Network Analysis and Landscape Stratigraphy

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ABSTRACT

This paper considers the potential application of network analysis to the representation and interpretation of landscape stratigraphy. Physical and chronological relationships between archaeological features and deposits are commonly represented as stratigraphic matrices. Stratigraphic matrices typically place an emphasis on vertical relationships between individual stratigraphic units, neglecting the chronological implications of any physical relationships between units. Consequently, alternative methods of representation, including land-use diagrams, have been developed to facilitate the interpretation of stratigraphic sequences. These methods, typically used on well-stratified sites, have been adapted for the analysis of unstratified cropmark sites, supplementing stratigraphic sequences with ceramic phasing. This paper builds upon these methods, considering ways in which physical and chronological relationships between archaeological features can be encoded as geometric and logical networks. Potential applications are considered with reference to a number of case studies, including the development of prehistoric barrow cemeteries and later networks of linear earthworks.

1. INTRODUCTION

Recent discourse on landscape archaeology, particularly with regard to the development of prehistoric monument complexes, has been strongly influenced by the notions of time-geography (Hägerstrand, 1970) and structuration theory (Giddens, 1984). Studies have shown that architectural order is imposed on the landscape through projects which are implemented over a prolonged period of time (forward looking). Conversely, others have highlighted the way in which reference is made to monuments that are already in existence, emphasising the role of social memory (backward looking). Physical and chronological relationships are implicit in both instances.

Following the widespread adoption of GIS within landscape archaeology, physical relationships between (contemporary) monuments have been constituted in terms of movement or visibility. Chronological relationships, however, have been largely neglected. Considerations of time are predominantly based on the analysis of a series of "snapshots" or finite moments in time. Polygon overlay (Langran, 1992) and image differencing (Lock and Daly, 1999) have been used to identify continuity and change between successive "snapshots". Network analysis offers an alternative approach, allowing the introduction of greater flexibility and increased time depth.

2. CASE STUDY

Potential applications of network analysis to landscape stratigraphy will be explored with reference to a case study from Eastern Yorkshire. Aldro is one of a series of later Neolithic and Bronze Age barrow cemeteries that have been recorded on the Yorkshire Wolds. A significant number of the monuments within the Aldro barrow cemetery were incorporated into later linear earthworks. These earthworks, constructed from the Late Bronze Age onwards, have been interpreted variously as linear boundaries (Fenton-Thomas, 2003) and rights of way (Llobera, 1996). Many correspond to parish boundaries and respect much earlier alignments.

The relative sequence of monuments at Aldro has been established through stratigraphy and ceramic phasing. This sequence can be used to construct a network where locales (e.g. barrows and intersections) can be represented as nodes, connected by arcs that signify physical and chronological relationships. Network features and connectivity rules can subsequently be used to model the impact of dominant locales and establish a greater degree of temporal resolution. Systematic encoding of the relationships between locales also provides a mechanism whereby interpretative narratives can be constructed around the development of the archaeological landscape.

3. STRATIGRAPHIC REPRESENTATION

Stratigraphic matrices are a highly codified, topological representation of physical and stratigraphic relationships (Fig. 1). Established methods, such as the Harris matrix (Harris, 1979), have been criticised for neglecting both the time depth represented by a stratigraphic sequence and the significance of physical relationships between stratigraphic units (Chadwick, 1999). Alternative methods have consequently been proposed, for example the Dalland matrix (Dalland, 1984). Land-use diagrams (Fig. 2), showing physical relationships on the X axis and chronological relationships on the Y axis, have also been widely adopted by archaeologists working on extensive or complex sites.

Methods of interpretation and representation developed for stratified sites have been adapted for use on cropmark sites

at Wellbrae, Scotland (Alexander and Armit, 1993). A relative chronology for the site was constructed on the basis of the stratigraphic sequence. Ceramic phasing was subsequently used to introduce additional features into this chronology. Similar approaches have been adopted at other sites and are commonly referred to as *horizontal stratigraphy*. Whilst not conforming to the laws of archaeological stratigraphy, these approaches are ideally suited to the representation and interpretation of chronological relationships within the archaeological landscape.

4. RELATIVE CHRONOLOGY

4.1. BARROW CEMETERY

The Aldro barrow cemetery is comprised of thirty-four barrows (Fig. 3). It is divided into five discrete topographic groups (Divisions A to E), each of which is considered to represent a separate element of the barrow cemetery. All of the barrows within the cemetery were excavated during the late nineteenth and none have been re-excavated. Consequently there are no radiocarbon determinations for the cemetery and the construction of a chronological sequence is reliant upon stratigraphic relationships and ceramic phasing. Chronologically diagnostic pottery was recovered from thirteen of the barrows. Five discrete phases of activity (Phases 1 to 5) can be identified within the barrow cemetery.

4.1.1. PHASE 1 – TOWTHORPE WARE

The earliest phase of activity at Aldro is associated with Towthorpe Ware (3,500-2,790 cal BC). This phase of activity, associated with the foundation of the barrow cemetery, is restricted to Divisions A and E (barrows 88 and 94 respectively). The alignment established by barrow 94 is respected by later monuments in Divisions B and E. Sherds of Towthorpe Ware were also recovered from residual occupational debris incorporated into the fabric of barrow 116.

4.1.2. PHASE 2 – PETERBOROUGH WARE

The foundation of the Aldro barrow cemetery was followed by a period of expansion, with the construction of the earliest dated monuments in Divisions B and D (barrows 30 and 49 respectively). Sherds of Peterborough Ware (3,400-2,500 cal BC) were recovered from these barrows. Evidence for earlier activity was identified in both instances, including a hearth on the old land surface beneath barrow 49.

4.1.3. PHASE 3 – BEAKER

The development of the Aldro barrow cemetery continued during the Beaker period (2,100-1,500 BC) with the construction of barrows 54 and 116 in Division A. Both monuments are associated with multiple burials. Whilst all of the burials within barrow 54 came from a single grave, barrow 116 had three separate graves. The beakers from these graves were not contemporary, perhaps indicating re-use of the monument.

4.1.4. PHASE 4 – COLLARED URN

The majority of dateable barrows within the Aldro cemetery were associated with the emergence of the Collared Urn tradition (1,600-1,300 cal BC). Divisions A, B and E all witnessed continued monument construction. The only dateable barrow within Division C (barrow 179) was also constructed at this time, perhaps suggesting a second period of expansion. This phase of activity would appear to correspond to a decline in the importance of inhumation.

4.1.5. PHASE 5 – LATE BRONZE AGE

A single barrow within the Aldro cemetery was dated to the Late Bronze Age (1,150-1,000 cal BC). This barrow would appear to be associated with the abandonment of the barrow cemetery. Unlike other barrow cemeteries on the Yorkshire Wolds, none of the barrows would appear to have been re-used during the early mediaeval period.

4.1.6. UNDATED BARROWS

The remainder of the barrows could not be dated through ceramic phasing. Several are associated with specific funerary rites and can tentatively be fitted into the overall chronology. Barrows that contain cremations only are likely to be associated with Phases 4 and 5.

4.2. LINEAR EARTHWORKS

A complex network of linear earthworks has been identified within the immediate vicinity of the Aldro barrow cemetery. These earthworks are though to date from the Late Bronze Age onwards. Many appear to correspond to earlier alignments established by monuments within the barrow cemetery. Several of the linear earthworks respect the alignments of barrows, either directly (barrows C77, C80 and C78) or indirectly (barrows 49, 51 and 97). Three intersections of earthworks also coincide with burial mounds (barrows C48, C76 and 256). The persistent correlation between linear earthworks and barrows is widely recognised (Barrett, 1994, p. 152).

5. NETWORK ANALYSIS

Networks are a vector data model where geometric features are encoded as a series of arcs and nodes. Logical relationships between these features are defined by a series of connectivity rules. They are commonly used to encode transport systems or utility networks. "Flow" through a network can be controlled by assigning weights or directionality to arcs, or by designating nodes as sources or sinks, Despite the widespread adoption of network analysis by new geographers, it has largely been neglected by archaeologists (Wheatley and Gillings, 2002, p. 135).

5.1. LOGICAL NETWORKS

The relative chronology for the Aldro barrow cemetery can be encoded as a logical network (Fig. 4). Chronological relationships between barrows (nodes) can be represented as a series of lines (arcs). In contrast to stratigraphic matrices and land-use diagrams, the representation of the chronological sequence as a network clearly shows the spatial development of the barrow cemetery through time. Networks can also be constructed that take into account the physical nature of the relationships between barrows, including the orientation of burials and point-to-point visibility.

5.2. GEOMETRIC NETWORKS

The linear earthworks in the immediate vicinity of the Aldro barrow cemetery can be encoded as a geometric network (Fig. 5). Earthworks can be represented as arcs joining nodes that represent start/end points, intersections and barrows incorporated into linear earthworks. By encoding barrows as nodes within the network, it is possible to identify boundaries that follow earlier alignments. Networks could also be constructed from least cost pathways and morphometric analysis of topographic surfaces. Subsequent comparison could potentially identify linear earthworks that were used as pathways and those that formalised natural boundaries.

5.3. NETWORK FEATURES

Attributes can be attached to both arcs and nodes within the network. Each barrow within the network can be ascribed to a phase. Foundation barrows, start/end points of linear earthworks or points where radiocarbon determinations had been obtained could be designated as sources or sinks. Where a relationship exists between two barrows, a weight can be ascribed to the corresponding arc. This weight may be an absolute value (i.e. calendar years) or, perhaps more usefully, a relative value (i.e. number of phases) that express the time-depth represented by the arc. Similarly, attributes can be attached to arcs that record the form or preservation of a linear earthwork.

6. INTERPRETATIVE POTENTIAL

Encoding physical and chronological relationships between features as a network also provides a mechanism for constructing interpretative narratives. It has been suggested that the distribution of barrows on the Yorkshire Wolds represent an attempt to map the heavens on earth (Mortimer, 1895). The Ursa Major constellation was identified as a recurring motif in prehistoric barrow cemeteries (Fig. 6). Whilst the notion of sabianism (star-worship) may no longer be acceptable, the idea that conceptual order is imposed on the landscape through the structure of barrow cemeteries still has academic currency.

Studies have shown that secondary burials within prehistoric round barrows often make specific reference to the placement and/or orientation of the primary burial(s) (Mizoguchi, 1993). Reference to an earlier event or person is ascribed particular significance or meaning and may indicate a relationship with the deceased. Similarly, it has been suggested that linear barrow cemeteries represent a physical manifestation of prehistoric genealogies. The interpretative potential of network analysis is further highlighted by Simon Patterson's reworking of the Tube map – The Great Bear (1992). Stations and lines have been re-labelled to represent significant individuals from a range of professions.

CONCLUSION

Network analysis has a great deal of potential for the interpretation and representation of landscape stratigraphy. Physical and chronological relationships between archaeological features can rapidly be encoded as a logical or geometrical network. The resultant networks can subsequently be used to explore and develop archaeological interpretations.

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FIGURES

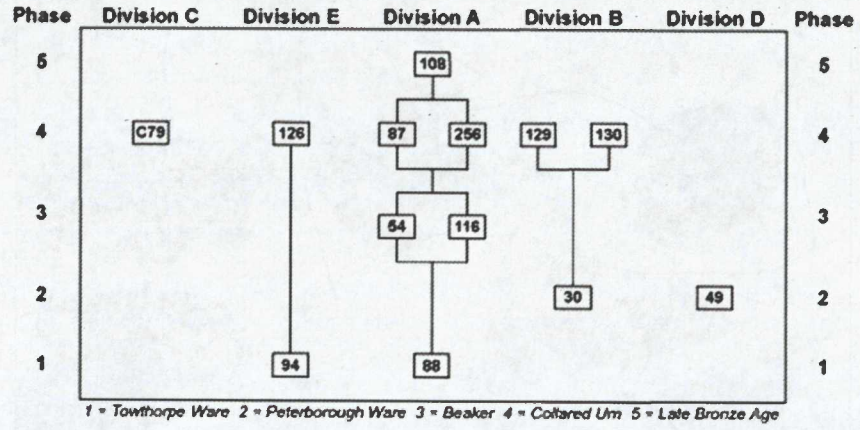

Fig. 1 – Stratigraphic matrix for the Aldro barrow cemetery.

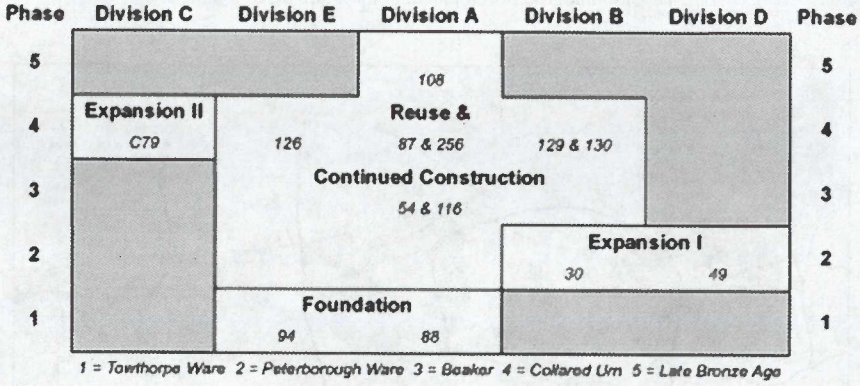

Fig. 2 – Land-use diagram for the Aldro barrow cemetery.

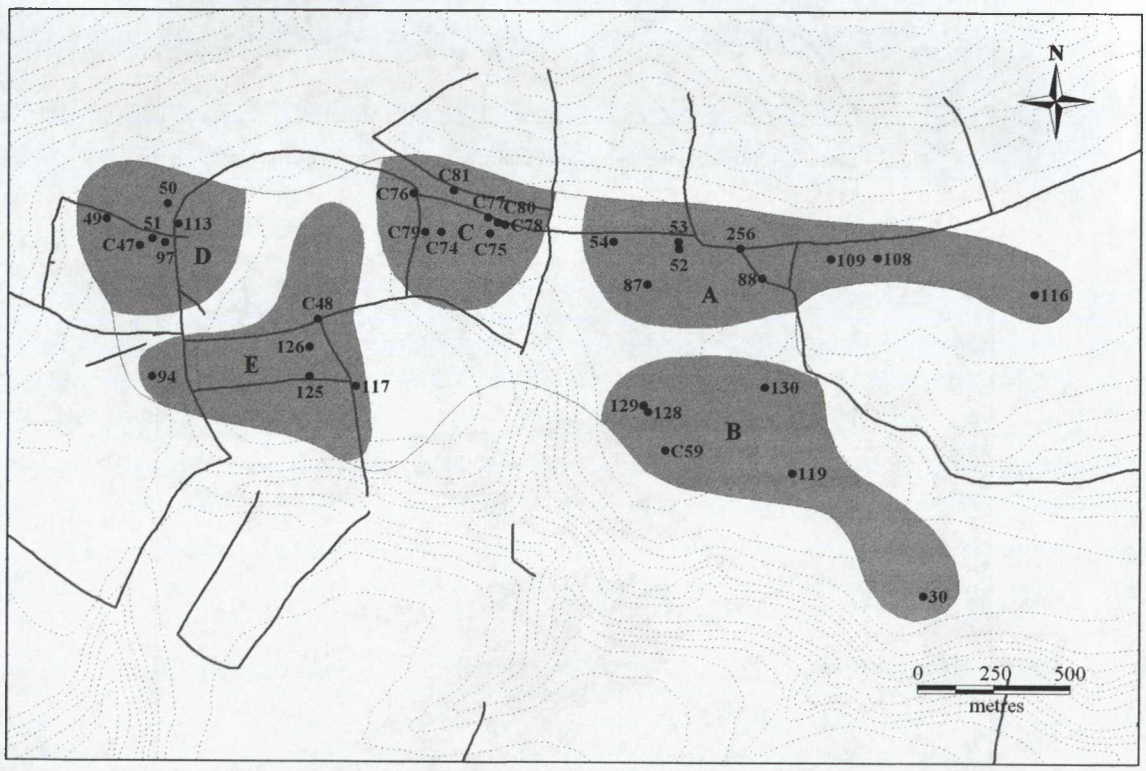

Fig. 3 – Aldro barrow cemetery and associated linear earthworks.

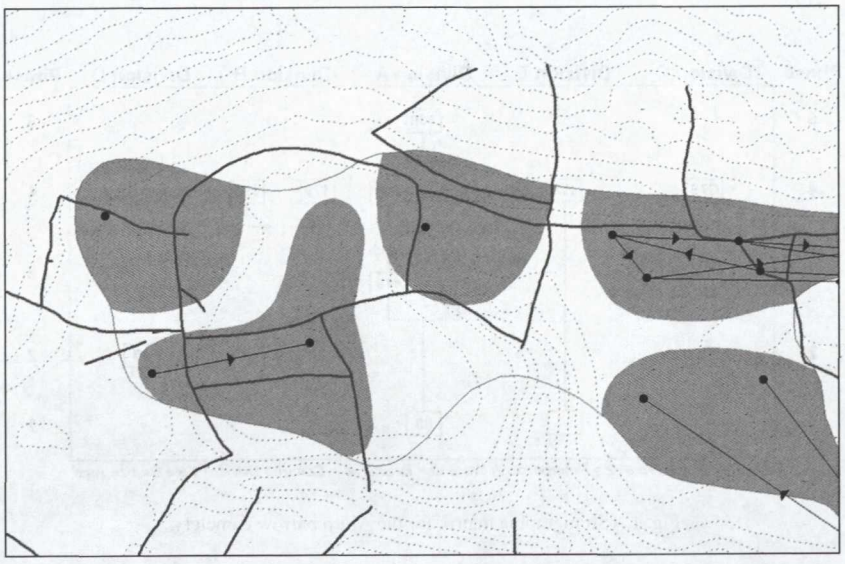

Fig. 4 – Chronological development of the Aldro barrow cemetery.

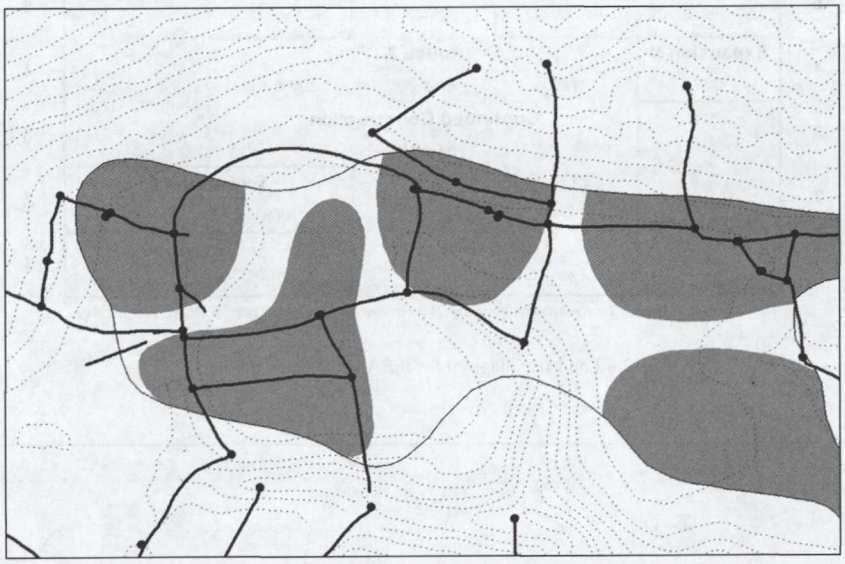

Fig. 5 – Linear earthworks in the immediate vicinity of the Aldro barrow cemetery.

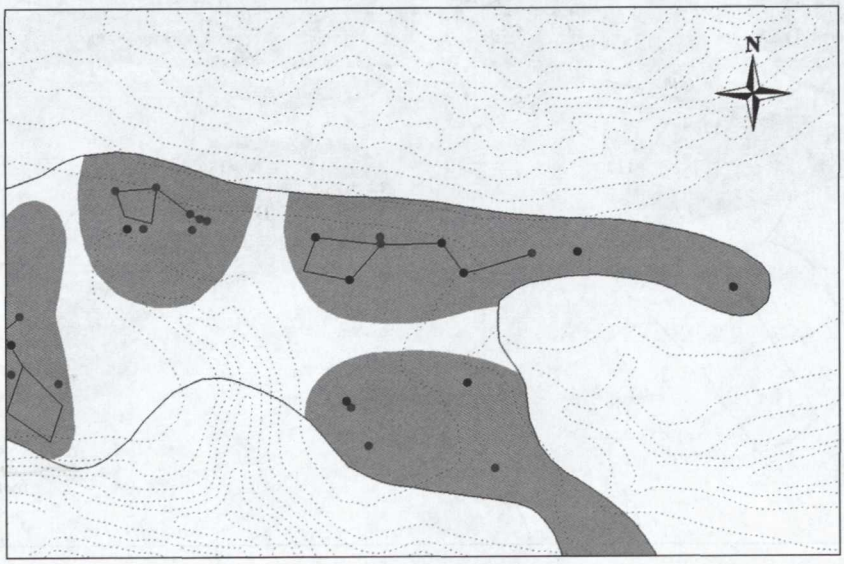

Fig. 6 – Representations of Charles's Wain (after Mortimer, 1895).