GIS and landscape archaeology: the South Cadbury Environs Project

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Introduction

- South Cadbury (exc. 1960s)

  Iron Age hillfort – 7 ha. interior

  5th/6th Century AD – King Arthur

  Increasing importance of landscape archaeology

  Classic excavation reinterpreted in its landscape context

- Analytical GIS

  Functionality beyond data management and display

  1) Network Analysis – dating of geophysical anomalies using test pitting data
  2) Modelling colluviation – implications for visibility of archaeological remains

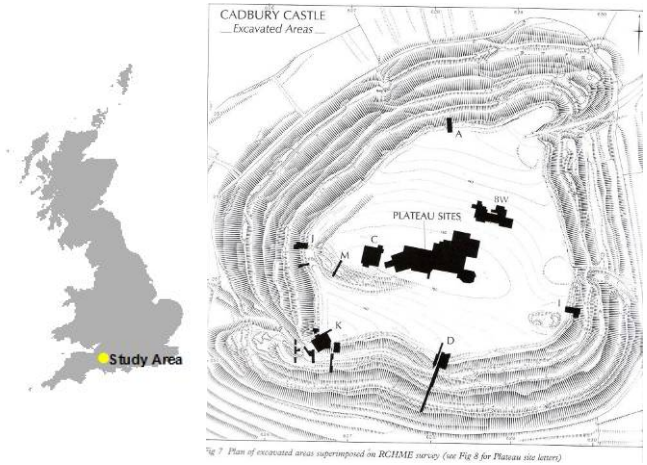


Fig 7 Plan of excavated areas superimposed on RCHME survey (see Fig 8 for Plateau site letters)

Fig 39 General view from the north-east of the south-west gate under excavation

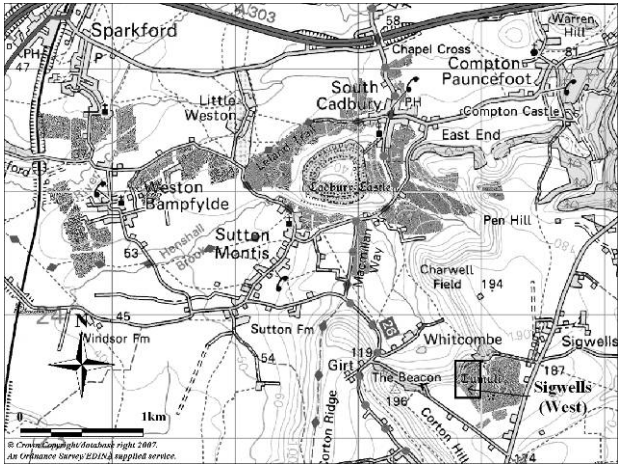
South Cadbury Environs Project

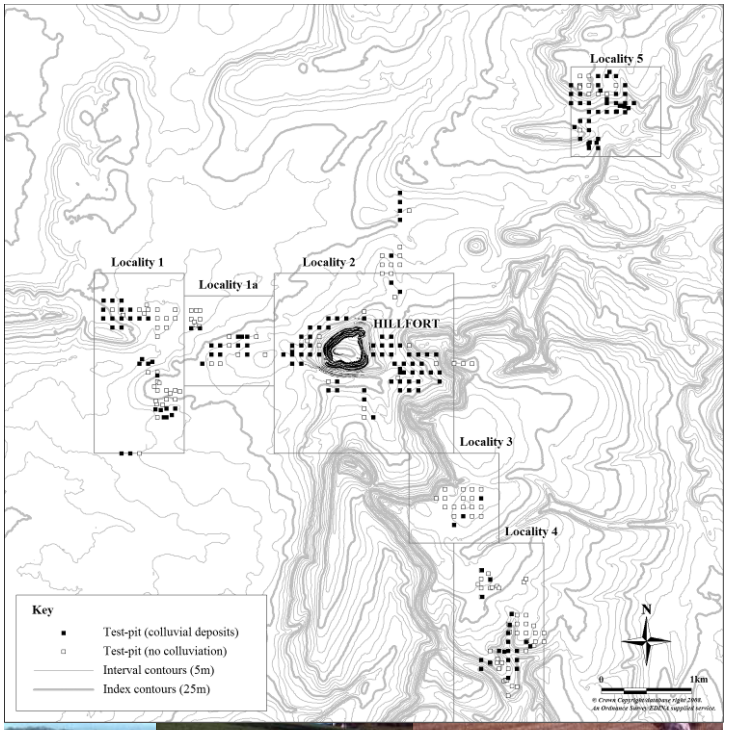
- Fieldwalking
- Geophysics
- Excavation

  Shovel Testing (Topsoil only)

  Test Pitting (Full excavation)

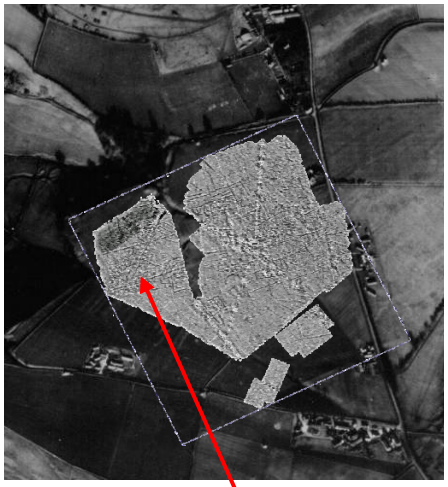
  Trial Trenching

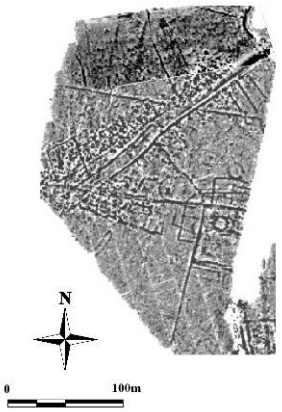


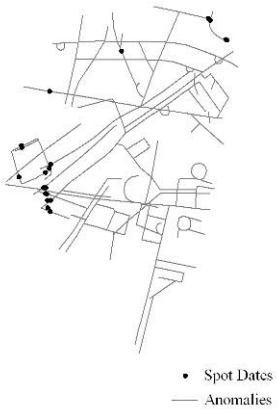


Dating Geophysics

- The Sigwells (West) dataset
  Good results from geophysics
  Focus for test-pitting/excavation
  Preliminary phasing (6 systems)
  Two main trends:
  1) WNW/ESE (System 1: AD200-400)
  2) NE/SW (System 2: 100BC-AD200)
- Ceramic phasing
  8 phases based on excavation
  1) Neolithic
  2) Early Bronze Age ≈ System 4
  3) Middle Bronze Age ≈ System 4
  4) Middle Iron Age 1 ≈ System 2
  5) Middle Iron Age 2 ≈ System 2
  6) Late Iron Age ≈ System 3
  7) Early Romano-British
  8) Middle Romano-British ≈ System 1







Network Dataset

- Network dataset:

  Arcs (edges) and nodes (junctions)

  Turn features

- Heads-up digitising:

  1) Edges linking start/end points of anomalies and intersections with other anomalies

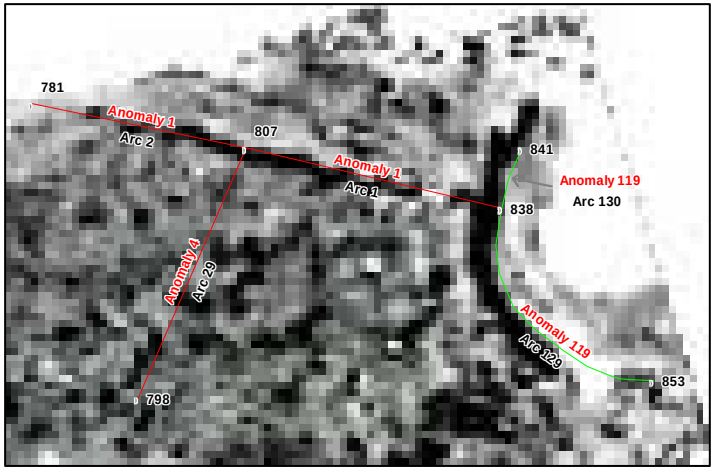
  2) Nodes created at start/end points and all intersections regardless of connectivity

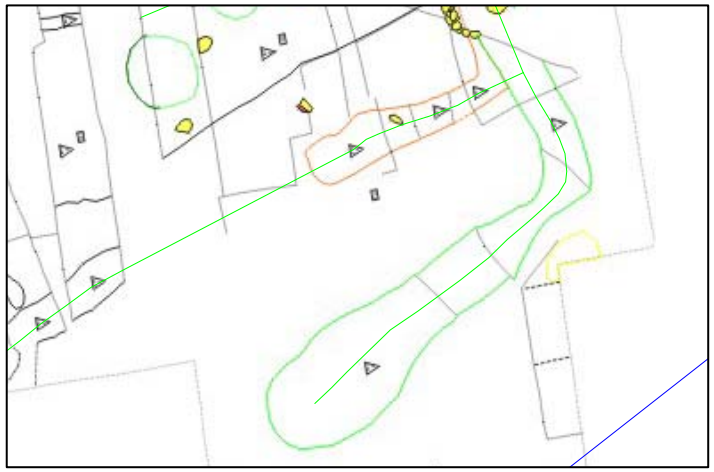
- Cleaning:

  Checked against excavation plans

  Remove gaps (e.g. entrances)

  Link interrupted anomalies





Adding Complexity

- Impedances

  Initial travel ‘costs’ based on length of edge

- Connectivity

  Z-values used to establish connectivity

  Offsets apples to z-values to model stratigraphic relationships

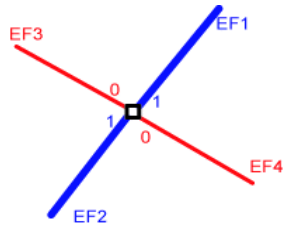
- Turn features

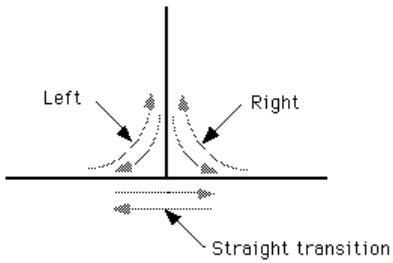
  Contemporary features parallel or perpendicular to one another

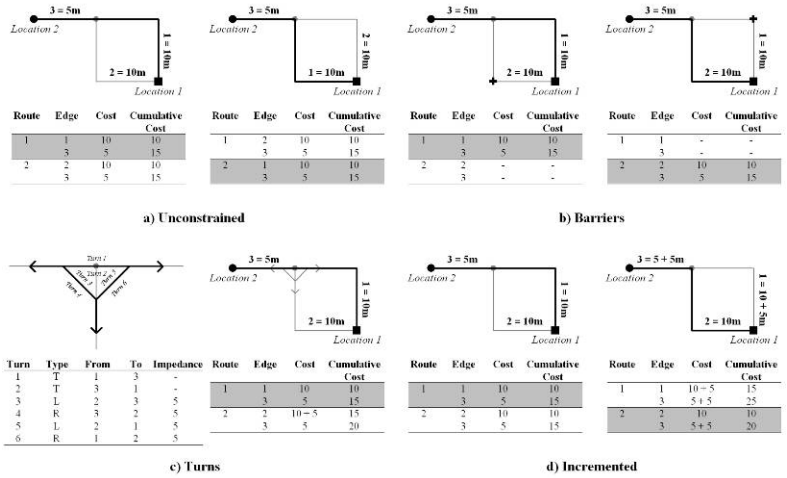
  Impedances assigned to turns to model physical relationships

- Building

  Network dataset built in ArcGIS

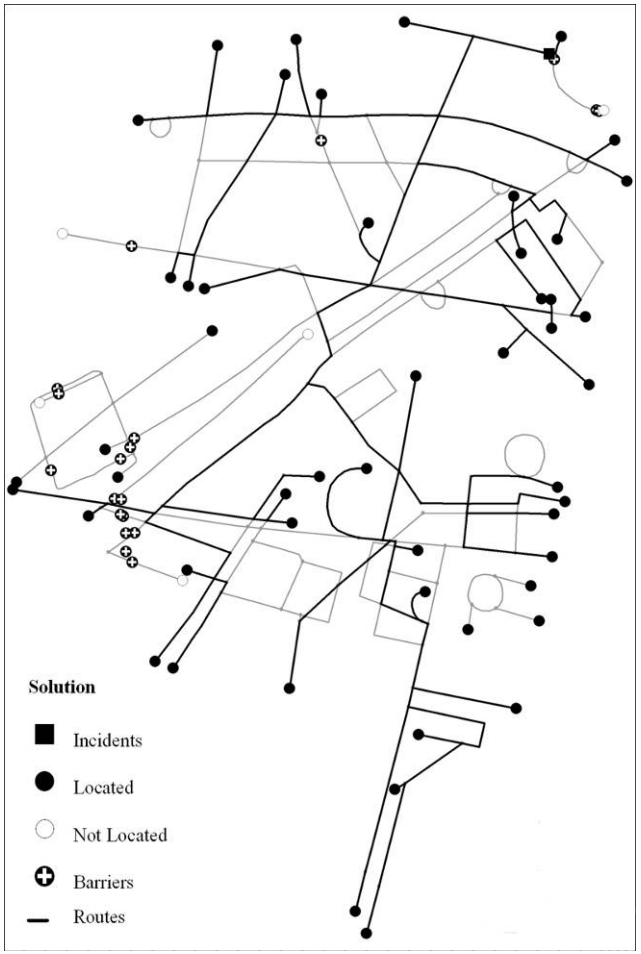






Closest Facility Analysis

- Network locations
  - Facilities – start/end points of network
  - Incidents – contemporary spot date(s)
  - Barriers – later spot date(s)
- Network solution
  - Shortest route to every facility from each incident
  - Individual solutions for each phase of activity
  - Number of barriers decreases with time
- Iterative process
  - ‘Logic’ matching
  - Initial solutions – unconstrained
  - Later solutions – constrained



Combining Solutions

- Overlay

  Overlay individual solutions starting with most recent phase

- Aggregation

  Anomalies dated on basis of either:

  1) number of arcs per phase

  2) total length of arcs per phase

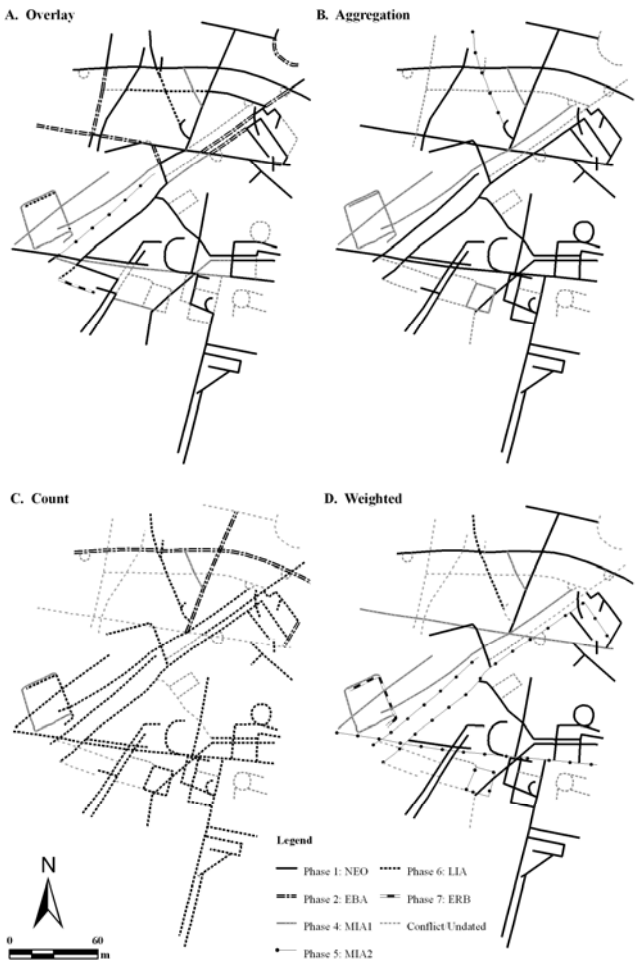
- Raw count

  Number of times an arc is used in the solution for each phase

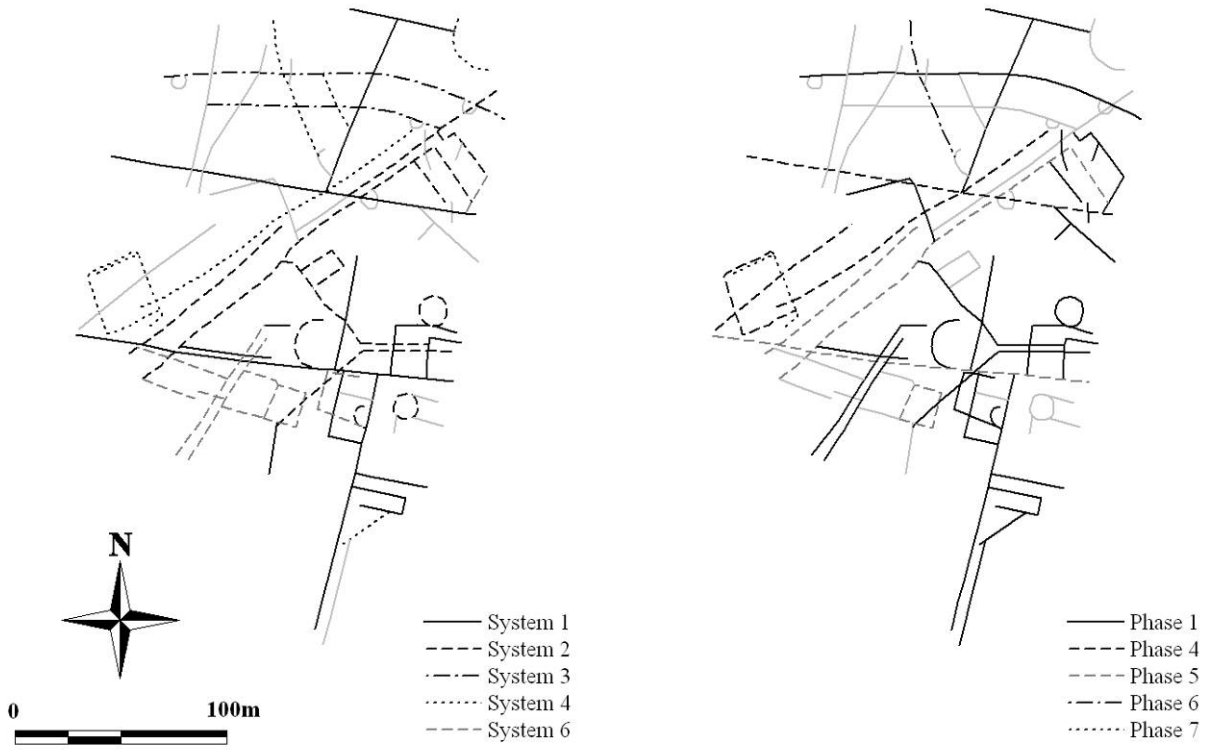
  Counts for individual arcs aggregated for each anomaly

- Weighted count

  Raw counts standardised and converted into percentages



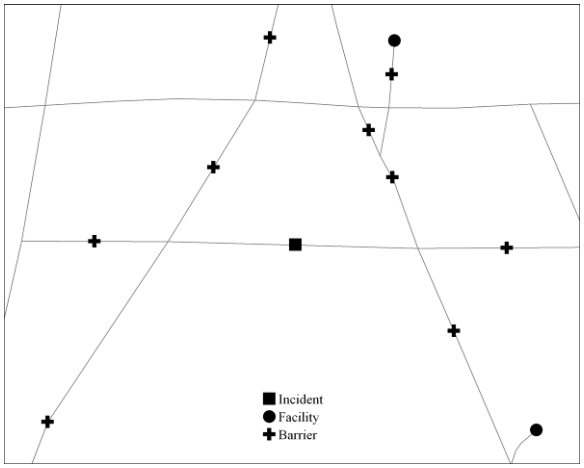
Comparison of Results



Provisional phasing (left) and network-based phasing (right)

Testing the Methodology

- Assessment of robustness
  - 5 random datasets (Samples 1-5)
  - Network locations created for spot dates using arc centroids
  - Number of spot dates per phase kept constant
  - Solutions compared against initial network-based solution
- Comparison of solutions
  - Direct hits = solution identifies latest phase
  - Indirect hits = spot dates one of possibilities
  - Sample 2 (Phase 1) – systemic error no possible solution
  - Multiple direct and indirect hits - high confidence in methodology



Anomaly	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Initial Solution
1	●	-	●	●	●	●
2	○	●	○	○	●	●
45	-	-	-	-	-	-
46	-	-	-	-	-	-
119	●	●	●	●	●	●
120	●	●	○	●	●	-
122	○	○	○	○	○	●
123	-	●	●	●	-	●
124	-	-	-	-	○	-
138	○	○	○	○	○	●
148	-	-	-	-	-	-

● Direct Hit ○ Indirect Hit - Miss

Colluviation

- Long recognition of the importance of geomorphological processes and their impact on the archaeological record (e.g. Butzer's Human Ecology, 1982)

  Linked to past land-use practices

  Often recognised and discussed within the context of surface survey

  Computer-based attempts to model and visualise, interpolating surfaces

- Archaeological Use of Flow Models

  Verhagen (1995) – most detailed consideration of methodology:

  Concluding emphases:

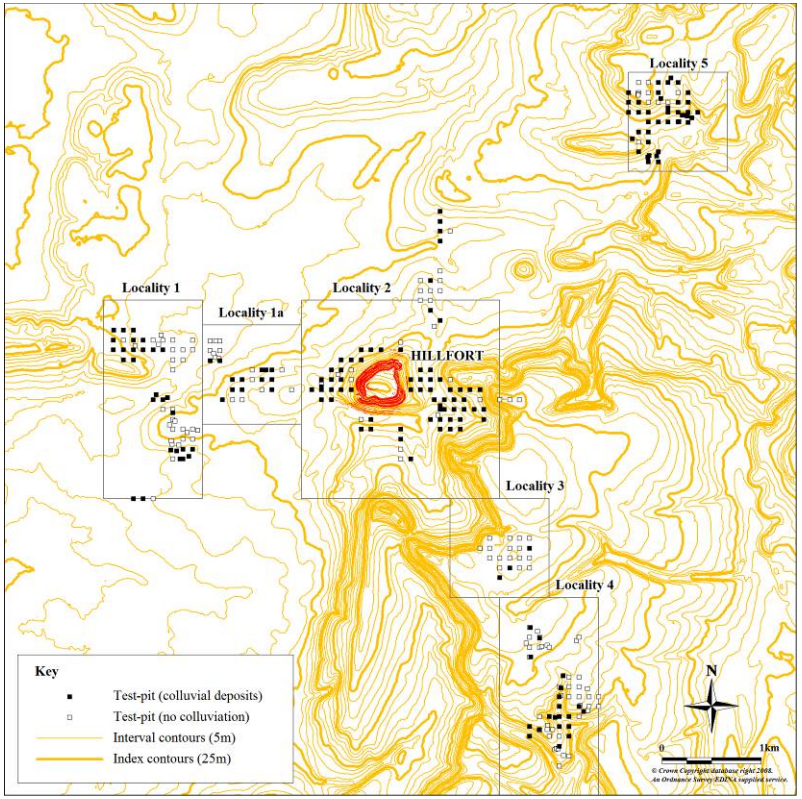
  Importance of DEM resolution and quality (interpolation artefacts can affect 'flow')

  Importance of small-scale local effects, problems with

  Large-scale generalised modelling

Test-Pitting Data

- Study Area
  - 12km by 9km centred on hillfort
  - Localities 1 to 5
- Regular Test Pits
  - 241 test pits (139 with colluvial deposits)
  - 1m by 1m test pits on 100m grid
- Targeted Test Pits
  - 71 test pits (31 with colluvial deposits)
  - Assessment of geophysical anomalies
- Colluviation
  - Episodes of colluviation –
    - Min = 1 Max = 7
  - Cumulative depth ≤ 1.68m



Topographic Analysis

- Morphometric classification

  Six feature types (Wood 1996):

  1. Plane
  2. Channel
  3. Ridge
  4. Pass
  5. Peak
  6. Pit

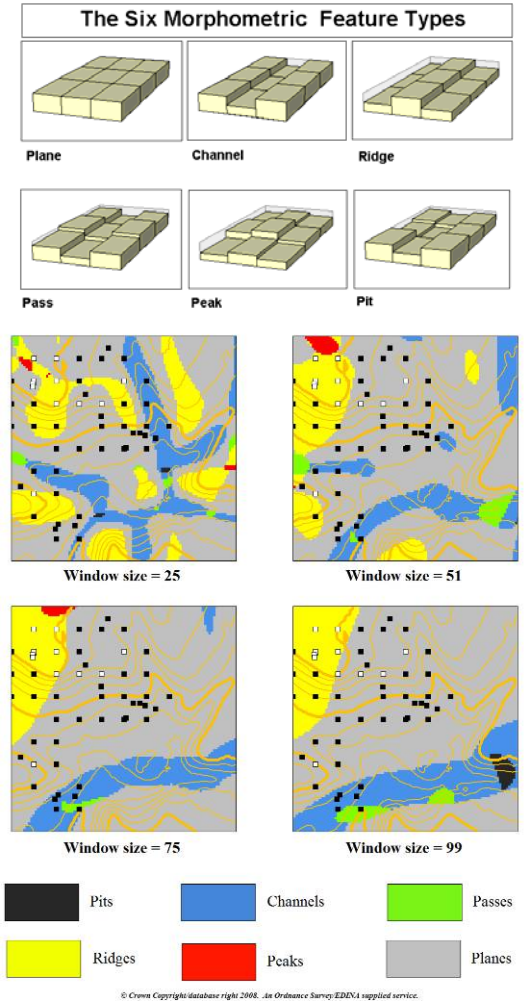
  Scale dependent classification

- Fuzzy classification

  Individual datasets created for window sizes from 3 to 99

  6 new datasets created, one for each feature class

  Cell with values between 1 and 0 - confidence in classification



Colluvial Zones

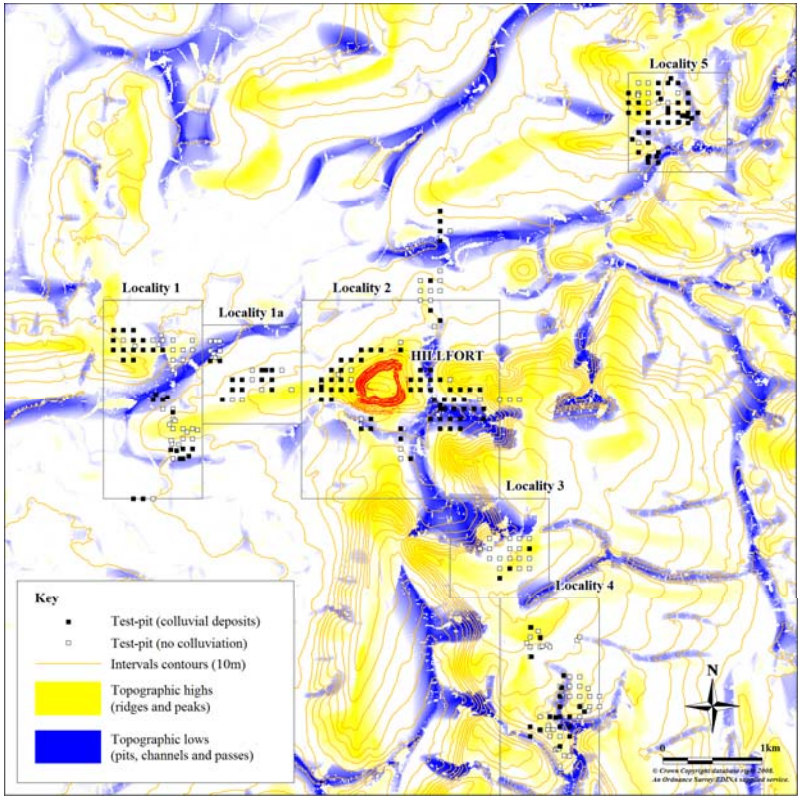
- Key topographic zones

  Transition between topographic highs and topographic lows (i.e. planes)

  Net deposition at margins of topographic highs ('depositional' exceeds 'erosional' potential)

  Net deposition at margins of topographic lows

  No deposition or net erosion along centreline of topographic lows



Modelling Colluviation

- Planar surfaces

  Isolate planes

  Weight points on planes where ‘depositional’ potential is greatest
- Slope

  Identify range of slope values for test pits with colluvial deposits
- Curvature

  Weight upslope and downslope areas
- Weighted surfaces

  Weighted colluvial zones based on interpolated depths of colluvium from test-pitting

Surface parameters for test-pits with colluvial deposits

	Min	Max	Mean	S.D.
Elevation	34.00m	189.00m	48.73m	36.37m
Slope	0.43º	12.88 º	3.81 º	2.49 º
Aspect	012 º	356 º	193 º	95.86 º
Curvature	-0.68	0.39	-0.06	0.13

Colluvial Deposits

- Phases of Colluviation

  Modern – 43 test pits

  Medieval – 7 test pits

  Romano-British – 8 test pits

  Late Prehistoric – 8 test pits

  Early Prehistoric – 6 test pits

  Post Glacial – 9 test pits

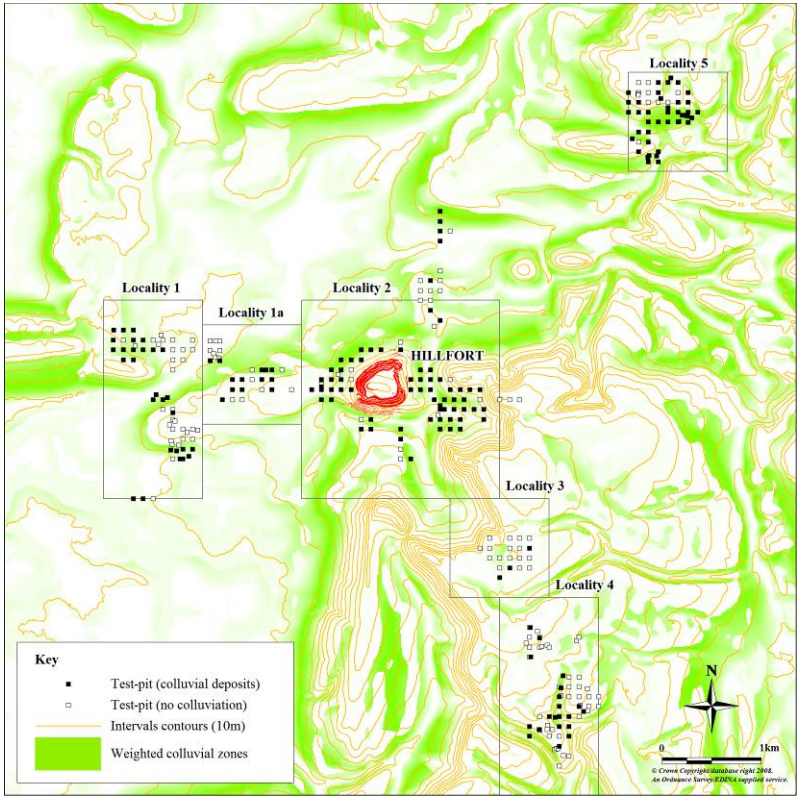
- Depth of Colluvium

  Interpolate continuous surface for each phase of colluviation

  Include test pits with no evidence of colluvium (Depth = 0cm)

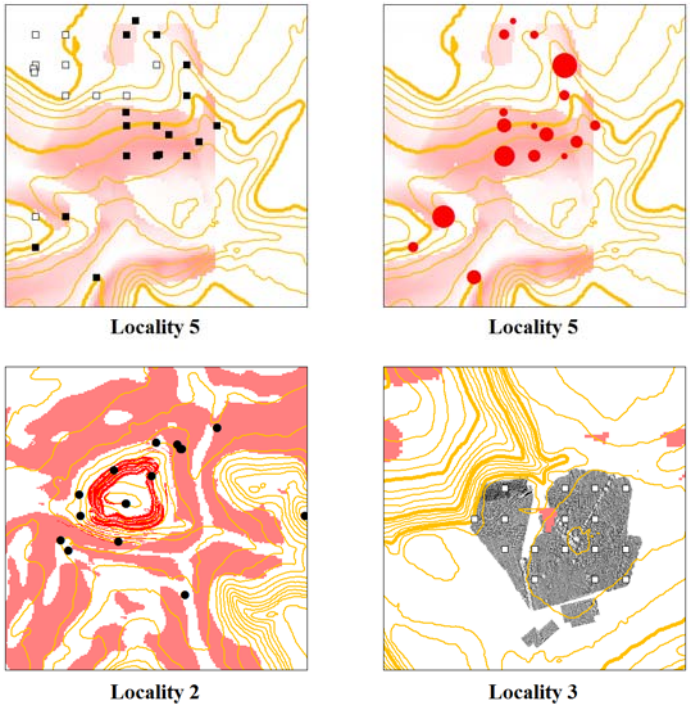
  Exclude undated colluvial deposits from all test pits

  Modify interpolated surface using weighted colluvial zones



Evaluating the Model

- Modern colluviation
  - Locality 5 - cluster of test pits with modern colluvial deposits
  - Weighted interpolated surface respects local topography
  - Interpolated values correlate with measured depths
  - Assumptions for model independent of data from test pits
- Archaeological visibility
  - Relationships to areas of geophysical survey
  - Correlation with known archaeological sites



Conclusions

- Network Analysis

  A robust methodology which can be applied to larger datasets

  Iterative process which highlights potential dating errors

- Potential limitations

  Methodology best suited to large-scale datasets with

  1) A widespread spatial distribution of spot dates
  2) Multiple spot dates for each phase of activity

- Modelling Colluviation

  Implications for archaeological visibility and landscape change

  No assumptions made about colluvial zones

  Independent validation of model using test-pitting data

- A work in progress

  Future work to include:

  1) Hydrological modelling
  2) Reconstruction of past land surfaces