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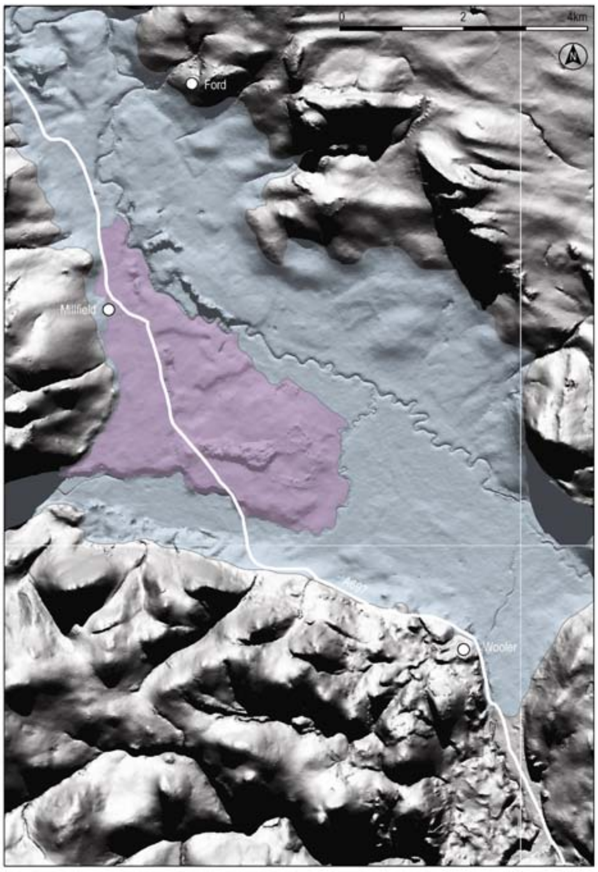
Geological Landscape Character Assessment, Northumberland National Park and surrounding area

Geology and Landscape Northern Britain Programme

Commissioned Report CR/06/108N



BRITISH GEOLOGICAL SURVEY

GEOLOGY AND LANDSCAPE NORTHERN BRITAIN PROGRAMME

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Keywords

Landscape, Northumberland, Geology, National Park.

Front cover

Reconstruction of palaeo-Lake Millfield, with area of extant glaciofluvial fan at Millfield. Overlain on NextMap hillshade model.

Bibliographical reference

EVEREST, J D AND LAWRENCE D J D. 2006. Geological Landscape Character Assessment, Northumberland National Park and surrounding area. *British Geological Survey Commissioned Report*, CR/06/108N. 23pp.

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J D Everest and D J D Lawrence

Keyworth, Nottingham British Geological Survey 2006

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British Geological Survey offices

Keyworth, Nottingham NG12 5GG

☎ 0115-936 3241 Fax 0115-936 3488
e-mail: sales@bgs.ac.uk
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☎ 01491-838800 Fax 01491-692345

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff, CF15 7NE

☎ 029–2052 1962 Fax 029–2052 1963

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501
www.nerc.ac.uk

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Summary

This report describes work carried out by BGS as part of the wider Northumberland National Park Authority Land Characterisation Project. It incorporates an innovative method of categorising the geological contribution to the physical landscape and was undertaken in association with a geodiversity audit of the area. Data from the study was provided to the Authority for incorporation in its GIS. Further description of the landscape will be included in the reports arising from the Geodiversity study.

1 Introduction

The objective of this exercise was to produce an assessment of the physical landscape that was not necessarily dictated by formally designated geological boundaries. In essence a 'feel' of the landscape was what was under review, and for this it seemed logical to devise a set of criteria by which the landscape could be interpreted in terms of its visual physical characteristics. Different criteria had to be applied, other than those that would normally be used when compiling a standard geological map. It was obvious that these criteria must encompass relatively broad types of landscape, as the creation of a landscape categorisation that was too specific, would simply result in a likely mimicking of existing published geological maps.

1.1 METHODS

For the initial assessment the NextMap (©Intermap Technologies) digital elevation model (DEM) was employed. From low-level radar survey the ground surface for the whole of the UK has been mapped at 1m vertical and 5m horizontal resolution, the data from which forms the basis for the DEM. Using ArcMap 9.1 (©ESRI, 2005) the DEM was reinterpreted to produce a photorealistic hillshade model of for the region, which showed landscape and landform features at very high resolution. By being able to look at the area of study as a whole, it was possible to make generalisations concerning various 'landscape types'.

Areas of similar featuring were delimited on the basis of their visual character; for example where it was clear that bedrock was exposed at the surface and displayed an overall streamlined appearance. By assessing the landscape firstly at a broad scale of 1:100,000, large areas of similar character were identified. By focussing at the higher scale of 1:25,000 the boundaries between these areas were positioned more precisely.

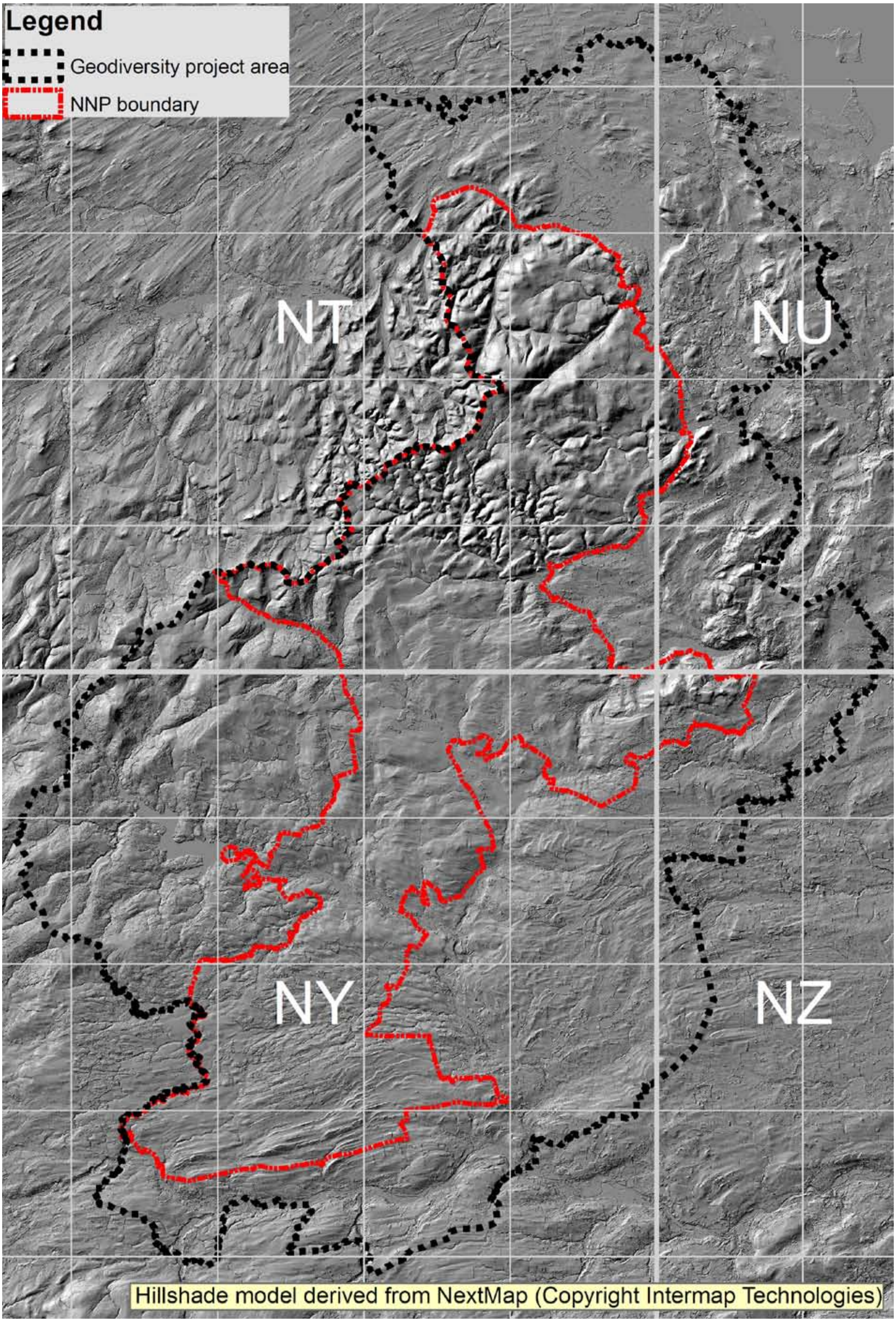

Figure 1 NextMap hillshade model for project area

1.2 INTERPRETATION AND VALUE

One interesting outcome of the process was how the areas of relatively broad character classification correlated with published BGS superficial deposits maps. This was not intended, indeed these maps were not studied prior to the commencement of the character assessment, for fear of influencing its construction and content. As would be expected, areas of bedrock at or near surface on published maps correlated well with those areas identified as streamlined, unmodified or weathered bedrock in the character assessment. Likewise those areas of extensive glacial till were obvious in the assessment.

It is clear from the broad categories employed in the study that geological or geomorphological process, rather than lithology or deposit, is the critical factor in determining landscape character. In this respect many of the categories are the result of different processes involved in glaciation and deglaciation of the landscape, the most dominant geomorphological processes to have influenced the landscape of northern Britain for the last 50 million years. As a result the character assessment is a potentially useful tool, when used alongside BGS map products detailing the lithological constituents of the landscape, as it affords a relatively straightforward insight into the history of geological and geomorphological processes operating in an area.

1.3 DATA

Polygon data relating to the geological landscape categories described in this report were digitised in ArcMap 9.1 (©ESRI, 2005). The digital information has been provided to Northumberland National Park Authority in the form of ‘shape’ files for incorporation in the Authority’s MapInfo GIS.

2 LANDSCAPE CATEGORIES

In summary the categories described below differ from units that are typically routinely mapped by the BGS in several respects. Primarily their categorisation does not necessarily describe the characteristics of deposits, rather they define a series of landscape types. Their derivation is largely based on a visual interpretation of form, rather than composition. That said, there is still an element whereby the broad classification of the material at the ground surface is acknowledged. Therefore, though greatly simplified into generic categories such as ‘bedrock’ or ‘till’, this is perhaps less important for landscape classification than the surface featuring in this instance. Thus designations such as ‘streamlined’ or ‘unmodified’ give more information to the viewer than a system only naming deposit types.

By categorising the landscape in this way, mostly by employing remote methods of survey (DEM and walk-over surveys), a completely different system of landscape designation has been achieved, to that more usually employed by the BGS. It is hoped that the user will be able to identify these designated categories when travelling through the region, without the need for more detailed geological knowledge.

2.1 BLOWN SAND, COASTAL DUNES

These character areas occur in coastal areas where the combination of wind and wave action have moved large amounts of fine sand and silt material along the coast and some way inland.

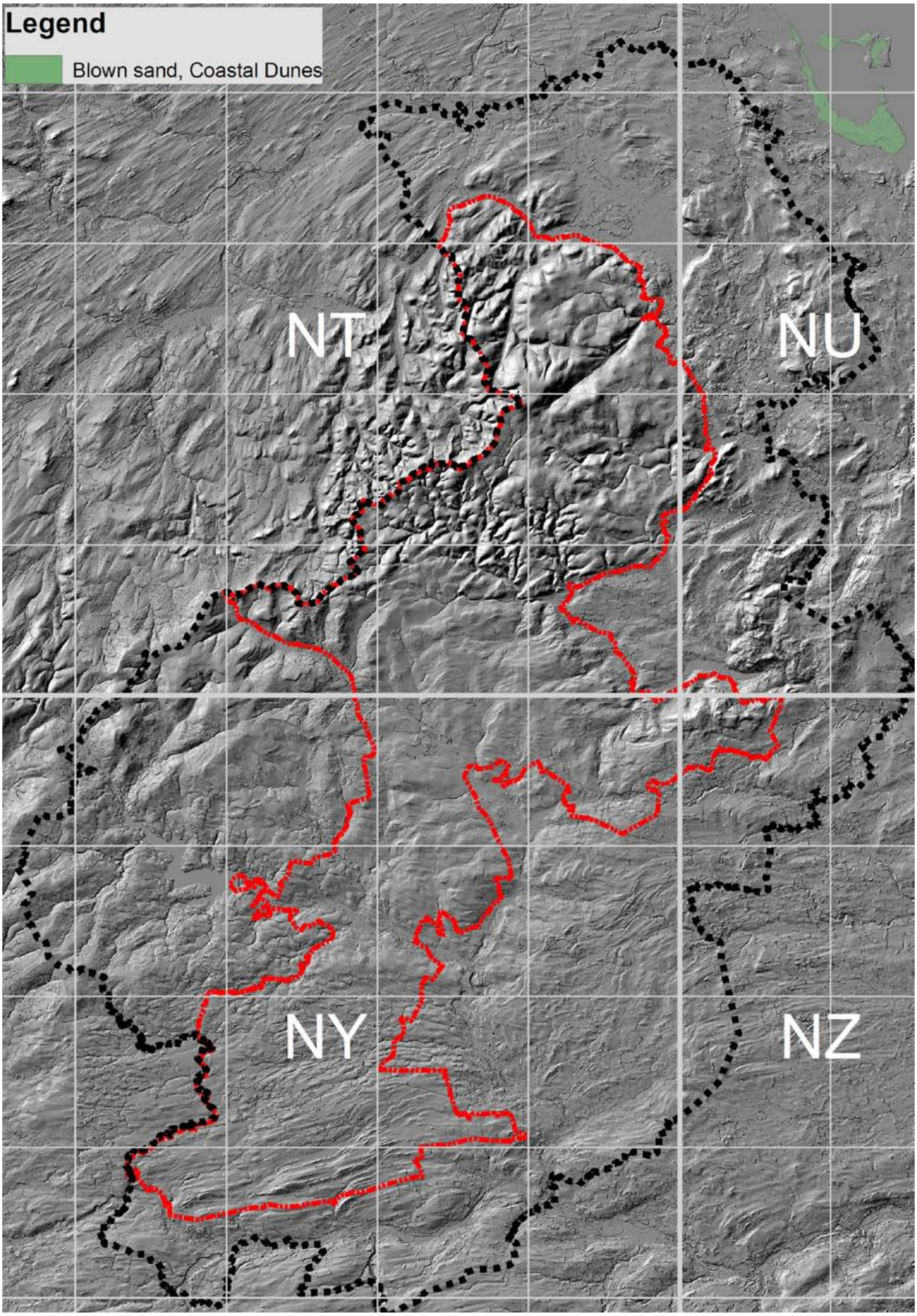

Figure 2 Blown Sand, Coastal Dunes

2.2 ALLUVIUM, FLOODPLAIN

Areas that are characterised by fluvial (river) activity, usually comprising predominantly flat land surrounding an active river channel. These areas may include modern floodplain and river terrace deposits, plus land associated with past (palaeo) fluvial activity, usually within the last 11.5 thousand years (the Holocene Period). This palaeo-floodplain may no longer be affected by modern rivers, but exhibits the same landform characteristics.

Sediments usually comprise silt, sand and gravels, though some upland floodplains may have a large proportion of pebbles, cobbles and boulders. Sediment is often 'sorted' by grade, or size of particle transported by the river.

Within the Landscape Character Assessment (LCA) area most rivers are valley-confined. They have sharply defined boundaries with surrounding topography often rising steeply from the valley floor. The Tyne and North Tyne valleys are good examples of this, making the identification of areas of alluvium relatively straightforward.

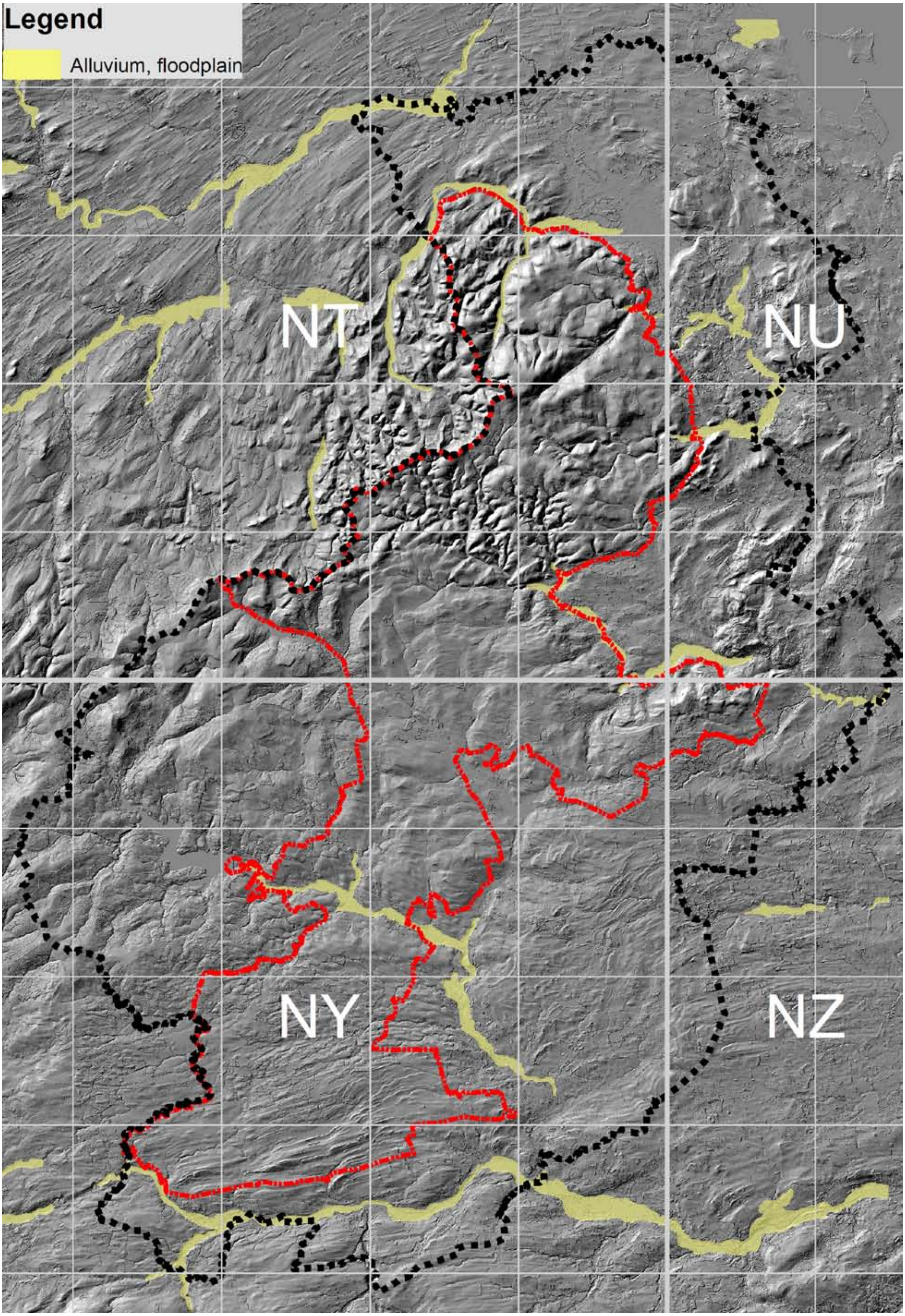

Figure 3 Alluvium, Floodplain

2.3 GLACIOFLUVIAL SAND AND GRAVEL, GLACIOFLUVIAL FAN

Retreating glaciers are associated with large amounts of meltwater. Where meltwater flow regimes change from confined systems, such as subglacial channels or valleys, to lower relief, unconfined areas, a fan may form. These features slope gently from the apex (or issuing point), and if topography allows they form low-lying conical features. They are composed primarily of material that is easily transportable by flowing meltwater, commonly gravels and sands, and fan deposits are often well sorted by grade or size of the material.

There are several examples of glaciofluvial fans in the LCA, the largest of which lies to the north of Wooler, issuing from the mouth of the Glen Valley and spreading eastwards across the Millfield Plain. The upper levels of this fan are some metres above current river level, and are most likely to have formed immediately following deglaciation of the area. The second significant fan in the region is likely to have been formed over a long period following the retreat of the ice. This, the Allen Gorge fan spreads northwards from the narrow outlet of the gorge, across the southern part of the Tyne Valley. The distinct levels visible in the fan reflect phases of construction, possibly related to periodic reactivation of the Stublick Fault, followed by periods of ‘fan head trenching’ as sediment supply has more recently declined, and the fan has been incised by the Allen River.

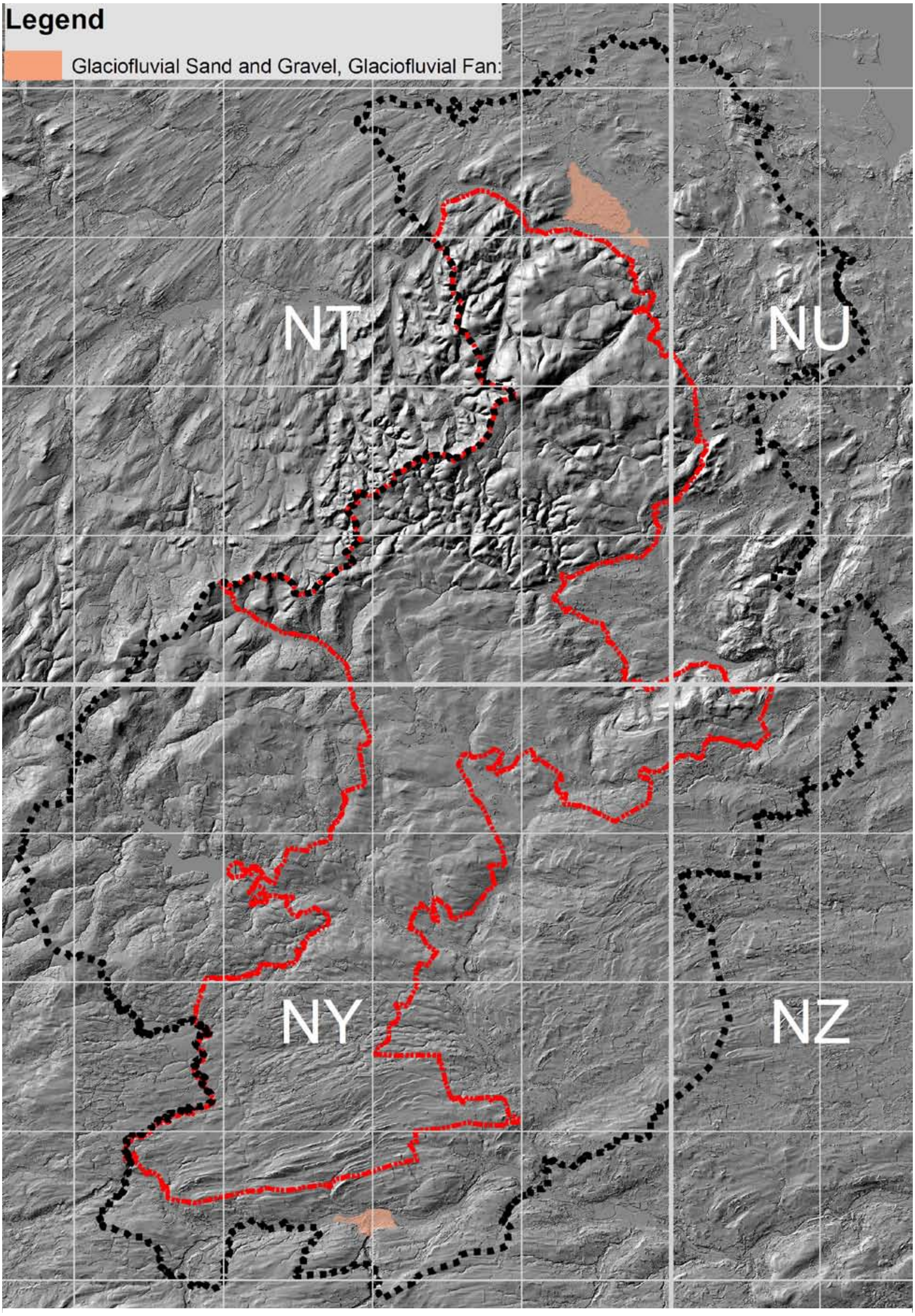

Figure 4 Glaciofluvial Sand and Gravel, Glaciofluvial Fan

2.3 GLACIAL SAND AND GRAVEL, ICE-CONTACT MELTOUT

This category describes areas where the landscape has been dominated by glacial deposition. During retreat of the ice sheet tremendous amounts of meltwater flowed both beneath and alongside the diminishing glaciers. Similarly in the areas that had been abandoned by the ice, meltwater stream networks flowed across large expanses of floodplain (sandur). Glaciers carry huge volumes of sediment that they have scraped from the landscape beneath them, and this is also released along with the meltwater. Some of this material is carried away by the meltwater to form sandur plains, but some is also deposited where the glaciers are melting.

Material tends to form a moundy, hummocky landscape, made up of low hills and ridges, depressions and hollows, with what appear to be abandoned river channels running through them. Within these areas one can find examples of ‘classic’ glacial scenery- moraines, eskers, kames and kettle holes, all related to the retreat of the ice. The material that comprises these features is often dominated by sand and gravel deposits, but may contain clay and boulders. Often there is no organisation in the deposits, all grades and types being mixed up together. In areas where meltwater has had a greater influence some sorting of sands and gravels may occur, as in fluvial systems.

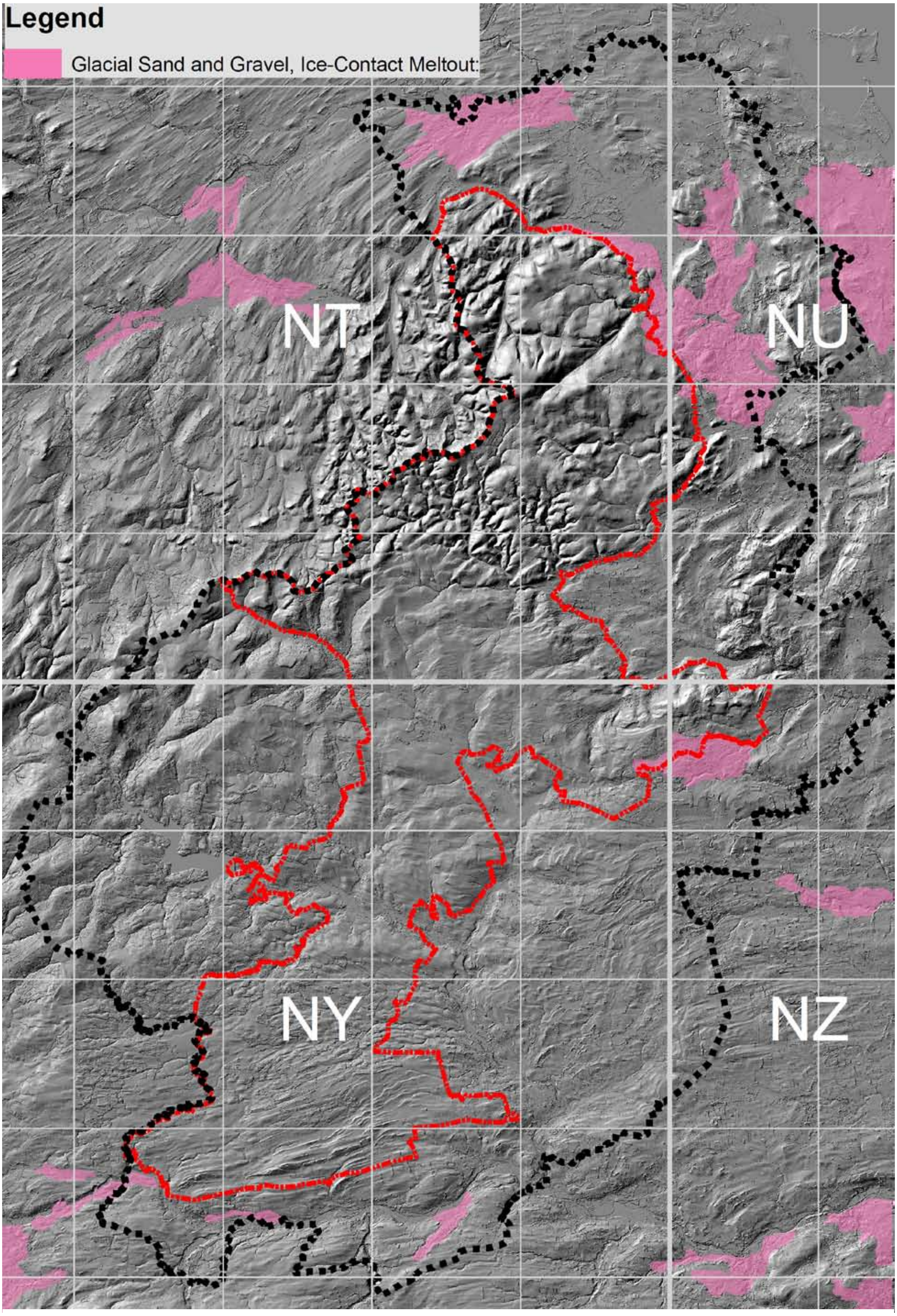

Figure 5 Glacial Sand and Gravel, Ice-Contact Meltout

2.4 LACUSTRINE, GLACIAL LAKE

Where meltwater from a glacier margin cannot escape and flow away downhill, ponding occurs. This is often caused by the landscape topography acting as a dam, or sometimes may occur when the edge of the glacier prevents meltwater from escaping. These latter are called ‘pro-glacial lakes’ in that they occur in front of a glacier. Where ice forms the dam the lake is only temporary, as once the ice melts away, the dam no longer exists and the water can escape. However if ponding of meltwater is caused by topography, then as long as a water supply continues, the lake may remain for long periods.

The Millfield Plain has been interpreted as the bed of a glacially fed lake, most likely supplied by flow from the Glen Valley to the west. The low lying hills to the east and south may have provided sufficient obstacle to form effective low dams to water escape. The association of this lake with the glaciofluvial meltout deposits around Wooler, Powburn and Wooperton is further evidence for the decline of an ice sheet margin from the south and east, westwards and northwards.

Glacial lake sediments are normally made up of clays and silts. In many cases these form layers both in terms of their colour, and also their grain size. Spring and summer melting from the glacier produce much more water, which has a greater ability to carry larger sediment particles, whereas winter melting tends to be smaller scale, with only finer particles being able to be transported. This summer/ winter difference leads to distinct bands in the sediments.

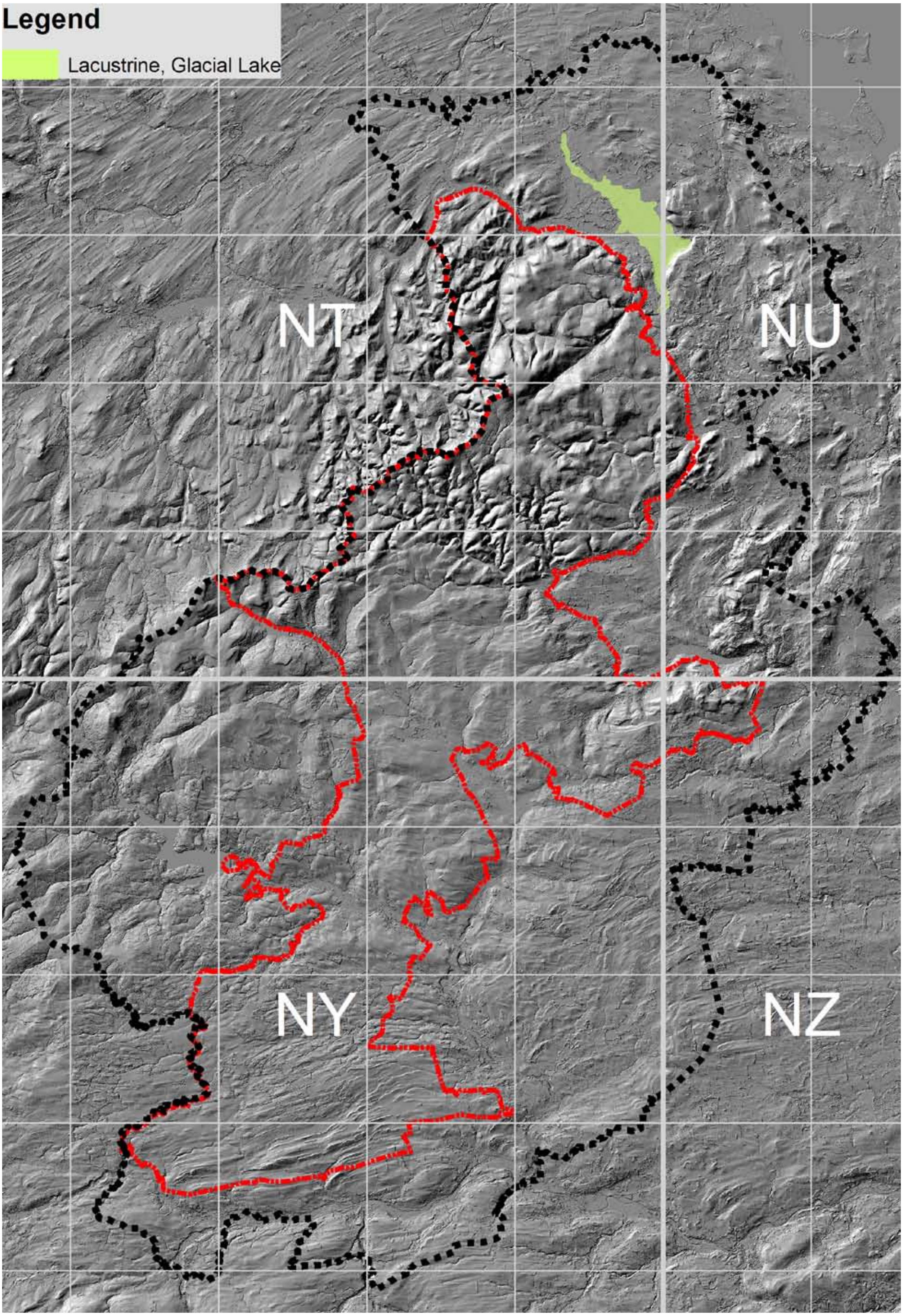

Figure 6 Lacustrine, Glacial lake

2.6 TILL, UNMODIFIED

Till is material that has been deposited beneath a glacier. Often called Boulder Clay, it blankets landscapes that have undergone glaciation. In some places in Northumberland estimates of 60m thicknesses have been made. Till-covered landscapes tend to include valley bottoms, valley sides, flatter plains and the tops of lower-lying hills. As till tends to cover the underlying landscape in lowland areas, it masks the bedrock topography. Landscapes tend to have even surfaces or are gently undulating, the surface topography often being determined by the speed of the ice flowing over it. Tills tend to be composed of clays, sands and gravels, often with cobbles and boulders. As a general rule, the further the material making up the till has been transported, the finer it will be. This is not a strict rule, as large boulders can survive transport over many kilometres.

Landscapes that appear to be unmodified, even though they have been glaciated, have not undergone the tremendous streaming effects of fast moving ice. Areas around Whittingham and on Middle Moor, near North and South Charlton appear to be covered with till that has no distinct surface topography, rather than that reflecting the underlying bedrock surfaces.

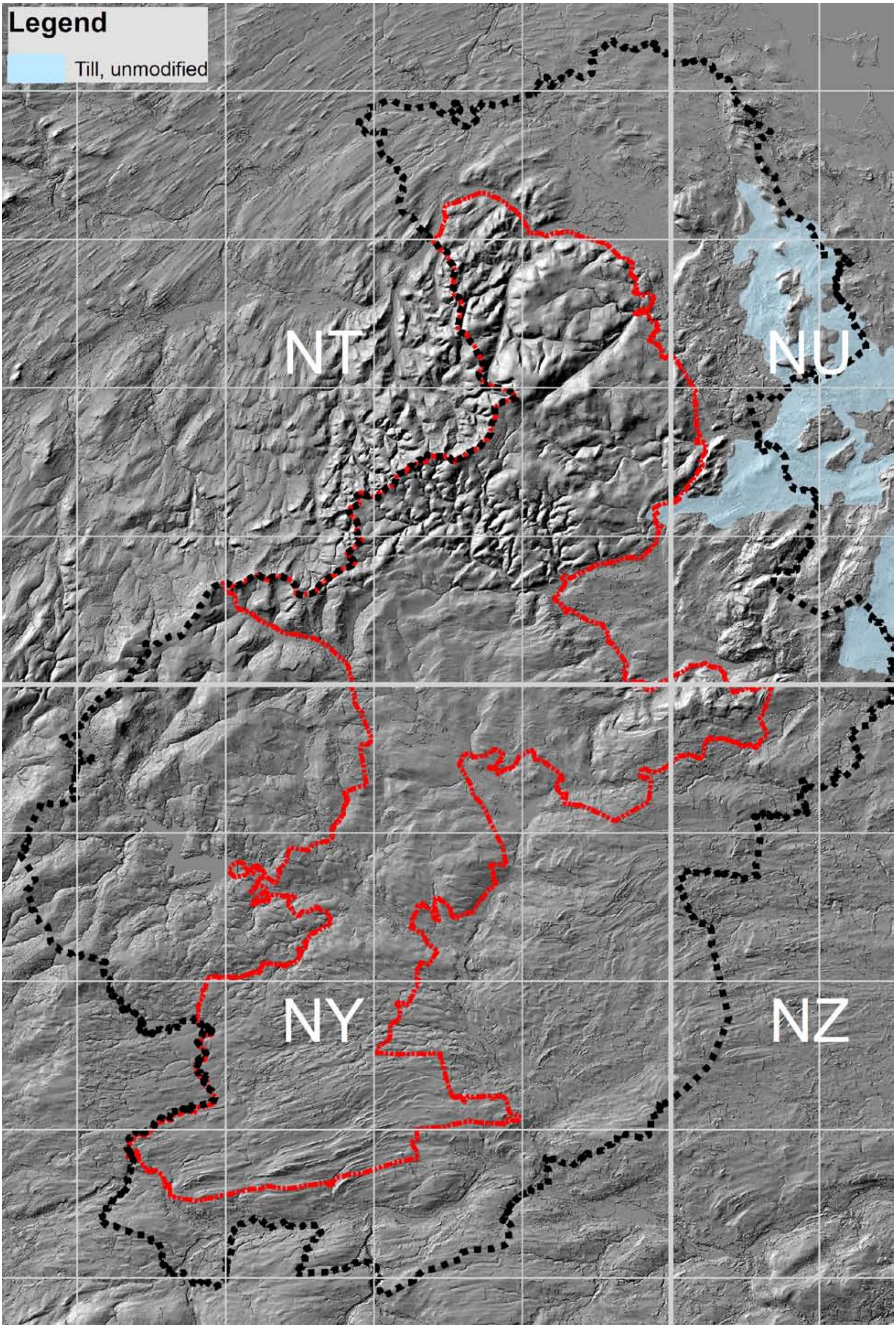

Figure 7 Till, Unmodified

2.7 TILL, STREAMLINED

In areas where ice sheet flow has been particularly rapid, the surface of the till has been smoothed or streamlined into long, linear features by the overriding ice. These features are common in both the area to the east of the Tyne Gap and in the valley of the Tweed, where drumlins, flutes, megadrumlins and megaflutes can all be seen, though it is clear that much of the landscape covered by the LCA has been subjected to this sort of glacial activity. These landscapes are similar to what is being formed beneath huge ice sheets such as the West Antarctic Ice Sheet today, and from the air display very distinct landform characteristics. The till in this area has been plastered across much of the lower-lying landscape, forming the basis for the poorly-drained soils of much of the National Park region. The Cheviot appears to support very little till, most likely as a result of iceflow diverging around the massif, and the likely presence of a cold-based ice cap spread across the summits.

The lineated till features in the area reflect the streamlining effects of at least two very large ice streams. Both the Tweed and Tyne Gap Ice Streams drained eastward from the main ice divide of the British Ice Sheet, and probably operated during and soon after glacial maximum, about 22,000 years ago. They formed part of a system of constantly shifting ice streams, which transported much of the total mass of the ice sheet from the central ice divide and accumulation areas, out to the margins beyond the modern coastline of Britain.

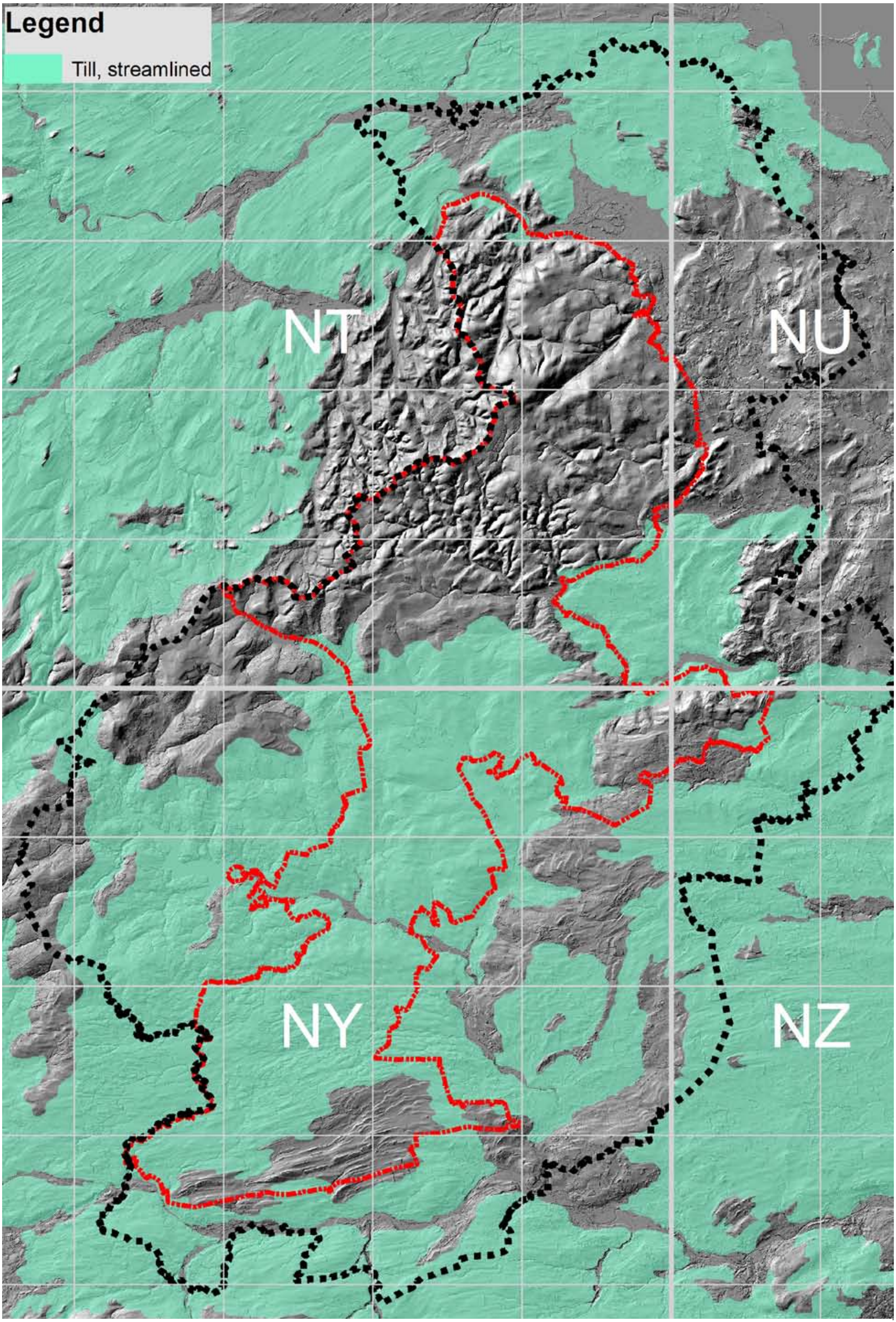

Figure 8 Till, Streamlined

2.8 BEDROCK, UNMODIFIED

Despite almost certainly being covered by the same ice sheet as the ‘Streamlined Bedrock’ (pp. 23-24), these bedrock surfaces seem to have been little altered. They display no evidence of streamlining, and little evidence of deep weathering. Slopes tend to be convex, often with fairly thin coverings of weathered material upon them. Their preservation, in contrast to the other bedrock-dominated landscapes, is almost certainly determined by their position relative to the fastest flowing parts of the ice sheet. It is believed that the fastest ice flow went to the north and south of the Cheviot, through the valleys of the Tweed and the Tyne Gap. Even though they were ice covered, the Cheviot probably supported an ice dome that moved very little throughout the Late Devensian, only contributing a small amount to the overall flow from west to east in the region. Such domes are argued to be composed of cold-based ice, which is frozen to the underlying substrate. Without the influence of free meltwater and limited ability for basal sliding, the ice is unable to significantly erode the landscape beneath.

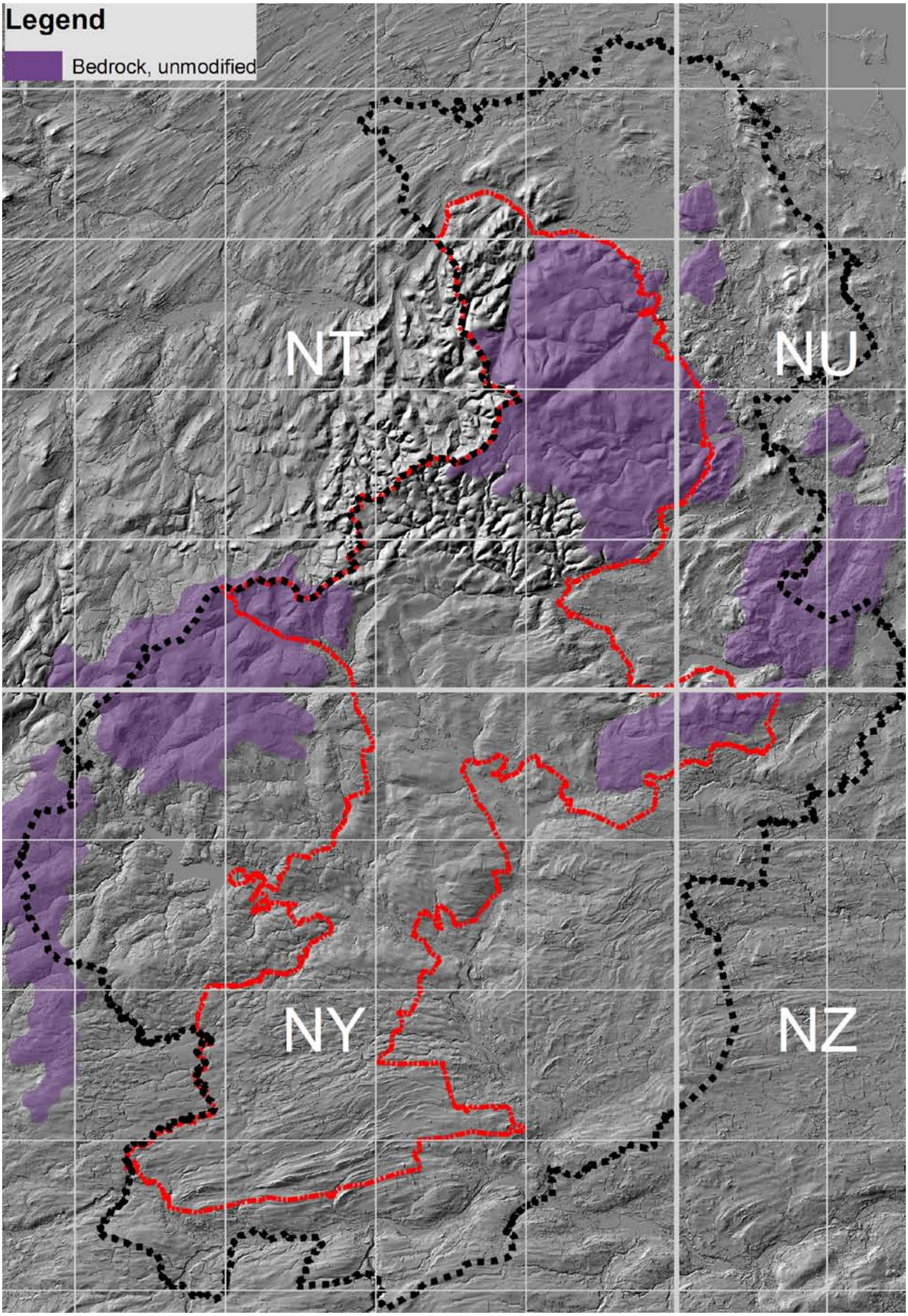

Figure 9 Bedrock, Unmodified

2.9 BEDROCK, DEEPLY WEATHERED

The areas described by this category usually form part of upland regions. Bedrock may not necessarily crop out at the surface as distinct exposures, but is more often covered with a thick blanket of degraded bedrock material. Hillslopes tend to be concave, with large sediment accumulations at their bases, and valley profiles tend to be ‘V’ shaped. From the air these areas exhibit extensive downcutting by river and stream networks, creating typically dendritic drainage networks that have not been influenced by glacial erosion of uplands as in other areas in the LCA.

Such material is often taken to be indicative of long sub-aerial exposure, which often includes periods of extremely warm climate. The Cainozoic period is linked with the creation of weathered bedrock material, and one suggestion is that areas of weathered bedrock in the LCA have undergone little erosion for the last 2 million years, in comparison to other areas. A more likely explanation is that since the area has undergone at least two major glacial episodes, and probably several more over the last 2 million years, the weathered bedrock found in the area is the remnant of a much more extensive deposit that has been progressively removed by glaciations.

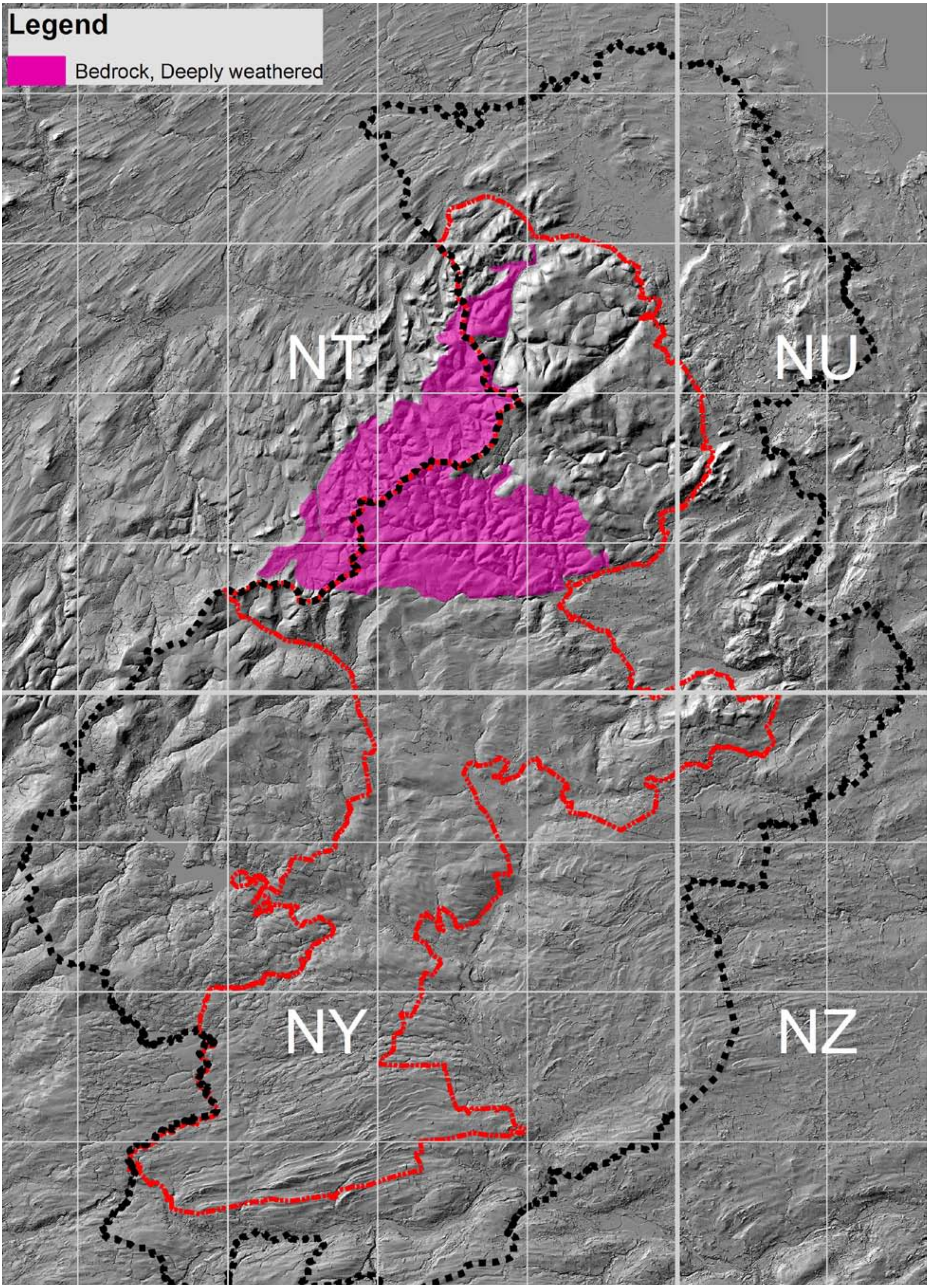

Figure 10 Bedrock, Deeply weathered

2.10 BEDROCK, STREAMLINED:

This category describes areas where bedrock outcrops at the surface, or occurs very near the ground surface, often only supporting up to a metre of soil, where overriding by fast flowing glacial ice is apparent. From the air the slopes appear to be streamlined, or smoothed, as a result of the abrasive activity of a large powerful ice sheet. Hill summits tend to be smoothed, and valley slopes are oversteepened, producing ‘U’ shaped profiles. Bedrock outcrops are often associated with a ‘tail’ of sediment extending down-ice, which act as ice flow direction indicators. The ice sheet was probably flowing across the area from around 25 to 15 thousand years ago (the Late Devensian Period).

The different rock types in the region may exhibit differences of form as a result of this process, as a result of their inherent lithological characteristics. The dipping Carboniferous beds of sandstone and limestone often demonstrate relatively unmodified dip slopes, but with streamlining along the cuesta and scarp slope.

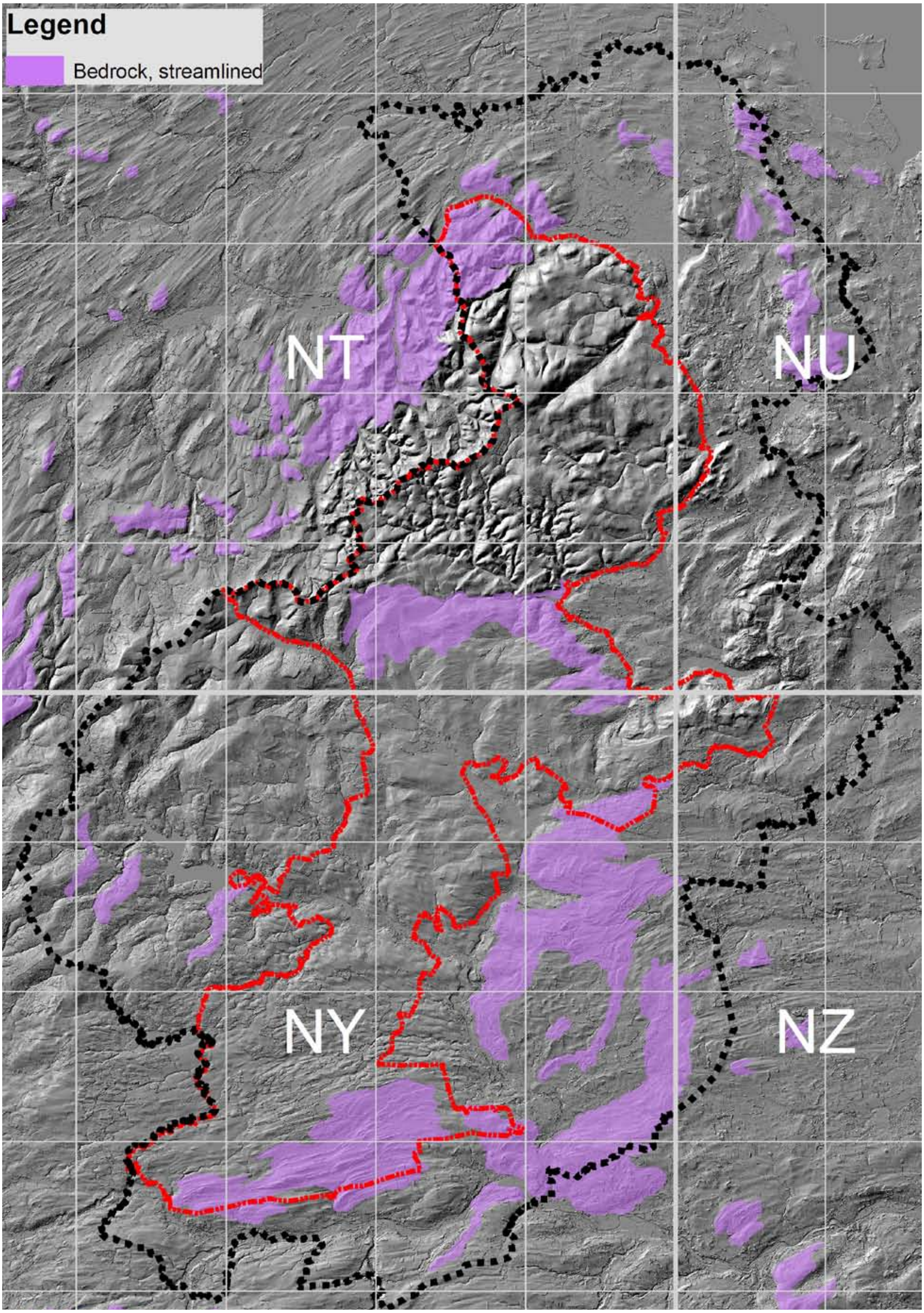

Figure 11 Bedrock, Streamlined