ALSF AGGREGATE EXTRACTION IN THE KIRKHAM AREA

First Preliminary Progress Report

Oxford Archaeology North

THE UNIVERSITY of LIVERPOOL

Department of Geography

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English Heritage

NGR: SD 420 320 and 930 530

CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

1.1.1 This report presents the results of the first stage of the ALSF Kirkham Moraine Aggregate Extraction project. The work was undertaken as a joint project between University of Liverpool and Oxford Archaeology North (OA North), and was funded by the Aggregates Levy Sustainability Fund and under the overall management of English Heritage. The responsibility of the project was split such that Liverpool University undertook the geological and geomorphological elements of the project, and OA North undertook the archaeological elements; the palaeobotanic work was split between both organisations.

1.1.2 The programme of work is as defined within a project design (March 2006) submitted by University of Liverpool and OA North. The tasks completed (1-11), as defined in the project design, represent the preliminary phases of data gathering and set up for the project.

2. AGGREGATE EXTRACTION: STAGE ONE PROGRESS REPORT

2.1 CURRENT PROGRESS

2.11 ***Tasks 1and 2 Project Management:*** Project Management is an ongoing task. To date the project has been initiated, the contracts have been established and there has been considerable liaison between the two contributing organisations.

2.1.2 ***Task 3 and 4 liaison and Management Meetings:*** liaison for the set up tasks has been undertaken by telephone and email. At this preliminary stage this has mainly involved JC, NRW (OAN), PDI (LCC) and RC (LU) maintaining contact over data collection progress and ensuring mutual access to the various datasets as acquired.

2.1.3 ***Task 5 GIS preparation (Completed)***: the GIS framework for the acquisition of new data for the ALSF Kirkham will be undertaken using ARCGIS 9.2. All data will be acquired in an ARCGIS compatible format and eventual products will be supplied to end-users as either ARCGIS shapefile or geodatabase formats for vector data, and georeferenced tiff's for raster format data. A project FTP site has been adapted from the previous project with directories specific to the Ribble Kirkham project at the University of Liverpool (ftp://geog-gis.geog.liv.ac.uk/). The FTP site allows rapid transfer of data between Liverpool and OA North, all common data products will be stored and archived on the FTP site. The OA North project directory has been created using a tested file / directory template designed for use in large scale GIS and database based projects. An initial GIS project has been created to access and examine the datasets gathered. An Access database has been created based upon the Ribble ALSF and is ready to accept the new area data.

2.1.4 ***Task 6 Modern Mapping (Completed)***: following discussions with the project partner Lancashire County Council (LCC), and in particular, Peter Iles (Specialist Advisor (Archaeology) Lancashire County Council Environment Directorate) the project is using Ordnance Survey baseline mapping under LCC licences. Access to LiDAR has been facilitated via the involvement of Peter Iles (LCC) and Phil Catherall (EA), continuing the arrangements put in place by Jennie Stopford for the original ALSF Ribble project. The necessary licences have been completed and the data will be dispatched by CD shortly, this means the LiDAR (where covered, Fig1) for the study area and permission to use the existing (Ribble) materials for the publishing process has been achieved. On arrival the data will be accessed by the project group through the ftp site (ftp://geog-gis.geog.liv.ac.uk/).The following modern Ordnance Survey baseline mapping products have been obtained and added to the project GIS, they have also been uploaded to the FTP server for use by both organisations.

- Current Ordnance Survey Profile 10 m resolution DEM
- Current Ordnance Survey 1:10,000 (digital raster)
- Current Ordnance Survey 1:25,000 (digital raster)
- Current Ordnance Survey 1:50,000 (digital raster)

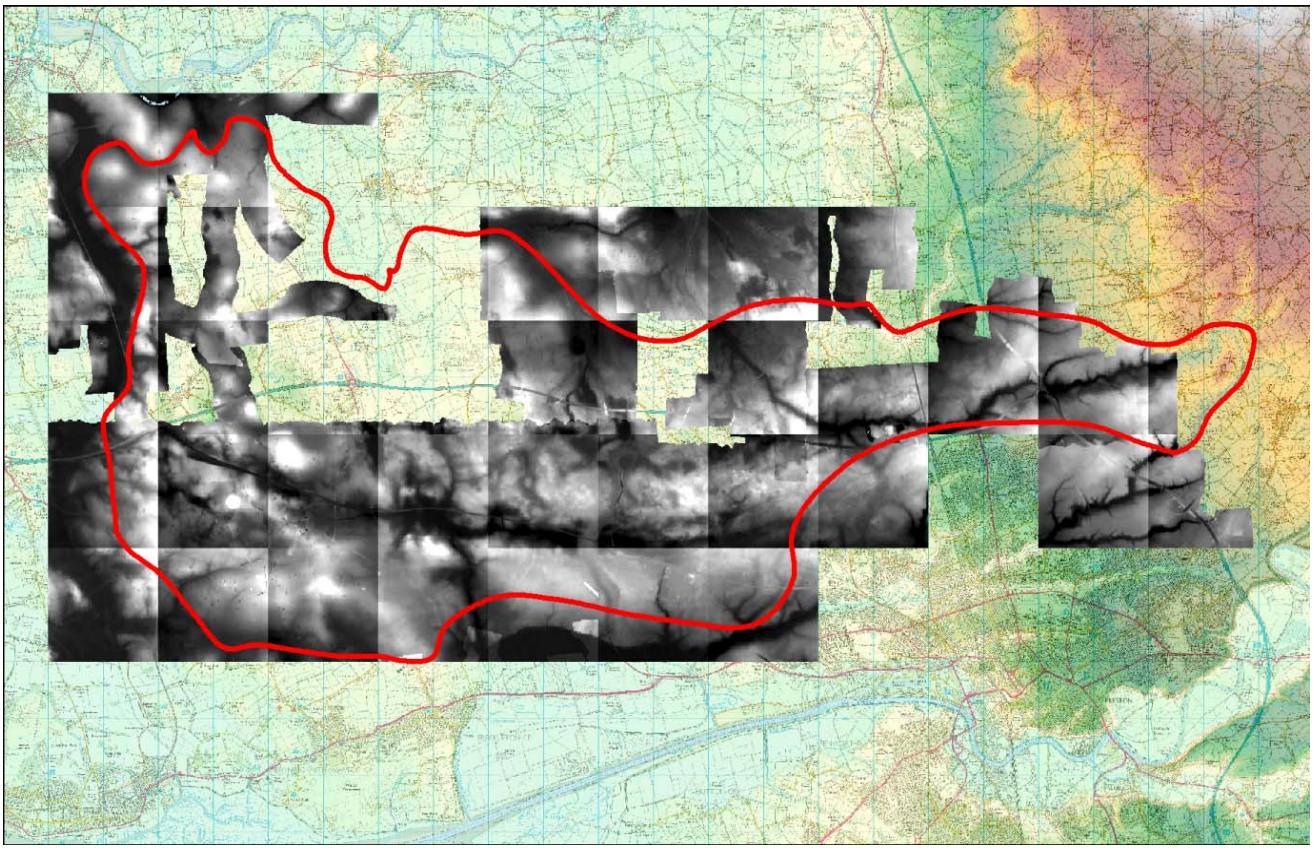

Figure 1: Available Lidar coverage across the study area

2.1.5 The following constraints datasets have been acquired and added to the project GIS, they have also been uploaded to the FTP server for use by both organisations.

- Ancient Woodland
- National Nature Reserves
- Sites of Specific Scientific Interest
- Special Areas of Conservation
- Ramsar (conservation and wise use of wetlands)
- Special Protection Areas.
- Areas of Outstanding Natural Beauty (AONB)

2.1.6 ***Task 7 Collate Available Geological Data:*** Lancashire County Council has made available baseline geological data from the British Geological Survey, using LCC licences, and this has been compiled into the GIS. These data comprise 1:50,000 scale Solid and Drift layers for the Preston, Garstang, Southport and Blackpool sheets. We also have the BGS Memoirs for the critical Blackpool and Garstang map regions. Other sources of geological information include Mineral planning reports commissioned by LCC and the various databases of current, recent and historical extraction compiled by LCC, the Northwest of England Regional Aggregate Working Party (RAWP) and the BGS Britpits database. The LCC and RAWP records are extremely comprehensive.

2.1.7 Three reports have been commissioned by Lancashire County Council's (LCC) Minerals and Waste Group: the Department of the Environment-commissioned report (Allot and Lomax Ltd 1990), a report by Entec UK Ltd (2005) in partnership with the

British Geological Survey (BGS). The more recent Geoplan Ltd (2006) report provided a more targeted and detailed investigation with an assessment of mineral quality based on a wider range of sources. The Geoplan and Entec reports are the best available assessment of sand and gravel aggregate reserves within Lancashire (Chiverrell *et al* 2007). However, little of the identified target areas has been assessed by borehole investigation, but the main constraint is that understanding of Lancashire's sand and gravel resources is still largely underpinned by the BGS mapping.

2.1.8 The principal problem with the identified areas of search and the outlines of mineral deposit available from the LCC reports and BGS mapping (Figure 2) is that they are over-simplified. In the case of the BGS mapping they reflect the surface materials identified using little or no exposure. The M55 borehole series (Figure 3) shows an implication of this approach, with significant quantities of mineral buried but within a couple of metres of the surface. This type of deposit is within the window of allowable overburden thickness considered by the extraction industry. Key locations along the M55 borehole series are the thick sequences of sand to the west of the M55/A6 interchange, which have been exploited in the past at Bradleys Sand Pit (Figures 2 and 3). In addition, further thick sequences of sand occur around the M55/A585 interchange, where there is no history of extraction.

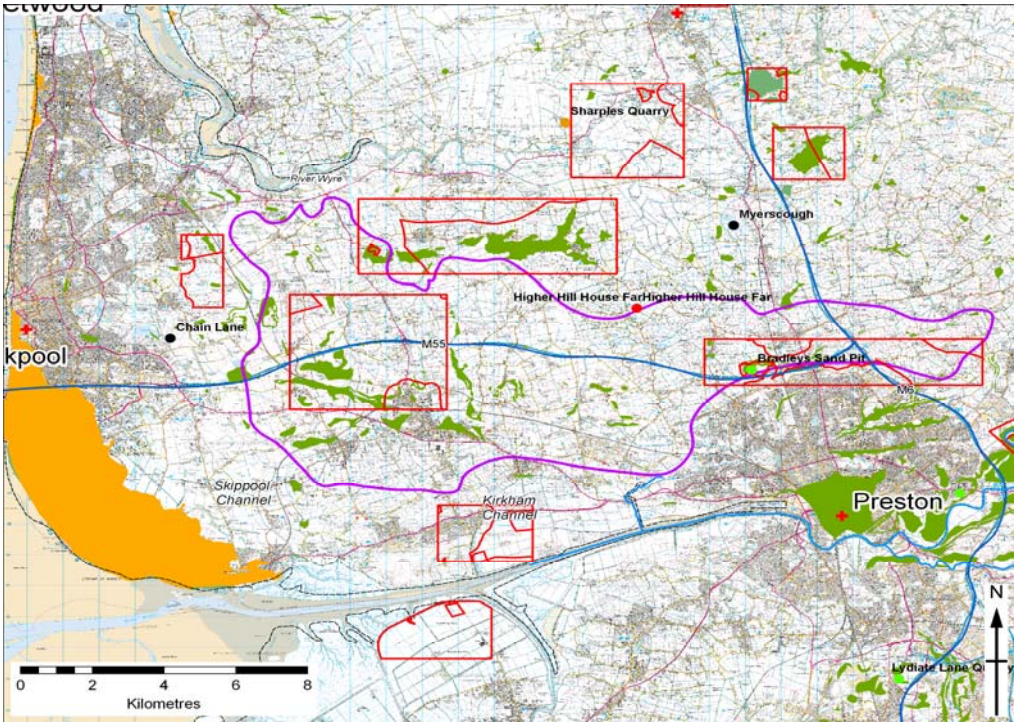

Figure 2: Distribution of sand and gravel (Green) and sand (Orange) after Geological Map Data © NERC 2007; also identifying the LCC areas of search as a red outline and the Kirkham study area as a purple outline. Aggregate operations are marked as coloured circles; past extraction sites in grey-black, current active workings in green and refused applications in black.

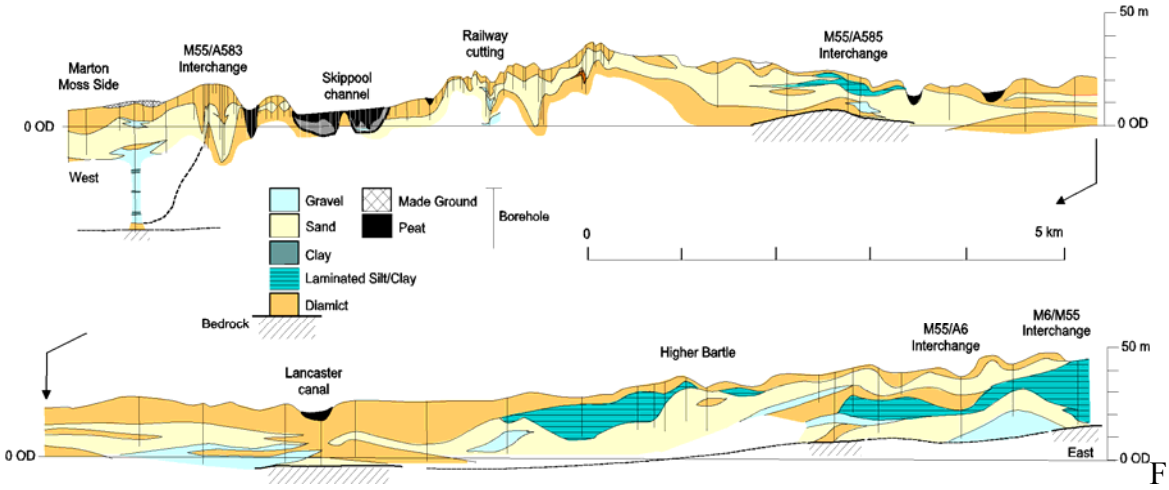

Figure 3: Interpretation of the M55 borehole series, with the large thicknesses of sand around the M55/A585 interchange of particular interest.

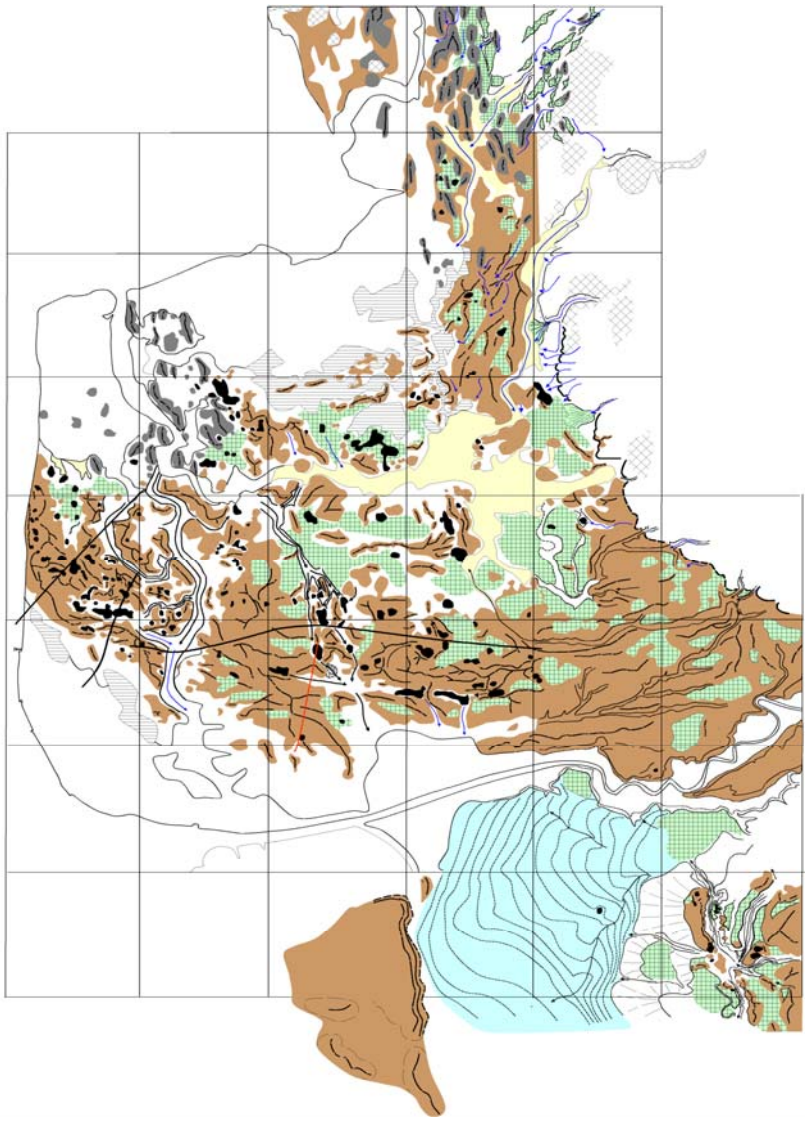

Figure 4: Outline glacial geomorphology of Lancashire (Thomas *et al*, in preparation #2) identifying: glacial ridges (brown), flat sandur plains (green), drumlins (grey), uncertain terrain (light blue) and alluvium (yellow).

2.1.9 Relying on the existing map information to identify the extent of workable mineral deposit is clearly not an appropriate approach, because much of the area is mapped as diamict or glacial till. Whilst these deposits are not usually of value for aggregate extraction, in a setting like the Kirkham End Moraine the geomorphology and glacial geology is complex and best understood through a detailed programme of geomorphological mapping and allied examination of all available borehole data and exposure. Interpretation of these data source will provide sediment – landform models that allowing a better estimation of useable aggregate reserves. Preliminary geomorphic mapping (Figure 4) from OS Profile and other data sources shows the complexity of the geomorphology, with the Kirkham Moraine comprising a series of ice front push ridges separated by flat areas and ice marginal river systems. These are depositional settings conducive to the deposition of thick sequences of sand and gravel, and these environments are extensive within the Kirkham end moraine, an interpretation that is supported by borehole evidence for considerable quantities of sand.

2.1.10 ***Task 8 Obtain and Incorporate Data Sources about Aggregates:.*** BGS (http://www.bgs.ac.uk/boreholes/home.html) borehole archives (Figure 5) have been interrogated in association with the outline geomorphological mapping to identify potentially useful borehole. There are a large number of boreholes, consequently the assessment and archiving of these records is still in progress. However a strategy for interrogation of the data has been devised and is driven by understanding of the geomorphology. The Kirkham moraine is an ice marginal ridge complex produced by ice advancing southwards across Lancashire from Cumbria, which means to develop a sediment-landform model a series of transects are need that cross the moraine parallel to ice-flow direction.

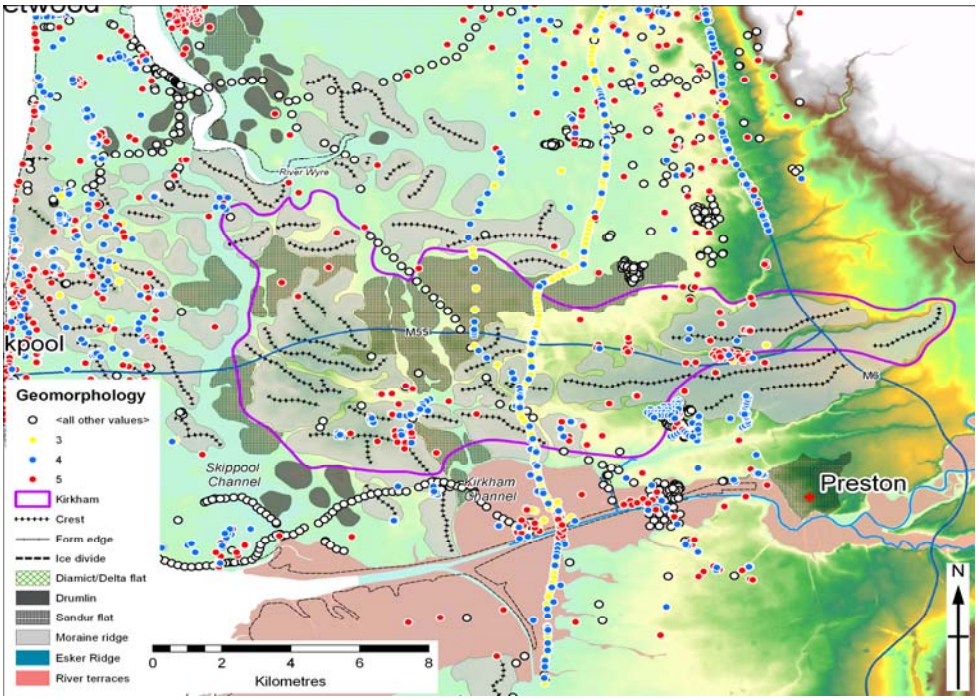

Figure 5: Borehole distribution within the Kirkham study area. Classes 3-5 are useful boreholes, whereas the white with black outline circles are not useful. This distribution map does not include the M55 and M6 borehole series obtained by other means.

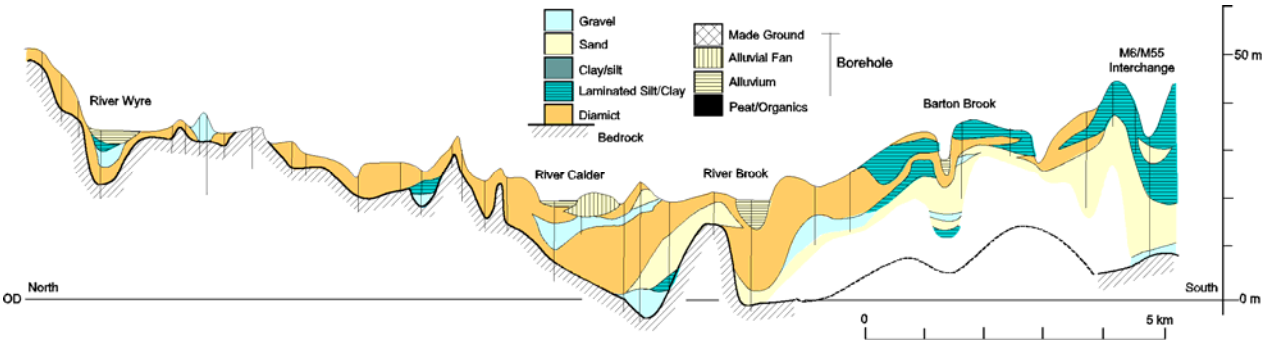

Figure 6: Interpretation of the M6 borehole series, north from the M55/M6 junction, with deposits dominated by diamict and glaciolacustrine mud typical of a push moraine complex.

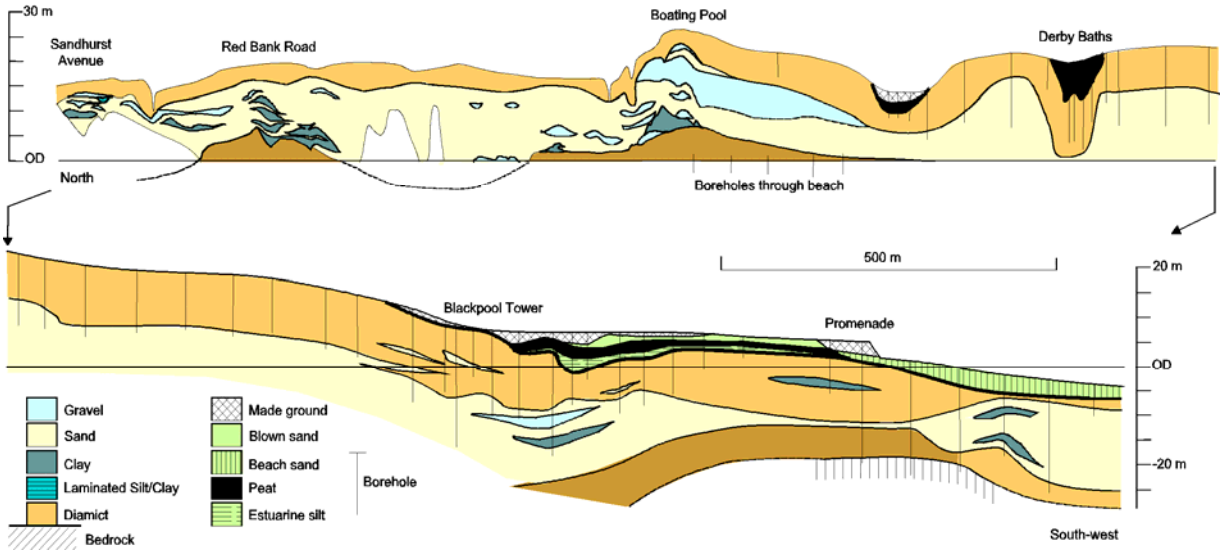

Figure 7: Interpretation of the Blackpool coastal sections (after De Rance, 18**; Chiverrell *et al* 2007), comprising significantly larger quantities of sand and gravel deposit when contrasted with the higher altitude and landward M6 series (Figure 5).

2.1.11 There are boreholes available from the M6 (Figure 6) and information from the former coastal exposures at Blackpool (Figure 7), and in places the M55 series provides serial sections that traverse the moraine complex. The priority for the current research is to assess as many boreholes as possible from Figure 4, but in particular to produce a number of new largely north-south transects (Figure 8). These transect reflect the greatest density of boreholes, and also cross the Kirkham moraine at strategic intervals. The overall objective is to produce a 3-dimensional model of stratigraphy and deposits of the Kirkham moraine complex. This research will enhance understanding of geomorphology and evolution of the Kirkham moraine, the mineral aggregate, and will contribute important information for both the academic publication (#2) and the popular publication (Task 31)

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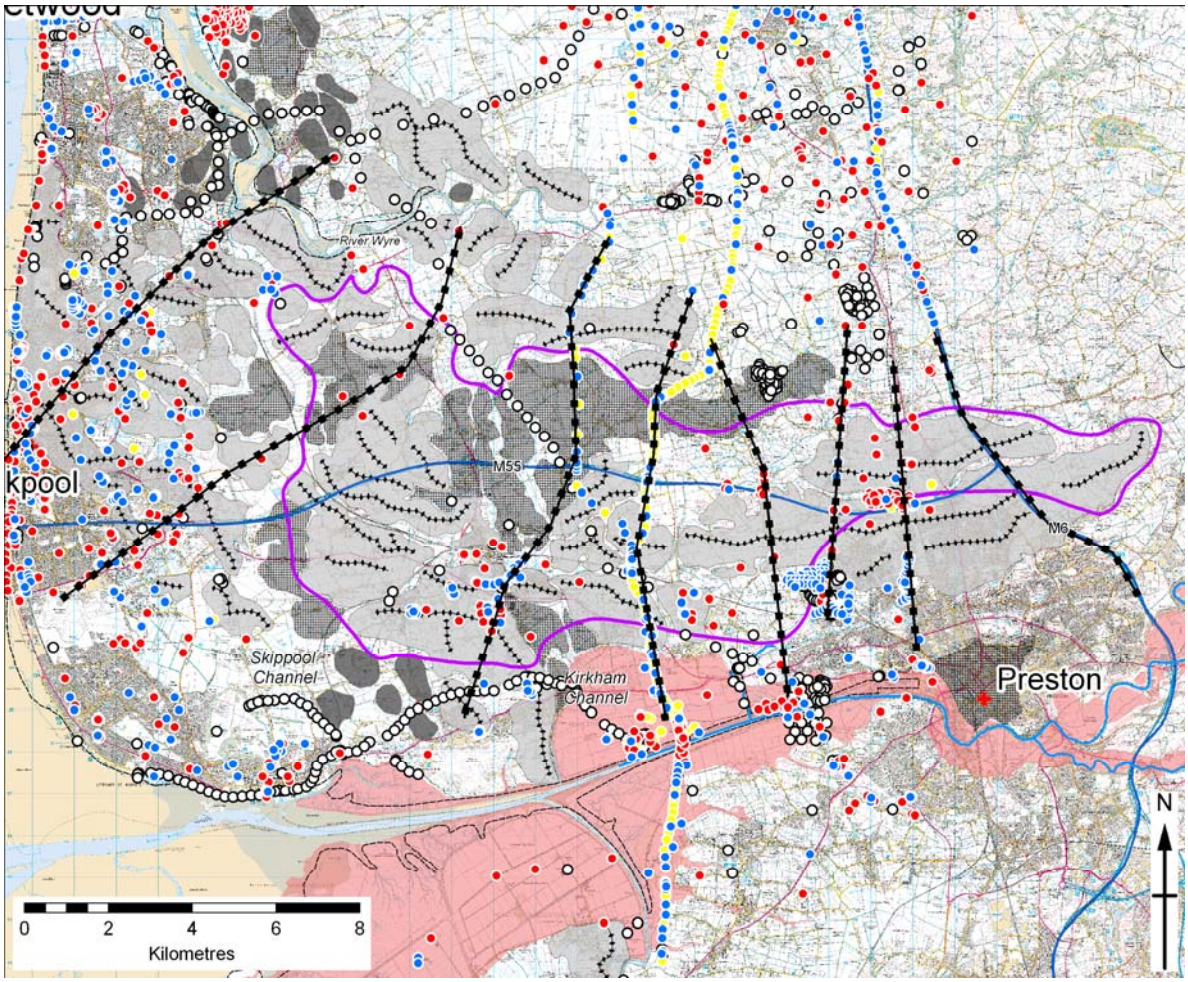

Figure 8: Proposed borehole transects across the Kirkham end moraine. These compliment the existing M6, M55 and Blackpool coastal sections.

2.1.13 ***Task 9 Historic Mapping (ongoing):*** the Ordnance Survey first editions (6" to 1 mile) digital historic maps have been loaned by LCC for the duration of the project, and have been in added to the project GIS, and uploaded to the FTP server for use by both organisations. Additionally the maps of Yates (1786), Speed (1610); Saxton (1577); and the Ordnance Survey detailed 1:2500 (25 inch to 1 mile) maps for Lancashire have been acquired in PDF format from the Digital Archives Association in Warrington. As with Ribble stage one ALSF these will not be georeferenced in the GIS but will be consulted for background information. LCC does not hold the second or third edition historic six inch maps for the area. Enquiries have been made to EH Ordnance Survey Licence officer, David Gander, to obtain the gap in the holdings under EH licence, as was done with the original ALSF Ribble project. A licence agreement is being posted to OA North, upon the signing and returning of which the final set of maps will be dispatched

2.1.14 ***Task 10 Aerial Photographs (ongoing):*** the NMR has been contacted and a cover search has been performed of the their holdings for the study area, this returned

344 specialist obliques, 8 military obliques and 2158 vertical images for the Kirkham area. Peter Iles (LCC) has provided shapefiles which show the location of the oblique aerial photographs held by the Lancashire HER. These holdings are being cross referenced against the NMR, to avoid duplication, and any additional photos held by the NMR will be ordered. The vertical images held by the NMR will not be consulted as the colour air photo mapping (flown in 2000) which is available in ready-georeferenced digital format from LCC has superseded them. An appointment has been made to visit the Lancashire HER to scan the relevant obliques and collect the vertical images on disk.

2.1.15 ***Task 11 Archaeological and Palaeoenvironmental Data Capture* (*Completed):*** following discussions with Peter Iles, the HER datasets for the Kirkham area have been established and supplied by LCC. The Monuments data supplied has been inputted into the project database and consists of some 518 records, a summery of this data is shown below (Table1). The general pattern of monument distribution in the study area is shown in figures 9 and 10, which also highlight the principal areas of aggregate search.

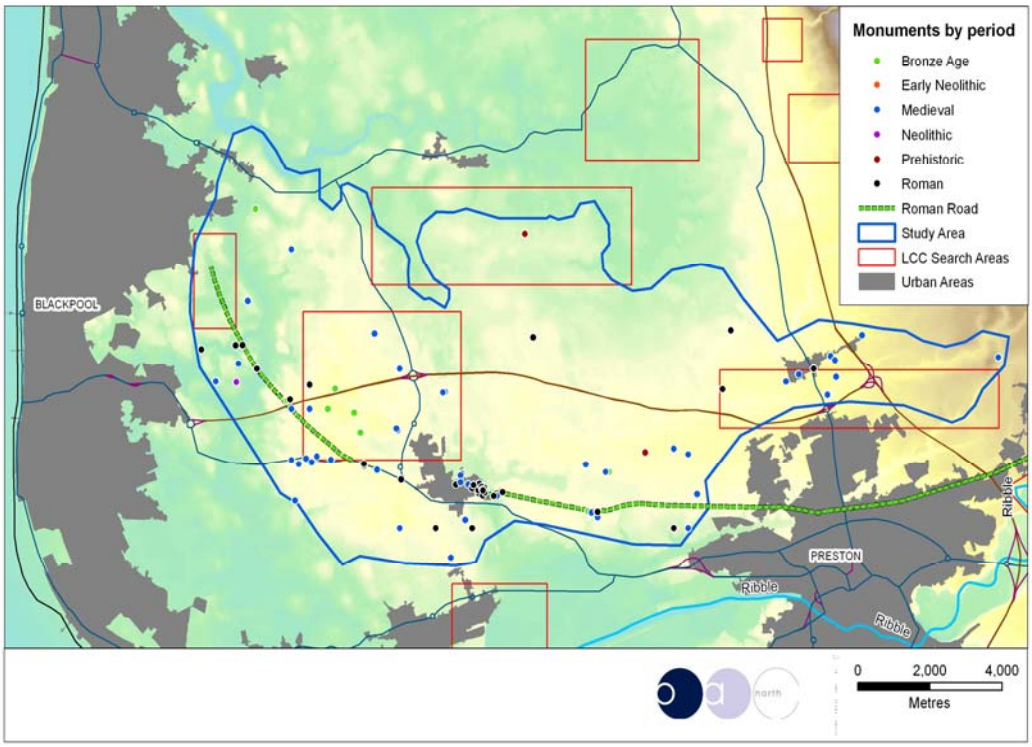

Figure 9: General distribution of earlier monuments and LCC areas of search

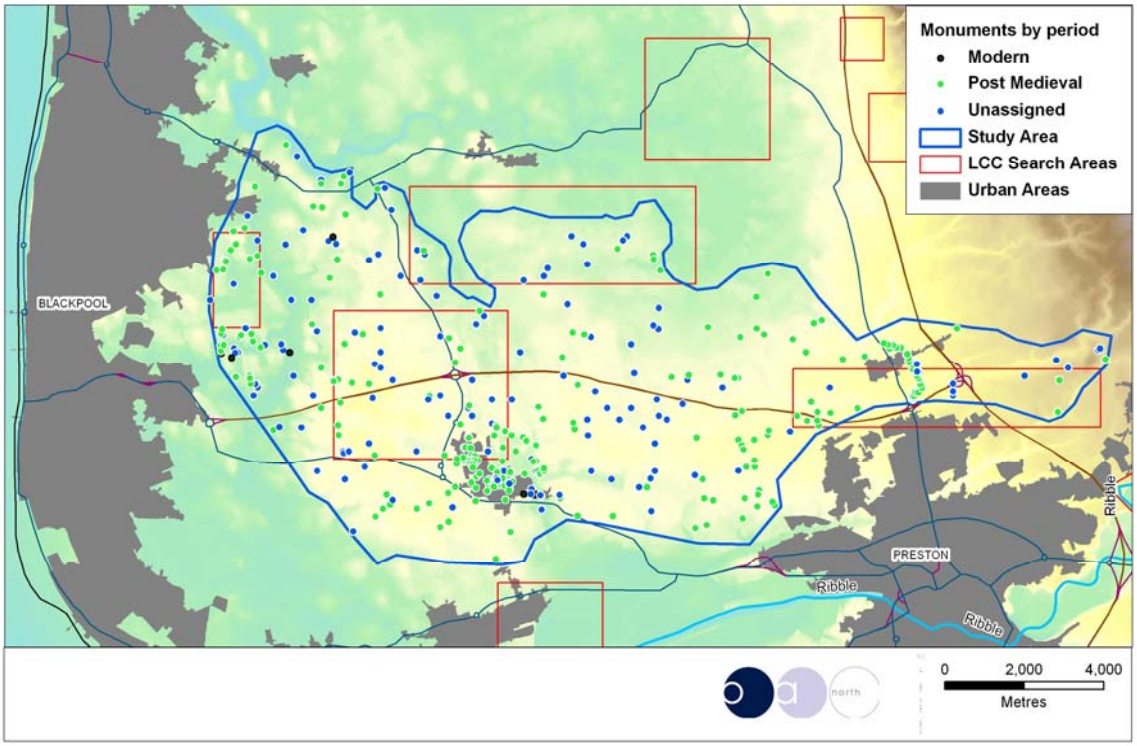

Figure 10: General distribution of later monuments and LCC search areas

Period	Count
Early Neolithic	1
Neolithic	1
Bronze Age	10
Prehistoric(not specified)	2
Roman	39
Medieval	49
Post Medieval	269
Modern	7
Unassigned	140

Table 1: Monuments in study area by period

2.1.16 Additionally the following data has been obtained and incorporated into the GIS and is being added into the project database:

- Listed Buildings
- Ribble Valley Rapid Assessment Survey
- North West Wetlands Survey
- Events (points and polygon)
- Scheduled Ancient Monuments (points and polygons)
- Roman Roads

- Parish Boundaries
- Conservation Areas
- Estuary Reclamation data
- Lancashire Historic Landscape Characterisation Polygons

2.1.17 The sites identified during the North West Wetlands survey are a significant resource for this project and even preliminary inspection shows considerable prehistoric activity in the LCC search areas (Figure 11). The maps produced for the West Wetlands survey have been scanned for the Lytham Moss and Skipool Valley areas. These have been trimmed and merged to create one raster image for the area, this has been georeferenced to produce a single map of the survey in the GIS.

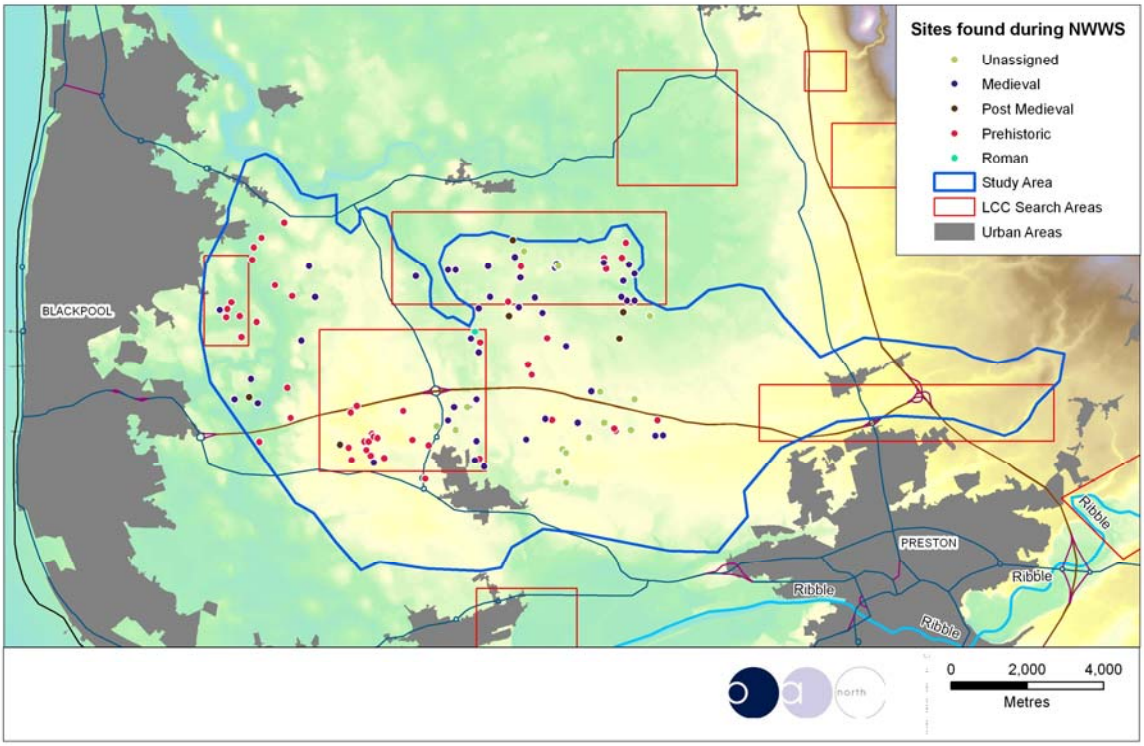

Figure 11: Sites identified during the North West Wetlands Survey

2.1.18 ***Grey literature search (completed):*** the following table (Table2) summarises the holdings of the OA North library, the Archaeological Investigations Project, the Archaeology Data Services and the National Monuments Record Excavation Index for England. These events are not confined to those within the study area, but include a wider area to provide a general background context for understanding the archaeology of the area. All reports have been located within the GIS and there distribution plotted (Fig 12) This will be combined with the events data supplied by LCC to provide maximum detail of the known archaeology of the area.

Report Type	Number of reports
Unconfirmed	12
Archaeological Assessment	18

Archaeological Evaluation	38
Archaeological Excavation	2
Building Recording	31
Topographic Survey	1
Walkover Survey	4
Watching Brief	14

Table 2: Preliminary results of grey literature search for Kirkham area

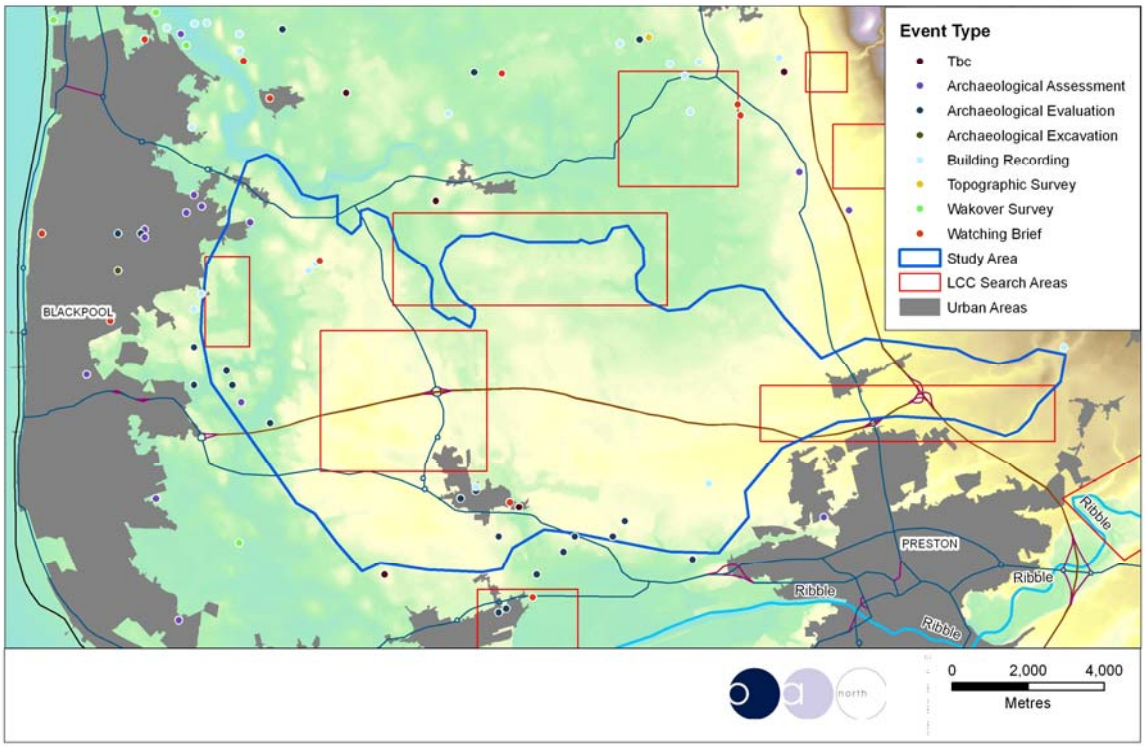

Figure 12: Preliminary results of grey literature search

2.2 ACADEMIC PUBLICATION WORKSTREAM, (ONGOING):

#1. Chiverrell, RC, Thomas, GSP, Foster, GC, Sediment – landform assemblages and digital elevation data: a refined methodology for the assessment of sand and gravel reserves, Engineering Geology. Paper first draft complete and submission ready (see included PDF file).

#2. Thomas GSP, Chiverrell RC, Foster GF, and BGS representatives, The glaciation of the Fylde peninsula and adjacent areas, Lancashire, England. Quaternary Science Reviews.

Paper outline plan

1. Introduction

Previous work: Basically Gresswell (date? – see BGS memoir) (coined name Kirkham moraine). BGS work. Other authors – Eyles and McCabe – did they mention the apparent fan exiting the Ribble?

Aim.

1. To define the morphology of the Fylde peninsula (and adjacent areas) using NextMap data at 2m contour interval, shading, ground truthing, etc. Particularly the form of the Kirkham moraine.
2. Define the glacial stratigraphic succession from an analysis of borehole records through the area
3. Define a set of sediment-landform assemblages based on 1 and 2.
4. From 3 identify a glacial event sequence

   [Fig: Location Map]

   Brief description of area, basic geology solid and drift.

2. Geomorphology

Description of method of remote mapping and ground truthing. Definition of major components:

1. Moraine ridge systems – multiple, closely spaced arcuate ridges. Kettle systems
2. Drumlins and ground moraine – upice of main arcuate ridges
3. Sandur systems – predominantly parallel to moraine ridges as marginal troughs, often coalescent. No direct, ice-front fans - buried out and removed by Holocene estuarine marine
4. Channel systems. Mainly large direct outflow, some marginal
5. Odd structures (a). Large fan at exit of Ribble. Either large ice-front alluvial fan or large sub-aqueous fan. (b) N-S asymmetric moraine ridge fronting fan (a). Difficult to explain steep asymmetry other than as ice-contact ridge from lobe coming out of Ribble. Very similar form to de Greer moraine (cf Eyles and McCabe again). Problems here glaciomarine???

   [Fig: Geomorphology Map)

3. Internal Structure

Introduction: BGS Borehole archive. Cross-section line selection. Interpretation of borehole records and section construction. Strike and dip sections. Construction of three dimensional model. Limitations of data.

Illustration and description of cross sections. (M55 line, M6 north line, Blackpool line, some further cross-section lines (ie n-s), some special area lines.

Summary stratigraphic succession. Definition of formal lithostratigraphic units. Sub-drift surface.

[Fig: Cross sections ~ 5 or 6)

[Fig: 3D model of all sections]

4. Sediment-landform assemblages

1. Up-ice subglacial diamict plains with localised drumlin swarms (east of Fleetwood, south of Lancaster.

2. Retreat stage ice-stagnation, ice-cored arcuate multi- moraine ridges – principally an east-Irish sea lobe derived from Lake district ice and subsidiary ice from NE.

3. Large direct channel systems crossing moraine.

4. Proglacial sedimentation (mostly buried out or removed) but possibly includes thick sandur floor underlying estuary of Ribble or lake or even (!) shallow water glacio marine sedimentation.

[Fig: map of sediment landform assemblages]

5: Event sequence

Summary: Stage during retreat of LGM. Probably contemporaneous with Bride Moraine?? Ice streams – local off Pennines, eastern Irish Sea (from eastern Lake District – central Irish Sea (from western Lake district/Solway/S. Uplands. Form series of lobes running E-W from onto coast. Moraine product of minor ice-marginal oscillation during major still stand episode (Kirkham episode?). readvance phase. Stratigraphy basically tripartite. Lower Till main Devensian advance – Upper Till readvance.

Key issues -

1. Age

2. Ice-margin conditions – proglacial fan/sandur or lacustrine or glaciomarine??

3. Relation to Pennine ie Ribble ice.

[Fig: Models]

#3. Chiverrell, RC; Foster, G, Thomas, GSP, Hamilton, D, Marshall, P, Radiocarbon dating landform development in fluvial environments. A poster version of the paper will be presented at the British Society for Geomorphology Annual Conference: Geomorphology a 20:20 Vision in early July 2007. The published version of the paper is scheduled for Earth Surface Processes and Landforms.

Paper outline plan

1. Introduction

The principal objective of this paper is to outline approaches for improving the interpretation of the chronological control for fluvial geomorphic sequences, essentially in river terraces and the fills of alluvial basins. The fragmentary non-sequential nature of fluvial archives is more akin to some archaeological contexts, where the dated horizons have a probable order of deposition, information is available from several dating techniques and hiatuses in the sequence may be identified to some extent. In these settings Bayesian approaches and deposition models allow testing of hypotheses and assist interpretation of often complicated sequences.

2. Fluvial geomorphic sequences

Explore the nature of geomorphic development in upland Britain glaciated during the Devensian, the types of geomorphic setting – staircases of fluvial terraces, alluvial basins, etc. Define focus – how to understand Ribble style situations. What are the key questions addressable by geochronology?

3. Approaches to radiocarbon dating fluvial environments

Radiocarbon dating strategies in these types of environment. Lewin et al alluvial ensembles approach. Indicative value of dateable horizons. TAQ and TPQ relationships to stratigraphic and geomorphic events. Dating geomorphology or sediments pros and cons? Reworking issues – paired dates.

4. Hypothesis testing for geochronological series

Three types of approach – exemplified from the Ribble research

i) Significance testing of differences between pairs of dates

ii) Building relative order models – exclusion and retesting – identification and approaches to handling problem dates

iii) Event estimation – generating probabilistic estimates of event boundaries

iv) Inclusion of other control information.

5. Conclusions

Recipe sheet for geomorphologists utilising radiocarbon dating to address sequences of change in fluvial environments.

Awareness of scales of reworking – sample material strategies – paired dates – robust treatment of ages

#4. Chiverrell, RC; Foster, G, Thomas, GSP, Hamilton, D, Marshall, P, Sediment transmission and storage: the implications for landform development. An oral version of the paper was delivered in the 'Quantifying and modelling of human and climate controlled sediment dynamics' session at the European Geosciences Union General Assembly in Vienna 15th -20th April 2007. The published version of the paper is scheduled for a special issue of Catena from this session. The paper was titled as follows: Chiverrell, RC; Foster, G, Thomas, GSP, Hamilton, D, Marshall, P, 'Sediment transmission and storage: the implications for landform development.

Paper outline plan

1. Introduction

The principal objective is to examine the complexity of change within fluvial geomorphic settings focusing in particular on terraced river systems inside last glacial maximum limits. In these settings Bayesian approaches and deposition models allow testing of hypotheses and assist interpretation of often complicated sequences. The time transgressive nature of geomorphic change is shown through the abandonment and incision that produces terrace sequences. Are terraces and their abandonment discrete reach-wide events or do they reflect they time transgressive phases of incision and aggradation between meanders. What are

implication of this story of temporary storage and remobilisation for understanding sediment budget and flux in the fluvial geomorphic system?

2. Fluvial geomorphic sequences

Explore the nature of geomorphic development in upland Britain glaciated during the Devensian, the types of geomorphic setting – staircases of fluvial terraces, alluvial basins, etc. Define focus – how to understand Ribble style situations. What are the key questions addressable by geochronology?

3. Case study: switch from terrace 3 to terrace 4 of the lower Ribble

- Present the lower Ribble terrace sequence focusing on the geomorphology of terraces 3 and 4.
- Demonstrate the 14C dating of palaeochannels for these surfaces – discussion problem dates – Chi square tests
- Using the Event function in Oxcal to highlight offsets in timing of transition from 3 to 4 as the active channel
- Focus discuss on implications for discerning the nature, timing and rates of geomorphic change.

4. Discussion and conclusions – addressing the follow question

- Are terraces in this type of setting valid chronostratigraphic units
- Are there better conceptual mechanisms for understanding geomorphic change than terracing
- Implication of storage and transmission for reconstructing sediment budgets and flux through the fluvial system

#5. Chiverrell, RC; Foster, G, Thomas, GSP, Hamilton, D, Marshall, P, Late Pleistocene and Holocene evolution of the Calder, Lancashire, Journal of Quaternary Science.

#6. Chiverrell, RC; Foster, G, Thomas, GSP, Hamilton, D, Marshall, P, Coupling relationships: hillslope - fluvial linkage in the Hodder catchment, NW England, Geomorphology.

1. Introduction

The fluvial geomorphology of the Hodder river system entirely post dates deglaciation and comprises some relict features that date to late glacial times, but with an extensive suite of hillslope (gullies and alluvial fans) and fluvial (river terraces) landforms that date to the late Holocene. This paper uses the well-known hillslope geomorphology record (Harvey and Renwick 1987; Chiverrell *et al*, 2007) and relates it to new research on the Hodder fluvial sequence.

2. Hillslope geomorphology of the Bowland Fells

Synthesis of the previous research in the region based on the Harvey and the Chiverrell papers. Summary of the dates. Proper Bayesian treatment of the fan data

base – discuss in terms of TPQ and TAQ constraint, show the region CPFD and synthesis of current understanding.

3. Fluvial evolution of the Hodder

Geomorphological mapping and sediment investigations in the Hodder Valley were conducted along a c 4.5km reach where the river flows south around a large meander bend at Burholme Farm. For the reach between Burholme and Dunsop Bridges present the geomorphology, chronological control.

- Geomorphological mapping – terraces and palaeochannels - height range analysis and mapping identified a clear four-stage river terrace staircase. The lowermost terrace, T4, exhibits complex surface morphology, suggesting a time-transgressive sequence, and has thus been sub–divided into four sub-terrace units. Only a limited number of palaeochannel forms have been identified within the reach, and these depict clearly meandering plan-forms on the surfaces of Terraces T3 and T4, with little palaeochannel definition on Terraces T1 and T2.
- Stratigraphy and sediments – borehole programme. Several cores were taken from Hodder Terraces T2, T3 and T4, but only six of these, on Terraces T3 and T4, yielded sediments suitable for fluvial reconstruction and dating.
- Radiocarbon dating control is available from terrace T2, T3 and T4.
- Geomorphic models – and Bayesian analysis

4. Discussion and conclusions – addressing the follow questions

- Correlation and coincidence – linking the two parts of the system
- The coupling relationship – rapid, responsive, temporal change, storage and transmission.
- Downstream connectivity to lower Ribble? Comparison with the sequences obtained downstream must be contemplated with caution, owing to local base-level control between this reach and the Lower Ribble Valley.
- Forcing of the geomorphic system – how the impact of external forcing factors (people, climate and storms) is moderated and propagated in a connected /coupled system.

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FIGURES AND TABLES

