Late Holocene human occupation of the Quequén Grande River valley bottom: settlement systems and an example of a built environment in the Argentine Pampas

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Abstract

This paper presents a preliminary model of the occupational history of the valley bottoms at the edges of the bed of the Quequén Grande River (Argentina) during the late Holocene. The ultimate goal of the research is to situate some aspects of technology, mobility, land-use patterns and settlement systems as a proximal consequence of a long-term process of ‘lithification’, that is, the positioning of lithic raw material across otherwise lithic-free areas of the landscape.

In order to address this issue, distributions of lithic artefacts are used to discuss features of the regional technological organisation and settlement systems and the relationships between people and the landscape. In that sense, lithification, a variant of a ‘provisioning places’ strategy, has implications for other aspects of a human adaptive system. The lithification process has influenced the organisation of technology, in particular the degree of planning and anticipation necessary, which in turn affects the degree to which technological strategies (eg, curation and expediency) were employed. Lithification also has implications for the organisation of logistical and residential mobility strategies by encouraging reoccupations, changing periodicity of reoccupation, altering landscape use patterns, and making for longer seasonal or task-specific stays. One end result is an artificial conflation of resources, and a lessening of resource heterogeneity. For example, there will be more places where critical resources, such as water, fauna, and flora, co-occur with the lithic resources needed to exploit them. The lithic raw material distribution is only partially dependant on natural occurrence because the environment has been reorganised and (intentionally or otherwise) built by human activity. We propose that in the Pampas the late Holocene witnesses a process of ‘building a landscape’ which had implications for social organisation and hence played an important role in regional human adaptation and cultural evolution.

1 Introduction

Undoubtedly, the spatial arrangement of critical environmental variables such as water, food and lithic raw material are important determinants of behavioural organisation and archaeological site location. Yet none of these resources has a completely fixed location on the landscape. Water flows and can be carried short distances by people. Food can move on its own legs, or be placed in bags. Rock can be quarried and turned into portable tools, or small nodules can become part of a person’s gear. But each resource has differences in its underlying distribution, inherent portability, durability and ability to be cached. Some resources, such as lithics, are essentially indestructible and if moved from one place to another may persist in the new location, and be available there for a
very long time. The environment is altered by a combination of these re-positioning activities, which may have a very transient or an almost permanent effect on the world to which humans must adapt. And while many agricultural societies are understood to alter their landscape, the same is also true of those who subsist by hunting and gathering.

However, many studies of technological organisation take the view that the environment is something separate from humans, something neutral to be entered into and adapted to (Ingold 1993). This Cartesian view should be questioned. Rather, we believe that humans and their environment make an inseparable, mutualistic pair, with the human niche created in a two-way, reflexive interaction with the environment. Post-processualist archaeologies have urged the revision of overly-rigid formulations of human ecology. However, we feel that productive alternatives to the Cartesian status quo are uncommon. To exemplify this theory of the mutualistic environment, we use the relatively easily-assessed proximal process of lithification (Webb 1993), namely the positioning of lithic raw materials across an otherwise lithic-free landscape. This strategy of provisioning places (Kuhn 1995) with critical, yet otherwise unevenly distributed resources, could encourage a substantial re-organisation of both the use and perception of the landscape. In effect, the lithic residue of patterned human activity acts to change the very settlement system which gave rise to the activity pattern in the first place. Yet, because the redistributed resources are then subject to depletion through use, there may be a long term cyclical or reflexive relationship between people and the environment they are modifying. It is proposed that lithification is a human behavioural component that results in a long-term built environment (Ingold 1993), a tangible, enduring record of a people’s own history, which may have implications for both short and long-term mobility, settlement strategies, and for the organisation of technology. Taking into account the changes in the landscape caused by human action, we will discuss some possible ways in which these anthropogenic changes subsequently influence the occupational history of this region. In the following sections we introduce a relevant archaeological case study from the Argentine Pampas, followed by discussion in light of these introductory comments.

### 2 Environmental background for the south-eastern portion of the humid Pampas

The Pampas are a grassland plain located in eastern Argentina between 31° and 39° south latitude. The boundaries of the Pampas, which comprise approximately 600,000 km², are the Parana river to the north-east, the South Atlantic Ocean to the east, and the Sierras Centrales and foothills of the Andes Cordillera to the west. Two principal sub-regions have been proposed within the Pampas region: the humid Pampas (or eastern or proper Pampas), and the dry (or western) Pampas. These sub-regions are divided by the 600 mm isohyet, which runs parallel between the steppe or pseudo-steppe of the Provincia Pampeana to the north-east, and the xerophilic forested area called Provincia del Espinal to the south-west (Cabrera 1976; Soriano 1992; see figure 1). The study area is centred on the middle stream of the Quequén Grande River (figure 1), which is located within the Area Interserrana Bonaerense (Necochea District, Buenos Aires Province, Argentina), in the humid Pampas sub-region.

The humid Pampas are characterised by a temperate climate, with a warm period between November and March. July and August are the coldest months. Rainfall decreases from the north-east, where there is approximately a 1000 mm annual average, to the south-west, where the average is approximately half that. The sub-region is dominated by graminaceous steppe or pseudo-steppe vegetation, characterised by short shrubs and grasses (Cabrera 1976; Soriano 1992). The zoographic classification of the area falls within the Dominio Pampásico of the Guayano Brasileña sub-region (Ringuelet 1955), in which mammals and birds are adapted to open environments. The humid Pampas is a grassland, one of whose defining characteristics is a nearly complete absence of native trees.

Within the humid Pampas, seven biogeographic areas can be identified, as shown in figure 1. These are the Northern, Southern, Western, the Salado River depression, the Interserrana, the Ventania and Tandilia hills. Of these, only the last three areas, which cover an estimated landscape of ca 90,000 km², are relevant to this paper. The Interserrana area is a very flat grassland plain located between the Tandilia and Ventania hills, with the Atlantic coast to the south-east and the Caruhé depression to the west. The Tandilia hills lie in a discontinuous group,
300 km long by 60 km wide, the highest point of which is 525 m above sea level. The Ventania area is a continuous range of hills 180 km long and 60 km wide, with their highest point reaching 1247 m. These two hill ranges were the main prehistoric sources of lithic raw material, such as quartzite, chalcedony, granites, cherts and others (see discussion below) across the humid Pampas (Bayón et al 1999; Flegenheimer & Bayón 2002; Politis 1984).

Palaeoenvironmental research suggests that conditions throughout the Holocene times were basically arid/semi-arid, although during the middle Holocene (ca 6500–3500 years BP) the hypsithermal brought warmer and, probably, more humid climatic conditions. Around 4500 years BP the ecosystem started to undergo a return to more semi-arid/arid conditions which lasted until 1000 years BP, when current environmental characteristics were reached (Bonadonna et al 1995; Prieto 1996; Tonni et al 1999; Zárate et al 2000; amongst others).

3 Late Holocene archaeological background of the south-eastern portion of Buenos Aires Province

Few late Holocene subsurface archaeological sites from this area had been studied before 1970, with most archaeological information derived from surface sites and museum collections (Politis & Salemme 1990). Since the early 1980s, systematic and extended excavations in stratified late Holocene sites have been more common (see Berón & Politis 1997; Politis & Madrid 2001).

Late Holocene sites in our sample fall within the Zanjón Seco Phase of the Interserrana Bonaerense Tradition as proposed by Politis (1984). The main characteristics of the tradition are a dominance of quartzite as raw material, and the use of flakes as...
blanks, with subsequent unifacial (unimarginal) reduction. Traits specific to the phase include small triangular bifacial projectile points, pottery, bone tools, and the exploitation of animals such as *Lama guanicoe* or guanaco (large wild camelid), *Ozotoceros bezoarticus* (small deer), *Rhea americana* or Rhea, (large flightless bird), *Lagostomus maximus* (large rodent), and *Chaetophractus villosus*, *Zaedyus pichiy*, and *Dasypus hybridus* (small armadillos), among others (Martínez & Gutiérrez in press; Miotti & Salemme 1999; Mazzanti & Quintana 2001; Politis & Salemme 1990). Increased numbers of food-processing implements such as large grinding stones suggest a greater dependence on plant resources than in earlier times.

On the basis of recent research (Barrientos 1997; Martínez 1999, 2003; Politis et al 2001; Politis & Madrid 2001) it has been proposed that the Interserrana and Serrana areas have been more intensively occupied during the last 3000–2000 years BP than formerly. Places in the landscape associated with riverine and lagoon environments became the location of residential, multi-purpose and long-lasting settlements, frequently used and re-used through time. These changes were part of an increasing process of cultural complexity that included intensification (Martínez 1999). The concept of intensification has been applied to hunter-gatherers societies in different ways but is generally attached to the notion of complexity (see Ames 1994). It is important to remember that no one single factor or prime mover is usually responsible for the rise of cultural complexity and/or intensification. These processes deserve individual attention or explanation for each particular case because there are so many divergent points of view stemming from different theoretical orientations. Lourandos (1985), for example, stressed that transformations related to resource intensification have commonly been considered as a by-product of external forces such as climatic or demographic changes. While economic intensification (Crown & Wills 1995) and resource intensification and production have been the most commonly addressed in hunter-gatherers societies (see Basgall 1987; Broughton 1994; Janetski 1997; Wohlgemuth 1996), other spheres such as ritual, exchange, status, social networks, alliances, and so on can be also intensified, fuelling changes in the technological, subsistence and settlement base, and accelerating the process of socio-economic changes (see discussion in Lourandos 1985; 1997; Price & Brown 1985; Bender 1981; Williams 1987; Mackie 2001; among others). Thus, based on a socially oriented approach, intensification is understood here as a process where not only economic and resource production are promoting changes but also more intense and competitive social relationships would play an important role. In consequence, intensification refers to social as well as economic variables, which may themselves bear directly or indirectly on the economy (see discussion in Martínez 2003).

### 3.1 Archaeological overview of the study area

In the Interserrana and Serrana areas the following sites have been investigated: Arroyo Seco 2, (upper component), La Toma (later component), Tres Reyes 1 (upper component), Zanjón Seco 2 and 3, Cortaderas, Fortín Necochea, Campo Borchetto, Laguna de los Chilenos, Laguna de Puán, Laguna del Trompa, San Martín 1, Ea. La Mascota outcrops, Laguna de Puan, La Liebre outcrops, Arroyo Diamante outcrops, El Guanaco, Túmulo de la Malacara, Paso Otero 1 (upper component), Cerro La China 1 and 2 (upper component), Cueva Tixi (upper and middle archaeological levels), Lobería 1 and 2, among others (see references in Politis & Madrid 2001). These include both surface and subsurface sites.

The size of the middle stream of the Quequén Grande river is ca 1000 km² (figure 2), although the archaeological sites examined are located in the valley bottoms of the Quequén Grande River and its tributaries, covering an area of only ca 160 km². In general, within the Pampas grasslands, settlements located along the river valleys are either at localised flat areas along the riverbanks or on gently undulating low relief. All of the sites within the study area are located at the edges of the valley bottoms or on low-lying linear rises immediately adjacent to the river (see figure 2). Subsurface and surface archaeological materials are usually found in the same features (aeolian settings) of these landforms. Only about 40 cm separates the younger part of the La Póstrera geological formation (where Zanjón Seco 2 and 3 are located, see discussion below) from the current soil surface. The archaeological materials from both surface and subsurface sites correspond to the same archaeological component, but have been disturbed.
Late Holocene human occupation of the Quequén Grande River valley bottom: Martínez & Mackie

3.2 Subsurface sites

At least two different landforms – fluvial plains and aeolian deposits – were simultaneously used for different kinds of settlements, linked by multi-purpose base camps and special purpose killing and initial processing activities (Martínez 1999). Although the Zanjón Seco sites (see figure 2) are located close to the ploughzone, degradable materials like bones and pottery have not been uniformly destroyed by agriculture. Both the integrity of individual bone specimens and the preservation of the oval garbage structure filled with bones in Zanjón Seco 3 (Politis 1984) suggest that these sites are in primary context. This is possible because these sites are located near the steep banks of the river where ploughing activities are not typically carried out. The portion of workable land beside the river depends on the topographic features and a boundary which separates an area with undisturbed sealed subsurface sites from another with disturbed surficial sites is created, based largely on modern agricultural practices (figure 3).

Analysis of the lithic technology and faunal remains from sites such as those at Zanjón Seco indicates that they are the...
result of multiple activities, leading to their interpretation as base camps (Politis 1984; Politis et al 2001). Activities carried out at Zanjón Seco 2 include tool reduction, and the secondary butchering and consumption of prey. Both lithic technology and faunal remains are well represented. Zanjón Seco 3 represents a rubbish deposit or garbage structure, located in a small natural oval depression that contains mainly guanaco bones and very little lithic debris (Politis 1984; Politis et al 2001). In these late subsurface sites guanaco is typically the most important animal resource, although there is also evidence that small animals were also consumed (Politis 1984).

3.3 Surface sites

Natural tall grasses and the dynamics of cultivated fields have influenced the archaeological visibility of these sites and the composition of surface artefact scatters. Ploughing in the surrounding area of the river valleys has had a twofold effect. On the one hand, artefacts become permanently relocated both horizontally and vertically. On the other hand, archaeological visibility changes through time due to the cycle of tilling activities (ploughing, seeding, harvesting, etc). Given the conditions of site formation processes previously described (differential erosion and aggradation), combined with the timing of field seasons, the number of artefacts present at sites cannot be established by any single survey. This means that gaining a larger sample of materials will depend on performing a series of surveys in different seasons in the same tilling areas.

Surface artefact scatters have been used from a regional perspective for such different purposes as providing functional interpretations (Orcutt 1986; Sullivan 1995), for the reconstruction of patterns of formation processes (Camilli 1989), for understanding differential patterns in subsistence (Sullivan 1995), as indicators of where subsurface deposits should be investigated (see discussion in Dunnell & Simek 1995) among others. In this study, the ultimate goal of analysing surface material will be to understand the distribution of lithic raw material throughout the landscape, taking into account its source, (e.g., outcrops), its place of deposition, and the consequences for settlement systems, the organisation of technology, mobility, and the construction of a landscape through a strategy of provisioning places (sensu Kuhn 1995; see below).

3.4 Lithic raw material outcrops in the humid Pampas: distribution, quality and abundance

Given the main issue addressed in this paper, knowledge about the distribution, availability and quality of lithic raw materials is a key topic. As noted, quartzite is the most common raw material in both surface and subsurface sites (ca 90%), followed by chalcedonies, quartzes, cherts, silicates, and others. Quartzite includes a great variety of rock types that should be distinguished from each other, and their provenance identified (Bayón et al 1999:188; Flegenheimer & Bayón 2002). Rock outcrops of any kind are rare in the Interserrana area, especially ones suitable as lithic resources. In general, the rock exploited came from the surrounding Tandilia and Ventania hills, but there is an uneven natural distribution of kinds of rocks across that landscape. The Tandilia ranges are characterised by isolated rather than continuous outcrops (see figure 4) and the rivers do not transport lithic material more than four km from a watersource. In contrast, the Ventania Hills are formed by continuous ranges, and rivers transport and move quartzites ca 100 km along the main streams that flow into the Atlantic ocean. This creates secondary natural deposits of quartzites from the hills to the sea in the boundaries between the south-eastern portion of the Interserrana and Ventania areas (Bayón et al 1999; Bayón & Zavala 1994; Flegenheimer & Bayón 2002; Flegenheimer et al 1996; Flegenheimer et al 1999). Thus, the Tandilia and Ventania hills and the surrounding areas show different spatial patterns of availability of raw material.

Two main groups of quartzites can be identified by microscopic thin sectioning, and their differences in distribution across the landscape plotted: orthoquartzites are present in Tandilia hills and metaquartzites are found in the Ventania hills (for more details regarding the continuity, visibility, secondary deposition and distribution of these kind of rocks see Table 1 in Bayón et al 1999:195; Flegenheimer & Bayón 2002). It is possible to distinguish the two kinds of quartzite by macroscopic analyses alone, using properties such as grain size and composition, brightness, the presence of siliceous cement, cortex thickness, degree of weathering, fracture type and properties of surfaces, colour, among others (Bayón et al 1999:201). The most important quartzites represented in the archaeological record belong to the upper orthoquartzites of the
Sierras Bayas formation in the Tandilia Hills. The well known, fine orthoquartzite outcrops of Del Diamante (see figure 4) are in the Tandilia range, specifically in the surrounding area of the localities of San Manuel and Barker. With much less frequency, silicified dolomites, microcrystalline silicas and cherts have also been recognised in this area (see La Liebre outcrops in figure 4; Barna & Kain 1994; Flegenheimer 1991; Flegenheimer et al 1996; Flegenheimer et al 1999; Pupio 1996).

In the northwest part of the Tandilia hills, Barros and Messineo (2003) have used macroscopic analysis and X-ray diffraction to source outcrops of chert and silicified dolomites. Geological maps show the orthoquartzites of the Sierras Bayas formation are probably present in this area, although actual outcrops or quarries have not yet been recognised in surveys (Barros & Messineo 2003).

Another point of interest is the presence and absence of quartzites different than the orthoquartzites recorded at Tandilia hills, and the other rock types in the mountain ranges or in the adjacent plain. In the archaeological sites, raw materials such as chalcedony (microcrystalline silicas or the so-called *ftanitas*, see discussion in Barros & Messineo 2003), rhyolite, silicates, and so on follow the quartzites in declining abundance. In the case of chalcedonies there are still some doubts about whether or not this rock is present in both ranges (Franco 1991, 1994; Lozano 1991). Outcrops of rhyolite have been identified in the west sector of Ventania hills and the adjacent plains (Oliva & Moirano 1997). Limited outcrops are also identified in the Interseñana Area itself (see Llambías & Prozzi 1975), such as coarse grained quartzites in the Lumb locality (Politis 1984; Ormazabal 1994), silicified tuff (Madrid & Salemme 1991), and quartz (Politis 1984). These are low grade materials in an otherwise almost rock-free area.

To an even lesser degree, basalt pebbles from the Atlantic coast – where large quantities of this raw material can be found – were utilised, as well as artefacts and blanks mainly featuring bipolar reduction. The frequency of both basaltic raw material and artefacts decreases toward the interior of the Pampas (Politis et al 2003).

In addition to the study area data mentioned...
above, Bayón & Flegenheimer (2003) have analysed a late Holocene surface collection from the El Guanaco site. These authors discuss the lithic raw material database at a regional level and the different modalities of rock transport, noting that orthoquartzites of the Sierras Bayas formation are the best quality raw material in the Pampean region. They propose that artefacts made of these orthoquartzites have been moved more than 275 km in all directions. In the particular case of the El Guanaco site, 146 kg of rocks were transported distances ranging from 13 km (eg, pebbles from the Atlantic coast) up to almost 300 km considering that quartzites are coming from both Tandilia and Ventania mountain ranges. Although much of this raw material was employed in grinding tools, 46 kg were flaked artefacts or cores made mainly on the Sierras Bayas formation orthoquartzites. Pyramidal and discoidal cores up to 500 g are commonly found together with exhausted ones. Bayón and Flegenheimer (2003) interpreted this as evidence of the stockpiling of raw material, and they also proposed a site provisioning strategy. Grinding artifacts (eg, mortars and pestles) found at this site have also been interpreted as site furniture, further reinforcing the idea of extensive anticipation and planning.

3.5 The lithic artefact sample

The data presented here are derived from the archaeological materials housed at the Museo de Ciencias Naturales del Club de Pesca de Lobería (see Martínez 1999). They have been collected by Mr Gesué Noseda, who for 40 years has conducted amateur surveys in the surrounding area of the Quequén Grande River and its tributaries. These places have been repeatedly revisited, and the collection was assembled under the criteria of a single collector. All items recovered have been mapped (see figure 2), all classes of artefacts were identified by site, and typological and technological studies have been carried out (Politis 1984; Martínez 1999). Even though no formal distributional approaches (sensu Dunnell & Dancey 1983; Dunnell & Simek 1995; Ebert 1992) have been performed, complementary analyses based on systematic surveys from other surface sites (eg, El Puente, La Horqueta, Campo Placenza sites, etc) have been done by the first author (see Martínez 1999).

To date, ca 100 surface archaeological sites have been recorded in the middle basin of the Quequén Grande River. Figure 2 shows the location of the main sites (n=70) which without exception are located along the banks of the Quequén Grande River and its tributaries (an area of ca 160 km²). Thousands of artefacts have been recovered from this area, of which a sample has been studied in order to record artefact variability and attributes like size, weight, and volume (Martínez 1999). There are 917 lithic artefacts in this sample, comprising different categories such as mortars, pestles, bola-stones, hammerstones and cores. Table 1 shows classes of artefacts, and their quantity, the frequency of sites where artefacts were found, weight of artefacts, number of artefacts per km², and the weight of artefact classes per km².

In the case of mortars, 299 items have been recovered from 52 sites (74 per cent of the sites), and they are the heaviest items recorded. Considering the area of the valley bottoms (160 km²) an estimation of

<table>
<thead>
<tr>
<th>Artefact class (n:70 sites)</th>
<th>Number of artefacts</th>
<th>Number &amp; percentage of sites per artefact class</th>
<th>Weight (kg)</th>
<th>Number of artefacts per km² (total:160 km²)</th>
<th>Weight by km² (kg) (total:160 km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortars</td>
<td>299</td>
<td>52 sites (74.28 per cent)</td>
<td>1701.5</td>
<td>1.86</td>
<td>10.63</td>
</tr>
<tr>
<td>Bola Stones</td>
<td>227</td>
<td>45 sites (64.28 per cent)</td>
<td>63.5</td>
<td>1.41</td>
<td>0.39</td>
</tr>
<tr>
<td>Pestles</td>
<td>88</td>
<td>27 sites (38.57 per cent)</td>
<td>28.2</td>
<td>0.55</td>
<td>0.17</td>
</tr>
<tr>
<td>Cores</td>
<td>235</td>
<td>26 sites (37.14 per cent)</td>
<td>112.6</td>
<td>1.46</td>
<td>0.7</td>
</tr>
<tr>
<td>Hammerstones</td>
<td>68</td>
<td>16 sites (22.85 per cent)</td>
<td>18.9</td>
<td>0.42</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>917</strong></td>
<td></td>
<td><strong>1924.7</strong></td>
<td><strong>5.7</strong></td>
<td><strong>12.02</strong></td>
</tr>
</tbody>
</table>

Table 1 Summary of artefact frequency, size and distribution in the study area (after Martínez 2002)
10.6 kg/km² can be made. In a sample of mortars coming from the Zanjón Seco locality, the weight of these artefacts varies between 1 and 17 kg, although ca 70 per cent fall between 1 and 9 kg (Ormazabal 1994). A figure of almost two items per km² can be estimated.

The acquisition of raw materials thus becomes a key element for understanding this pattern. In the middle stream of the Quequén Grande River, outcrops of a brown-dark coarse grained quartzite have been recorded at the Lumb locality (see figures 2 and 4), 10 and 35 km distant from Zanjón Seco and La Horqueta archaeological sites, respectively (see also figures 1 and 2). For Zanjón Seco, lithic raw material from Lumb can be considered as a local resource, but this situation is likely different regarding La Horqueta, due to the distance (approximately 35 km from the outcrops) and also the nature of rock and the purposes for which has been used. The quality of the Lumb quartzite outcrops is poor for production of flaking artefacts and they have been almost exclusively used for ground stone artefacts. For instance, in the case of the Zanjón Seco sample, ca 85 per cent of grinding artefacts have been made on the coarse grained Lumb quartzite. Nevertheless, 12 per cent of the mortars recovered from the Zanjón Seco area were made on igneous rocks (eg, probably granites) from the Tandilia hill ranges ca 50 km away (Ormazabal, 1994; Politis 1984, see figure 1).

Both cores and flaked formal artefacts have been mainly manufactured on a fine-grained ortho-quartzite. As mentioned before, this quartzite comes from the surrounding area of Canteras del Diamante outcrops (Flegenheimer et al 1996; see figures 1 and 3), located between 50–70 km from the study area in the Tandilia ranges (see discussion below). Other exotic raw materials from the Tandilia hills, such as granite and, probably, chalcedony have also been used, although their frequencies are low compared to quartzite. Considering the cores (figure 5), quartzite is the best represented raw material: 235 items have been recovered from 26 sites (37.1 per cent of the sites). Weights vary from a few grams up to ca 10 kg (figure 6), with 70 per cent of the specimens weighing less than one kg. Core types include amorphous, pyramidal, bipolar, discoidal, prismatic, and globular. Most of the cores have multi-directional flake scars, although those with only bi- and uni-directional flake scars are also present. Small chalcedony cores, which for the most part are exhausted, are less commonly found at these sites (Martínez 1999).

Bola-stones are also well represented and they are mainly manufactured on granite. Pestles, hammerstones and pottery (N=1344) are also found in these contexts. Besides these, a significant amount of formal-informal tools as well as debris have also been observed. For example, ca 1000 formal tools (sidescrapers, scrapers, knives, etc) have been recovered from the surface site of El Puente (see Martínez 1999). In general terms, the content of the assemblages tends to have a pattern: ie, co-presence of categories such as projectile points, preforms, side scrapers (the so-called raederas), scrapers, knives, notches, short retouched edges, and multi-purpose tools as well as pottery. A variety of debris from renewed cores, such as side and platform flakes and microflakes produced by retouching activities, are present, leading to great variability in the debris from blank retouch. Most of this debris does not have remaining cortex (see Martínez 1999; Politis 1984).

Due to the formation processes described above, and the fact that only a few collections have been studied, the quantity of artefacts and lithic raw material previously described is only a very minimal estimation. In other words, considering the problems of visibility and natural-cultural formation processes, these figures do not exhaust the potential information which could be gained from future surveys or provided by

**Figure 5** Variety of cores collected at the edges of the Río Quequén Grande (1 cm = approx 15 cm)

**Figure 6** Detailed view of one the largest quartzite cores recovered from the middle stream of the Quequén Grande river
other unknown private collections. Nevertheless, the available data are sufficient to instigate a discussion of different aspects of the distribution of lithic raw material and the organisation of technology.

3.6 Summary of study area archaeology

The majority of the stone tools in the Interserrana area are made of quartzites obtained from the surrounding Ventania and Tandilia hills. For the purposes of this paper the most important outcrops are those of good-quality orthoquartzite located in the upper fluvial valley of the Arroyo Diamante (Flegenheimer et al 1996; Flegenheimer et al 1999), the nearest source to the study area. The macroscopic characteristics of the majority of quartzite cores and formal tools found at the sites of the middle stream of the Quequén Grande River indicates that the raw material belongs to the upper orthoquartzites of the Sierras Bayas Formation located in the Tandilia hills, more precisely those located in the surrounding area of the Cantera del Diamante outcrops (see figure 4). These are nearly 50–70 km from the sites studied here. As noted, the El Guanaco site (Bayón & Flegenheimer 2003) contains orthoquartzite from the Sierras Bayas Formation that was transported 125 km from its source (see figure 4).

Cores and artefacts found on surface sites at Del Diamante Quarry resemble those of the middle stream of the Quequén Grande River (figure 7). This quarry is suggested to have been exploited at least since ca 4500 years BP (Flegenheimer et al 1999). Less good quality quartzites, such as those coming from the Lumb locality and isolated outcrops of the Interserrana area, were also exploited, but with less frequency, as were chalcedonies. Due to their differing qualities, some quartzites show variable patterns of exploitation and distribution. For instance, artefacts made on the brown-dark coarse grained quartzite coming from the Lumb locality have a lower frequency. This material was usually used only for ground stone technology. Conversely, the fine grained orthoquartzites from the Tandilia hills have much higher frequency of association with artefacts and debitage such as cores, and formal and informal tools with differing degrees of reduction. Different kinds of artefacts have been manufactured with this raw material, differential uses have been inferred, and variable patterns of management, exploitation and distribution of these lithic raw materials between the geomorphic zones are clear. At this point it can be suggested that a mixed pattern of quartzite exploitation was practiced. The Lumb

Figure 7 Cores observed at the Cantera del Diamante outcrops (photograph by Gustavo Martinez)
quartzite can be considered as a local raw material in the case of Zanjón Seco locality (the eastern portion of the study area, see figure 2), and as an exotic in the case of La Horqueta locality (the western portion of the study area). Orthoquartzites and granites from the Tandilia hills are in all cases considered exotic raw materials, due to their distance. The lithic assemblages from both the stratified and the surface sites have common technological characteristics (Martínez 1999; Politis 1984).

It is important to note that the assemblages include a significant number of heavy items such as grinding stones, mainly metates and manos, and cores which are large in size and number, and which are widely spread throughout the area. That is also the case of hammerstones and bola stones. The presence of large artefacts and cores a long way from the source of the raw material raises questions of mobility and procurement patterns which we address below. The Inteserrana area is largely devoid of rock of any type, let alone suitable material for making stone tools. Data from both sealed and surface sites will be used together in a preliminary model which describes the main characteristics of technological organisation, settlement and mobility strategies, and also the relationship between humans and the physical and social environment as exemplified through the process of lithification. We think that the patterned association of these materials at the edges of the valley bottom sites shows a strongly structured archaeological record, and the analysis of this structure will permit the recognition of at least some aspects of the organisation of the cultural system which produced it.

4 Hunter-gatherers and the built environment

The structure of the regional archaeological record depends on the long term behavioural patterns of hunter-gatherers operating in conjunction with non-cultural factors related to both resource distribution and landscape dynamics (Binford 1990) and to cultural factors such as the material residue of previous human activity (Ingold 1993; Gosden 1994; Zedeño 2000). Analyses drawing on the former are commonplace in processual approaches, while those inspired by the latter are much less common, particularly in the archaeology of hunter-gatherers. Nevertheless, it is difficult to establish the boundaries between them as complex natural and social factors can include processes and conditions not explained by taking into account only one or the other. The concept of lithification seems to have properties for merging both approaches together.

In this, we follow Ingold’s (1993:169) definition of a building as ‘any durable structure in the landscape whose form arises and is sustained within the current of human activity.’ Over time, the built environment loses its distinction from the natural environment, and both become part of the human niche. This process of reflexive niche construction via long-term historical accumulation has profound implications for how we think of the archaeological record. We outline some examples of this process before returning to a general discussion of its influence in the Pampean case study.

Ethnoarchaeological research carried out in tropical rain forest has yielded important information related to the construction of landscape. Study of the Nukak, a hunter-gatherer group from the Amazonian tropical rain forest of Colombia, shows that they manipulate or manage gathered wild plant resources in a way that is not domestication (Politis 1996 a & b). When they move from one camp to another, viable seeds of exploited wild plant species remain in the abandoned camps. In order to build the camp, the Nukak cut some small trees and branches off, and as a result the sunlight is easily able to reach the soil under the canopy. The discarded seeds in these camps are thus in a better competitive position relative to the other wild plants. Nukak construction, consumption, and mobility behaviour thus has a twofold effect on their local environment. On the one hand, through exploitation they create a plant resource patch which will be further exploitable in future circumstances and, on the other they alter the natural distribution of plant resources by changing the diversity of wild plants in small spots through the landscape. The Nukak have a high residential mobility and the paths they use to move around are always in a close spatial relationship with the old and abandoned campsites which, as a consequence of Nukak’s behaviour, contain enhanced populations of those wild plants collected during normal daily foraging activities (Politis 1996 a & b).

Similar behaviours have been observed in other hunter-gatherer groups. Laden’s (in Bailey & Headland 1991) work among the Efe groups, in the Ituri forest has shown that edible plants have a more dense concentration in paths and old camps sur-
rounding areas than in other randomly sampled areas of the forest. In this regard, it is suggested that ‘. . . the Efe’s use patterns of the forest and its plants has resulted in a non-random distribution of edible plants and has inadvertently enhanced the abundance and exploitability of those plants for human foragers’ (Laden, personal communication in Bailey & Headland 1991:266). Deur (2000) has documented the enhancement of naturally occurring rhizomes in small ‘gardens’ in Kwakwa’kawakw (Kwakiutl) territory on northern Vancouver Island, Canada. Elsewhere on the Northwest Coast of the Americas, non-agricultural people nonetheless managed many resources, including the weeding, tilling, and burning of meadows to promote production of camas bulbs, a variety of edible lily (Beckwith 2002). Although disused for a century, these meadows still show an unnaturally high concentration of the edible varieties of camas. In the same vein, Hutterer (1982:175) has suggested that ‘certain aspects in the patchy distribution on plants in tropical forests may be an effect of long-range and continuous human presence.’

Another example of hunter-gatherers manipulating the resource structure of the environment is the widespread practice of deliberate fire-setting in order to enhance young green growth with the aim of attracting herbivores (eg, Johnson 1994; Turner 1991; for a review see Lewis 1982). Once again, it is possible that short term intentionally-motivated behaviour had long term unintentional consequences for the overall patchiness of the environment, and this may have influenced, or even created, the long-term fire regimes which are important parts of many forest ecosystems.

The manipulation of wild plant resources by hunter-gatherer populations, which is a different process from domestication (at least in the classical sense of this term), has had some influences on the reproduction, distribution and, abundance of these plants. This manipulation or management (intentional or otherwise) of wild resources by everyday hunter-gatherer foraging, mobility, technology and settlement systems strategies shows that in some tropical forest (eg, Amazonia) and temperate forest (eg, British Columbia) environments, the very concept of primary forest should be reviewed (Pollitt 1996 a & b; Deur & Turner in press; Boyd 1999; cf Denevan 1992).

The ethnoarchaeological cases mentioned above can be reinforced with archaeological observations made by Gnecco (2000, 2003) in the mountain tropical forest of Popayán (southwestern Colombia). Criticising the ecological-reductionism approaches Gnecco (2000:123–126; 2003) suggests that the hunter-gatherer groups were already altering the natural structure and distribution of resources in these ecosystems with a high sense of territoriality as early as in the Pleistocene-Holocene transition.

While discussing the rise of complex hunter-gatherer societies in the Western District of Victoria, Australia, Williams (1987) describes the construction of artificial features such as mounds, which do not appear in the archaeological record of this region until after 2500 years BP. Except for sandy deposits, all the poorly drained soils of the region become waterlogged, but by building mounds a more intensive settlement of the region becomes possible as the settlements need no longer be restricted to well-drained lunettes. Once the mound is built, it can be used as a campsite during periods of prolonged wet weather or flooding. Mounds can be resurfaced for long term use and the largest clusters are found in areas where sedentism was made possible by a high biomass and diversity of foods resources. Thus, the construction of mounds was a necessary condition which allowed people to live in these flooded areas on a semi-sedentary to sedentary basis. Williams suggests that the stockpiling of discarded sediment into mounds represents a significant change in behaviour leading to an increased investment in durable facilities and, because of this, people increasingly returned to the same camp-site. The building of mounds is linked to all of the changes in social networks and not only represents a substantial change in settlement patterns and sedentism, but they also can be considered as a territorial symbol (Williams 1987:318–319, see also Lourandos 1997).

A similar case has been identified in north-west Uruguay and the lowlands of southern Brazil (South America) with the so-called cerritos (small mounds). Research carried out by Andrade Lima & Lopez Mazz (in press), Lopez Mazz (2001), Bracco et al (2000), Cabrera (1999), among others, has shed new light on the knowledge of these societies in localities such as Merin lagoon, San Luis, etc. The cultural development of hunter-gatherer-fisher societies in an environment of rich and biodiverse wetlands linked with the Atlantic can be tracked back to the last 5000 years BP. As was the case in Australia, the mounds were built as a strategy to make the settlement of fre-
quenty flooded areas feasible. An important change in settlement patterns occurred ca 2500 years BP, after the hypsithermal, when a specialised economy of hunting and gathering was established along with the management (without implying domestication) of palms like butiá (*Butiá capitata*). All these features suggest a process of intensification related to a broad spectrum economy (López Mazz 2001:243). There was an increment of population, a specialised economy in a highly productive environment, more sedentism and reoccupied places, a reduction in residential mobility, etc, along with technological innovations such as pottery, microliths, etc. Traits of complexity are indicated by an incipient social differentiation, settlement system hierarchies, monumental activities, variety of funerary patterns, cooperative participation in the construction of *cerritos*, etc. Mounds with higher numbers of structures, variety of forms, dimensions and settlements along the main natural landforms of the landscape show the construction of landscape.

Realising that foragers can manipulate their environment is clearly essential if one is to understand how they adapt with that environment. We perceive a general trend towards acknowledging that the human-environment relationship can be mutualistic at all scales of societies. Lithification is a further example of this environmental manipulation. In western New South Wales, Australia, a systematically sampled surface survey of a sandy environment mapped almost 200 cobbles of lithic raw material (quartzite, silcrete and sandstone), most of which must have been imported from at least 40 km distant (Webb 1993). Many of these cobbles were worked in one manner or another, including use as grinding stones, anvils, and cores. Importantly, at least some were imported whole, their flaking qualities untested. Webb (1993:108) interprets this pattern as the deliberate positioning of cobbles across the landscape in places where there was a potential requirement for stone, a process she terms the ‘lithification of a sandy environment’. Another example of this process is given by Close (1996). In the eastern Sahara there are many sandy stretches lacking in lithic raw materials. Close documents that untested cores weighing up to 40 kg were transported distances of 10 to 15 km. While the largest cores were probably carried by pack animals, this was not always the case and the underlying motive, to stockpile a missing resource on the landscape in anticipation of future needs (Close 1996:551), is relevant. In effect, this caching allowed an expedient lithic strategy to be implemented despite the natural lack of raw material (Close 1996:551). As described above, a third example of the lithification of a rock-free environment is found in the Pampas. All these examples can be compared to Parry and Kelly’s (1987) paradigmatic example of the provisioning places strategy: in some semi-sedentary contexts of North America in which activities were concentrated in long term-residential locations, people simply moved raw materials to these places, henceforth exploiting them casually or expediently, in predictably occupied sites. In the case of the Pampas, places with other resources such as plants, water and guanaco were provisioned with large cores, hammerstones, anvil stones and mortars (Martinez 1999). The implications of this built environment are discussed below.

### 4.1 Provisioning places, building environments

Hunter-gatherer settlement systems can include different kinds of mobility (residential and logistical) in different degrees, producing mixed patterns which do not simply accord with the ends of the collector-forager continuum (Bamforth 1990; Binford 1980, 1982; Kelly 1983, 1992, 1995, among others). For this reason, we are not trying to define the organisation of the late Holocene cultural system of the study area into types, i.e., as collectors or foragers. Rather, we will try to identify whether the mobility strategies included, to some degree, both components. The same reasoning is applied to such other dichotomies as the two basic strategies commonly recognised in the organisation of technology, curation and expediency (Binford 1979; Nelson 1991), and in such technological strategies as provisioning places and provisioning individuals (Kuhn 1995). Thus, from an organisational point of view it is crucial that curated and expedient technologies, logistical and residential mobility systems, collector and forager settlement systems, and provisioning strategies must not be considered, through typological thinking, as mutually exclusive systems (Binford 1987:45; Kuhn 1995:25; Nelson 1991:65).

The study of technological organisation is one of the most sensitive ways of examining how these strategies interrelate. Raw material, tool design and settlement system analyses can be used to elucidate how technological changes reflect broad scale behav-
such as lithic raw material should allow one to understand some aspects of the past cultural systems.

Raw material availability plays an important role in the organisation of technology (eg, Andrefsky 1991, 1994; Bamforth 1990; Nelson 1991; cf Carr 1994 and Odell 1996). The principal lithic raw material outcrops exploited by indigenous people in the humid Pampas are located in the hilly areas. Most formal artefacts such as cores, sidescrapers, scrapers, and projectile points are made primarily of quartzite and secondarily of chalcedony, both of which require lengthy transport into the region (see Politis 1984; Flegenheimer et al 1999; Franco 1994). There is an uneven natural distribution of lithic raw material and an absolute absence of rocks in the lower portion of the tributary streams that flow into the Quequén Grande River, the only known exception being the poor quality quartzites from Lumb. The most frequently used quartzites are naturally absent alongside the Quequén Grande River and evidently the late Holocene people were moving rocks throughout different geomorphic zones (ie, the Interserrana, Tandilia and Ventania areas as well as the Atlantic coast), in a spatial pattern reflecting the availability of raw material.

Nevertheless, the presence and distribution of lithic raw materials does not exclusively depend on their natural distribution. An anthropogenic stockpile of lithic raw material forms, in effect, an artificial outcrop or quarry, and can therefore become a source for subsequent exploitation. This stockpiling process is known as lithification (Webb 1993:108). Given the amount and the characteristics of the rocks and artefacts previously described for the middle stream of the Quequén Grande River, a strategy of deliberate positioning of lithics across the landscape in places where there was a potential requirement for stone could have taken place. This process would have implications for depth of planning in artefact production, transport, and maintenance, and the strategies by which potential raw material needs are met (Kuhn 1995:22). Within this framework, two basic strategies can be considered: provisioning people and provisioning places. The first refers to strategies in which individuals always have at least a limited toolkit at hand. Because individuals are mobile, if they provision themselves it is usually with light, versatile, general purpose items. On the other hand, provisioning places refers to a strategy for coping with anticipated requirements by supplying places in the landscape with raw materials, cores and implements having further toolmaking potential, which are likely to be needed in future circumstances. This strategy requires accurate knowledge about the location where different activities might occur. Materials provisioned to a place can be of any size, limited only by limits on human effort and desire. Beyond these differences, both strategies share the same basic principle of planning or anticipatory organisation.

It is proposed that one of the central effects of the lithification process in the study area was to make a heterogeneous lithic resource environment more homogeneous: a system of artificial quarries was established by the placement of large numbers of large cores across the landscape. This process would help produce conflations of resources in some geomorphic zones, in this case, the valley bottom of the river. It is likely that people were bringing lithic raw materials to these places along the river in order to combine them with other important resources such as guanaco2, water, and small animal and plant communities along this riverine environment. The durable archaeological result are sites which contain unusually large cores and other lithic site furniture.

The lithification process has implications for the extension and periodicity of settlement. The availability of stone in these areas would have encouraged longer stays3 and the reoccupation of these places (sensu Camilli 1989 and Camilli & Ebert 1992). Artefacts and debris generated through a provisioning places strategy would predominate in assemblages representing more prolonged occupational events or in a pattern of more regular and predictable reuse of places. The presence of stockpiled metates, manos, hammerstones, cores, among other materials, is suggestive of site furniture (Binford 1979), which encourages multiple reoccupations. One possibility is that cores, blanks and tools derived from them acted as insurance gear, which is: ‘cached through the region, not in terms of specifically anticipated seasonal needs, but in terms of what might generally be needed at the location at some time in the future’ (Binford 1979:271). Nevertheless, the possibility that they have been left in these places anticipating seasonal needs (eg, ‘seasonal gear’, Binford 1983) cannot be excluded.
Available raw material derived from tools already discarded in these places could have been easily utilised in order to repair or recycle tools. Variation in the extent of artefact reduction could also reflect scavenging and the reuse of previously abandoned materials (Kuhn 1995). The availability of lithic raw material would also have conditioned decisions about whether to replace or maintain tools through further reduction, and it would have been linked to the cost of stockpiling raw materials (Kuhn 1994). Thus, recycling and re-use of tools would have been carried out in these sites leading to the production of a variety of artefacts and debris. Particularly, formal tools like sidescrapers (raederas) and circular scrapers have undergone a systematic series of transformations from the time of their manufacture until they were discarded or lost (see Dibble 1987). In this sense, such tools would have been flexible (Nelson 1991), and utilised within a maintenance strategy (Bleed 1986). The modular design of the sidescrapers is compatible with this idea.

The presence and variability of formal tools and debris as well as the several stages of manufacture and broken implements represented in these sites suggest that tool production, maintenance, reworking and repair (a complex strategy of lithic production sensu Ebert 1992) would have been carried out in these places where residential multipurpose camps have been established. The relatively stable geomorphology of the late Holocene aeolian settings where these sites are located would have led to long term multiple reoccupations (Camilli 1989; Ebert 1992), resulting in persistent places (Schlanger 1992), used repeatedly during the long-term occupation of the region (Martínez 1999; Politis 1984; Politis et al 2001).

Another implication of this lithification process is for the technological strategies of curation and expediency. Through lithification, both strategies could have been simultaneously employed to some degree. Curated technology should mean the anticipation of tool use requirements is accounted for by the advance procurement of raw material and manufacture of implements. Likewise, expedient technology depends on the availability of raw material at the time and place of need through happenstance or, where the material is not abundant or evenly distributed, through caching and stockpiling (Nelson 1991:80; Andrefsky 1994). The treatment of lithic raw materials (bulk procurement, stockpiling strategy, and so forth) in the study area provides insights into expedient technology. Nelson (1991) points out that an expediency strategy requires the accurate anticipation of both sufficient materials and sufficient time to make tools. The former condition seems to be satisfied by the bulk procurement and stockpiling of raw material along the river. The latter condition, sufficient time, is satisfied if these sites are indeed base camps (Martínez 1999; Politis 1984; Politis et al 2001), which implies longer occupations and regular reuse. Taken together, these characteristics could encourage the deployment of expedient technology. Both expedient and curated strategies therefore require a high degree of anticipation, and understanding precisely what this entails could be an important key to understanding mobility systems and the reoccupation of places (Binford 1983; Gamble 1995).

Lithification also has implications for mobility strategies. Both logistical and residential mobility could be inferred from certain technological features of the lithic assemblages of the study area. The diagnostic technological feature to identify a logistical component of this system should be the bulk procurement of lithic raw material, which in the study area includes both grinding implements and cores. The bulk of lithic resource extraction must have been carried out in other geomorphic zones (eg, the Tandilia hills) and the material then transported back to base camp locations in the river valley bottoms (cf Stafford & Hajic 1992; Binford & O’Connell 1989). The fact that the bulkier items like raw stone, large cores, unworked tool blanks and so on were moved around the landscape reflects the planned provisioning of places. This is one of the major characteristics of systems organised logistically: ‘a wide-ranging ‘caching’ strategy which insures the dispersion in the habitat of goods and materials which may be needed later’ (Binford 1983:285). However, as part of this process, artefacts and raw materials can have different life-cycles and frequencies of use and replenishment. On one hand, even if metates and large cores are classed as site furniture they have different implications for the future availability of raw material. Grinding implements can be understood as stable site furniture without any further transformation beyond abrasion by using. Cores, however, are unstable site furniture because they have a reductionistic use-life history over which they are transformed into other instruments (some of which will leave the site or be exhausted), and into debris. Thus, cores are implicated in a lithification-depletion...
cycle whereas metates and manos are not. On the other hand, in order to identify the provisioning places strategy it is not necessary that the archaeological record shows a great number of these kinds of artefacts. As site furniture elements, they need not show a high frequency because, while the frequency of other kinds of artefacts tends to increase through time as a site is used and reused, the presence of site furniture elements in sites tends to be relatively constant through time (Binford 1979; Camilli 1989; Nelson 1991).

However, the settlement system could also include, to some degree, a component of residential mobility. The previously mentioned process of homogenisation in resource distribution (eg, places with an accumulation of important resources such as lithics, water, fauna, etc) could encourage the further employment of a residential mobility strategy, with groups moving between these places marked by agglomerated resources.

Therefore, in the Pampas we argue that both places and people were provisioned. In the former, the lithification-depletion process was potentially unstable, with the implication that, through building the landscape via lithification the mobility strategy could have fluctuated between the two ends of the residential-logistical continuum. While logistic mobility was employed in the provisioning places strategy (resources moved relative to consumers; Binford 1980, Kelly 19834), residential movements (consumers moved relative to resources) could have been possible between these persistent places (sensu Schlanger 1992), which contain a (partially anthropogenic) conjunction of resources and materials.

5 Discussion

From the ethnoarchaeological and archaeological examples a common conclusion can be drawn: through different activities such as the management of wild plant resources, the movement of lithic raw materials, the building of facilities, deliberate burning practices, etc, hunter-gatherers manipulate the environment in ways that alter the natural distribution of resources, changing their availability and abundance.

All of these activities result in a built environment, and the lithification of the late Holocene Pampean landscape is another example of this general process. We feel that the process, while shedding light on some of the commonplace conceptual frameworks, such as caching and anticipation, usually employed in the archaeology of hunter-gatherers, is also interesting in its own right.

Some authors (eg, Franco 1994) have reasoned that lithic raw material in the Interserrana area is scarce and its distribution differs from, for example, other resources such as guanaco, which are abundant and wide ranging. Franco (1994:86) suggests that the establishment of caches of cores, flakes and artefacts in the Interserrana area was performed to save energy through making lithic procurement more efficient. Indeed, provisioning the landscape with insurance gear is the probable proximate mechanism for the lithification of the landscape. Nevertheless, while it is true that natural outcrops in the Interserrana area are scarce and unevenly distributed, this area should be thought of together with Ventania and Tandilia when considering problems of acquisition of lithic raw material. The main outcrops at Tandilia and Ventania are scarce only in a spatial sense: these outcrops actually contain abundant material (eg, Flegenheimer et al 1999). Hence, the notion of availability and acquisition of raw material should be challenged, because lithic raw material is not a scarce resource, only an inconveniently distributed one. Moreover, if lithic raw material is readily available (or not) it is partly because humans have made social, economic, and technological decisions that create this condition (Nelson 1991:77; see discussion above). The availability of raw material during the late Holocene in the southeastern portion of the Pampean region is not only a reflection of the geological setting, but was produced by humans modifying and building the resource structure of their environment.

Understanding the lithification process involves working at different temporal and spatial scales, and hence the dynamics of the longer term process regarding the timing of the lithification, the shape and frequency of the renewal and depletion cycle should be understood. Nevertheless, in discussing to what extent this process was unintentional or intentional we would argue that in most aspects, such as technology, mobility, and settlement strategy, they share the operational need of accurate anticipation. Although almost any act of knapping stone could be considered as lithification via the production and deposition of waste (see discussion above), the difference lies in a deliberate action of provisioning places and anticipation. In this light, the process of lithification should be seen, at
least to some extent, as an intentional one, in which people monitored the degree and kind of raw material resources in order that they would be able to confidently predict their future needs. This sort of planning is adequate for proximate contingencies, and would include the anticipated presence of site furniture and other elements of the intentionally-built environment. In other words, one interpretation of this process would be simply as long term caching behaviour in response to the otherwise largely lithic-free environment (ie, Kuhn’s provisionment of places) but at another scale with a different implication for landscape approaches, a complementary interpretation is that lithification produced a built environment. The consequences of each interpretation are different.

Anticipation entails a conscious behaviour but the results go beyond the interests of a single generation because the outcomes in the long term are a changeable/changed landscape, and not a pristine nature for future generations to inhabit. This notion has been invoked by one of the authors (Martínez 2002, 2003) in order to understand mechanisms linked with learning, cultural variation and the introduction of behavioural and artefact innovations during the late Holocene, particularly in the study area and in the eastern portion of the Pampaean region. From this, the existence of learning mechanisms such as guided variation, direct bias, indirect bias and frequency dependent bias under the theoretical foundations provided by the Dual Inheritance models (Cavalli-Sforza & Felm 1981; Boyd & Richerson 1985; Durham 1991, Richerson & Boyd 1992; Rosenberg 1994) was explored. As was mentioned, during the last 3000–2000 years BP the Interserrana and Serrana areas have been more intensively occupied, suggesting an increase in population density, changing demography, a greater dependence on plants (supported by the indirect evidence of larger amounts of facilities such as processing grinding stones), technological innovations and artefact acquisitions (eg, the bow-arrow and pottery), reoccupation of specific places in the landscape associated with riverine and lagoon environments represented by residential, multi-purpose and long lasting settlements frequently used through time, etc. These changes were part of an increasing process of cultural complexity which would have included a process of intensification that mainly affects three spheres: intensification in production, in the use of specific places of landscape, and in social relations (Martínez 1999, 2003; Politis et al 2001). These changes would have generated new environmental and social conditions during the late Holocene and the management of lithic raw material can potentially shed new light on our understanding of this process. In this regard, there is something that cannot be explained under the microeconomic umbrella of evolutionary ecology, or its derivative optimal foraging theory: as part of the lithification process a great amount of lithic raw material remained under-exploited, as shown by the cases of quartzite cores up to ca 10 kg (figure 6)\(^5\). The cycle of lithification-depletion was permanently activated beyond immediate needs. Following Rosenberg (1994:329) it can be suggested that ‘...beyond obvious proximate utility, the key determinant is familiarity and perceived compatibility with key utilitarian elements of the emergent system’. Regarding lithic raw material procurement and exploitation, the structure of the archaeological record of the eastern portion of the Pampaeas is probably part of a wasteful behaviour (Neiman & Monticello 1997), and thus does not necessarily fit the expectations of optimality (see discussion below).

Any strategy of lithic reduction will inevitably produce detritus which could be considered as a trivial lithification of the activity area. What separates this process, inherent since the first stone tools were made (Potts 1991), from lithification in the sense we are using the term here are the questions of scale and intentionality. First, lithification is intrinsically a regional phenomenon, in which heterogeneities of resource distribution are evened out through human agency. Lithification does not always imply intensification, which in the Pampaeas we believe is signalled by a suite of adaptive changes that integrate into a new organisational background. Second, while the creation of adebitage scatter is largely unintentional and even undesired, lithification always includes an element of intentionality and anticipation. The intention might not initially have been to lithify a resource-poor environment, but rather merely to stockpile raw materials for an expedient reduction strategy. Over time, the implications of repeated stockpile might have become clear, and an intentional strategy of environmental alteration could have arisen, which itself then acted to transform social organisation. In this model, lithification can be seen as an exaptation, (Gould & Vrba 1982), in which a structure which evolved for one purpose then is coopted for another
purpose. It is a powerful fact that evolution does not act on a blank slate, but modifies that which has gone before, occasionally producing structures which are adaptive, but not necessarily optimal. By analogy, lithification can be seen as exaptation built upon short term stockpiling behaviour. Some behaviours which arise under one set of socio-cultural variables can become coopted for new purposes when the need arises, and persist because of peoples’ familiarity with them as part of the habitus. It follows that lithification need not be optimal in a strict sense. A cost-benefit approach to optimality is a useful heuristic device in many cases. When we note that the case of long term stockpiling of surplus lithic material is not optimal, we do not imply that optimality models are not useful tools for interpreting past social behaviours. Indeed, deviations from optimality expectations are often of most interest.

This suggests that explanations might have been linked with other dimensions that go beyond the merely utilitarian and adaptive patterns. Taking into account the socio-environmental conditions previously described for the last 2000 years BP that were part of an increasing process of cultural complexity, the learning and transmission processes which may have been most influential are indirect bias and frequency dependent bias (see definitions in Boyd & Richerson 1985; Richerson & Boyd 1992). Under these socio-environmental circumstances it is expected that conformist versions of behaviours based mainly on imitation have taken place. Mechanisms such as guided variation would have played a minor role (if at all) due to the risk that strategies such as trial and error entail in more complex societies where the weight of tradition and punishment are strongest and cultural mechanisms encourage imitation rather than innovation. This model is in agreement with the lithification-depletion cycle due to the fact that they lead to a routinisation (see below) in which alternative behaviours are not evaluated. Rather, existing strategies were maintained through imitation and copying (Martínez 2002), prompted by the material residue of previous action.

This line of thought enhances Kuhn’s argument about provisioning places because it accommodates both intentional and unintentional action over the very long term. While it is clear that some degree of intention is needed to move the amount of lithic raw material implied in this processes, the long term effects of provisioning places cannot be adequately examined within the short term of cumulative single-event intentionality. Instead, theoretical bridges between individual action and the long term broad scale occupational history of the landscape are needed.

Gosden’s (1994) usefully ambiguous concept of the landscape of habit removes us from discussions of the intentionality of the lithification over the long term, and potentially leads to a greater understanding of the landscape than could any view solely based on systemics, feedback, and proximate anticipation/fulfilment of need. The landscape becomes understood as the sum of the constituent acts of dwelling, meaning it is a circular reasoning to think of long term adaptation to something that is, in effect, a record of past and present activity in the world (see the concept of ‘taskscape’ in Ingold 1993). It is a powerful fact that life must be lived amongst that which went before, and this must be as true of hunters and gatherers as any other group of people. While hunters and gatherers are not commonly thought of as creating their own worlds, their actions in the environment may produce material culture and environmental change, which in itself is productive of further actions. Material things are not ‘passive brute objects, but are engaged in reflexive relationships with the people who create or use them’ (Gosden 1994:17), a relationship which over the longer term creates a built environment, a niche constructed through action and imagination (Lewontin 1982:159). In this way, the material world acts as a prompt, with the structured residue of past actions (the archaeological site in the past) helping structure future action. This is a kind of indirect communication mediated through material culture (Wilson 1975:186; cf Mackie 2001:62–63). The raw material left behind at sites acts as a signal which encourages reoccupation, even, hypothetically, when there is considerable time lag between occupation events, or no relationship between occupiers and re-occupiers. In effect, the lithic residue of past life may contribute to how learning by imitation takes place – it forms a landmark, which structures future action by transforming a space into a place (Zedeño 2000:108–111). The process of imitation is not always one of observing people and doing as they do, but can include observing the material record, and doing as they must have done to produce that record. The latter behaviour is, of course, not dependent on direct contact between people or generations. The archaeological site in the past was not passive, but was a structurer of human action.
and, through its ability to cue subsequent behaviours, could have led to increased routinisation in mobility and settlement patterns. Routine is produced by, and produces, the habitus of individuals (Bourdieu 1977). Yet, as noted, cores are unstable site furniture, and the repletion-depletion cycle they impose itself will produce long term variation in mobility patterns – continuity and change are embedded in the same recursive relationship to the landscape.

Our suggestion then, is that the landscape of habit can be glimpsed archaeologically in those aspects of material culture or patterns of deposition, such as lithification, which both result from and structure practical action, in the sense of Bourdieu’s (1977) habitus. To echo Bourdieu, in the Pampas, a structured disposition to stockpile lithics gave rise to a structured deposition of lithic raw material, which itself acted as a structuring deposition, whose persistence in the environment influenced the technological organisation and settlement patterns of subsequent generations.

6 Conclusions

The concept of landscape has been recently discussed and different views of it have been proposed (Gosden & Head 1994; Pickering 1994; also see papers in Ucko & Layton 1999, amongst others). The principle that humans seldom are in a position to occupy truly pristine environments, and, particularly, that hunter-gatherer societies are not adapted to a neutral niche, but actively (if not intentionally) engage in constructing that niche, should become keys for better understanding hunter-gatherer landscapes. We propose that the lithification of the valley bottoms of the middle stream of the Quequén Grande River illustrates how the environment can be built and changed by hunter-gatherer social practice. Although multiple factors could have been involved, the most important point is that the lithic resource distribution over the landscape was not a wholly natural pattern, but was produced by a change in the organisational properties of behaviour in the late Holocene. The large cores and mortars stockpiled along the edges of the Quequen Grande River may have served as a structuring component of the social landscape by providing a new, artificial distribution of this resource. Through the late Holocene, the strategy of provisioning places had a long-term recursive influence and was part of a social phenomenon which re-organised the complex relationships between subsistence, technology, mobility and, settlement systems. Thus, the landscape history itself should be considered a potentially crucial variable: shaping, and being shaped by, the long-term human adaptation to the Argentine Pampas.

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Notes

1 When orthoquartzites are mentioned they refer to Sierras Bayas Geological Formation.
2 By examining the guanaco bone assemblages from Zanjón Seco 2 and 3 Politis (1984) concluded that guanaco were killed nearby.
3 The ‘garbage structure’ of Zanjón Seco 3 shows a pattern of intra-site variability which suggests planning for longer periods of occupation, an idea also reinforced by the previously mentioned distribution and quantity of grindstones.
4 Binford (1980) and Kelly (1983) only discuss the movement of food resources when discussing logistical and residential strategies. In this regard, we consider critical resources on the Pampas to include non-food items, such as lithic raw material and fuel. Although Binford (1979:273) suggests that procurement of raw material is normally incidental to the ‘execution of basic subsistence tasks’, we are not presently concerned with what tasks are embedded in which. Rather, we are interested in the effects of the collection of raw material and its patterns of distribution across the landscape.
5 Note that the Australian (Webb 1993) and Saharan (Close 1996) lithification examples also went beyond immediate needs and left large quantities of ‘wasted’ (surplus) material across the landscape.
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