

**UNPUBLISHED PAPER PRESENTED TO THE UISPP MEETING LISBON****C62 - Coastal geoarchaeology: the research of shellmounds**

(Marisa Coutinho Afonso, Geoff Bailey)

**“MICROSTRATIGRAPHY OF SHELL MIDDENS OF TIERRA DEL FUEGO”**

VILA, A. (\*); ESTÉVEZ, J. (\*\*); PIANA, E. (\*\*); MADELLA, M. (\*); BARCELÓ, J.A. (\*\*); ZURRO, D. (\*); CLEMENTE, I. (\*); TERRADAS, X. (\*); VERDÚN, E.; (\*\*), PIQUE, R. (\*\*); MAMELI, L. (\*\*); BRIZ, I. (\*).

**ABSTRACT:**

The results of the joint research of Spanish and Argentinean teams since 1986 on shell middens of Tierra del Fuego can be useful guidelines for excavating and explaining similar archaeological sites around the world. We assume that human activity is organized in space and time and, as a consequence the random, non-random or homogeneous structure the resulting archaeological evidence has to be demonstrated before assuming a palimpsest nature of the deposit. We show the possibilities and relevance of recovering microstratigraphy of shell middens and discuss the need of using sampling methods that cover a wide surface of short discrete occupation episodes.

**RÉSUMÉ:**

Après plus de vingt ans de recherches au Canal Beagle (la Terre du Feu) nous croyons utile de présenter nos résultats à propos de la méthodologie de fouille des gisements archéologiques de la zone, gisements appelées amas de coquillages ou “concheros”. C’est l’essai de validation de l’hypothèse sur le caractère palimpseste de ces amas qui nous a conduit a cette méthodologie. L’application systématique de l’ensemble des techniques nous a permis voir l’importance de récupérer la microstratigraphie et développer un système de échantillonnage extensif sur des surfaces d’occupation.

**KEY WORDS**

Shell middens, Microstratigraphy, Sampling methods

**MOTS CLÉS**

Amas de coquillages, Microstratigraphie, systèmes d'échantillonnage

---

\* (\*) Departament d’Arqueologia i Antropologia. IMF- CSIC Barcelona, (\*\*) Grup de recerca d’Arqueologia Social americana. Universitat Autònoma de Barcelona. Unitat Associada al CSIC., (\*\*\*) Antropologia. CADIC- Ushuaia

## 1. THE DEVELOPMENT OF AN EXCAVATION AND RECORDING SYSTEM:

“Shell middens”, “amas de coquillages”, “concheiros”, “sambaquis”, “escargotiers”, “concheros”, “conchales”, “kjokkenmoddings”, “kitchen middens”... There are many names in different languages just to refer to a sort of archaeological site characterized by high accumulations of shells and that denotes the attention paid to them. They are very variable in shape and size and were also attention calling for their high archaeological visibility and the very good preservation of the archaeological remains contained (cf. Waselkov, 1987)

However, the character of undifferentiated palimpsest commonly attributed to shell mounds has reduced these advantages of good preservation of the archaeological record. The usual excavation systems tend to segment the deposits in coarse arbitrary partitions of the stratigraphy and sample the record in columns assuming an overall homogeneous distribution of the remains.

Actually, shell middens include very often a complex interoccurrence of different nature lenses (Orquera and Piana 1992) mainly because of:

- 1) The high-speed volume accumulation due to the large amount of residues produced by shellfish consumption and the amount of air contained before being compacted.
- 2) The limited extension of circumscribed deposits.
- 3) The scarcity of soil matrix that imbeds the archaeological remains -shells included- which enables to distinguish short abandon moments that are not so easy to notice in other types of archaeological sites.
- 4) The possibility of being used as trash accumulations and/or for direct occupation; this also enlarging the possibility of anthropogenic postpositional alterations.

This complexity (Orquera and Piana 1992, 2000 and 2001) imposes the need to develop a specific methodology for the analysis and interpretation of archaeological evidences.

Archaeologically the sites on the coast of Tierra del Fuego have been described as shell middens. They are consequence of the social activities of human groups that have intensively exploited the littoral and maritime resources including a large amount of mollusks (basically mussels).

In this paper, our aim is to present some methodological issues as developed by the joint research of Spanish and Argentinean teams since 1986 on the Archaeology of the southernmost part of America.

It is our idea that such issues can be useful as general guidelines for excavating and explaining similar archaeological sites in other parts of the world. First, we assume that human activity is organized in space and in time. Therefore the resulting archaeological evidence must be, on principle, organized. In any case, the random, non-random or homogeneous structure of the evidence has to be demonstrated before assuming a palimpsest nature of the deposit.

Here we will focus only on the possibilities and relevance of a methodology trying the microstratigraphy of shell middens and consequently discussing the need of using a sampling method that covers a wide surface of short discrete occupation episodes.

### **First Essays: *Lancha Packewaia* and *Túnel I* sites**

The Argentinean researchers were interested in the history and variability of fisher-hunter-gatherer human adaptation in the Beagle Channel, from the peopling of the area to the ethnohistorical *Yamana* people (Orquera et al 2006) but before the joint research had not studied any archaeological site from the ethnohistorical period. The Spanish research team was interested in the development and testing of new methods and in the theory about hunter-gatherers archaeology, specially focusing in Social Archaeology subjects (Vila, 2006, 2004; Vila and Wünsch, 1990).

Consequently, since 1986 a Spanish-Argentinean team worked on eighteen and nineteen century archaeological sites of the northern coast of the Beagle Channel, this zone was, according to the descriptions of the ethnographers and travelers, part of "territory" of *Yamana* people (Estévez and Vila, 1995).

Archaeological systematic studies in Tierra del Fuego started with the *Proyecto Arqueológico Canal Beagle* (PACB) in 1975 (Orquera et al. 1978 and Orquera y Piana 1988, Orquera *et al* 2006). According to the normal practice of that time, the first excavations (*Lancha Packewaia* and the beginning *Túnel I* sites) were done by artificial levels within broad natural layers, even though acknowledging –a simple look at shell middens profiles makes it obvious- that such technique will most probably mix different occupational events.

The search for a better excavation method to record and recover the stratigraphic complexity, the occupational sequence and the formation

processes of the shellmiddens led the PACB, in 1982, to subdivide the shell layers into sub-shell middens. At the beginning the essay-error process was guided by observable criteria such as shell's state, consistence, texture, disposition and color, the soil matrix nature, abundance and color and the presence or absence of other elements as small pebbles (Orquera and Piana 1992). Soon, a more trustable independent variable was found: sub-shell middens were separated from each other by stratigraphic surfaces that were possible to detect at the excavation. This allowed isolating a sequence of subunits as if they were book pages. As it is explained in Orquera and Piana (1992), shell middens are a pack of interlocked shells separated from other units mostly by stratigraphic discordant surfaces, and occasionally by very thin non-shells layers. An experimental study on sub-shell middens formation was started in 1984. The results enabled to understand how such stratigraphic surfaces were formed, therefore this excavation methodology was tested in Túnel I and other archaeological sites as *Shamakush I* and *Shamakush X*. Since the recovering of such differences and the recognition of criteria depends on the digger's recognition capability, there was a need for a strict and detailed recording, complemented by an exhaustive photographic control and a later laboratory re-analysis. So, other than tridimensional registering of the findings, also each subunit pre-excavation limits was measured and pictured before and after it's extraction.

Still an effort was made to develop a better recording method.

From 1988 in the frame of our Spanish-Argentinean international research projects<sup>(1)</sup>, the sampling techniques have been developed and new registering methods have been used.

### **The sites *Túnel VII* and *Lanashuaia*: standarization of the recording methods.**

This new way of excavating an archaeological shell midden was systematized in a registration protocol at the Spanish-Argentinean excavations of *Túnel VII*, a yamana settlement of the XVIII and XIX centuries, were the excavation covered the full extension of an occupational unit so to investigate spatial horizontal synchronies.

After the ongoing criteria, in this excavation, the differences between subunits were described according to a formalized and standardized questionnaire of the

sediment structure and composition that was confirmed by the analysis and quantification of these variables in the sediment composition. The limits of every subsequent subunit were set and registered, taking a general contextual picture of the subunit and some detailed pictures of each square meter before and after the extraction. The subunits were extracted in the inverse order of its deposition. The depth of the surfaces was also measured following a fifty square centimeter grid. The formalized and standardized recording of the sediment structure was completed with the notation of the 3D location and relative situation (geographic orientation, gradient and archaeological/anatomical position) of anthropic residues which means, for instance, all identifiable and sort of bones fragments longer than 3cm. We recovered all kind of archaeological evidences on a millimeter screen at the excavation.

Such procedure allowed a preliminary spatial volumetric reconstruction of superposition of the surfaces, the process and the sequence of the site formation.

The volume of each of the 272 subunits isolated on the 32 square meters was measured. Their range varies from 160 liter to just 0,3 liter in a not normal distribution. Their surface, also very variable, ranging from 0,02 to more than 5 square meters. These subunits yielded 22.303 lithic residues and tools, and more than 10.000 bone fragments (excluding fish).

After a statistical test to verify the optimal procedure, fish remains were also sampled because of their little size and the huge amount of them found. The system consists of the homogenization of all the sediment extracted on each subunit and the recovering even of the smallest remains; all this work is carried out by an expert member of the team in laboratory conditions. Fish remains vary from 0 to 228 pieces per liter in the samples of the subunits (Estévez and Vila, 1995).

There was also a significant variation in the composition of the different components of the subunits (fine sediments, granules and small pebbles, mollusks, charcoal, bones and flakes). We recovered 4liter samples of homogenized sediment from each subunit, in order to estimate the NMI of mollusks for the complete subunit and to see variations in the internal composition of the shell midden. Every component from each sample was weighed and the MNI for the mollusks was calculated.

We submitted the data of 35 randomly chosen subunits of *Túnel VII* site to an inferential statistical test. The application of the Principal Component Analysis to the resulting weighs of the components shows that the relative quantity of every sediment component found in the subunits is not homogeneous and there

are important and not random differences among the samples and their components. This test also showed that the most important difference is the relation between the variable *mollusks* and the variable *pebbles*. These differences between the subunits are related to their location in the hut. The 100% of the subunits characterized by high content of pebbles corresponded to the inner part of the hut, whereas the 88,89% of the subunits with higher quantity of mollusks were situated outside of the hut. Half of the mussel hinges yielded the mussel's MNI ranging from 19,7 individuals/dm<sup>3</sup> to 224,2 individuals/dm<sup>3</sup> with a mean of 89,5 individuals/dm<sup>3</sup>. Subunit differences estimated by the weigh of the components behaved as those estimated by MNI: subunits with a higher density of mollusks than the mean were located outside the hut, while the subunits inside the perimeter of the hut contained a density of mollusks under the mean. (Verdún, 2005).

Such results implicate the inner-hut maintenance by cleaning outside the shell but letting or intentionally adding granule and small pebbles.

In the excavation of *Túnel VII* site we used Kubiena boxes for micromorphological analysis. Our aim was to verify the hypothesis about the site formation process by the identification of the stratigraphic subdivisions using microscopic evidences of trampling and accumulation and abandon episodes. We took samples from relevant locations such as shell middens top surfaces, superposed fireplaces... and a couple of big boxes (55\*15cm) including the whole stratigraphy on the place where the main entrance of the huts could be situated.

The overlapping of fireplaces and subunits showed that this site was probably reoccupied in different moments along a maximum period of a hundred years -from the end of the eighteenth until the end of the nineteenth century- as the dendrochronology, the <sup>14</sup>C and the European material found in the excavation shows

After the positive results obtained from the excavation of *Túnel VII* site, the methodology was applied again with important ameliorations and better technological support, on new field research since 1995 at the *Lanashuaia* site, which is situated about 60kms eastwards. At this moment, we began to explore new techniques for the automation of data recovering and recording using automatic topographic stations, field computers and GIS software.

During the excavations of *Mischiwen III* and *Cabaña Remolino* in 2001 we began to use systematically digital photography with image rectification systems (Vila, Casas, and Vicente, 2006).

This technology made all data processing much faster and easier.

### ***Shamakush VIII*: the introduction of automatic recording procedures.**

In the 2002 fieldwork at *Shamakush VIII* site a more developed and formal recording procedure was put in work. *Shamakush VIII* is a single component site dated  $1400 \pm 90$  (AC 1678) and  $1380 \pm 115$  (AC 1681)  $^{14}\text{C}$  uncalibrated BP (Piana y Vázquez 2005).

The field season at this site was designed in order to build a model for a computer-based representation of the shell middens formation processes.

To be able to decompose the archaeological site in their components, we built a geometric representation of measured spatial variables. (Adán, et al. 2003 and Barceló, et al. 2002) Such variables, as previously used in all of the excavations since the use of the subshellmiddens units, consisted of strata, layers, concentration areas, and ground deformation patterns. They can be described in terms of contact surfaces, which are consequence of a change in the formation process acting on a specific location. In this excavation, the analytical unit used it has always been the upper stratification surface of a deposit. The bottom or basis is, by definition, the upper part of other depositions formed before.

We used a vector based data structure. Each observed discontinuity or contact surface was divided using a precise grid, with nodes at 1 meter. Each square meter was photographed separately, and the resulting digital image was corrected using 5 control points (grid nodes). Point coordinates were measured in the field with a Total Station. The obtained data were sent to the computer where the scale and distortion of the original image were altered in order to coincide exactly with coordinates. Once rectified, the pictures were joined in a mosaic, to obtain a precise image of the observed discontinuity. The border correctly scaled can be transformed into a vector, and the discontinuity or sedimentary area can be described as a polygon made of oriented vectors. The building of a geometrical model of their relationships is, then, a fairly straightforward task.

The photo mosaic becomes a real image map of the ground. It contains landmark data (shape, size, location) and retinal properties (texture, composition). We use GIS software for processing this geometric representation of the observed discontinuities.

A 3D view of each surface contact is easily computed when interpolating measured z values, a volumetric representation of the whole site is also possible. This volume representation of the site sedimentation can be contrasted with a 3D colour view were the represented values can be any other

variable different from elevation (another archaeological distinct structure: a qualitative variable, such as the presence or concentration of some material; or a quantitative value, such as the value of some sediment property or any phenomenon that can be measured or found at every location).

The aim of all this development was to simplify and accelerate the field recording as well as the laboratory treatment of all collected data, which is very important because the system of recovering subunits in shell middens requires a lot of time and it produces a huge amount of information which has to be processed and exploited.

## 2. DISCUSSION OF THE RESULTS: THE NON RANDOM CHARACTER OF DEPOSITION IN SHELL MIDDENS

Obviously, the structural visualization of a shell midden is not the only purpose of the approaching. After all, an archaeological site is the place where social actions “were” performed. As a result of the social strategies of managing resources and people, physical space is being modified: people excavated pits, they accumulated sediment, they built walls and they broke the original shape, size, and texture of some surface entity. Some times, the nature of past actions did not generate any modification in the main shape, size or texture features of space surface; but it produced a modification of its composition: people accumulated artefacts when they produced garbage and they deleted things when they cleaned the hut.

To understand human activity within the spatial and structure model of our sites in Tierra del Fuego we used ethnoarchaeological knowledge as a reference frame. Yamana constructed perishable huts of about 3,5m of diameter. These huts were occupied only once during a couple of weeks, or repeatedly after abandonment periods. The consumption remains abandoned in the settlements are the main component of the sites.

The excavated sites are mainly circles surrounded by a ring composed by shell middens and other consumption residues originating a simple stratigraphy in some sites or a more complex stratigraphy in others. The archaeological record matches well with the ethnographic descriptions of the shape, size and discontinuous but repeated use of circular huts by yamana people.

In Tierra del Fuego sites, we could relate garbage areas constituted mainly by middens of mussels surrounding other areas that were cleaned.

Given the main human character of the deposited material, we can assume that its deposition structure (form and content) has to do with the organization of



human activities. This organization of remains and therefore the human use of space is something that has to be analyzed prior to consider the deposit as a random feature. The possibility of a random nature of deposition has to be demonstrated and explained in any case as a result of entropy introduced by accumulation of random human or taphonomic activity (Mameli, Barceló, Estévez, 2002). If we assume from the beginning a hazardous or non-structured distribution and if we use a consequent sample technique, then we can hardly discover the hidden organization nor can we demonstrate the actual performance of the sample we have taken. This concept led the development of the subshellmidden excavation from its very beginning (Orquera & Piana 1992). Instead, we better develop the search for the finest significant differences trying to explain them.

As an example we can show some results and simulations obtained on our sites.

### **Explaining the formation process: micromorphological studies**

As we have explained before, the identification of subunits followed a visual recognition aided by a qualitative and quantitative description according to standardized variables and tested by the detection of stratigraphic discontinuity surfaces. This was tested when the measurements and the pictures were already taken. Notwithstanding that micromorphology has been profusely used in archaeological studies (Solé and Vila, 1991; see also French 2003 for a review), its application to understand midden structure and stratigraphy has been neglected (an exception is the work of Simpson and Barrett 1996). Micromorphology samples were collected during the several field season (Taulé 1995) as an integral part of the applied methodology for providing information. That was done through the analysis of the pedofeatures, on the spatial variability of the deposits, on the depositional histories (e.g. the episodes of formation) of the sites and on the stratigraphic superpositions that constructs the shell middens.

One of the most important results is the presence of a number of micromorphological features that point to the occurrence of post-depositional processes which permit to identify units of deposition. These are the related to near-surface pedogenesis features (e.g. textural and excremental) that suggest a short-term exposure of the shell midden units. Most of the organic material shows a good degree of decomposition suggesting high biological activity. A compacted level of in situ also often characterizes the exposed surfaces broken shells originated from trampling (Figure 1). Besides, probably secondary deposits of broken shells are observable, which would result from

rearrangements of the deposits during or prior an episode of occupation. On the basis of these preliminary observations, it has been possible to highlight episodes of depositions that represent the change of depositional focus and structure reorganization that happened during the shell midden/hut life. The micromorphological studies helped to the understanding of the actual formation process and therefore to test the validity of the field identification of subdivisions. The big Kubiena boxes will allow comparing the record of the deposition sequence gathered during the excavation with the formation processes revealed by the microscopic observation. The comparison of this evidences as well as the information obtained from other applied methodologies has helped in elucidating the formation processes of these peculiar sites and has shown the importance of micromorphology for understanding shell middens structure.

### **Establishing the stratigraphic sequence:**

The representation of the superposition of subunits and its correlation follows a system like the Harris Matrix that is elaborated from the superposition of the maps of every subunit (Estévez and Vila, 2000). The superposition of the marks left by the fireplaces on the abandoned surfaces during the successive occupations (a sequence of colors –from black to light yellow- result of the temperature and fire action on the soil) allows the establishment of a sequence of occupations. The subunits can be related to the different episodes of occupation by their overlapping. In *Túnel VII* site there were at least ten discrete re-occupations (Estévez and Vila 2006), whereas in *Lanashuaia* (Piana, Estévez, Vila, 2000) there were no more than two occupation episodes, which in any case are difficult to isolate (figure 2).

Some of the subunits show an ambiguous position in the process of “rebuilding” of the stratigraphy because they did not overlap with the subunits that allow the segmentation of the sequence of occupation episodes. And, of course, despite the fast sedimentation rate of shell middens, we don't think it could exactly be a Pompeii like process. But in such cases the record of the exact position of items and the fifty centimeters grid allow the use of refitting bones and lithics to help in this stratigraphic analysis and to solve such problems of alternative stratigraphic positions of some subunits and of taphonomic movements.

In *Túnel VII* refitting of bones was helpful for eliminating some ambiguities in the correlation of subunits in the time sequence and to look to the synchronic

dynamics. The bone-refittings do not have all the same discriminatory value for this proposal. We classify them in different kinds and probabilities: repairs (re-assembling of ancient broken bones), rearticulations of exact matching bones and hypothesis (sure, probable and possible) about reassembling of individual skeletons. We have to consider the state of conservation of the bones and the marks on their surfaces (trampling, polishing, rolling, weathering), as well as their place (on the bottom, body or top) in the subunit and how are they lying (horizontal, vertical, following the shell orientations and so on).

In the 32 square meters of *Túnel VII* site we have measured 10.500 items exactly and the rest of items in a 50 cm grid. From a total of 10.476 faunal pieces we found 1.555 refittings. We established 76 repairs for bird bones, which was really a hard task. We also established 443 refittings for sea lions and 13 for guanaco. Forty-four parts of different sea lion skeletons could be rearticulated. But the high quantity of such refittings allows filtering the most significant ones in a qualitative and a statistical way: 25% of these refittings, link different subunits. Looking closer to them we can link subunits that were first not stratigraphically related. For instance we could follow some dynamics of deposition related to people's activities and space management: a part of a skeleton lies on the bottom of a midden subunit; it was covered very quickly by garbage. Another piece was incorporated in the body of a shell midden subunit produced by wiping away the garbage. These elements of the skeleton are not in the anatomic connecting position and show a slight trampling on the bone surface. Another piece has been deposited on the top of a third shell mound. This last element is characterized by a higher degree of trampling and weathering.

The refitting of stones artifacts has also a different weight depending on the type of residues involved. We establish three types of categories concerning to: refitting core to flake, flake to flake and on the same flake.

### **Synchronic variation of remains distribution in shell middens: the need for an extensive excavation approach:**

The simulation of sampling procedures showed that we would not get an adequate picture of the global content of the site with samples of a half square meter of the whole stratigraphic column, nor with samples of a square meter. In *Túnel VII* the distribution of all bone remains of the vertebrate taxa in distinct squares meters offers significant differences.

	Square 1/2	Square 5/3	Square 10/4	Square 15/5
BIRDS	64%	54%	53%	35%
WHALES	4%	2%	5%	26%
GUANACO	1%	2%	1%	1%
SEALION	29%	40%	35%	32%
NON DET.	3%	2%	5%	7%

The faunal samples deposited in different spots over an occupation episode or over the whole sequence vary significantly from the center to the peripheries of the occupation area.

But even the frequencies by half square meters inside the same square can vary significantly.

	square 5-3	square 5-4	square 6-3	square 6-4
BIRDS	68%	40%	47%	67%
WHALES	1%	1%	3%	4%
GUANACO	3%	1%	3%	1%
SEALION	28%	53%	45%	28%
NON DET.	0%	5%	3%	0%

In order to state horizontal variability in deposition, which we consider in our case an outcome mainly of anthropic processes, phytoliths analysis was carried out on 12 samples from one of the depositional subunits (B355). This subunit is located inside of the shell ring, which represents the inside of a hut. The phytoliths assemblages clearly show meaningful differences in their composition and densities, which depend on the location of the samples. One of the samples has a very high phytoliths density, which means a higher input of plant material. This sample contains jigsaw-type phytoliths from *Blechnum penna-marina* (Poiret) Kuhn, a fern of Tierra del Fuego that typically grows in close forests. This implies the gathering of the species outside and a special accumulation of its debris close to this spot, which is located close to the limit of the hut. This special accumulation coincides with the use of these plants for conditioning and covering the hut walls and roof as described in the ethnographic record.

The distribution of stone tools and rejects of the stone tool production is also not even but very meaningful (Clemente and Estévez, i.p.) showing specific tendencies of accumulation.

**The diachronic variability: the need of dissecting thin episodes.**

In the sequence of *Túnel VII* occupations, that spanned just over a century we stated a statistically significant variation in all types of consumption goods. The relative composition of firewood along the sequence of episodes shows significant differences (Piqué, 1999) as shown in the table below:

<i>Episodes</i>	<i>Embotrium</i>	<i>Drymis</i>	<i>Ribes</i>	<i>Chilothrium</i>	<i>Berberis</i>	<i>Maytenus</i>
A	64%	25%	7%	3%	0%	0%
B	35%	42%	14%	8%	0%	1%
C	30%	36%	22%	9%	1%	0%
D	44%	31%	16%	7%	2%	0%
E	40%	41%	13%	4%	1%	0%
F	44%	37%	13%	5%	1%	0%
G	32%	44%	18%	5%	1%	1%
H	35%	39%	16%	7%	1%	1%
J	52%	29%	12%	4%	2%	1%
TOTAL	4521	4035	1693	647	119	48

Actually all the categories vary along the sequence. Every occupation episode shows a different composition in the archaeological items recovered. They do not co-vary along the sequence of episodes, nor are they strictly caused by a seasonal organization of the activities (figure 3). That means that every single episode does not represent a meaningful sample of the global strategies over a century. A global picture of the yamana exploitation and subsistence strategies does not emerge with a simple sum or a mean of the activities fulfilled. Their variability and flexibility would be missed if we could not isolate the samples of every episode (Estévez and Vila, 2006). This is why the dissecting during the excavation of the minimal occupation episode is justified.

3. DISCUSSION: EXPLAINING THE FORMATION PROCESS

In fact, refitting as well as the other spatial sampling techniques and stratigraphic isolating of subunits, and the establishment of a detailed sequence of occupations was not only designed to fix stratigraphic links and to control post-deposition processes but also to accomplish the identification of activities and reject areas, intra site circulation of products and articulation of working activities: processes of flaking, re-sharpening and recycling tools and other items, butchering, dismembering, cooking and consuming food.

Plotting the different residues types allows depicting the dynamics of the work and the distribution of the consumed goods. It makes evident the wall effects helping to understand the organization of space (Estévez and Vila, 2006, Clemente and Estévez, i.p.).

The potential variability between stratigraphic subunits (in a vertical diachronic or horizontal synchronic sense) depends on the organization of activities of production, distribution, consumption and deposition as well as on the inequality of consumption and on the recurrence, normalization, regulation and fixing of habits of discarding residues and of arrangement of space (Zurro, et a. 2006).

We can verify the recurrences and the variability in the strategies of subsistence, in the organization of space and in the distribution of real value (the labor effort invested in the production of the item) or the consumption value of the products of labor (Grup Barceló et. al., 2006).

In sum: a shell midden is not necessarily a homogeneous block of sediments. The variability inside can be very significant of the economic and social system that produced it and a sample of homogenized sediment did not represent but obscure this information. It is a good goal to try and to improve finer dissecting of shell middens and other sites.

#### 4. REFERENCES

ADAN, M.; BARCELO, J.A.; PIJOAN-LOPEZ, J.; PIQUE, R.; TOSELLI, A. (2003) Spatial Statistics in Archaeological Texture Analysis. In *The Digital Heritage of Archaeology. Computer Applications and Quantitative methods in Archaeology*. M. Doerr and A. Sarris (ed) Hellenic Ministry of Culture. Archive of Monuments and Publications.

- BARCELO, J.A.; BRIZ, I.; CLEMENTE, I. ESTEVEZ, J.; MAMELI, L.; MAXIMIANO, A.; MORENO, F.; PIJOAN, J.; PIQUÉ, R.; TERRADAS, X.; TOSELLI, A.; VERDÚN, E.; VILA, A.; AND ZURRO, D. (2006)  
Análisis etnoarqueológico del volr social del producto en sociedades cazadoras recolectoras. In: *Etnoarqueología de la Prehsitoria más allá de la analogía*. Departament d'Arqueologia i Antropologia IMF-CSIC. Barcelona. p.189-208
- BARCELO, J.A. de CASTRO,O., TRAVET,D, VICENTE, O. (2002)  
Towards a 3D representation of Archaeological Layers. *Archeologie und Computer* vol. 6. Wien, Phoibos Verlag.
- CLEMENTE, I. and ESTÉVEZ, J. (2006)  
Space Management During the Firs Occupations of the Site Túnel VII (Tierra del Fuego, Argentina). Conference: The Archaeology of Household. Barcelona. (i.p.)
- ESTEVEZ, J. and VILA, A. (eds.) (1995)  
Encuentros en los conchales fueguinos. *Treballs d'Etnoarqueologia*, 1, Barcelona: CSIC-UAB
- ESTEVEZ, J. and VILA, A. (2006)  
Variability in the lithic and faunal record during ten reoccupations of a XIX century Yamana hut. *Journal of Anthropological Archaeology*, vol 25(4), p. 408-423
- ESTEVEZ, J. and VILA, A. (2000) *Estratigrafias en contexto*. *Krei* nº5 , p. 29-61.
- ESTEVEZ, J. and VILA, A. (1995) *Etnoarqueología: El nombre de la cosa*. *Treballs d'Etnoarqueologia*, 1,p.17-23 Barcelona:CSIC-UAB
- FRENCH,C. (2003) *Geoarchaeology in action: Studies in soil micromorphology and landscape evolution*. London: Routledge.
- MAMELI L. BARCELO, J.A.; ESTÉVEZ, J. (2002) The Statistics of Archeological Deformation Process. A zooarchaeological experiment. *Archaeological Informatics: Pushing the Envelope*. G. Burenhult (ed) p. 221-230 (BAR Int. Series 1016)

ORQUERA L.A. and PIANA, E.L. (1988) Human littoral adaptation in the Beagle Channel region: the maximum possible age. *Quaternary of South America and Antarctic Peninsula*, 5, p.133-165

ORQUERA L.A. and PIANA, E.L. (1992). Un paso hacia la resolución del Palimpsesto. Análisis espacial en la arqueología patagónica. In L.A. Borrero and J.L. Lanata (compil.). Buenos Aires. Ed. Ayllu. p.21-52

ORQUERA L.A. and PIANA, E.L. (2000) Composición de conchales en la costa del canal Beagle (Tierra del Fuego, República Argentina) Primera Parte. *Relaciones de la Sociedad Argentina de Antropología Tomo XXV*, p.249-274

ORQUERA L.A. and PIANA, E.L. (2001) Composición de conchales de la costa norte del Canal Beagle (Tierra del Fuego, República Argentina) Segunda Parte. *Relaciones de la Sociedad Argentina de Antropología Tomo XXVI*, p.345- 368

ORQUERA, L.A.; SALA, A.E.; PIANA, E.L.; TAPIA, A.H. (1978) Lancha Packewaia: arqueología de los canales fueguinos. Buenos Aires: Huemul.

ORQUERA, L.A.; PIANA E.L.; ÁLVAREZ, M.R.; FIORE D.; VÁZQUEZ M.M.; ZANGRANDO A.F.J., TESSONE A.Y TIVOLI A.M. (2006). El Proyecto Arqueológico Canal Beagle. *Arqueología de la Costa Patagónica. Perspectivas para la Conservación* (compil.: I. Cruz, M.S. Caracotche, M. X. Senatore y B. Ladrón de Guevara). Cap- 16:288. Río Gallegos..

PIANA, E.L. y VÁZQUEZ, M.M. (2005). El Sitio Shamakush VIII: puntualizaciones sobre el uso de recursos y la gestión del asentamiento en el canal Beagle. In *Actas XV Congreso Nacional de Arqueología Argentina*. (i.p.)

PIANA, E.; ESTEVEZ, J.; VILA, A. (2000) Lanashuaia: un sitio de canoeros del siglo pasado en la costa norte del canal Beagle. *Desde el País de los Gigantes*. Tomo II, p. 455-469

PIQUÉ, R. (1999) Producción y uso del combustible vegetal: una evaluación arqueológica. *Treballs d'Etnoarqueologia*, 3. Madrid: CSIC



SIMPSON, I. A. and BARRETT, J. H. (1996) Interpretation of midden formation processes at Robert's Haven, Caithness, Scotland using thin section micromorphology. *Journal of Archaeological Science* 23, p.543-556.

SOLE, A. and VILA, A. (1991) La micromorfología de suelos aplicada a la arqueología: dos casos a modo de ejemplo, el Cingle Vermell y Mediona I. In *Recent Developments in Western Mediterranean Prehistory: Archaeological Techniques, Technology and Theory*. Oxford B.A.R., nº574 vol.I

TAULÉ, A. (1995) Primeros trabajos micromorfológicos en concheros de la costa del Canal Beagle. *Treballs d'Etnoarqueologia*, 1, p.113-126 Barcelona.CSIC-UAB

VERDÚN CASTELLÓ, E. (2005) Aproximació a l'estudi dels conquillers a través de la malacofauna. Trabajo de Investigación de Doctorado, Departament de Prehistòria, UAB. Barcelona.

VILA, A. (2004) Proyectos etnoarqueológicos en Tierra del Fuego (Argentina). *Bienes culturales*, nº3 (Excavaciones arqueológicas en el exterior), p. 193-200

VILA, A. (2006) Propuesta de evaluación de la metodología arqueológica. *Treballs d'Etnoarqueologia*, 6, p. 61-76

VILA, A. and WÜNSCH, G. (1990) Un pequeño paso antes del gran salto: buscando como preguntar (o investigación teórico-Metodológica en Tierra del Fuego) *Xàbiga*, 6, p. 19-31.

VILA, A.; CASAS, A.; VICENTE, O. (2006) Mischiuen III, un contexto funerario singular en el Canal Beagle (Tierra del Fuego) *Revista Española de Antropología Americana* nº36-1: 47-61

WASELKOV, G. A. (1987) Shellfish gathering and shell midden archaeology. *Advances in archaeological method and theory*, vol. 10, p.93-210.

ZURRO, D, BRIZ, I., ÁLVAREZ, M. and VILA, A. (2006) The integrity of social space: Hunter-gatherers at the end of the world. *Communication. Conference: The Archaeology of Household*. Barcelona. (i.p.)

FIGURES

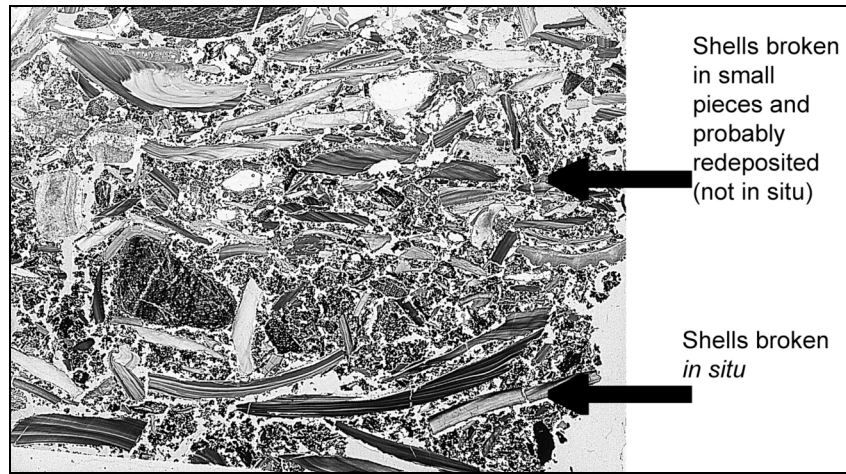


Figure 1. Micromorphology section of a sample in one of the Kubierna boxes of *Túnel VII* showing episodes of reworked and in situ broken shells.

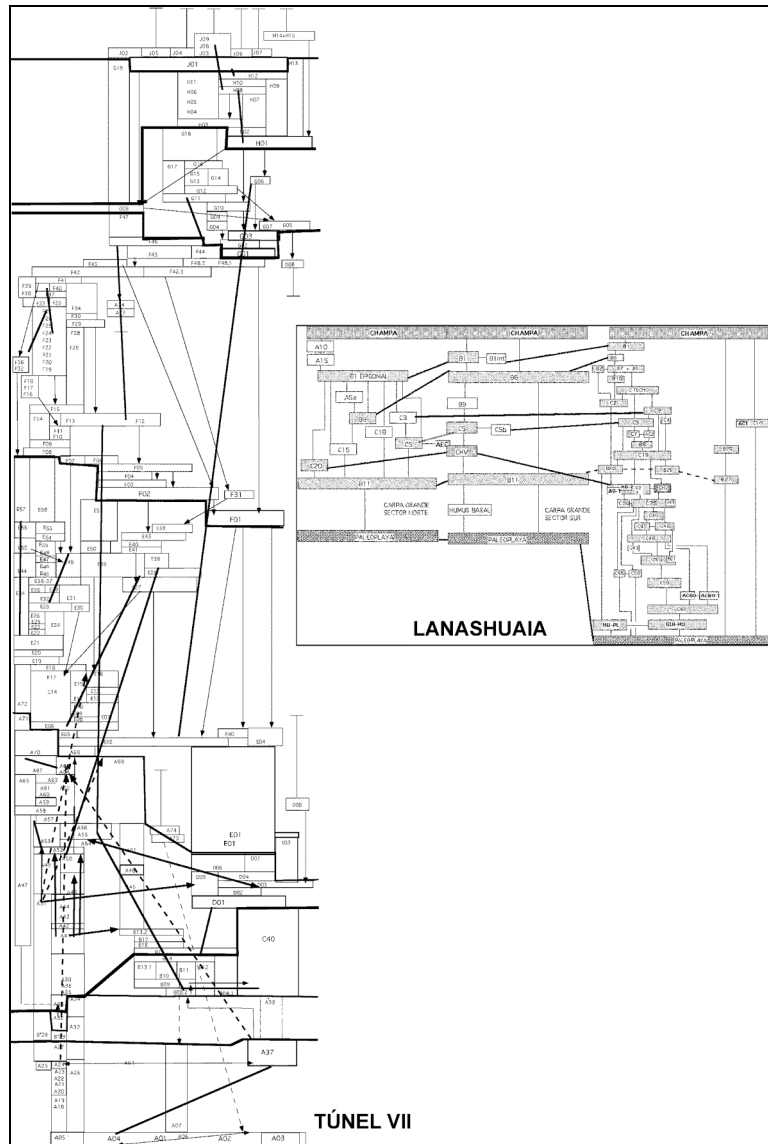


Figure 2. Stratigraphic matrix of the sites *Túnel VII* and *Lanashuaia*

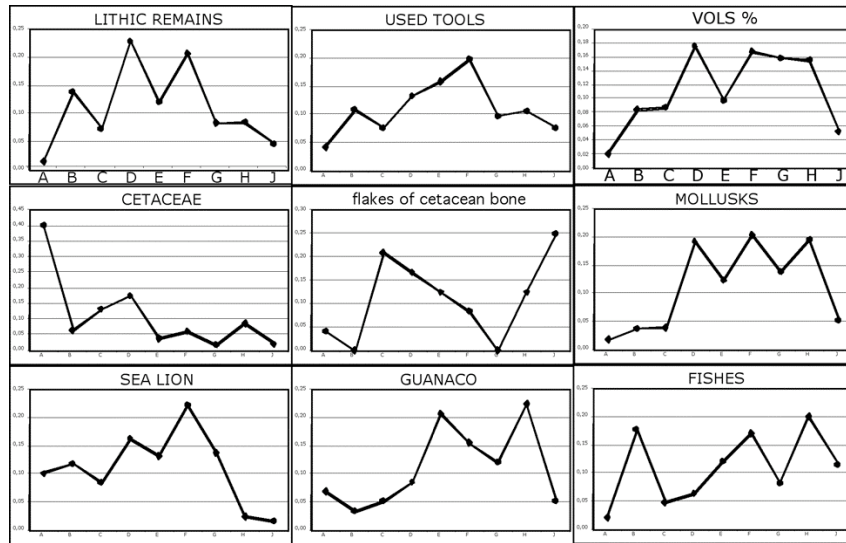


Figure 3. Relative frequencies oscillations in several main items along the sequence of occupation episodes in *Túnel VII* site.

Notes:

---

(\*) Departament d'Arqueologia i Antropologia. IMF- CSIC Barcelona, (\*\*) Grup de recerca d'Arqueologia Social americana. Universitat Autònoma de Barcelona. Unitat Associada al CSIC., (\*\*\*) Antropología. CADIC- Ushuaia

<sup>i</sup> The projects developed during these 20 years were supported basically by the Spanish CSIC, Ministerio de Cultura, Ministerio de Educación y Ciencia, Generalitat de Catalunya, EU XII Comission and the argentinean CONICET.  
The first project was co-directed three of the autors and by Luis Abel Orquera. Nuria Juan-Muns, Joan Miquel Lozano, Alfredo Maximiano, Oriol Vicente and Marian Berihuete contributed to this work with some specific analysis.