Black Burn, Cumbria

[NY 685 415]

Highlights

Black Burn demonstrates channel pattern and sedimentation style changes associated with the downstream movement of a sediment wave, generated by historical mining activity. At this locality, late Holocene river terraces with excellent examples of braided stream palaeochannel traces are also found.

Introduction

Black Burn (catchment area 64 km^2), one of the principal headwater tributaries of the River South Tyne, is a steep, boulder-bedded upland stream that drains in a northeasterly direction from Cross Fell, which at 893 m is the highest peak in the Northern Pennines. In a 1 km long reach immediately upstream of the disused Rodderup Fell mine, the progressive downstream transfer of coarse sediment introduced into the channel by hydraulic mining (hushing) can be documented over the past 200 years or so. This is still continuing at the present-day with aggradation of coarse bed sediment and braiding in the lower part of the study reach. River landforms and sediments associated with valley floor aggradation and incision, linked to the down-valley movement of a sediment mega-form (*sense* Church and Jones, 1982) or slug (*sensu* Nicholas *et al.,* 1995) are especially well-developed.

Description

The reach lies immediately above the disused Rodderup Fell lead mine [NY 699 427], 5 km southeast of Alston (Figure 5.1). The river at this point flows through an alluvial basin (the largest in the Black Burn catchment), 850 m long and up to 250 m wide, bordered by steep, convex till-covered valley-side slopes. At the head of the basin, on the east bank of the river, a number of prominent gully-like erosion scars produced by hydraulic mining for metal ores, run down the hillside and debouch on to the valley floor. At the mouths of some of these, cones of coarse mining debris still remain, although considerable volumes of hushed sediment have been eroded, transported downstream and incorporated into the historical floodplain. Along with Hudeshope Beck [NY945 293] in upper Teesdale, this is one of the few sites in the Northern Pennines at which upstream input of coarse mining debris generated by hushing can be clearly linked to downstream channel and floodplain sedimentation.

Three alluvial terraces are evident on the valley floor (Figure 5.2). The highest two terrace units (4 m and 3 m above the present river bed). are vegetated, formed of coarse gravels overlain by a thin veneer (0.2–0.4 m) of silts and sands. Both terraces have a series of well-developed palaeochannels preserved on their surfaces (Figure 5.3). Wood excavated from the fill of one of these palaeochannels in the 4 m terrace has been ^{14}C dated to *c.* 366 cal AD, while a tree trunk recovered from the base of the 3 m terrace gave a date of *c.* 420 cal AD. These dates indicate large-scale valley floor incision and aggradation, of the order of 3 m, which occurred in Black Burn towards the end of the Roman occupation. The lower terrace (2 m above the present river bed) is composed of boulder- to cobble-sized sediment (with little or no plant cover), the surfaces of which are covered by lichens, the most prominent of which are *Rhizocarpon* sp. and *Huilia tuberculosa.* On this terrace upstream of the confluence of Black Burn and Rowgill Burn [NY 684 417] there are a series of exceptionally well-preserved meander cutoffs (Figure 5.4). Historical maps (Figure 5.5) show that these were part of the active channel up to the end of the 19th century until being cut off some time between 1900 and 1957. On the north-west side of the valley floor, downstream of Rowgill Burn, are found a number of inactive mid-channel bars that were part of the active channel until 1957. Side channels adjacent to these bars have been choked and plugged by boulder-sized sediment deposited during a major flood, that resulted in the natural straightening of the channel.

Interpretation

Historical maps (Figure 5.5) and lichenometric dating show that the 2 m terrace marks the limit of channel reworking of the valley floor since the mid- 18th century. Analysis of metal concentrations in these sediments shows generally higher concentrations than those of the 3 and 4 m terraces, although metal levels in the former unit are comparatively high, especially at sites closest to the margin of the valley floor reworked since the middle of the 19th century. It is likely, therefore, that floods during and since this period have partly inundated earlier terraces, depositing metalliferous sediment. Although mining in the Black Burn catchment dates back at least to the 1780s, it is equally likely that metal contamination of this older fill may have been associated with a pre-18th century phase of mining.

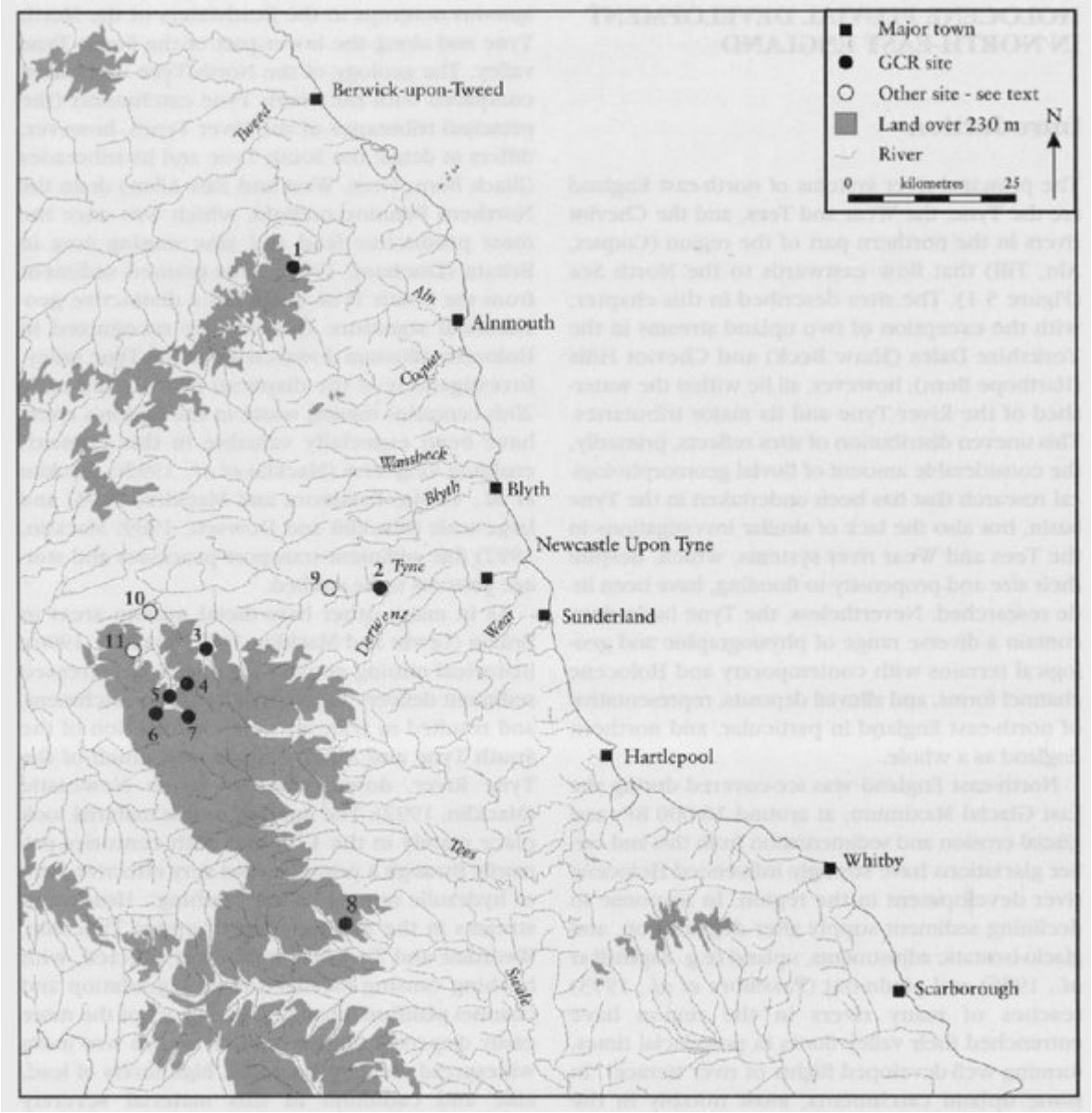
Black Burn is presently a steep (0.023 m m^{-1}) boulder- and cobble-bedded stream which is capable of transporting bedload material the intermediate axes of which exceed 70 cm. Above Rowgill Burn the river is laterally confined by alluvial terraces (described above) and is currently incising through bedrock with a prominent knick-point 50 m upstream of cross-section C (Figure 5.2). Height relations between current bedload sedimentation levels and coarse-grained alluvium deposited between the middle 19th to early 20th centuries changes in a systematic fashion down the study reach. At cross-section C the present channel is 1.9 m below late 19th century alluvial sediments, and at cross-section B 1.6 m, while at cross-section A the river bed is less than 0.4 m below alluvium deposited in the early part of the 20th century. Below cross-section A the present channel is aggrading, with coarse bed material burying the late 19th and early 20th century floodplain.

River landforms and deposits in Black Burn are of particular regional interest by virtue of it being the most upland river system in north-east England the late Holocene and recent development for which have been documented. Moreover, the study reach presently constitutes the most extensive and currently active boulder-bedded stream in the Tyne basin, with good examples of mid-channel bars and boulder berms formed by historical floods, as well as high- and low-sinuosity palaeochannels. In this respect, Black Burn is similar to steep gradient boulder- and cobble-bedded upland streams described by Harvey *et al.* (1979) in the Bowland Fells and by Milne (1982) in the Cheviot Hills. Although changes in the availability of coarse sediment over Holocene and historical times can be studied in a general way in both of these areas, at Black Burn it is possible to identify historical metal mining as the principal source, and primary cause, of increased sediment supply to the valley floor in recent times. Down-valley coarse sediment transfer rates can also be determined, as well as associated patterns of sediment storage and channel change. By quantifying the volume of hushed sediment introduced into the reach and comparing this with amounts of hushed material currently stored on the valley floor, it should be possible also to calculate a sediment budget for the study reach over the past 200 years, and perhaps longer.

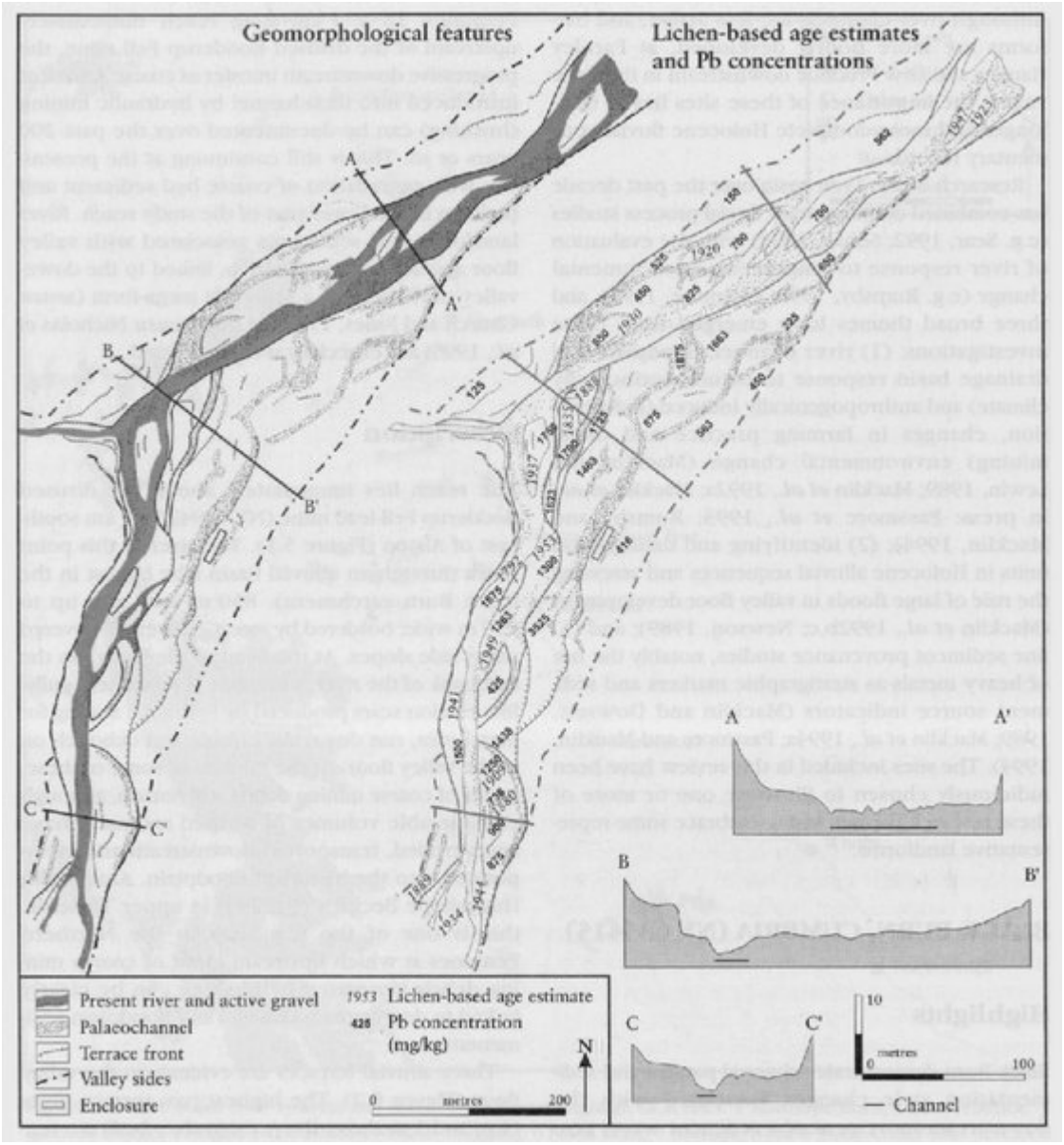
Conclusion

Black Burn displays alluvial landforms and deposits associated with the down-valley movement of a sediment waveform associated with the episodic input of coarse mining waste. It is one of the few sites in the Northern Pennines at which upstream input of coarse sediment produced by hushing for metal ores can be clearly linked to downstream historic floodplain sedimentation. The study site also constitutes the most extensive, laterally mobile, low-sinuosity boulder bedded river reach in the Tyne basin.

References



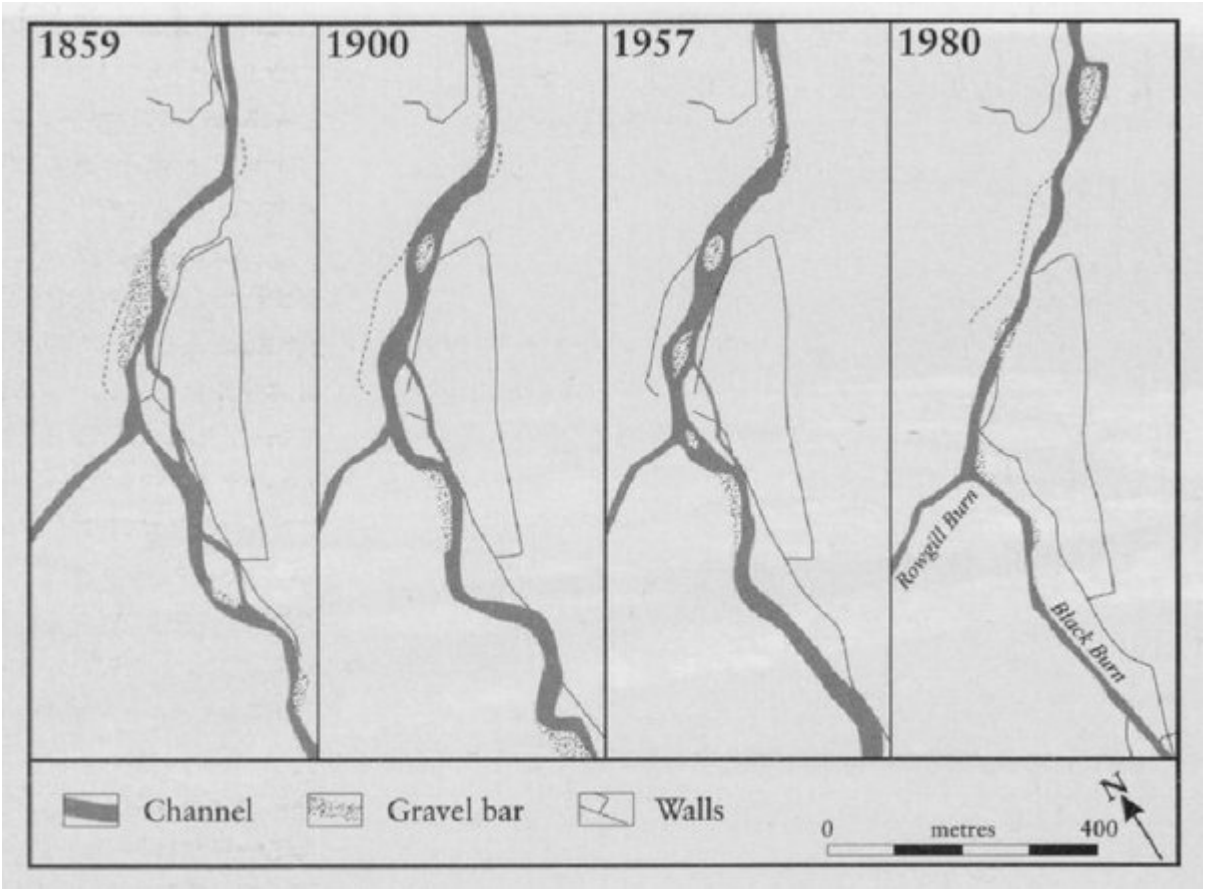
(Figure 5.1) The major river systems and relief of north-east England. GCR Sites: 1 Harthope Bum; 2 Low Prudhoe; 3 Blackett Bridge; 4 Blagill; 5 The Islands, (Alston Shingles); 6 Black Burn; 7 Garrigill; 8 Shaw Beck. Other sites descibed in the text: 9 Farnley Haughs; 10 Lambley; 11 Thinhope Burn.



(Figure 5.2) Black Burn: geomorphological features and dated sedimentary units, with cross-sectional profiles.

(Figure 5.3) Black Burn, looking downstream in a northeasterly direction, showing well-developed palaeochannels on low river terrace surfaces. (Photo: M.G. Macklin.)

(Figure 5.4) Black Burn, looking upstream in a southerly direction, showing prominent meander cutoffs dated to between 1900 and 1957. (Photo: M.G. Macklin.)



(Figure 5.5) Channel change at Black Burn, 1859–1980.