# Chapter 10 Concluding comments

## 10.1 Introduction

In this chapter, the thesis objectives are revisited to assess the contribution of this study to existing knowledge of Pleistocene palaeoenvironments of the Gordano Valley, the Bristol Channel/Severn Estuary region, southern England and northwest Europe.

## 10.2 Aerial extent, surface morphology and geometries of the Pleistocene sediments

High resolution coring and field sampling has significantly revised understanding of the spatial variations in valley floor Pleistocene minerogenic sediments from that achieved by earlier studies (Jefferies *et al*. 1968, Mills 1984, Gilbertson *et al*. 1990, Hill 2006). Although access restrictions prevented a full stratigraphic survey, an enhanced understanding of the aerial extent, surface morphology and geometries of the Pleistocene minerogenic sediments, summarised in Figure 10.1, has been achieved. The creation of two- and three-dimensional stratigraphic diagrams further clarified the surface morphology and geometries of the sediments, facilitating identification of a hummocky surface and an axial channel or basin. The morpho-sedimentary reconstructions have informed interpretations of process and environment (see section 10.4).

## 10.3 Stratigraphy of the Pleistocene sedimentary units

Although stratigraphic surveys of the valley had been undertaken previously, only a very limited understanding of the minerogenic sediments had been achieved. Detailed stratigraphic sampling and analysis of cores has enabled a new understanding of the stratigraphy of the minerogenic sediments. Variation between valley fringe and valley axis stratigraphies, shown in Figure 10.2, records multiple discrete depositional events with intervening depositional hiatuses and episodes of pedogenesis.

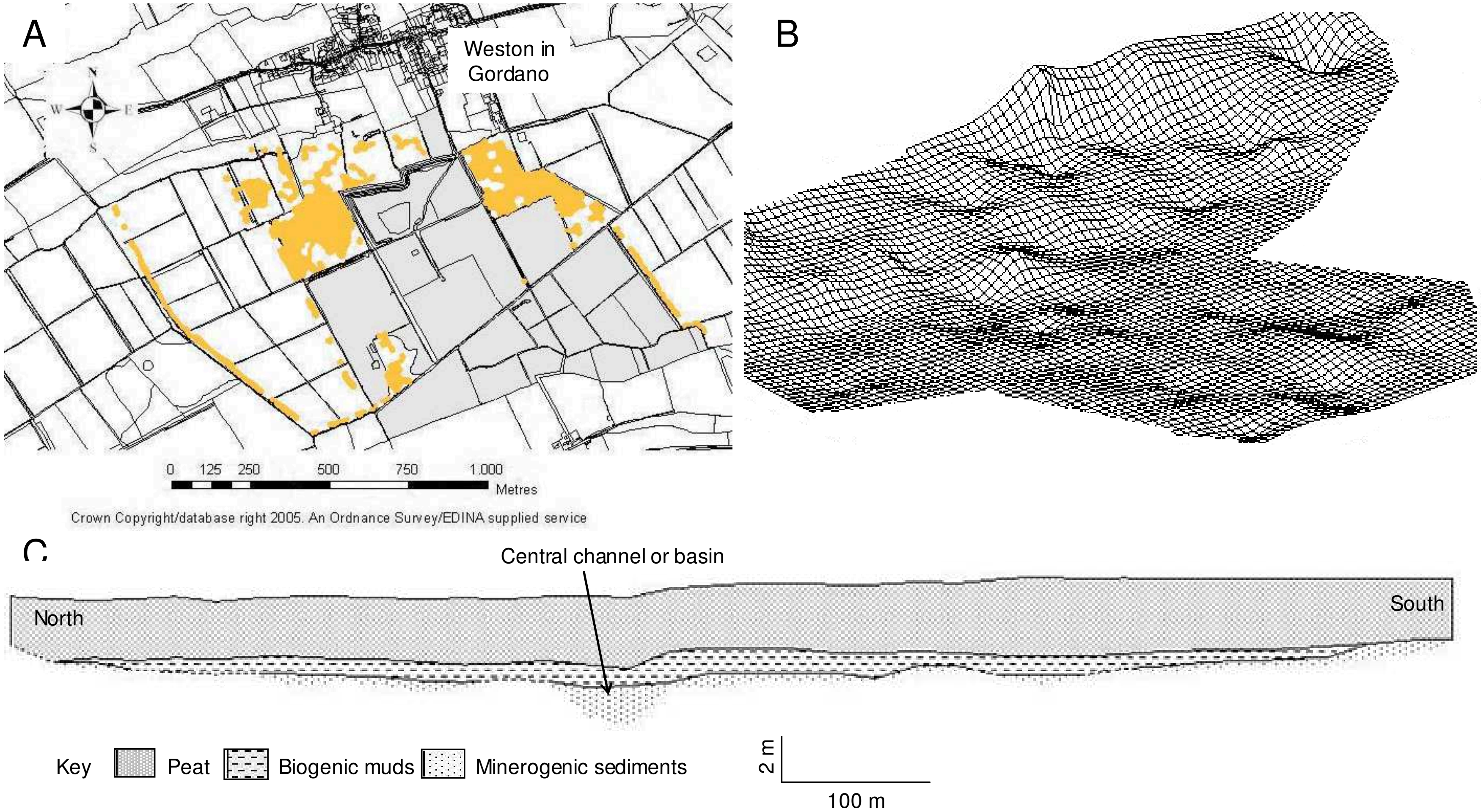


Figure 10.1: A. Aerial extent of Pleistocene minerogenic sediments determined in this study. B. Hummocky surface morphology of the minerogenic sediments. C. Composite cross-valley section showing geometries of the minerogenic sediments onto which biogenic muds have been deposited

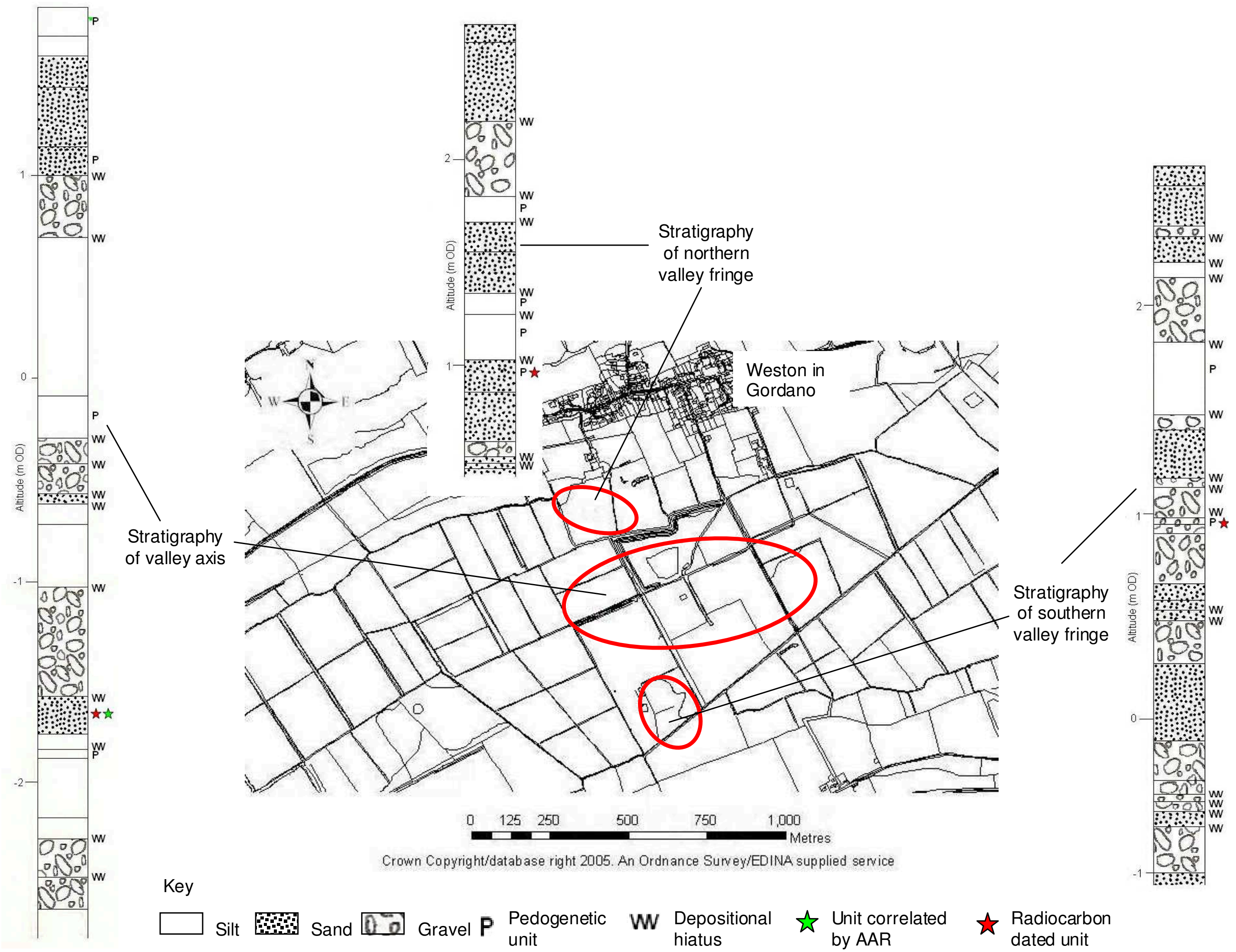


Figure 10.2: Composite schematic stratigraphic logs of the minerogenic deposits of Gordano Valley showing their locations on the valley floor

## 10.4 Characterisation of the Pleistocene minerogenic sediments of the Gordano Valley and interpretation of their depositional environments

The Gordano Valley sediments indicate repeated episodes of fluvial activity, recording changes in fluvial style, stream competence, discharge regime, sediment:water ratios and material availability; a local provenance is indicated. Six main depositional environments are inferred: muddy, silt-sand bedded and gravel-bedded rivers, braided streams, intertidal interconnected freshwater pools and alluvial fans.

During warm stages muddy rivers, freshwater streams and interconnected pools which were open to tidal influence and intertidal sands and muds, with relative sea levels close to those of the present day (although potentially influenced by isostatic uplift) are inferred. At these times, the streams were inhabited by a freshwater fauna that included molluscs and ostracods and there is a rich aquatic vegetation. Brackish water periodically transgressed into the valley during high tides, during which episodes marine shelf ostracods and foraminifera were deposited. During cold stages active alluvial fan deposition was interspersed with periods of landscape stability. Braided streams fed by meltwater and/or intense rainfall flowed across the surface of alluvial fans. Palaeosols developed during periods of relative landscape stability, but episodes of pedogenesis were repeatedly interrupted by sediment burial; this pedogenesis/burial cycle is possibly the result of climatic fluctuation. Periods of aridity are marked by the formation of carbonate deposits from shallow water tables within the sediments and aeolian reworking of fluvial deposits. Climate varied throughout sediment deposition; periods of semi-aridity, climate amelioration, temperate and cool, wet climate are all recorded, and water table fluctuations resulted in geochemical changes to sediments from repeated submergence and emergence.

## 10.5 Geochronology of the Pleistocene minerogenic sediments of the Gordano Valley

The application of AMS radiocarbon dating to palaeosols, AMS radiocarbon dating and AAR geochronology to mollusc shells and OSL dating to quartzitic sediments has provided a temporal framework for local palaeoenvironmental change, which can be related to climate fluctuations during the Middle to Late Pleistocene period, and has contributed significantly to the understanding of the timing of palaeoenvironmental changes in the Gordano Valley and the wider region.

This study marks the first application of the RPC/intra-crystalline fraction technique to provide an AAR geochronology in the Bristol Channel/Severn Estuary region. This appears to show that the Gordano Valley contains rare evidence of late temperate stage (possibly MIS 7a) fluvial sediments. OSL dating of quarzitic sediments provides a range of Early Devensian dates (*c*. 94-62 ka) for minerogenic sedimentation, whilst radiocarbon dating indicates that soil formation ceased on two occasions (*c*. 22 Cal ka BP and *c*. 13.3 Cal ka BP) in response to climatic deterioration occurring at the onset of the Devensian (MIS 2) glacial maximum and the Younger Dryas Stadial.

Although radiocarbon dating and AAR correlation of mollusc shells from sediments in TG8 provided dates of *c*. 45 ka BP and MIS 7 respectively, because the radiocarbon date is at the limit of the technique, more confidence has been placed in the AAR correlation; further dating is required to confirm the MIS 7 age of these deposits. This demonstrates the importance of having dates independently corroborated. Use of multiple dating techniques is recommended wherever possible to corroborate findings, particularly where a date is at the limit of a technology.

**10.6 Revised model of Pleistocene events in the Gordano Valley**

The preferred model of Pleistocene events in the Gordano Valley proposed in this study, summarised in Table 10.1, is a significant advance over the earlier models of Jefferies *et al*. (1968) and Hill (2006), in terms of stratigraphic resolution, palaeoenvironmental interpretation and geochronology, although it has not been possible to reconcile the altitude of deposits with suggested tectonic movements (Westaway 2010b). In this model, only seven units are recorded between Triassic bedrock (reached in core GV) and MIS 7. The presence of hiatuses indicates episodes of sediment erosion, although the extent, timescale and mechanism for this is unclear; no evidence has been found for glaciation of the valley floor, although the regional presence of glacial deposits (e.g. Campbell *et al*. 1998) would suggest the probability of ice occupying the valley on at least one occasion.. The earliest Pleistocene sediments (pre-MIS 7) represent fluvial deposition in muddy and gravel-bedded rivers. During MIS 7 there were intertidal sands and muds, interconnected freshwater pools and a sand-bedded river. Subsequent fluvial deposition was replaced by Early Devensian (*c*. 90 ka, probably MIS 5b) landscape instability with, possibly, initiation of alluvial fan sedimentation. Climate amelioration and landscape stability, probably during MIS 3, resulted in pedogenesis; this was terminated by MIS 2 climate deterioration *c*. 22 ka. Late Devensian Lateglacial Interstadial climate amelioration *c*. 15 ka resulted in a hydroseral succession (Hill *et al*. 2008) and pedogenesis; this was terminated *c*. 13 ka by recommencement of alluvial fan sedimentation during Younger Dryas Stadial climate deterioration.

Table 10.1: Summary of Pleistocene environmental change in the Gordano Valley. Dashed lines indicate temporal uncertainties. Hydroseral environment at 15 ka is based on Hill *et al*. (2008)

| Age | Units | Sedimentological characterisation | Inferred depositional environment | Inferred post-depositional environment |
|---|---|---|---|---|
| | NR16 | Gravel-bedded river, ?debris flow | Alluvial fan | Semi-arid; sparse vegetation; shallow water table |
| 13 ka | NR15 | Gravel-bedded river | | Climatic cooling; fluctuating water table; reduced vegetation cover |
| | NR14-12 | Gravel/sand-bedded river | | Cool to temperate, wet climate; shallow water table; organic productivity |
| 15 ka | TG17-21 | Braided streams | Hydroseral | Shallow, fluctuating water table; waterlogging; fluctuating organic productivity; pedogenesis |
| | CGA7 | Muddy river | Alluvial fan | Temperate climate |
| 22 ka | CGA6<br>CGA5 | Sand-bedded river | Fluvial | Climatic amelioration; low water table |
| | CGA4 | Gravel-bedded river | | Semi-arid; sparse vegetation |
| | CGA3 | Aeolian | | |
| | CGA2 | Muddy river | Fluvial | Semi-arid; sparse vegetation |
| | CGA1 | Braided stream | | |
| 90 ka | TG-OSL | Landscape instability | ? Alluvial fan | |
| | TG14 | Gravel -bedded rivers | Fluvial | Low water table; increased aridity; reduced vegetation cover |
| | TG13 | | | Shallow water table; organic productivity; pedogenesis |
| | TG12 | Sand-bedded river | | Shallow water table; increased aridity; reduced vegetation cover |
| | TG11<br>TG10 | Muddy rivers | | Wet, temperate climate; organic productivity |

Table 10.1 (continued): Summary of Pleistocene environmental change in the Gordano Valley. Dashed lines indicate temporal uncertainties

| Age | Units | Sedimentological characterisation | Inferred depositional environment | Inferred post-depositional environment |
|---|---|---|---|---|
| | TG9 | Gravel-bedded river | Fluvial | Shallow water table; increased aridity; reduced vegetation cover |
| 195 ka | TG8 | Sand-bedded river | Interconnected streams/intertidal | Fluctuating water table; increasing aridity; reduced vegetation cover |
| | | Braided stream | pools | |
| | TG7 | | Interconnected streams/intertidal | Fluctuating water table; organic productivity |
| | | Braided streams | pools | |
| | TG6 | | | Wet, temperate climate; organic productivity |
| | TG5 | | | |
| | TG4 | | | |
| Older Pleistocene deposits | TG3-2 | Gravel-bedded river | Fluvial | Increasing aridity; shallow water table; reduced vegetation |
| | | | | Wet, temperate climate; organic productivity |
| | | Muddy river | | |
| | TG1 | | | |
| Triassic bedrock | | | | |

Establishing a geochronology has allowed the Pleistocene development of the Gordano Valley to be placed within a wider context, enabling the palaeoenvironmental changes in the valley to be compared to the known histories of other sites in southern England and northwest Europe, and the deposits to be linked to wider climatic forcing factors. A number of environments common to Pleistocene sediments found across the region are present in the Gordano Valley. Regionally, other findings are scattered over a wide area; in the Gordano Valley they occur in a more compact space, demonstrating the unique preservation potential of the valley. In the wider region, the Gordano Valley shows good agreement with other evidence for Devensian palaeoenvironmental change. However, earlier (MIS 7) deposits may be more significant as they appear to differ altitudinally from most other coastal sites at this time.

This study constitutes the first reconstruction of Pleistocene palaeoenvironmental change in the Gordano Valley from the valley's minerogenic sediment archive and has contributed to an enhanced understanding of landscape response to climate change in both the Gordano Valley and the wider Bristol Channel/Severn Estuary region during the Mid-to-Late Pleistocene. Through detailed analysis, complex sequences of depositional and post-depositional environmental change, interspersed with periods of non-deposition, involving a number of processes (hillslope, various fluvial, intertidal) have been identified. This detail has been possible using relatively small volumes of material from core samples and a multi-faceted methodology. Although such an approach is time-consuming and generates a large volume of interrelated data from which individual signatures or even dominant mechanisms are difficult to characterise, this study has demonstrated the potential to produce high-resolution reconstructions of environmental change from relatively small volumes of material.