Methodological Reflections on Shell Midden Archaeology: Issues from Tierra del Fuego Ethnoarchaeology

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Based on our work in Tierra del Fuego, we offer some ideas on midden formation processes. We discuss our aims in conducting excavations on midden sites (Túnel VII and Lanashuaia) and we describe the specific methodology used. Our experience demonstrates that it is possible to obtain ‘fine grade’ results about the societies who built these middens providing we place them in the broader context of resources and territorial management.

Introduction: The dialectical theory in stratigraphy

In this paper, we offer some personal reflections on the nature of middens and in particular their formation processes. Our focus is based on our view of the middens as objects of archaeological study and we conduct our work from a specific theoretical standpoint. We therefore begin by offering an historical perspective on the discipline in which we work.

The principles of geology were consolidated and structured prior to the formulation of the materialist dialectics of Marx and Engels. The validity of the proposed dialectic in relation to an understanding of Geology is still questioned today, largely due to academic inertia, and metaphysical approaches are common. The predominance of formal logic in the Natural Sciences limits our understanding of the studied phenomena. The principles of formal logic – identity (if a statement is true it is true), contradiction (no statement can be both true and false at the same time), and excluded middle (a statement is either true or false) – predispose one to consider reality as static and everything as divisible into independent parts. Moreover, the dominant reductionist positivism in the field of science supports the identity of a phenomenon and its explanation while the final aim is the (supposedly objective) description of the phenomenon (Woods and Grant, 1995).

It is important and relevant here to make reference to the vision and work of the French archaeologist Georges Laplace. He confronted the metaphysical typology of lithic artefacts with a dialectical analysis associated with analytical description (Laplace, 1974). His system was extended to microwear and basic structure within a structured whole (Vila, 1977; 1987) and was also applied to the study of skeletal remains (Estévez, 1978; 1979). Finally, his approach was used to develop methods in stratigraphy (Saenz de Buruaga, 1996).

The contribution of Laplace (Laplace and Meroc, 1954) to excavation method and stratigraphic analysis of archaeological sites was also important and ahead of its time. The possibilities of the system designed primarily for close monitoring of the stratigraphic record exceeded its original goals. It also permitted the creation of a ‘volumetric’ reconstruction and an understanding of distribution and spatial association within a site. In short, it permitted a three-dimensional tomographic impression of any excavation, something which today has become easy and routine through use of computer systems (Weniger et al., 1991; Barceló and Vicente, 2004).

Laplace also pioneered the use of microcomputers and inferential and multivariate statistics as a means to achieve objectivity of observation. Objective and automatic excavation is, however, still out of reach, despite the exponential development of computer applications in archaeology. (Barceló, 2008). We believe that this limitation is largely due to the fact that computer programming has yet to develop appropriate algorithms and automated systems of dialectical analysis that account equally for dialectical processes.

But are sedimentological processes really dialectical processes? To what extent do they respond to the laws of dialectics? The weight of metaphysical thought and the temporal limitations of the subject make it difficult to imagine how geological phenomena, conceived as mechanical processes, could respond to dialectical laws or how they could be considered as dialectical processes (Bate, 1993). Sáenz de Buruaga (1997), however, has noted the dialectic relationship between subject and object in the process of stratigraphic understanding. To adopt this method of thinking and this worldview should be the same as accepting the logic of contradiction – matter as a world in motion generated by contradictions. Applying the dialectics of stratigraphy, as a specific component of the science of general laws of motion, it should be possible to deduce the general laws of stratigraphy based on the
In relation to this chapter, the key question is whether deposits in shell middens are representative of an ongoing process moving in an auto-dynamic process. This is because we have accepted a classification or a level of discreteness that is positivist-metaphysical, and we have not considered the grain of sand as part of a wider system, which in its totality is subject to dialectical processes of interaction. We have divided the system into parts that are not self-explanatory. In reality, a grain of sand does not move by itself, and the explanation of its motion will be based on its contextual relations with other materials in a spatiotemporal context. It will move if it does not offer sufficient resistance to wind force or the pull of gravity. As a single particle, considered in isolation, it will find its own definition and be subject to inherent dialectical processes at another level (e.g. at the physical or molecular level).

One of the initial findings of the dialectical method has been to demonstrate that the whole is different from the sum of its constituent parts. The question is to determine where we should segment our analysis in order to highlight the internal contradictions that produce the movement of the system as a whole. In this respect, we can obtain help from another law of dialectics, the transformation of quantity into quality: dialectical jumps make it possible to establish discrete levels, to identify the boundaries between them, and to structure the analysis in a hierarchical manner to take account of these different scales of interaction. These discrete levels permit us to identify significant boundaries between the different orders of contradiction, in terms of a geographical scale (space, macro-space ...), time scale, and even in the way a given phenomenon is observed (visual inspection, microscopy, X-ray diffraction, chemical analysis, etc.).

This transformation of quantity into quality is perhaps the most obvious characteristic of dialectical interaction, and also the one which is most understandable in stratigraphic analysis. When the gradual change in a measurable feature (e.g. temperature, humidity, or similar), exceeds a certain limit, a sudden qualitative change takes place, such as a change in colour of sediment, a change from deposition of sediments to erosion, a stress-fracture, and so on. While at first the change is gradual, it can accelerate to the point of radical change or reversal. This allows us to identify discontinuities, or at the very least, to note changes between layers and to characterize each with respect to the following or preceding layers.

Similarly, we can establish contradictions at different levels, that is, contradictory manifestations of the same phenomenon which cannot be understood without their counterpart, for example gravity versus the centrifugal force of rotation, plate subduction versus plate uplift, erosion versus sedimentation, and land uplift versus down-dropping at tectonic fault zones.

The main issue lies not only in systematic observation and description, and in recognizing the fundamental contradictions that are essential at each level of reality, but also in trying to integrate these different levels, in knowing how they interrelate and how to establish the links and dialectical relationships involved in making the leap from one to another. It is very well known that materialist dialectics conceive of things and of their conceptual images essentially through their connectivity, their inter-dependence, their dynamics and their processes of genesis and termination (Engels, 1987).

Stratification, as a natural phenomenon, responds to dialectical processes. We therefore have to understand it from a subjective point of view as individual observers, tentatively and arbitrarily establish levels of hierarchy, and test the validity of the significance thresholds that we have established, and the degree to which they correspond with reality. The stratigraphic record is not static, not only because our perception of it is not static, but because the objective reality (the stratification) is constantly changing and interacting. We can talk about mechanical and chemical interactions between components in a layer (solid and liquid particles, pores, etc.) but we can also talk about the dialectic between different layers (e.g. pressure, stress). A soil superimposed on a layer becomes in turn a substrate of the next superimposed layer incorporating a new soil. A stratum does not become fossilised after its deposition but continues to undergo transformations in relation to the levels which will cover it.

We should examine critically the boundary between a palaeosol and a layer of sediment because we should admit the possibility that the palaeosol is the consequence of a very gradual change in rates of sedimentation and sediment-alteration. The same is true for the example of the distinctions between clay, silt, sand, and gravel, which are based on arbitrary limits on the size of the particles.

In relation to this chapter, the key question is whether deposits in shell middens are representative of an ongoing...
process or are in fact the opposite, and are the result of discontinuous phenomena. If this is the case, at what scale
does this occur? At a macro level there is no doubt that midden deposits are a discontinuous phenomenon; it is
clear that the formation of any shell midden had a beginning and an end. But the smaller internal time scale is often
considered to be the result of an undifferentiated and continuous process of accumulation.
Consequently, artificial spits are used, even though macroscopically as the excavation progresses, discontinuities
become clear. Shell middens are products of human activity, and we must therefore be aware of the likelihood of
discontinuities. We know that human activities are structured in discrete cycles: discontinuities
in sedimentation related to discrete activities. There may be discontinuities related to management
of space. For example, people could create physical barriers between areas of a site used in different ways, or
through the use of containers such as baskets or skin bags. Those elements could generate new discontinuities
and new relationships, as for example between the interior and the exterior of dwelling structures or containers,
with the mixing together of the by-products and residues of the various activities carried out. By-products of
different production and consumption activities deposited together would acquire coherence as a new and
distinctive material entity that did not exist previously.

Between one cycle or moment of deposition and the next one, there can be a time lapse in which natural events
take place, which also leave traces, such as a layer of sedimentation or natural erosion. Taphonomic processes
can also intervene, such as decomposition, and thermal, physical or chemical alteration. Natural cycles also occur,
such as new seasonal or other processes of growth, movement and decay in the living beings, plant and animal life
that uses the site, or other cycles of human activity other than deposition that degrade or modify the surface
through trampling, movement, removal of raw materials, and cleaning.

The important point is the ability to identify the discontinuities and their identifying features and the ability to
identify the time span which has produced a given type of human activity, whether on a cycle of days, weeks,
months, seasons or years.

‘Any stratigraphical position is determined by a confluence of different processes (sedimentological, zoological,
botanical, human) ordered according to causal principles’ (Saenz de Buruaga, 1996, 13). Our role is to define
which of these processes predominate, or in other words and following the method that Engels proposed long ago,
to identify what is the contradiction that has become dominant by the emergence of a given feature and what
others have become subordinate (Engels, 1894). The universal inter-linkages between different material
phenomena impose a requirement to establish a coherent system of analysis that can identify the links
between all the elements that are dialectically interconnected, ranging from geographical-geomorphological
analyses at one end of the scale, to macroscopic and visual analyses, and thence to microscopic and
chemical analysis at the other end of the scale (Lozano, 1996). In addition, we should add in everything that
we can infer, based on observation and experimentation, of biological processes and social activities. If we are
rigorous in the application of these theoretical principles, although each category of knowledge and
analysis will inform specific aspects of the phenomenon, our full knowledge will transcend the sum of its
parts. Thus, for example microbotanical evidence may permit an understanding of the spatial distributions of
artefacts or the patterns of abandonment and reoccupation of a site. Many of these have been discussed for
a long time (e.g. Ham, 1982), but they are not entirely resolved and we believe therefore that they should
continue to be addressed.

In the present case, we aim for archaeological knowledge, in particular in relation to social activities. What
interests us is how to understand the hierarchical organization of stratigraphical phenomena from the
perspective of social activities. Our aim is to examine the interactions between these causal elements. To this
end, we need to identify the natural and taphonomic processes of site formation because these have affected
the archaeological evidence for human activity (including type of remains, size and quality). We have to
investigate how social activities, in their turn, have contributed to the construction of the site stratigraphy.
It is not possible to analyse separately sedimentological processes apart from anthropogenic and biotic ones,
particularly in shell middens. We have pointed out that in the current state of methodological development,
stratigraphical analysis is not a standardized, automatic process. There is an intervention (a dialectical
interaction) between the subject (the researcher) and the object of study (the site). A series of subjective
decisions has to be taken on how to continue the process of excavation, how to follow the strata, where to
sample and what type of samples to take, and so on.
Integrating the stratigraphy, before and during excavation, with the rest of the record, rather than treating it as a separate and self-contained task, is not obvious or easy. We have to consider what techniques or selected parts of techniques are suitable and which can be used or adapted, and how to structure them, always taking into account the archaeological objectives of the work. Despite the efforts already made in this direction with analytical stratigraphy among other conceptual tools (see review in Sáenz de Buruaga, 1996; 1997; papers published in the journal KREI devoted to Analytical Stratigraphy of the Universidad del País Vasco [University of the Basque Country] in Vitoria), we are still far from forming a methodology consistent with our substantive theory and one which can establish the hierarchical relationship between different levels of analysis, and achieve the necessary integration between them.

The study of Yamana settlements

Since 1988 the Archaeology Laboratory at the Barcelona centre of the Spanish National Research Council (CSIC), the Universitat Autònoma de Barcelona and the Centro Austral de Investigaciones Científicas de Argentina, have been working together in the Isla Grande (Large Island) of Tierra del Fuego. The aim of these projects was to study the final phases of indigenous society of those groups who lived in the Fuegian Magellan coasts until the 20th century and the impact of industrialisation on the regional resources. At the same time our aim was to develop and test new conceptual and operational tools for the archaeology of hunter-gatherer societies.

During the project, several sites were excavated including Tunel VII and Lanashuaia. These sites are situated on the north shore of the Beagle Channel (the Argentinian part of Tierra del Fuego). They are Yamana sites, dating to the 18th–19th centuries AD. This group is renowned for its continuous use of canoes for moving around, and for a livelihood based on the exploitation and management of shellfish, fish, birds and sea lions, together with limited use of plants for food, though plant-based materials were widely used (Estévez and Vila, 1998; Orquera and Piana, 1999a). The dynamic balance of the system and its reproduction was achieved through a social organization that permitted the monitoring of both production and biological reproduction (Vila and Ruiz, 2001).

The sites, which are mainly located along the coastline, are easily visible as individual circular relief-mounds with a central depression (Figure 1) in a sparsely populated landscape. They are considered to be shell middens because they consist predominantly of mollusc shells. Human participation in their formation is unquestionable: the shell mounds are products largely of human activity. The stratified levels are formed mainly of mollusc shells (predominantly mussels), other food waste and/or production of goods, in other words, human activity. At a secondary level, ash, organic matter, sand and pebbles (also largely brought in by humans or produced by their activities) have also contributed to the development of the middens.

Tunel VII is one such midden. This Yamana settlement is located about 10 km from Ushuaia, on the Argentinian side of Tierra del Fuego's Isla Grande in a small cove. This cove measures 40 m x 20 m, slopes in a north–south direction and is bounded by a steep rocky slope. The midden is almost at the water's edge, on a pebble beach with little protection from the frequent south-westerly and south-easterly winds.

We conducted five excavation campaigns here, between 1988 and 1993, as the first stage in our Tierra del Fuego research project (Estévez and Vila, 1995; 1998; Vila et al., 2007; Estévez, 2009). A broad horizontal area was excavated in Tunel VII to investigate spatial distribution of simultaneous deposits. The initial excavation exposed 72 square metres with a more detailed focus on a reduced area of 32 square metres. This area contained a circular ring which was characterized by the accumulation of mollusc shells. Inside this ring, areas of concentrated burning were identified (Estévez and Vila, 1998).

The 'midden' is highly representative both in its morphology and its formation processes of the archaeological settlement sites of the canoe societies who lived in the Fuegian channels, at least during their final phase. Dendrochronological dates place the age of the site between AD 1776 and 1898. Contact between the indigenous population and early European settlers began in earnest after the passage of the Beagle in 1830.

We excavated the second site, Lanashuaia, in 1995 and 1996. This site is situated about 60 km east of Tunel VII. It is also a shell midden dating to the 19th century. It lies on the beach on a very flat isthmus leading to a peninsula. A wide strip right along the coastline is marked by depressions surrounded by elevated rings; we believe these are all occupation units.

Stratigraphical features and the recording system: genesis and composition of the shell mounds

The extensive experience of our Argentinean colleagues L.A. Orquera and E. L. Piana (Orquera and Piana, 1992; 1999b; 2000; 2001) with this type of site, confirmed the possibility of dissecting the marine shell deposits, and of separating distinct ‘extraction subunits’ through a detailed understanding of levels of least structural resistance (discrepancies, stratigraphic contact zones). These discrepancies could be marked by
small lenses or films of fine sediment, or surfaces of greater compaction, or surfaces which were accentuated by differences in the consistency or colour of the different layers as well as the composition of the shell matrix. Larger discrepancies of humus or sand interspersed with the shells enabled subdivisions to be identified, although these did not necessarily cover the entire occupation.

Within the same subunits, it was possible to make associations between different elements (evidence for structural elements such as post holes and for combustion, such as hearths and heat-altered floors containing ash which were products of embers deposited on the floor) or significant associations between individual features (e.g. patches of limpets within mussel middens, or small pebbles forming an insulating layer, or groups of pebbles partially altered by heat, etc.). It is important to point out that experimentation was conducted systematically throughout our work, in relation to archaeological as well as taphonomic and post-depositional processes (Estévez and Mameli, 2000; Mameli and Estévez, 2001).

It was this experimentation, together with the abundant and varied ethnographic information, which helped to explain these subunits as the result of successive deposits of 'packages' of waste (mainly shells). These were then compacted through trampling, compression and weathering. These effects could have been generated in the course of a single occupation, or successive short reoccupations of the site.

An understanding of the dynamics of deposit formation was achieved through a combination of field recording of the composition of the subunits, topographic analysis, chemical analysis of the sediment (Lozano, 1996) and micromorphological analysis of thin sections of undisturbed samples taken at different points (Taulé, 1993; 1994) based on different interpretations of the site and/or the sedimentation. But it was also fundamental in this respect to take into account not only these classic elements of stratigraphy, but also the position and intrinsic features of the archaeological materials including stone artefacts and fauna (conservation, condition of surfaces, refitting, articulations and anatomical connections). Also, and because this was a recent site, biostratinomy and soil processes and the current growth rate of vegetation cover were also taken into account.

There is enormous variability in the matrices and content of subunits. Some could easily be characterized as shell middens as the sedimentary matrix between shells is very limited or almost nonexistent. In other cases however, the matrix is much more abundant, in which case they should be properly referred to as shelly soils or pebbly layers containing the occasional shell. It is also possible to make the case that a longer unoccupied period can produce a humic layer, which may be sandwiched between shell midden layers, and this will produce soil layers which again act as substrates for the new deposits of shell midden material.

The size of the subunits isolated through this process of delineating structural and stratigraphic discontinuities is varied. At Túnel VII, for example they range from 0.3 to 160 litres and their surface areas, which are also very variable, range from 0.02 to more than 5 square metres.

Their composition is also very different. In the Tierra del Fuego middens, the actual shell midden layers contain more than 45 per cent by volume of mollusc shells (Orquera and Plana, 1999b). In the sites that we dug, subunits could be very different from each other: from 54 to 486 molluscs per cubic decimetre in Lanashuaia and from 30 to 280 in Túnel VII. There was also a significant variation in the composition of the different components of the subunits (fine sediments, pebbles, molluscs, charcoal, bones and flakes).

The recording system

All these features mean that wide horizontal excavations require a methodology based principally on finding discontinuities and relationships. Our final system consisted of a synthesis of the recording system developed by our colleagues and our own experience of using the Cartesian coordinate system (Orquera and Plana, 1992; 1995; Vila, et al., 2009). The limits of the subunits and the depth of their surfaces were measured with reference to a horizontal grid divided into 50 cm squares. The formalized and standardized recording of the sediment structure was completed using three dimensional recording of location and relative position (geographic orientation, gradient and archaeological/anatomical position) of all human-linked material; this includes for instance, all bone fragments longer than 3 cm. Additionally, we recovered a huge amount of millimetre-sized archaeological evidence through sieving on site.

The enormous number of stratigraphic subdivisions produces a stratigraphically complex record (Figure 2). For example, in Túnel VII, which was occupied repeated we identified more than 406 subunits in the central occupation zone alone. If we add the homogeneity of all the isolated subunits to this, it becomes necessary to create a standardized recording sheet following a multi-option system that supports and complements the descriptions of the variations in lateral facies within the subunits and the independent record of significant associations of
Other associations are apparent only through statistical or laboratory analysis. Thus, for example, a use-wear analysis may link some stone artefacts with whale bone chips, and can highlight a working area (Wünsch 1991; 1996). The analysis of reworking, refitting and rearticulating, together with the analysis of post-depositional surface alteration (rolling, grinding, trampling, weathering) enables reconstructions of the material within the settlement dynamics and highlights ‘wall effects’.

All the subdivisions and their sequences were confirmed through comparison with the photographic record, and with the volumetric reconstruction of the sequence of layers, through an inferential statistical analysis of qualitative variables included in the recording sheet, and through the quantification of other variables recorded from the laboratory analysis of a four-litre sample of homogenized sediment.

We also took samples using Kubienna tins from relevant locations such as shell midden deposits, surfaces, fireplaces, and paths, and we took other samples to include the whole stratigraphic sequence in order to test hypotheses about site formation processes based on the visual identification of stratigraphic subdivisions. These tests comprised micromorphological analysis for evidence of trampling, and for episodes of accumulation and abandonment (Taulé, 1993; 1994; Vila et al., 2009; Villagran et al., 2011). Finally, all the stratigraphic units can be volumetrically reconstructed on a computer (Barceló et al., 2003).

Discussion

By using this method we can recreate the dynamics of site formation through the ways in which resources were managed, and through the residues created by production and consumption activities. It is possible to calculate all the material from each subunit even including ones that had not been recorded directly during the excavation (there are millions of fragments of molluscs and tens of thousands of remains of fish fauna) because we recorded the total volume of each subunit and we tested, statistically, the volume required to obtain representative samples (Juan-Muns, 1992; Estévez, 2000). These samples were selected and processed in the laboratory. Finally we were also able to evaluate the unequal distribution of residues and waste of consumption by comparing the objective value invested (that is the labour force invested in their production) with the value of consumption (the fulfilment of the needs that are supplied by the consumed product) (Vila, et al., 2009; 2010). At Túnel VII, in the basal layer (beneath a covering layer of shell midden deposited from a neighbouring occupation focus and a natural humic layer), the existence of a series of at least ten successive occupations was noted, marked by the superposition of heat-altered surfaces that could be identified and isolated (Figure 3). The occupations were centred in a circular area (about 3 m in diameter) in which the sediments were mainly sandy and humic. These sediments originate from the moraine that forms the rear of the cove and represents silt runoff which had slowly percolated down through the grass roots.

This quasi-circular feature was somewhat lower at its centre as a result of maintenance of a clean surface of shellfish waste, which coincides with the inside of a series of huts, superimposed and all in the same place (the branch structure left some post holes around the periphery). Around this circular space it was possible to isolate a series of overlapping subunits consisting largely of anthropogenic material, including shells mixed with food waste and evidence for production activities materials in the various subunits shows (Figure 4). significant and non-random variations in the The application of Principal Components relative proportions of these materials. The Analysis to the weights of the different most important difference is the relationship between molluscs and pebbles. Inside the quasi-circular feature, all the subunits (100 per cent) are characterized by a high content of pebbles corresponding to the inner area of a hut, whereas most of the subunits with higher quantities of molluscs are situated in the peripheral area (Verdún, 2005). Such results demonstrate that the Yamana added pebbles and soil to the central ‘quasi-circle’ and also cleaned it, getting rid of the shells and residues and placing them outside.

This structure, which corresponds well with those described ethnographically, is partly reflected by the distribution of post holes, which correspond to the sequence of subunits, as well as the ‘wall’ effects that were identified through refitting and plotting of all the items.

All this has enabled us to determine how human activity developed over successive occupations and how this activity closely models features of the sedimentation and microtopography. Thus we can see that the diameter of successive huts, the focus of food waste and the activities and subsistence bases of each of the different occupations, vary from one occupation to the next but without any seasonal tendencies. The almost exact placement of successive hut structures over their predecessors can easily be explained as the result of the microtopography produced by the previous occupations and by the fact that the hut structures used previously...
were left standing after abandonment and were available for re-use (Estévez and Vila, 2006). In the earliest occupation we found that the layer of beach pebbles was slightly dug out in the centre of the space which would later be occupied by the hut. In the successive layers, waste was preferentially deposited on the west side (the prevailing wind comes from the west). This produced an artificial elevation on that side that served as a wind-break (Figure 3A). In subsequent occupations when the west side was sufficiently raised, waste accumulations were deposited on the opposite side (Figure 3B). In this way, an artificial ring was built up around the hut which was repeatedly rebuilt.

The layering of these elements through the entire occupation sequence (Figure 3C) shows a repeated pattern of the use of space including a central circular area clean of shells and containing one or two central hearths and some small hearths or small heat-altered areas around the edge. The perimeter of this circle is marked by post holes. Around the outside of this area, a ring of accumulated waste developed, consisting of shell midden subunits (shells discarded after consumption). A number of small hearths were located outside the hut, on the east side. At the opposite end (on the west side), several piles of flakes mark possible areas of lithic tool production, though these could also be the result of cleaning and waste disposal from lithic work areas inside the hut. This western area also received waste from another probable hut situated further west (marked with another plot in Fig.10 3C), this waste material overlapping with that produced in the excavated hut. These final deposits ultimately covered those of the central depression in the excavated quadrants (Figure 2A).

In Lanashuaia, there were fewer subunits and the deposition sequence was much simpler. The original surface had been slightly lowered and an artificial depression was formed before a hut was built (Figure 5A). The site was first used as a location for the consumption of a Minke whale, which was undoubtedly shared with other units (family groups). On the outside, near the probable entrance facing the beach, waste from the processing of the whale had accumulated. Following this, waste material from the consumption of molluscs accumulated at the rear part of the depression in the lee of the prevailing wind. At the same time, there was an accumulation of stone tools and waste material which was concentrated at the end furthest away from the beach, behind the depression (Figure 5B).

All this evidence suggests that Yamana social units had a high degree of flexibility within a specific social model for the use of space, and one which can be analyzed from the perspective of site formation dynamics.

Conclusion

The above interpretations do not imply that no problems emerged in reaching the correct stratigraphic reconstruction. Indeed, although stratigraphic discontinuity was a clear criterion, we believe that these discontinuities can be organized in a hierarchy of importance. The area and volume of one or other stratigraphic subunit was highly variable. Some were only a millimetre thick while others were more than 10 cm thick. Some were separated by layers of humus or sand, while others were directly superimposed. All these observations are consistent with explanations of unequal accumulations of waste (caused by social dynamics) and with the uneven growth of sedimentary and plant-based cover (as observed experimentally).

Another aspect of the methodology which we were required to change, was the Cartesian reference system. At the first site, we followed a standard 2 × 4 m grid separated by a 1 × 4m baulk that served as a stratigraphic guide. The extent and heterogeneous internal composition of each of the subunits made the correlation between the sections on either side of the baulk extremely complicated, however, and in fact this difficulty was not solved until the baulk was taken down. Because of this problem, we decided in future excavations to eliminate the baulk.

Now we are not convinced of the need to use a Cartesian grid. The three-dimensional positioning of objects and the reconstruction of the topography of subunits is more easily achieved in modern excavation through use of a Total Station connected to a computer and a global referencing system. The same can be done for recording the microtopography of the subunits. This facilitates measurements of the volume of the deposit excavated. Very large subunits can be subdivided into smaller polygons to which the sieved sediment can be also be linked, while maintaining the facility to process and statistically characterize the contents of each unit.

We also emphasize the importance in shell midden deposits of this type, of avoiding a simplistic treatment of the archaeological finds as a separate body of material contained within an independently established stratigraphic framework. The ‘stratigraphic’ elements contain archaeological and social information of the greatest importance. In the case of Tierra del Fuego, the sites are without doubt predominantly a product of human management of the space occupied. This organization of space was not a matter of chance but came about as a result of specific social relations of production and reproduction, and understanding these relations is, from our theoretical and methodological perspective, the primary objective of archaeological analysis. Human action is, at the same time, the primary reason for the sedimentary record as these same residues of subsistence activities have become the dominant factor in the sedimentary build up. However, it is also human social action that has interfered with processes of sedimentation by removing sediments in certain areas of the site, for example by a slight initial
deepening of a circular area on the beach, by cleaning a central space around a hearth, and then by the clearing of waste from such areas. Although, in our case, there are clear discontinuities which enable a division to be established between ‘shelly soil’ from the centre (subject to cleaning) and ‘middens’ from the periphery of the occupation unit (made up of dumped waste), nothing, in theory, could have prevented a gradation and overlap between these two categories. Although we can see that there is a clear dominance of human activity in the determination of stratigraphic boundaries, non human agents also need to be taken into account such as gravity, climate (for instances frost and dissolution) and biotic factors. It is these which, by inserting thin films of sediment between the hearths, allow us to define the dynamics of the settlement. Thus, the study of the stratigraphy is one of the most archaeologically informative elements in reconstructing certain patterns or discontinuities in social organization. Stratigraphy also informs us about the social organization of the human group that occupied a site or settlement.

From the opposing perspective, it would be a mistake to separate the contents from the deposits they are contained in, considering the items only as a source of economic and social information, while in fact they can also inform us about the sedimentological and site formation process.

Naturally these taphonomic problems extend equally to the rest of the evidence contained within the stratigraphic matrix, and interpretation will often necessarily require analysis of the sedimentation itself as much as the materials encased within the sediments. Such a study, archaeologically contextualized and treated as a dialectic between observer and observed, allows not only a closer understanding of archaeological materials as particles of sediment, but also enables us to consider the intrinsic elements of stratification as archaeologically useful sources of social information. This latter point, of course, is not restricted to the area of the immediate settlement or archaeological deposit, but applies equally to the wider setting of the site, where transformations of the environment by biotic elements (such as plants and animals) and abiotic elements of climate and terrain produce ‘accumulations’ and modifications that inform on human social activities and are in part affected by them. There is no need to dwell more on the dialectical relations between these different factors and their corresponding spatial levels (site, river basin territory, etc.). We conclude that in order comprehensively to address this study, it is essential to construct a methodology that is sufficiently flexible to account for the reality in each case as well as enabling links to be made that permit movement from one level of analysis to another in order to correlate these correctly.

We believe that stratigraphic analysis should be understood as a flexible and open system, which is constantly open to modification according to the evidence, and which, through an analysis of the interactions between opposing tendencies and the different scales at which they operate, can lead to a more comprehensive understanding.

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Note

1 Friedrich Engels never published this work. He wrote the main part of the manuscript the main part of the manuscript between 1873 and 1883, and edited during 1885–1886. It was first compiled and edited in 1925 as “Dialektik der Natur” in: Marx-Engels-Archiv, Bd. 2, Moskau and Leningrad. The manuscript was sampled again, translated and first published in Spanish in 1978 by Editorial Akal.

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Figure 1. Lanashuaia: A) Surface after removal of the top layer; B) Stratigraphic section showing an association of burned stones at the limit of the shell midden.
Figure 2. Túnel VII: A) Schematic representation of stratigraphy; B) Final stratigraphic matrix showing overlaps, combinations, and correlations of subunits.
Figure 3. Túnel VII. Examples of plans with superimposed structural features representing different occupation episodes: a) Second occupation episode; b) Final occupation episode; c) Superposition of the most significant subunits from all occupation episodes.
Figure 4. Túnel VII: A) General view of the central zone of occupation after removal of the surface deposits. The white lines mark the reference squares and the edges of the subunits; B) Partial view of the stratigraphy.
Figure 5. Lanashuaia: A) Map of natural topography prior to occupation; B) Distribution of lithics and bone material. These have accumulated behind a low bank of earth which was created as the spoil heap from the shallow hollow dug for a hut placement; this hollow provided protection from the prevailing wind.