The Discovery of an Anglo-Saxon Grubenhaus at New Bewick, Northern UK using Electrical Surveying and Predictive Deconvolution

Paul Glover
Université Laval, Québec, Canada
Plan

- Introduction – The past revisited!
- What is a Grubenhaus?
- Where is the search area?
- How? – Experimental Methodology
- How? – Data Analysis – Predictive deconvolution
- Results
- Conclusions
- Who? – Acknowledgments
Typical excavated Grubenhäuser from 3 UK sites (Glover, 1985)

- **Small sized**

- **Excavated floors lined with planks or packed clay**

- **Multiple use – workshops rather than dwellings**
  - Pottery
  - Weaving
  - Metal-working
  - Animal husbandry...etc.

- **Usually found in association with timber-framed halls**
Grubenhäuser

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Line drawing of the New Bewick Grubenhaus
Grubenhäuser

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Reconstruction of the New Bewick Grubenhaus
http://www.bedesworld.co.uk/site_2003-05-10/building/nbkdescr.htm
General Location

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200 m from River Breamish

Elevation 94 m

1.8 km from Old Bewick Iron Age Hillfort (rock art)

16 km from

- Milfield
- Yeavering
- Thirlings

Anglo-Saxon royal/Palace settlements
General Location

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Light grey area represents The survey area (in two parts)

Dark grey area represents the subsequently excavated area
Marks include

- Tramlines
- Drainage
- Glacial Till
- Frost Cracking
- Old Hedge Boundaries
- Archaeological Remains
Methodology

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- ABEM Mk II Terrameter & in-house meter
- 33 electrodes multiplexed into 4
- Survey area 10140 m²
- May and June, dry weather with short winter wheat
- Light, sandy topsoil
Raw data from the first part of the survey area
Each structure has an electrical signature or source function

Predictive deconvolution – need to predict the source function

Source function can be calculated uniquely from a geometrical model of the subsurface feature

The model, however, is not unique

The method restores the target structure…

…but destroys structures of other geometries

Analysis carried out by matrix inversion
Data Analysis: The Source Function

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Diagram: Graph showing the fractions of density changes over traverse (m) with labels for topsoil (ρT), subsoil (ρS), and sunken-featured building (ρSFB).
Convolution: Synthetic Data

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Source signature
Discrete distribution function
Convolved function
Deconvolution: Restoration of location

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![Graphs and charts showing observed profile, inverse shape function, and result compared with a perfect deconvolution.]

- Observed Profile
- Inverse Shape Function A
- Result compared with that from a perfect deconvolution
Deconvolution: Restoration of location and extent

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Graphs displaying observed and deconvolved profiles.
Data Analysis – Test 1
Restoration of location

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**How? – Data Analysis**

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**Results**

**Conclusions**

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**Graphs**

**PROFILE A - B**

**PROFILE C - D**

**PROFILE E - F**

Original apparent resistivity profiles

Apparent resistivity profiles deconvolved with inverse shape function A
Data Analysis – Test 2

Restoration of location and extent

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**Profile A - B**

**Profile C - D**

**Profile E - F**

- Original apparent resistivity profiles
- Apparent resistivity profiles deconvolved with inverse shape function B
Results - Undeconvolved

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Results
- Undeconvolved
  - Deconvolved 3 m width
  - Deconvolved 4 m width
  - Deconvolved 5 m width
- Combined Data

Acknowledgments
Results – Deconvolved

Source function 3 m wide

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Undeconvolved

Deconvolved 3 m width

Deconvolved 4 m width

Deconvolved 5 m width

Combined Data

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Results – Deconvolved

Source function 4 m wide

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- Undeconvolved
- Deconvolved
  - 3 m width
  - 4 m width
  - 5 m width
- Combined Data
Results – Deconvolved

Source function 5 m wide

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Undeconvolved

Deconvolved 3 m width

Deconvolved 4 m width

Deconvolved 5 m width

Combined Data

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Proof by Excavation
(Gates and O’Brien, 1988)

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Deconvolved survey

<table>
<thead>
<tr>
<th>(in metres)</th>
<th>Survey</th>
<th>Excavated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>4</td>
<td>3.9</td>
</tr>
<tr>
<td>Length</td>
<td>5</td>
<td>4.7</td>
</tr>
<tr>
<td>Depth</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Topsoil</td>
<td>(0.3)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Gates and O’Brien, 1988
Complex electrical survey data can be deconvolved to provide the location and extent of buried features IF their source signature can be predicted.

Electrical survey at New Bewick predicts the presence of at least 6 grubenhäuser.

One of the predicted grubenhäuser has been excavated and confirmed with the same dimensions as the survey predicted.

The site shows other features, and may be the site of a significant settlement (timber-framed halls?)
Acknowledgments

- Mr. J Clark – New Bewick Farm
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