Micromorphological perspectives on the stratigraphical excavation of shell middens: a first approximation from the ethnohistorical site Tunel VII, Tierra del Fuego (Argentina)

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Abstract

Due to their problematic stratigraphy, shell middens have traditionally been excavated by artificial stratigraphical cuts. This approach has often led to the obliteration of the original depositional sequence, removing important information regarding depositional and post-depositional processes, and human frequentation. Since the 1970s, an Argentinian team has been excavating archaeological shell middens in the Beagle Channel with a detailed stratigraphic approach, based on the excavation of actual depositional units (peeling), rather than artificial cuts. In the 1980s, Spanish archaeologists joined the Argentinean and launched a series of new projects involving

the excavation of ethnohistorical Yamana fisher-hunter-gatherer sites. The first excavated midden site was Tunel VII, from which two monolith columns of about 50 cm each (C11 and C12) that spanned the whole stratigraphy were extracted. The two columns were consolidated with resin, and two series of thin sections produced to corroborate stratigraphical observations made in the field, and to verify hypotheses related to the formation of archaeological shell midden sites. We present here the first results obtained from the microscopical observation of seven thin sections from Column 11 (West column), extracted from a portion of the profile originally described as corresponding to the hut entrance and associated floor. The observation of microscopic features invisible in the field has provided supplemental information about the depositional and post-depositional processes affecting shell midden sites. We have also preliminarily defined a number of micromorphological characteristics identifying human activities such as discrete shell deposition events, phases of preparation of the hut floor, and compression by repeated trampling. Finally, we have explored the possibility of establishing some guidelines to characterise the length and character of frequentation phases of the site previous to its final abandonment at the beginning of the 20th century.

44 1. Introduction

45 An international team of researchers from the CONICET, the CSIC, and the UAB¹,
46 have been excavating archaeological and ethnohistorical shell middens in Tierra del
47 Fuego since 1988 (Estévez et al., 2007, Vila, 2004). The sites of Alashauaia,
48 Lanashuaia and Tunel VII were excavated in extension, and following actual, rather
49 than artificial, stratigraphical units (Orquera, 1995, Orquera and Piana, 1992). One of
50 the best documented of these sites was the ethnohistorical site Tunel VII, occupied by
51 Yamana groups during the 19th century (Estévez and Vila, 1995, Piana and Orquera,
52 1995). Thanks to the contribution of ethnographical and historical information, and to
53 the limited time elapsed between site abandonment and excavation, Tunel VII offered
54 a unique opportunity to test archaeological methods employed to study the formation
55 and use of shell middens. Micromorphology is used here in an ethnographical context
56 (Taulé i Delor, 1995), to develop a microstratigraphic approach to the excavation of
57 archaeological shell middens (Goldberg and Macphail, 2006, Homsey and Capo,
58 2006, McEwan et al., 1997, Simpson and Barrett, 1996, Stein, 1992). Only
59 microscopical observation in thin section provides the level of definition needed for
60 characterise stratigraphical units using evidence not visible to the naked eye in the
61 field.

62 Tunel VII is an open-air site located along the northern coast of the Beagle Channel
63 (Tierra del Fuego). The site is situated between 0 and 5 m above the present-day line
64 of high tide, on the slope of a moraine facing the sea to the south. The archaeological
65 evidence from the excavation of Tunel VII agrees with the ethnographic description
66 of the site. The formation of Tunel VII is considered the result of repeated
67 occupations of a round hut with the deposition of shells and other consumption
68 residues around its perimeter (Estévez and Vila, 2006). This process produced a ring
69 with a central depression and an entrance facing the sea (Figure 1). The site was
70 excavated between 1988 and 1993, following a grid system subdivided in areas of
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four by two metres, separated by 1-m wide baulks that were later removed (Orquera and Piana, 1995). Tunel VII was excavated in extension, recording each unit in a three-dimensional grid system. The units were excavated using a detailed stratigraphical approach. Their classification was based on the identification, during the excavation, of stratigraphic discontinuity surfaces, and on the systematic recording and quantification of over ten variables, such as matrix, shells, bones and lithic artefacts (Estévez et al., 2001). However, the level of fragmentation, inter-connection, compaction and distribution of the shells, which is unambiguous under the microscope, was not systematically recorded in the field. In 1993, two monolith columns were taken from the southernmost profile, closest to the shore. Column 12 (East column) was taken from sector III, while column 11 (West column) was taken between sectors II and III, after removing the baulk between sectors II and III. Micromorphological samples from column 11 are used here to examine the details of stratigraphical observations made in the field, and to test some of the original working hypotheses put forward to explain shell midden formation and use in Tierra del Fuego (e.g. the stratigraphical changes noticed during field work, and the intercalation of occupation and abandonment episodes).

2. The application of micromorphology to the excavation of shell middens

Two contiguous series of thin sections (A and B) were originally obtained from column 11, and numbered from 1 (uppermost) to 7 (lowermost) (Solé Benet, 1991). It was not possible to analyse all thin sections from both series because some of the units rich in organic matter were over-grinded during production. Therefore, thin sections from both series were selected to obtain the complete stratigraphy (Figure 2).

A high-resolution scan of the impregnated monolith was used to locate the thin sections, and to draw a first macroscopical stratigraphy of this portion of the site. Each microscopical sedimentological unit was defined using an alphanumeric coding (e.g. T7C11TS5AU22), indicating site name (T7), column number (C11), thin section number (TS5A), and unit number (U22). The actual boundaries and main characters of each unit were defined using a Leica MZ 95 stereomicroscope, and the fine groundmass was described using a Leica DM 2500. Thin sections were observed under plain-polarized light (PPL) and cross-polarized light (XPL), following

established guidelines (Bullock et al., 1985, FitzPatrick, 1993, Kemp, 1985, Stoops, 2003).

3. Thin section description

Throughout column 11 the dominant fine groundmass is made of microfaunal faecal pellets organised in porous spheroidal sub-round crumbs, composed of more or less humified sub-millimetric plant tissues and charcoal fragments (Vera et al., 2007). The coarse component is mainly made of shell, charcoal, gravel and sand, with occasional bone fragments and sharp clasts (possible tools). Stratigraphical units have been grouped on the basis of their microstructure as *spongy* and *blocky*. The most common is the spongy type that relates to the main phases of shell accumulation, and is characterised by spongy microstructure, enaulic c/f related distribution, aggregation in porous crumbs, weak separation, and is unaccommodated with packing voids. The blocky type, which relates to phases of incipient soil development, is characterised by sub-angular blocky microstructure, porphyric c/f related distribution, aggregation in sub-angular blocky peds, moderate separation, and is partially accommodated with planar voids.

The fine groundmass being homogeneous throughout the profile, stratigraphical units have been differentiated based on the characterization of the coarse fraction. Most relevant to the microscopic differentiation of units were the concentration and size of shell fragments and clasts together with the degree of shell compaction, fragmentation, inter-connection, species variation and distribution. These characteristics were used to infer on the extent and modality of the different phases of site frequentation and abandonment:

- Low species variation and fragmentation, with linear or banded distributions represent single tossing events.
- High species variability and fragmentation together with random distribution, represent longer frequentation, with repeated reorganisation of the unit by different activities, e.g. floor cleaning.
- Higher compaction of the unit represents continuous site frequentation.

- Lower compaction and incipient soil development associated with scarce anthropogenic features represents temporary abandonment.

The observation of specific pedofeatures, such as soil aggregates and sand lenses, provided information on the processes involved in the preparation of the hut floors (Table 1).

4. Microstratigraphy

The stratigraphic sequence of Tunel VII can be broadly divided according to the incipient edaphic features observed. These were present in only three layers: at the bottom of the profile (unit 1A), at the top of the profile (unit 19) and in units 11 and 12, situated between c. 20 and 25 cm below the ground (Figure 2). Unit 11 corresponds to field units B355 and B365 described by Orquera (1995), and it has been used as a marker to correlate the field and laboratory stratigraphies.

Units 1A to 2

The lowermost portion of the profile shows soil aggregates in unit 1A (Figure 3). The soil aggregates advocate for the presence of a shallow soil before the first occupation of the site and the construction of the hut. The occurrence of an admixture of soil aggregates with the earliest midden deposits suggests that Yamana people prepared the hut floor, creating a shallow depression as the base of the hut, breaking the original soil that had formed over the beach deposits.

Units 3 to 10 (below unit 11 – (field units B355 and B365))

Layers below unit 11 represent a sequence of occupation surfaces alternating with sediments deposited during periods of short abandonment. These episodes of abandonment were probably too brief to allow soil development and vegetation growth, resulting in the lack of explicit edaphic features. The earliest frequentation of the site, coinciding with the preparation of the hut base, seems to have been short, leading to the formation of thin layers characterised by the presence of randomly distributed, partially fragmented and partially interconnected shells of various species (units 1B and 3). Gravel found in unit 4, added after the occupation had started,

suggests its possible use for draining the hut floor. The last moments of these early phases of frequentation are constituted by the accumulation of units with fewer shell species, which are less fragmented, better oriented and interconnected.

The main continuous phases of occupation of the hut correspond to units 6, 8, and 10. The coarse component is here made of highly fragmented, randomly distributed and disjointed fragments of several species of shells (Figure 4). These phases of occupation alternate with short abandonments (units 7 and 9).

Unit 11

Incipient edaphic traits were observed in unit 11 (field units B355 and B365) that represent the longest gap in the occupation of the site (Figure 5). This unit is a little developed soil characterised by the presence of abundant parental materials from the underlying anthropic shell midden.

Units 12 to 17

The soil aggregates found in unit 12 suggest the deepening of the abandoned surface (unit 11) when frequentation starts again. However, this new episode of site occupation (the discrete depositional events) is less clear to identify, as the centre of the hut seems to have been displaced laterally. Deposits representing unequivocal occupation floors are absent above unit 12 because this area apparently became part of the peripheral ring where the shells were tossed. The discrete tossing events are made explicit by the rapid accumulation of interconnected and partially fragmented single-species shells, following a linear or banded distribution (units 12, 13 and 14) (Figure 6). A more refined quantitative approach to be applied in the future will allow further differentiation of the single depositional events that were intuitively recognized during field work. Isolated accumulation (tossing) events can be recognised up to unit 17, which represents the last moment of frequentation of the site. This unit has then been exposed to trampling after the formation of the modern soil and, as a consequence, the shells are sub-horizontally distributed, compacted and highly fragmented, but still interconnected.

Unit 18 and 19

The topmost units 18 and 19 (present-day topsoil) also show incipient edaphic traits, typical of the little-developed modern soils of this area. The lower soil horizon (unit 18) has abundant parental materials from the underlying shell midden (shells and charred wood). Both this and the little developed soil of unit 11 could be defined as *middensols* (Figure 7).

5. Conclusion

The production of thin sections allowed the observation of stratigraphical features that are difficult or impossible to define in the field, due to their microscopical size (structure and components of the fine groundmass), or to the looseness of the sediment during excavation (distribution, compaction and interconnection of the shells). The application of micromorphology to ethnohistorical shell middens produced a further set of observations that complement and add to those made in the field during excavation, also contributing to verify observational hypotheses, justify accurate excavation methods, and solve central questions about site formation. Through the micromorphological approach it was possible to clearly determine the cyclical history of the site, preliminarily characterise the intensity of different occupation and abandonment phases, and gather important clues relative to the construction technology of Yamana huts (Figure 8).

A key question in Yamana archaeology has been related to the processes of settlement preparation, and specifically to whether the original surface was somehow prepared before constructing the hut. There is now evidence attesting that the Yamana people at Tunel VII prepared a shallow depression before constructing the structure, breaking the pristine shallow soils that had developed on the gravel and sand at the edge of the storm line. This procedure seems to have been repeated after the longest time of abandonment, represented by unit 11. Furthermore, the bringing in of gravel in unit 4 suggests the preparation of a structure to enhance drainage in the hut's floor.

The combined micro- and macrostratigraphic approach is a much powerful tool to investigate shell middens formation and taphonomy, and can supply important clues on space organization and economic processes of prehistoric hunter-fisher-gatherers. Indeed, features such as the degree of fragmentation, interconnection and distribution

218 of the shells can be used to complement field observations to construct more
219 comprehensive site histories.

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220 References

- 221 BULLOCK, P., FEDOROFF, N., JONGERIUS, A., STOOPS, G. & TURSINA, T.
 222 (1985) *Handbook for soil thin section description*, Wolverhampton, Waine
 223 Research.
- 224 ESTÉVEZ, J., PIANA, E., SCHIAVINI, A. & JUAN-MUNS, N. (2001)
 225 Archaeological analysis of shell middens in the Beagle Channel, Tierra del
 226 Fuego Island *International Journal of Osteoarchaeology*, 11, 24-33.
- 227 ESTÉVEZ, J. & VILA, A. (Eds.) (1995) *Encuentros en los conchales fueguinos*,
 228 Bellaterra, Universitat Autònoma de Barcelona-CSIC.
- 229 ESTÉVEZ, J. & VILA, A. (2006) Variability in the lithic and faunal record through
 230 ten reoccupations of a XIX century Yamana Hut. *Journal of Anthropological*
 231 *Archaeology* (2006), 25, 408-423.
- 232 ESTÉVEZ, J., VILA, A. & GROUP, D. (2007) Twenty years of Ethnoarchaeological
 233 research in Tierra del Fuego: some thoughts for European Shell-Midden
 234 Archaeology. IN MILNER, N., CRAIG, O. E. & BAILEY, G. N. (Eds.) *Shell*
 235 *Middens in Atlantic Europe*. Oxford, Oxbow Books.
- 236 FITZPATRICK, E. A. (1993) *Soil microscopy and micromorphology*, Chichester,
 237 John Wiley & Sons.
- 238 GOLDBERG, P. & MACPHAIL, R. (2006) *Practical and theoretical*
 239 *geoarchaeology*, Blackwell Science Ltd.
- 240 HOMSEY, L. K. & CAPO, R. C. (2006) Integrating geochemistry and
 241 micromorphology to interpret feature use at Dust Cave, a Palaeo-Indian
 242 through Middle-Archaic site in Northwest Alabama. *Geoarchaeology-an*
 243 *International Journal*, 21, 237-269.
- 244 KEMP, R. A. (1985) *Soil micromorphology and the Quaternary*, London, Birkbeck
 245 College and Q.R.A.
- 246 MCEWAN, C., BORRERO, L. A. & PRIETO, A. (Eds.) (1997) *Patagonia*, London,
 247 British Museum Press.
- 248 ORQUERA, L. A. (1995) Tunel VII: la estratigrafía. IN ESTÉVEZ, J. & VILA, A.
 249 (Eds.) *Encuentros en los conchales fueguinos*. Barcelona, Consejo Superior de
 250 Investigaciones Científicas.
- 251 ORQUERA, L. A. & PIANA, E. L. (1992) Un paso hacia la resolución del
 252 palimpsesto. IN BORRERO, L. & LANATA, J. (Eds.) *Análisis espacial en la*
 253 *arqueología patagónica*. Buenos Aires, Ayllu.
- 254 ORQUERA, L. A. & PIANA, E. L. (1995) Tunel VII: la excavación. IN ESTÉVEZ,
 255 J. & VILA, A. (Eds.) *Encuentros en los conchales fueguinos*. Barcelona,
 256 Universitat Autònoma de Barcelona.
- 257 PIANA, E. L. & ORQUERA, L. A. (1995) Tunel VII: la cronología. IN ESTÉVEZ
 258 ESCALERA, J. & VILA MITJÁ, A. (Eds.) *Encuentros en los conchales*
 259 *fueguinos*. Barcelona, Universitat Autònoma de Barcelona.

- 260 SIMPSON, I. A. & BARRETT, J. H. (1996) Interpretation of Midden Formation
261 Processes at Robert's Haven, Caithness, Scotland using Thin Section
262 Micromorphology. *Journal of Archaeological Science*, 23, 543-556.
- 263 SOLÉ BENET, A. (1991) Micromorfología: Métodos y técnicas microscópicas
264 aplicadas a la Arqueología. IN VILA, A. (Ed.) *Arqueología. Nuevas*
265 *Tendencias*. Madrid, Consejo Superior de Investigaciones Científicas.
- 266 STEIN, J. K. (1992) *Deciphering a shell midden*, San Diego, Academic Press, Inc.
- 267 STOOPS, S. (2003) *Guidelines for analysis and description of soil and regolith thin*
268 *sections*, Madison, Wisconsin, Soil Science Society of America Inc.
- 269 TAULÉ I DELOR, M. (1995) Primeros trabajos micromorfológicos en concheros de
270 la costa del Canal Beagle (Tierra del Fuego, Argentina). IN ESTÉVEZ, J. &
271 VILA, A. (Eds.) *Encuentros en los conchales fueguinos*. Barcelona,
272 Universitat Autònoma de Barcelona.
- 273 VERA, M., SIERRA, M., DÍEZ, M., SIERRA, C., MARTÍNEZ, A., MARTÍNEZ, F.
274 J. & AGUILAR, J. (2007) Deforestation and land use effects on
275 micromorphological and fertility changes in acidic rainforest soils in
276 Venezuelan Andes. *Soil and Tillage Research*, 97, 184-194.
- 277 VILA, A. (2004) Proyectos etnoarqueológicos en Tierra del Fuego. *Bienes Culturales*,
278 3, 193-200.
279

- 279 Figure 1. Site location and overview (a), showing the position of column 11 (b)
- 280 Figure 2. Monolith and thin sections from column 11
- 281 Figure 3. Soil aggregates in unit 1A (a, the rectangle shows the area covered in b),
282 with an example of blocky microstructure (b)
- 283 Figure 4. Coarse fraction in unit 8, representing one of the main occupational phases
284 (a), with an example of spongy microstructure from the same unit (b)
- 285 Figure 5. Edaphic traits in unit 11 (a), with detail of the blocky microstructure (b)
- 286 Figure 6. Interconnected mono-specific shell deposits exemplifying shell deposit
287 derived from a single tossing event in units 13 (a) and 15 (b)
- 288 Figure 7. Topsoil. Trampling and fragmentation lead to the development of a
289 *middensol* over the units deposited during occupation of the shell midden. The upper
290 horizon (a) is less compact than the lower (b), and shows worm burrows and partially
291 decomposed plant tissues. Shell fragments are the main coarse component (c), while
292 humified organic matter and charcoal fragments dominate the groundmass
- 293 Figure 8. Proposed reconstruction of the shell midden stratigraphy, with position of
294 column 11 shown in the bottom figure
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296 Table 1. Microscopic description of the thin sections

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