rhythmic alternations of sandstone, siltstone, mudstone, shale, coal, seatearth and uncommon shales containing ironstone ribs or nodules; ganister is recorded, but it is not common. Although coal comprises a very small proportion of the total thickness, it is the one rock type that has contributed substantially to the economy; a total of 14 seams ranging up to about 2.3 m thick have been worked and with the exception of areas in the immediate vicinity of the Derwent valley the whole area has been mined to a greater or lesser extent; the geological structure of the area has led to a concentration of mining towards the east and south-east.

Four beds of ironstone, or more correctly shale containing abundant ironstone nodules, have been worked in the south-west and in the last century their working was one of the reasons which led to the establishment of the Consett Iron Company. Sandstone occurs widely in the Westphalian sequence but has

not been worked other than for purely local purposes.

(b) Details

(i) Viséan, Namurian and Westphalian A strata (lower part): Only the Chopwell Borehole (NZ 15 NW, Ms. Record No. 46, Fig. 3) sited near the north bank of the River Derwent SE of Chopwell has penetrated the whole sequence shown on the generalized vertical section. The bore was drilled in the latter years of the last century along with a number of other deep bores in the coalfield to search for workable coals in the sequence below the 'Coal Measures'; the borehole was sited just below the crop of the Victoria Coal (see below) and was sunk to a depth of more than 400 m; no coals of workable thickness were proved. The sequence which included thick 'grits' and limestone, was typical of that recorded in many parts of the northern Pennines, notably Weardale. No exceptional features were found.

Nothing is known in the area of Carboniferous measures below that proved in the Chopwell borehole; between one and two thousand metres of Lower Carboniferous strata may be present, resting on intensely contorted much older mudstones and siltstones. At some level in the Lower Carboniferous sequence a thick intrusive sheet of dolerite – the Great Whin Sill – is anticipated.

There is geophysical evidence (Bott, 1967) to suggest that a subsidiary 'boss' of the Weardale Granite may be buried at great depth in the vicinity of Burnopfield and Carboniferous strata may rest directly on granite here. It is not known if any mineralization is associated with the granite or with that of the Great Whin Sill in this area.

(ii) Westphalian A strata (upper part): The remainder of Westphalian A strata include the following named units:

Harvey Marine Band (base of Westphalian B)

	N.C.B. Index Letter
No. 1 Ironstone	
Harvey Coal	N
Tilley Group of Coals	P
Busty Coal (usually split into Top and Bottom)	Q
Three-Quarter Coal	R
Brockwell Coal (usually split into Top and Bottom)	S
German Bands Ironstone	
Victoria Coal(s)	T
Marshall Green Coal	U
Ganister Clay Coal	

All these crop out, the lowest coal, the Ganister Clay, occurring in the Derwent valley just west of Ebchester (Fig. 2); higher strata occupy a proportionately smaller area. All these strata constitute the former Lower Coal Measures.

The two lowest coals, the Ganister Clay and the Marshall Green, are thin and impersistent and have not been worked. The roof measures of the Marshall Green widely comprise a thick sandstone.

The Victoria Coal has been worked from drifts on both sides of the Derwent valley, notably near South Garesfield north-east of Rowlands Gill, and near Burnopfield. Small areas were deep mined, the largest area being north of Stanley: the coal was worked for its quality rather than its thickness. A small area was opencasted near Ebchester.

In the southern and south-western part of the area the roof of the Victoria Coal is formed by a seat-earth, and a thin coal, the latter succeeded by ferruginous mudstones and shales containing thin ironstone ribs or nodules; this is the so-called German Bands Ironstone. There is no evidence of this 'ironstone' having been worked in this area although wrought at outcrop on the adjacent sheet (NZ 05 SE) immediately to the west; along with the other iron "bands" it formed the basis on which the Consett Iron Company was established.

The remaining Westphalian A measures, those between the Brockwell Coal and the Harvey Marine Band crop out over a wide area on each side of the Derwent valley, and from Consett to Ebchester in the west.

The Brockwell Coal (Fig. 2), usually split into Top and Bottom members, has been extensively worked in much of the area except in a broadly north-south belt from Annfield Plain towards Flint Hill and Tantobie.

The Three-Quarter Coal is thinnner and workings were less extensive than in the Brockwell Coal; workings included a wide area on each side of the Derwent valley but much of the coal in the south-east of the district remained untouched.

The Busty Coal (Fig. 2), almost entirely split into Top and Bottom members, was the most widely worked seam in the area; only in a limited north-south belt between White-le-Head and Pontop Pike where it is thin and impoverished, has it not been mined. A thick sandstone is widely present in the roof of the Busty Coal and was formerly worked in the extreme south-west of the area at the Fell Coke works at Consett; the site of the quarry has long since been filled with slag and spoil from the Consett Iron works; typically it is a flaggy to well-bedded medium- to coarse-grained sandstone but it has little economic value.

The Tilley Group of coals comprise up to five generally thin seams ranged over 10—15 m of strata. The median coal, the Tilley, often split into top and bottom components has been worked locally near Medomsley, north of Pontop Pike near Hamsterley, near Chopwell and High Spen, and more widely east of a line from Stanley to South Garesfield. The lowest seam in this group of coals is referred to as the Hand the uppermost the Hodge, the latter having been worked in a limited area in the neighbourhood of South

Garesfield. Areas of Brockwell, Three-Quarter, Busty and Tilley coals have been opencasted south of Ebchester.

The Harvey Coal has been widely worked in the west but to a much lesser extent in the east; a small area has also been opencasted near Leadgate and east of Ebchester.

The No. 1 Ironstone seam, a mudstone up to 2.5 m thick with ironstone ribs and nodules, was worked in places in association with the Harvey Coal in the south-west of the area, notably under the central and north-east parts of Consett, and also along the north side of the Pont Burn north-east of Bradley Cottages; all the workings date from the last century and their full extent is probably not known. This was one of the ironstones worked in the early years of the Consett Iron Company.

(iii) Westphalian B strata: The Harvey Marine Band (Fig. 2), a marine shale or mudstone containing *Lingula*, is the lowest member of Westphalian B; it is also taken as the junction between the Lower and Middle Coal Measures.

Westphalian B includes the following named units:

	N.C.B. Index Letter
Crow Coal	
Ryhope Five-Quarter Coal	
Top Ryhope Little Coal	
Bottom Ryhope Little Coal	
High Main Coal	E
Five-Quarter Coal	F
Main Coal	G
Maudlin Coal	H
Durham Low Main Coal	J
Brass Thill Coal	K
Hutton Coal	L
Ruler Coal	M
Ten Bands Ironstone	MN/1
Harvey Marine Band	

The roof measures of the Harvey Marine Band (Fig. 2) in the Consett, Leadgate and Bradley Cottages area consist of up to 3.6 m of mudstone containing ironstone ribs and nodules: they were extensively worked in the last century along with No. 1 Ironstone seam for use by the Consett Iron Company; although the ironstone is proved locally elsewhere in the area, towards the north-east it tends to die out.

The Ruler Coal, the next named coal above the Harvey, is generally thin, though limited working has

taken place near South Garesfield and also more widely in the north of the area between Chopwell and High Spen.

The Hutton Coal, a consistently good seam, has been worked throughout the area except in the extreme north and north-east where it is largely impoverished.

In the 15—20 m of measures succeeding the Hutton, three closely-spaced seams have been widely worked: these are the Bottom Brass Thill, Top Brass Thill and Durham Low Main coals (Fig. 2). The Top Brass Thill is atypically more closely associated with the Durham Low Main rather than the Bottom Brass Thill, the latter being essentially a separate seam. The Bottom Brass Thill has been worked very widely except in parts of the north-east, east of Byermoor: workings in the Top Brass Thill/Durham Low Main are even more extensive; only east of Sheep Hill, Burnopfield and in the extreme north-east is it locally impoverished.

The Top Brass Thill/Durham Low Main coals are widely overlain by a massive to thick-bedded medium- and coarse-grained sandstone commonly known as the Durham Low Main Post; exceptionally this sandstone is up to 40 m thick but generally it is 20 to 30 m and interrupted by shaly beds. This sandstone has been worked only on a small scale mainly for local use and has little economic value.

In the south, and confined to a limited area north of Stony Heap, a thin mudstone containing ironstone ribs and large ironstone nodules was worked from drift mines for smelting at Consett.

The Main and Five-Quarter coals are present south-east of an irregular line from Pontop to Byermoor (Fig. 2) and have been worked widely. The Five-Quarter is locally split into two leaves. The Top Five-Quarter has been opencasted near Burnopfield and north-east of Byermoor.

The High Main (Fig. 2), generally the thickest seam in the district, has been worked widely in the south-east. Locally, near Pontop Pike it is subject to impoverishment or wash-out: these wash-outs generally take the form of sandstone-filled channels trending N.W.—S.E.

A sandstone up to 20 m thick overlies the High Main Coal and like the Durham Low Main Post has been worked for local use. Up to seven thin coals are present above the High Main; of these only the Crow Coal (Fig. 2) has been worked in the vicinity of Pontop Pike. Opencasting of some of the higher seams near Tantobie is proposed.

(c) Structure

The overall structure of the solid rocks is simple (Figs. 4 and 5), with strata dipping generally eastward at between 1 and 2°. In some areas the strata are almost flat, but elsewhere there are local minor rolls and flexures and the dip steepens near some faults. An exception to this general pattern is associated with the complex fault belt between Hamsterley Park and north of Tanfield Lea; south of the faults especially in a 300-m wide belt between Low Ewehurst and Tantobie, the strata tilt very steeply northwards while west of

Tantobie they approach vertical.

Deepest levels in coal workings are located in the vicincity of Stanley and Tanfield Lea.

The main faults in the area are:

1. A major fault complex which extends from Hamsterley Park to the Tanfield Lea area and throws down to the south. It consists of a number of sub-parallel fractures including linked members, and adjoining strata are locally so severely dislocated in a belt up to 300 m wide that coals there were largely unworkable. North-west of Hamsterley Park the faults cross the Derwent valley and divide into three main components: the eastern fault (known locally as the Tantobie Dyke[1]) is the largest and trends north-west under Chopwell with a downthrow west of up to 60 m. It ultimately joins the Ninety Fathom Dyke to the north of the area.

2. A major W.S.W.–E.N.E. fault crosses the extreme north-west of the area near Hedley Fell. The downthrow is at least 60 m to the north: it forms part of the Ninety Fathom Dyke – part of a major fault system in north-east England.

There are no other major displacements in the area, although several faults with relatively small throws extend over long distances. An example of this is the N.N.W.–S.S.E. fault near Pontop Pike which has a maximum throw of 15 m down to the east.

(d) Economic Geology

Coal and to a lesser extent ironstone have been the two main mineral products of the area, and only coal is still worked. Sandstone has been worked for local use.

(i) Deep mining: The deep coal mining industry has declined sharply in the last twenty years from a former position of considerable importance. The last deep mine in the area closed in 1980 and deep mining is now confined to workings extending westwards towards Byermoor from Marley Hill Colliery located on Sheet NZ 25 NW to the east. Although considerable quantities of deep coal remain unworked, further large-scale mining would be uneconomic. There is however scope for small-scale drift workings, e.g. the site of the former Consett Steelworks.

(ii) Opencast mining: Although opencast sites have been worked in the area and others are proposed, there is considerable scope for further workings of this type. In places near-surface coal has not been worked and much has been worked by pillar and stall methods which may leave up to half the coal in the ground. Furthermore, coal that was too deep to extract profitably from some former opencast operations could now be removed economically by re-opening and extending the workings using modern equipment methods. Parts of the site of Consett Steelworks overlie some reserves of coal that could be extracted by opencast workings (in addition to those recoverable by drift mining) and such operations could readily be combined with landscaping and reclamation of the site.

[1]The word 'Dyke' is frequently used in mining for a fault.

(iii) Underground gasification: There is considerable scope in this area for underground gasification of some of the remaining coal if and when the technique is perfected.

(iv) Water supply: Large volumes of water from flooded old mine workings are pumped mainly into the River Derwent near Hamsterley. The water would require minimal purification and could be used in the future to augment the public supply.

(v) Sandstone: None of the abundant sandstone in the area is sufficiently valuable to justify sterilisation of the outcrops.

(vi) Other minerals: No useful minerals other than coal are known in the area but could be present at depth, e.g. mineralization in lower Carboniferous strata.

(vii) Underground storage, underground waste disposal, and geothermal potential: The old mine workings are unsuitable for underground storage or waste disposal and their presence makes the ground generally unsuitable for the creation of artificial storage cavities. Little is known of the local geothermal gradient but there is no reason to expect that the area will be particularly favourable as a source of underground heat.

DRIFT DEPOSITS

(a) The rock surface and distribution of drift

The main features of the present day topography were established before the Ice Age but were modified during that period. Vast quantities of superficial deposits, mainly boulder clay, but also including sand and gravel, were laid down in varying thicknesses over the whole area. Erosion has since partly removed some of these deposits, leaving drift-free areas and areas in which the drift is relatively thin (Fig. 6): in general terms these include (a) areas above 210 m A.O.D. (b) areas of steep slopes facing north-west and west and (c) parts of some of the tributary valleys e.g. Causey Burn below East Tanfield, parts of the Pontop Burn and very locally in the Derwent valley.

Many of the present day valleys coincide with or are marginally offset from "buried channels" or "valleys" along which the drainage system was established before the Ice Age: rockhead in these areas therefore is often well below present surface level. The Derwent valley coincides generally with such a buried valley but varies substantially from it in detail. Geophysical and other data indicate that the floor of the buried valley of the Derwent ranges between +10 m A.O.D. in the north-east and +50 m A.O.D. in the west; in the north-east the buried valley lies mainly on the north side of the present valley, farther west it lies mostly just to the south.

A further deep buried valley is associated with the Pontop Burn, largely though not exclusively, lying just to the east side of or along the present valley. Another major buried valley is associated with the Causey Burn system.

The profiles of the buried valleys appear to be similar to those of the present day systems but may have been stepped in response to the varied resistance of underlying strata and their cross-sections are locally marginally steeper. Changes that have taken place since the Ice Age largely relate to the return to present sea level and include the development of river terraces and alluvium; the latter is defined as any area of river deposits that is liable to flooding under the most exceptional conditions.

(b) **Details**

(i) Boulder Clay: The bulk of the drift deposits comprise boulder clay which here consist of yellow, dull yellow, grey or pale grey generally stony clay: its thickness is very variable but is generally 3 to 8 m in this area. The stone content of the boulder clay is also variable, for although boulders occur widely, most of the stones are angular to sub-rounded fragments and chips of local rocks. Normally the boulder clay is moderately strong to strong but its overall strength can be weakened by lenses or pockets of laminated clay or sand and gravel: their presence may not be evident from surface indications but it is important to be aware that they exist. The uppermost 2 m of the clay is commonly less stony than the remainder. On some of the steeper drift-covered slopes, the uppermost parts of the drift may include a stony sandy 'wash' deposit produced by slow downhill movement of the deposit.

(ii) Sand and Gravel: The distribution of sand and gravel, defined on the maps as glacial sand and gravel is shown in Fig. 6; they occur widely north of the River Derwent west of Blackhall Mill and also over a large area east of Chopwell including Chopwell Wood, around and in the country east of High Spen towards Rowlands Gill. A fairly extensive deposit also exists between Annfield Plain and Stanley and also east of the Pontop Burn in the Low Ewehurst area. Most of these deposits are 'outwash' or 'deltaic' deposits formed during melting of the last ice sheet. Although most of these deposits are classed as sand and gravel and have been worked at several places notably Chester Hills, Beda Hills, Riding Hills and Kyo Laws (Fig. 6), little is known about the proportion of clay, silt and other impurities in the deposit as a whole. In the Chopwell Wood, High Spen and Rowlands Gill area the sand and gravel appears to have a similar origin to the Ryton/Greenside deposit (NZ 16) in Tyne & Wear, and might be a similarly valuable resource.

(iii) Other drift deposits: Glacial deposits in the buried channels and valleys largely consist of a heterogenous melange of boulder clay, gravel, sand, silt and locally, laminated and relatively stoneless clay. The thickness, lateral extent and quality of each bed is difficult to assess.

Near Tanfield Lea and towards the Causey Burn an irregular belt of sand, gravel and clay lay at the eastern margin of a series of temporary small ponds and lakes in which stoneless clay and laminated clay was laid down; this was formerly dug for brick clay.

All the above deposits resulted mainly from the movement of ice across the area and its subsequent

retreat. Later deposits include the river terrace system of the Derwent and, more recently, alluvium of this and also smaller streams.

(iv) Made Ground: Although not strictly a drift deposit, made ground (Fig. 6) is widespread in certain areas, notably at Consett and between Stanley and Annfield Plain. Most of the made ground is largely landscaped colliery waste dressed with soil. At and near Consett, by contrast, much of the made ground comprises slag, sinter, etc. and includes a large amount of waste from the steelworks. Most of the main tip for Consett works was immediately west of the area (NZ 05 SE and NZ 04 NE) between Benfieldside in the north and Hown's Gill in the south. Additionally material was tipped near the former Fell Coke Works where there was an old sandstone quarry. East of Consett the local authority has undertaken considerable restoration work in the vicinity of the old Crookhall Foundry and no trace remains of a former considerable expanse of spoil and waste ground. Elsewhere the 'pit heap' landscape is now largely a thing of the past and it is difficult to believe that much of this area was once the scene of a thriving coal industry.

During reclamation the spoil is generally redistributed over a much wider area in order to effect a suitable landscaped profile: the importance of mapping this type of deposit largely lies in the different foundation properties of the made ground and the underlying geology.

The fill of restored opencast workings constitutes a further type of made ground; from the geological point of view no matter how well compacted opencasted areas are they form areas of broken rock and have to be regarded accordingly. The largest restored opencast area is between Leadgate and Iveston where up to three seams have been removed.

The headwaters of the Iveston Burn are gradually being infilled by controlled dumping of mainly domestic waste.

(c) Economic Geology

The area includes two deposits of sand and gravel that might be worked profitably: these should be protected from development until their full potential has been assessed. These deposits lie around Broad Oaks (Chester Hills) west of Blackhall Mill, and in the broad area of Chopwell and Rowlands Gill.

Although sand, silt and gravel is associated with the river Derwent valley, the deposits are so located that they are unlikely to attract interest other than perhaps on the north side of the river south-east of Chester Hills.

GEOLOGY: RELATED CONSTRAINTS ON PLANNING AND ENGINEERING

(i) Subsidence: Except beneath the Derwent valley, the whole area has been undermined by workings in one or more coal seams. Current extraction and related subsidence is active only in the east in workings from Marley Hill Colliery, but further settlement over older workings in all other areas remains possible and no construction should be planned without careful examination of mining records and a detailed ground

search for signs of old workings.

(ii) Settlement of made ground: Made ground, especially where filling old quarries or former opencast coal workings poses problems of uneven settlement. Sites athwart the margins of such ground are particularly prone to this.

(iii) Landslips: Slope instability, leading to landslips, is known in the area only along the Derwent Valley; existing slips are at Lockhaugh Bank, NE of Rowlands Gill and SSW of Lintsford. Steep slopes on drift elsewhere could fail if overloaded or if artifically steepened.

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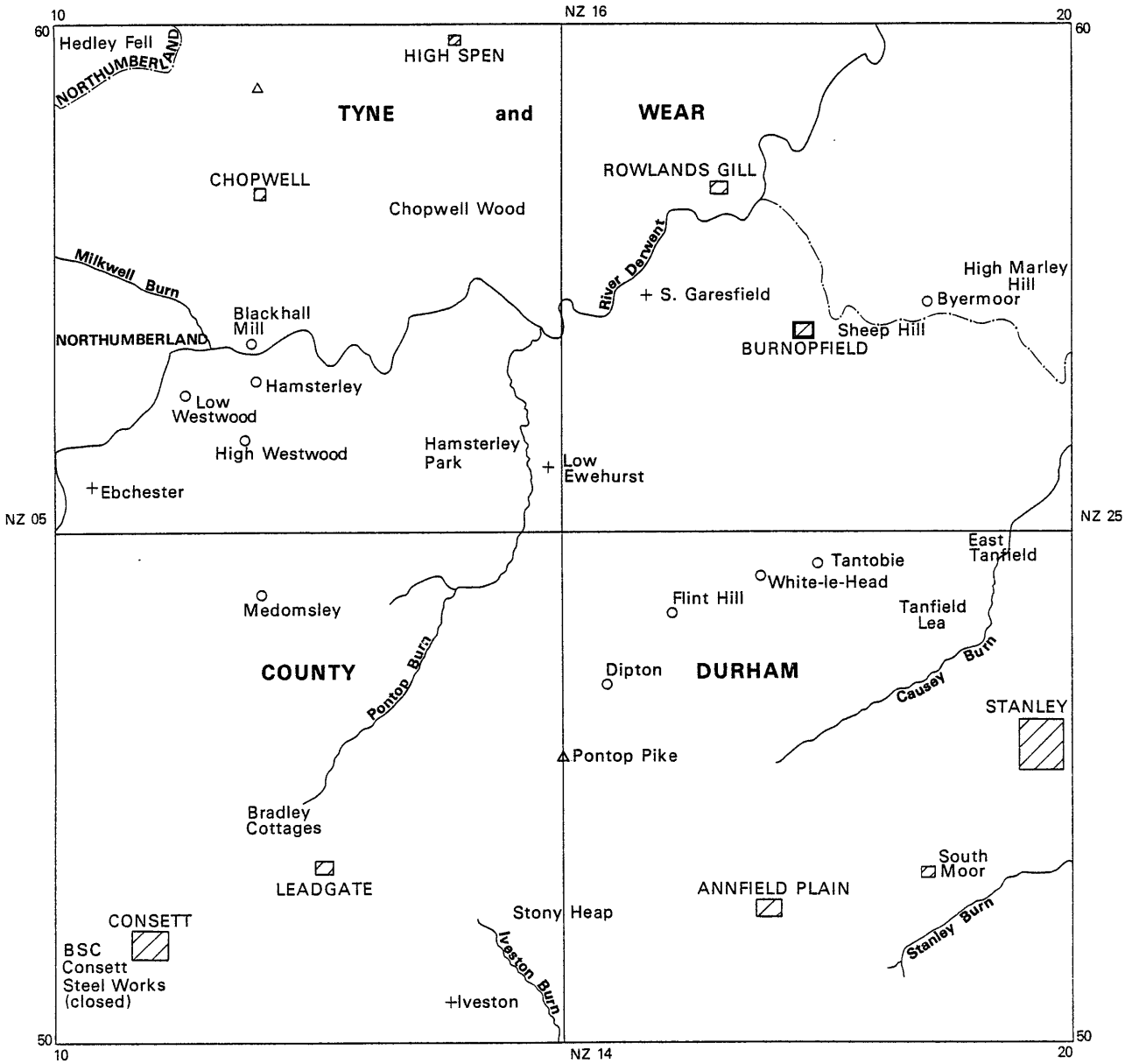


Fig. 1. Outline map of the area showing county boundaries and the main locations referred to in the text.

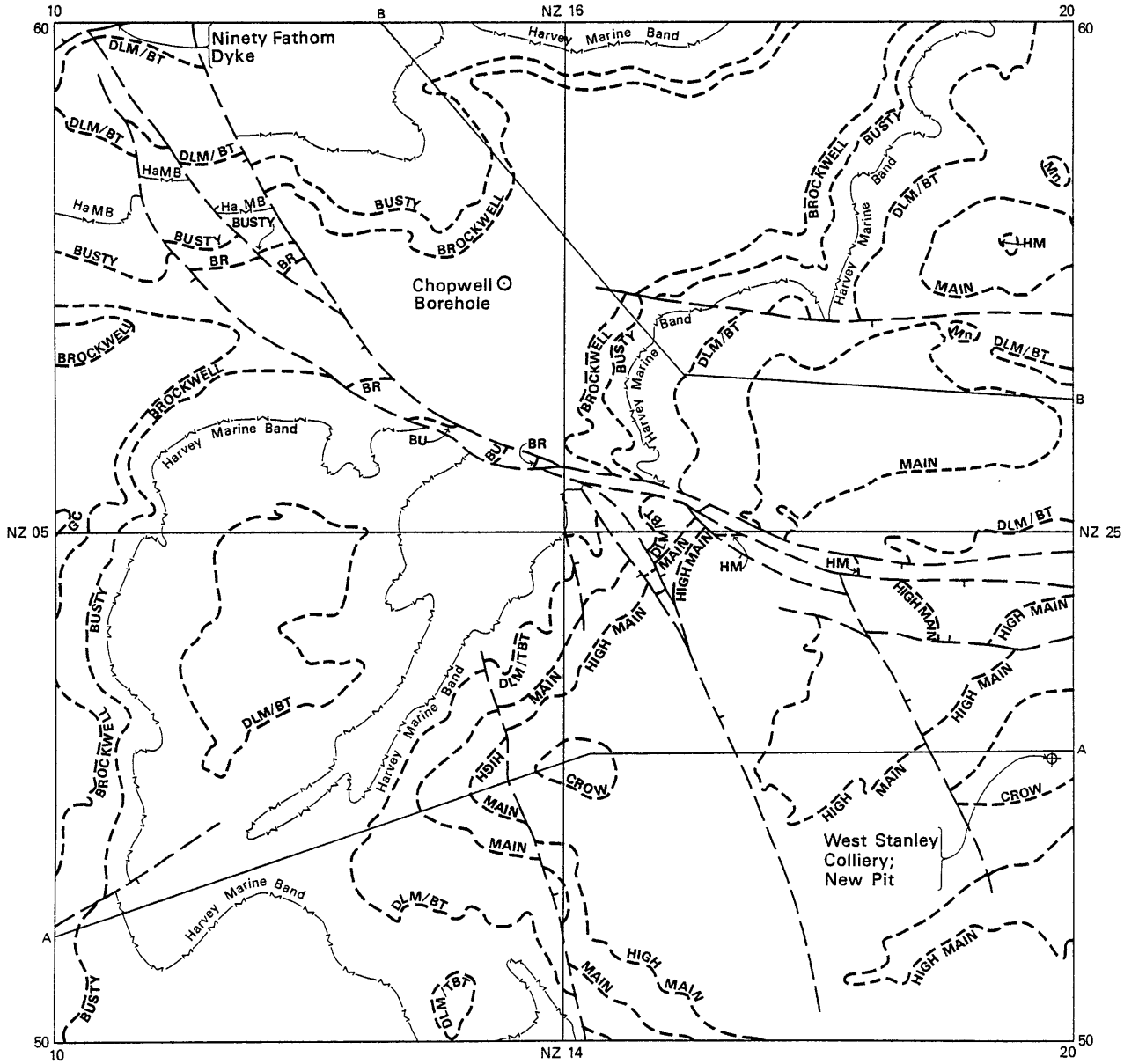
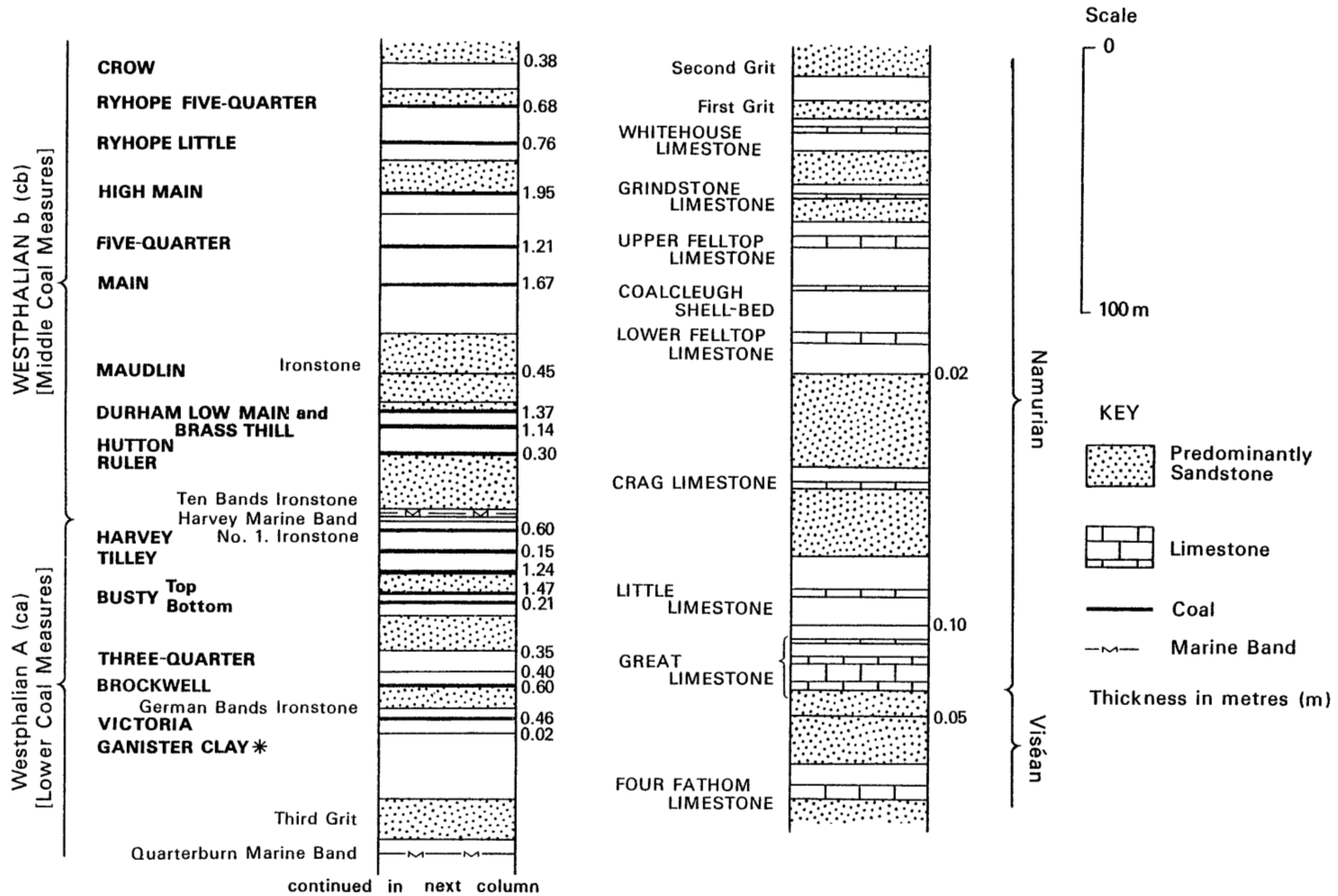


Fig. 2. Sketch map of the solid geology of the area showing the outcrop of a selection of coals and of the Harvey Marine Band. (See Fig. 5 for cross sections A-A, B-B)

SIMPLIFIED GEOLOGICAL SECTION OF SOLID GEOLOGY OF THE AREA BASED MAINLY ON WEST STANLEY SHAFT NEW PIT (NZ 15 SE/100) AND THE CHOPWELL BOREHOLE (NZ 15 NW / 146)



* Strata below this level do not crop out within the area and are proved only in boreholes.
For details of vertical sections see left hand margin of each quarter sheet of NZ 15.

Fig. 3. Generalized Vertical Section of strata in the area as proved by West Stanley Shaft and the Chopwell Borehole.

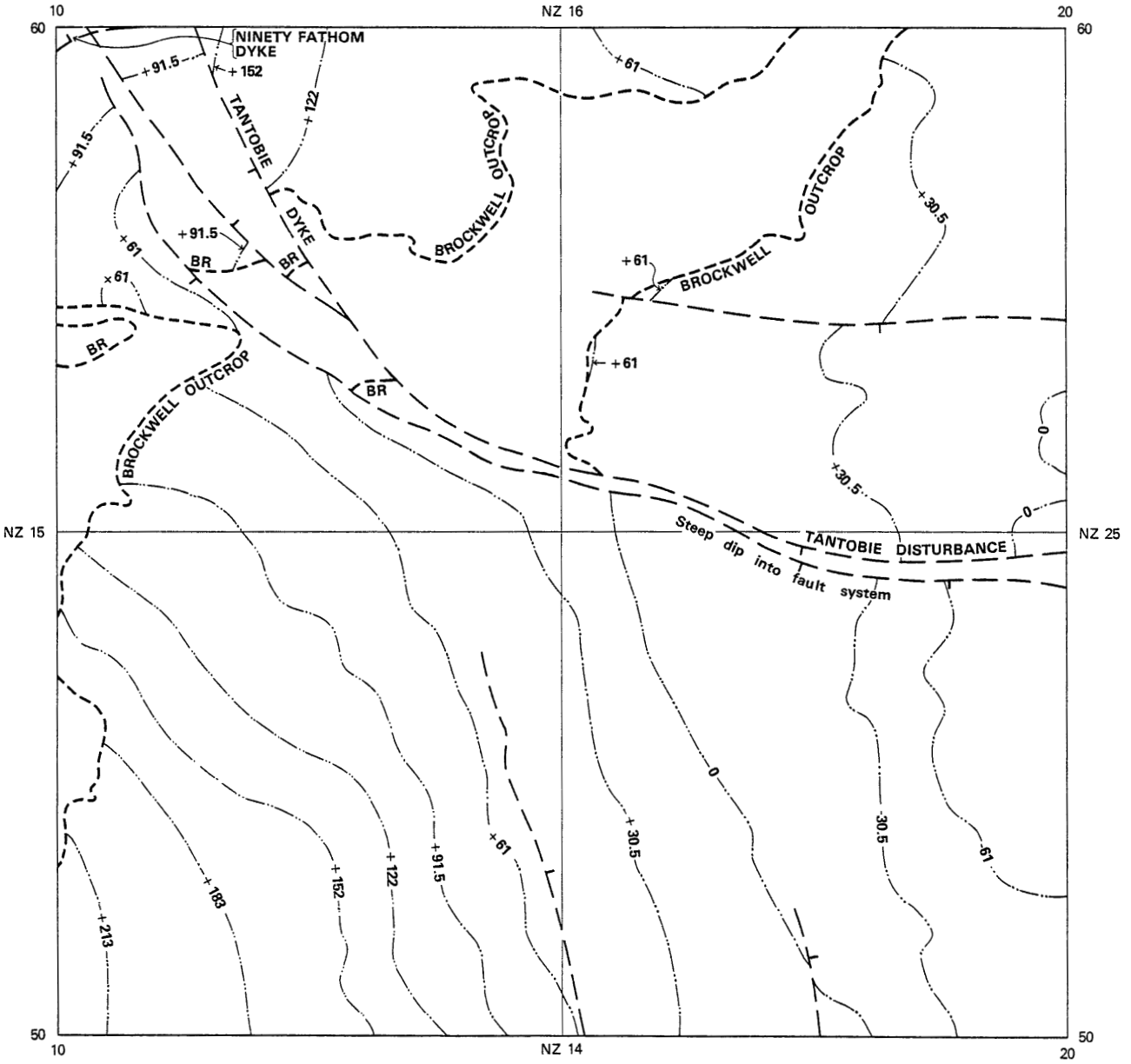


Fig. 4. Sketch map showing structure contours on the Brockwell seam (some faults omitted)

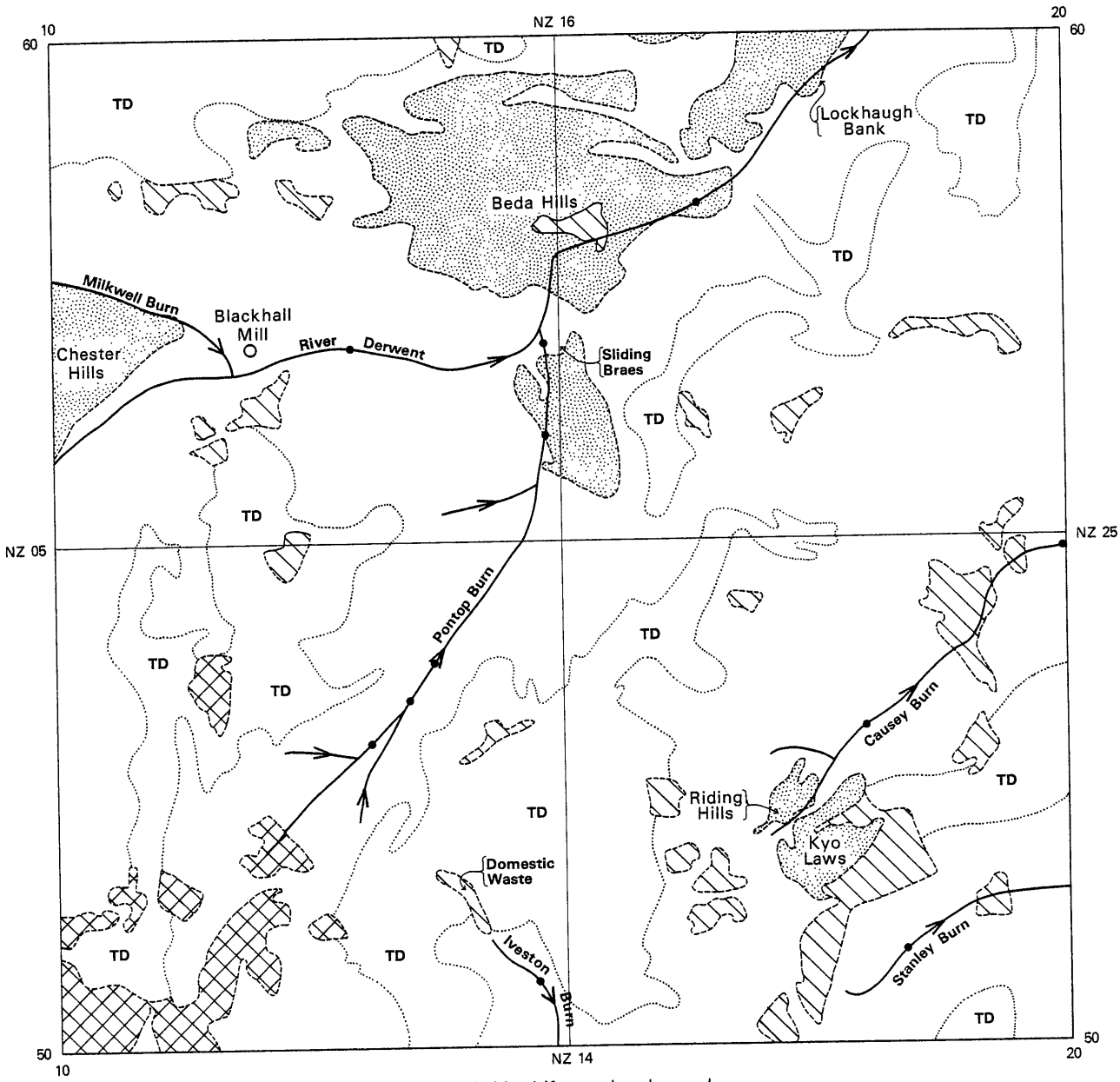


Fig. 6. Distribution of drift-free ground, areas of thin drift, sand and gravel, and made ground (opencast sites omitted)

Sand and Gravel

Made Ground (largely colliery spoil)

Made Ground (largely from iron works)

Approximate lines of major buried valleys

TD Drift-free ground & areas of thin drift