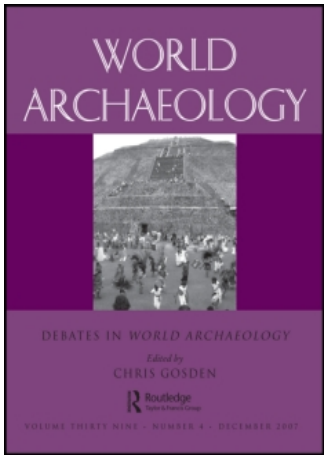

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Mother Earth: soil and people relationships during the prehispanic period (Northwest Argentina)

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Mother Earth: soil and people relationships during the prehispanic period (Northwest Argentina)

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Abstract

The objective of this paper is to explore the relationship between agricultural soils, land and cult behaviour. We consider that soils, as they were modified by humans, contain key information for the reconstruction of past behaviour linked to super-structural beliefs, not necessarily visible through the conventional material record. In this sense, the manipulation of lands and soils in the Andean region represents the unification of ritual activities and beliefs focused on the Pachamama (Mother Earth). We present the results of a study to examine soil management at a prehispanic agricultural settlement in Northwest Argentina, together with other evidence related to the agricultural symbolic universe, which reveals evidence of land categorization and land use preferences.

Keywords

Prehispanic agriculture; Formative Period; geoarchaeology; Northwest Argentina; archaeological soil.

Introduction

Terrestrial life is founded on soil. This has a deeper meaning if we consider the ways we depend on this 'substrate'. Beyond constituting a mechanical support, its characteristics have deep implications for the types of activities that can be carried out on it and their significance according to the cultural relationships that we establish with it. The aim of this paper is to establish the relationship between agricultural soils, landscape and cult behaviour using a case study from the Tafí valley, one of the Calchaquíes valleys in Northwest Argentina. We consider that soils, as they were modified by humans, contain

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key information for the reconstruction of past ritual behaviour not necessarily visible through the conventional material record.

From an archaeological point of view, the use of soils and land, visible through an archaeological context, reflects wider environmental knowledge by local prehistoric cultures. The study of these soils provides a broad perspective on land use and management not available from other sources (WinklerPrins and Sandor 2003). It is obvious that this information must be interpreted according to the technological and symbolic characteristics of each society studied.

In the Andean region, within which our study case is located, Pachamama is considered as the Mother Earth. It resides in the earth (and soil) and tends to the well-being of nature. As agriculture is a part of nature, Pachamama takes care of it too, especially controlling climate and soil fertility. For it to operate successfully offerings of ritual tributes must be made to the Mother Earth. The maintenance of soil in agricultural terraces and other structures is a spiritual endeavour to please the Mother Earth, which will reward with adequate climatic conditions, soil fertility and abundant harvest (WinklerPrins and Barrera-Bassols 2004). Today, this cult persists in Northwest Argentina in many populations from the Calchaquíes valleys. People make communal rituals periodically to ask for prosperity in any enterprise invoking Pachamama's motherly protection (Racedo 2005).

The Tafí Valley and its archaeology

The Tafí valley is located in the north west of Tucumán province, Argentina (Figs 1 and 2). It is the way into the Calchaquíes valleys and is an elongated tectonic basin with north-south slope direction, 450km^2 in extent, and the valley bottom is located between 1800 and 2500m above sea level (masl).The climate is semi-arid with scarce vegetation composed of highland grasses (Sampietro Vattuone 2002).

Archaeological research began at the end of the nineteenth century (Ambrosetti 1897; Quiroga 1899), the central subject of analysis being the presence of menhirs. At that time it was established that the people who made these sculpted stones were a unique entity independent from other cultural groups known at that time. In 1960 González and Núñez Regueiro undertook the first excavations on residential archaeological units at two sites: El Mollar and Km 64, demonstrating the existence of a specific sociocultural entity followed by the settlement of people coming from Santa María Valley after AD 1000 (González and Núñez Regueiro 1960). Radiocarbon dates locate Tafí settlements between 335 $\pm$ 70 BP (González 1961–4, 1962) and 1140 $\pm$ 50 BP (Berberián et al. 1988). The Tafí culture belongs to the Formative Period regionally represented by the first agricultural settlements.

Fundamental characteristics of this entity are discussed by González (1980): people with an agricultural economy and knowledge of advanced agricultural techniques (irrigation and agrarian terraces), with high population density judging by farm areas, focused on camelid (*Lama glama L.*) stocking. Settlement was not nucleated in villages but rather dispersed in small family groups on agricultural fields, sometimes very close to one another. Residential units are composed of small circular rooms (2–6m in diameter)

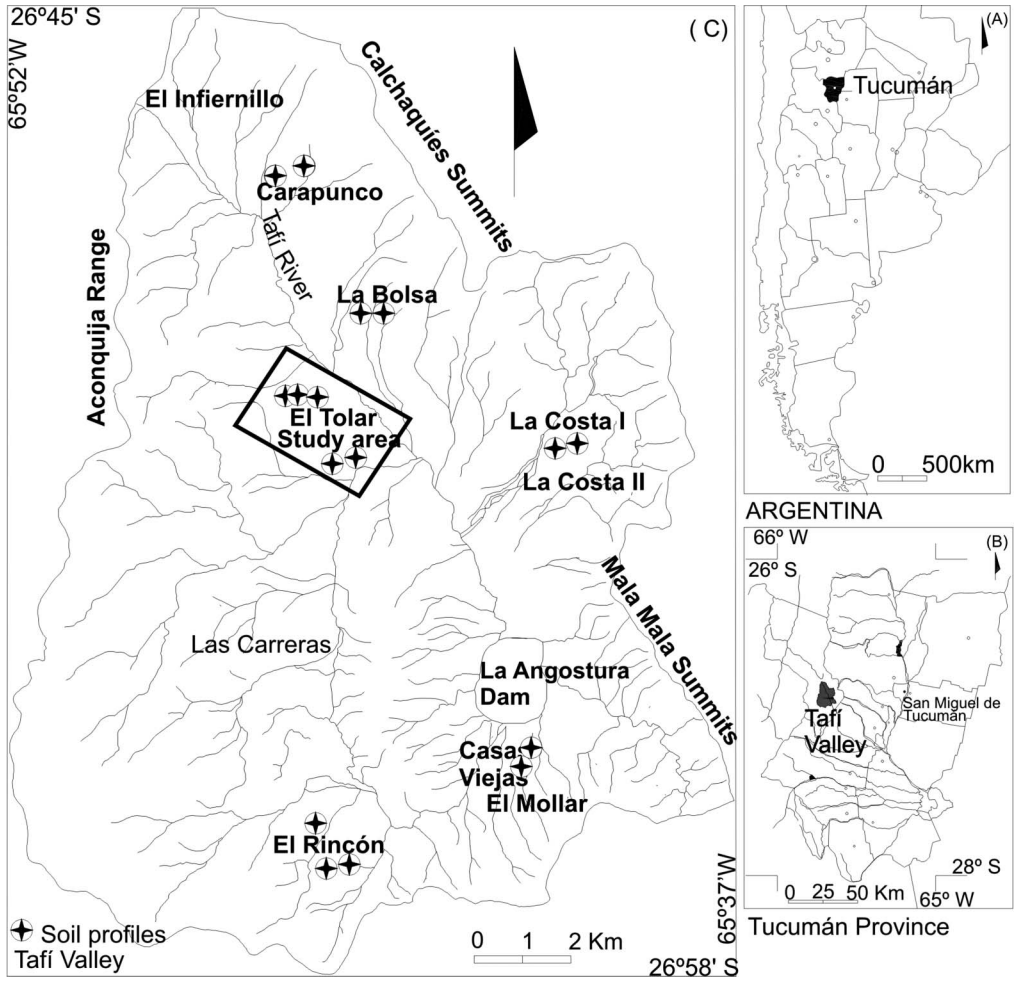

Figure 1 Study area location map: A) Argentina; B) Tucumán province; C) Tafí valley, with some of the archaeological sites cited in the text.

constructed around a big circular central patio (15–20m diameter) (Fig. 3). The stone walls occasionally reached 2 metres high, with roofs made of wood and mud. The larger enclosures were open spaces where many quotidian activities were performed. The dead were buried in these patios. Ceramic technology was very simple; most vessels are crude, with little decoration, monochrome and red painted (González and Núñez Regueiro 1960; González 1980).

The other category of archaeological evidence comprises lithic sculptures (menhirs and stone masks) and a ceremonial mound. Most of the menhirs were found and described by Ambrosetti (1897). In the Casas Viejas area, at El Mollar (see Fig. 1), he found thirty-two menhirs located between *c*. 2 and 200m apart. According to his detailed descriptions these menhirs were in general *c*. 3m high (Fig. 4). Some of them were sculpted with anthropomorphic and abstract features (Fig. 4b), others are phallic representations

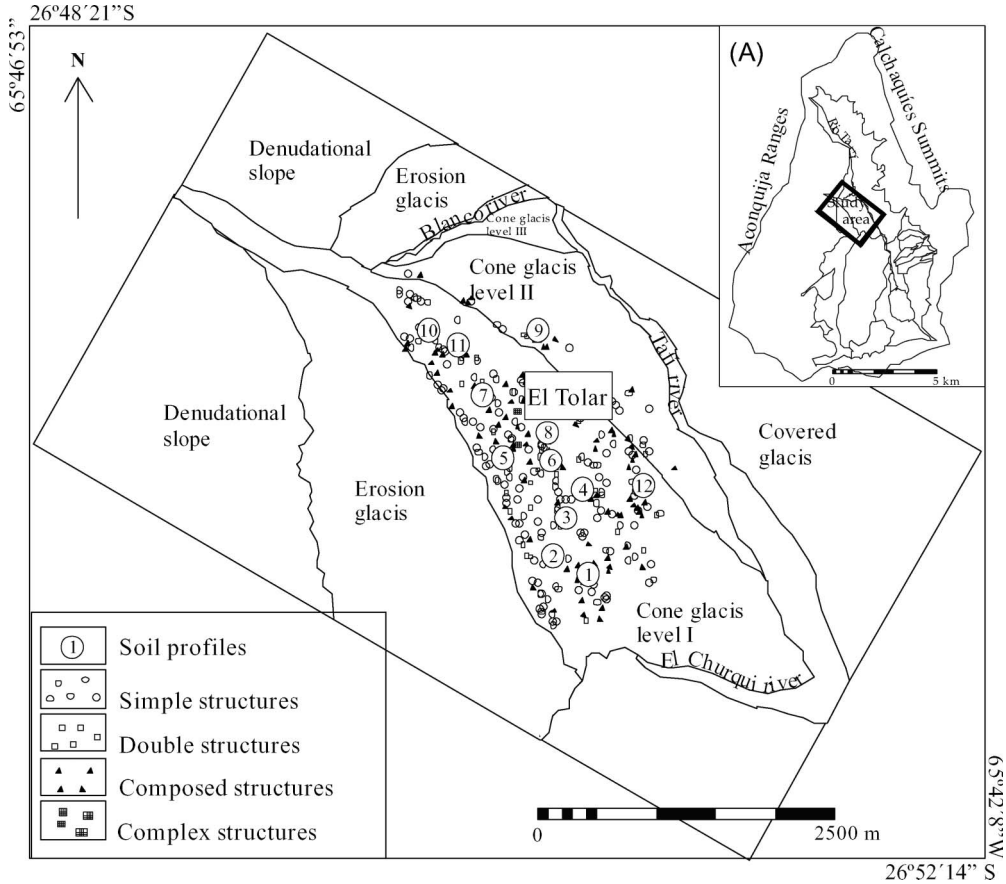

Figure 2 El Tolar archaeological site: map of circular archaeological structures distribution and profile descriptions.

(Fig. 4c) and some of them are plain. Located in agricultural fields many of them were upstanding in the 1890s, with sculpted faces oriented to the south or north. Ambrosetti found two other menhirs further north at the El Tolar archaeological site (Fig. 3 and Fig. 4a). Unfortunately, all the menhirs were removed from their original location without further archaeological study during military activity in the 1970s.

A ceremonial mound is located in a central part of a farming area with terrace walls and menhirs at Casas Viejas (Fig. 1; Gómez Cardoso et al. 2007). It was first excavated by González and Núñez Regueiro (1960); they established its ceremonial function and related it directly to the menhirs. It is a 3m-high elongated artificial mound, 30m north-south and 18m east-west. Composed of many materials, human remains are represented (including two adult males and one adult female, also incomplete skeleton remains and some burnt human bones). There are camelid bones (*Lama glama* and *Lama guanicoe* L.), ceramic fragments of different styles (crude and decorated wares from other contemporaneous populations such as Belén, Condorhuasi, Vaquerías and Santa María among others), ashes, stones and little stone walls in the upper part, probably to give it stability.

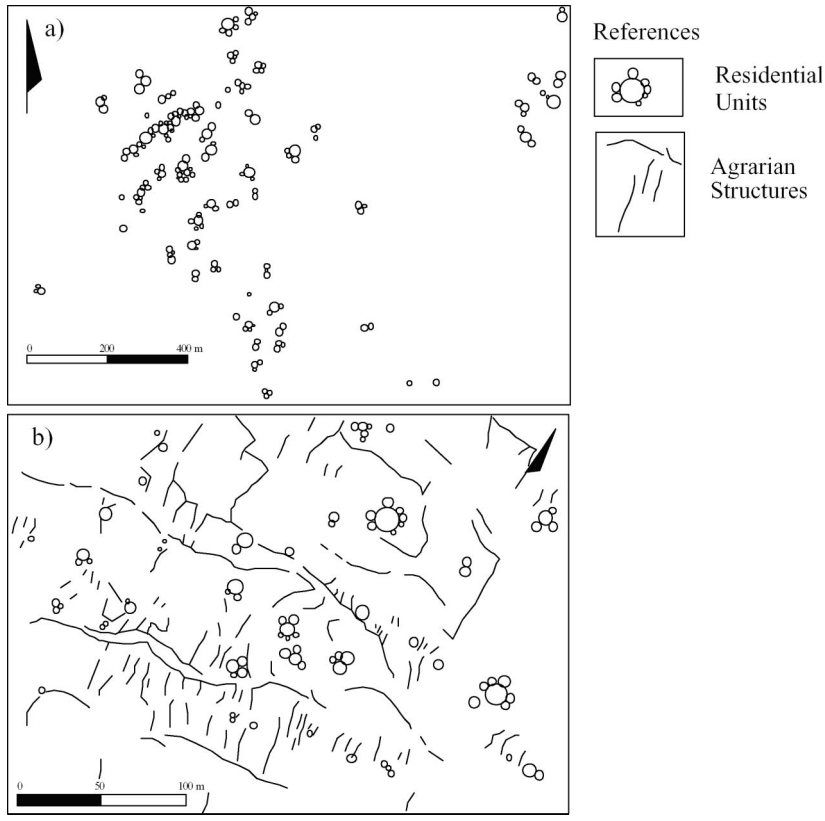

Figure 3 Typical archaeological structures from the Tafí valley.

Agricultural structures were settled on alluvial fans and cone glacis (a geomorphological unit defined by Viers (1973) as a covered glacis of moderated extension with the shape of a cone). In all cases residential and storage structures are dispersed on agricultural fields. Identified agrarian structures are constructed with stone walls perpendicular to slope with variable height (estimated between 0.60 and 1.50m high). Together with these walls, there are elongated accumulations of stones probably the result of field clearance for agricultural purposes (Fig. 2; Sampietro Vattuone 2002).

Because of its topographical situation, agrarian prehispanic structures, previous archaeological results and geomorphological characteristics, we took a specific landscape unit to focus our soil profile descriptions and sampling. This is El Tolar archaeological site (Fig. 3), a cone glacis with a dominant slope from 7 to 13 per cent. Many agricultural terraces could be identified together with dispersed residential units and storage structures. Charcoal dated from a residential unit located at the central part of the area indicates that the settlement was occupied and farmed around 1560 ± 35 BP (nsrl-10907) (Sampietro Vattuone 2000–2, 2002). Two menhirs, one of them sculpted, from the site were located in the agricultural terrace area (see Fig 4a; Bruch 1911). The sculpted one faced south, like the other menhirs found by Ambrosetti (1897) at Casas Viejas which were also dispersed on agricultural terraces and close to the ceremonial mound.

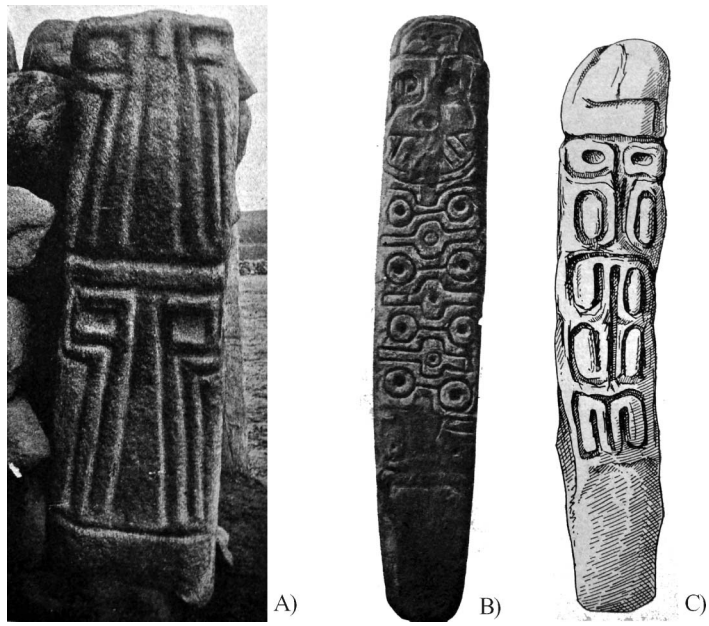

Figure 4 Some examples of menhirs found on Tafí valley: A) menhir found on El Tolar archaeological site, agrarian context, *c*. 1.32m high; B) menhir found on El Mollar, close to the ceremonial mound, 3.10m high; C) menhir found on El Mollar, agrarian context, 2.38m high (photographs taken from Bruch 1911).

Agrarian economy is based on the use of plant resources (wild or domesticated). In the Northwest Argentinean valleys squash was cultivated in lowland areas, while maize, beans and peanuts were grown in middle altitudes and tubers and quinoa in high altitudes, maize being one of the most important cultivars in the region (Oliszewski 2004, 2007). At El Montículo (Tafí valley) seeds of chañar (*Geoffroea decorticans*), algarrobo negro and blanco (*Prosopis nigra*, *Prosopis alba*), beans (*Phaseolus vulgaris*) and maize (*Zea mays*) were found. Gathered wild plants were used together with cultivated ones (Carrizo et al. 1997).

Conceptual framework

Our analysis of the soils and land is undertaken using the theoretical and methodological perspectives of geoarchaeology. We consider the best definition is that made by Rapp and Hill (1998), namely that geoarchaeology is the application of any method, technique, concept or knowledge of geosciences used to address archaeological problems. A key criterion is that archaeological interpretations are made using techniques based on earth sciences, where any physical object, feature or landscape altered or made by man is considered an artefact.

In this context, we considered soil to be an artefact. The diagnosis and identification of chemical and physical modifications are useful to interpret the past perception of

soils from a practical and even symbolic perspective. Soils are the main substrate over which many human activities are performed; accordingly, even if it is a natural element, it receives strong anthropic influences. These influences could be intentional to obtain some specific result, e.g. an improvement of harvest, the reduction of frost (as in the case of raised fields), the realization of offerings to promote best climate (in which way soil could be considered as artefactual in a strict way). On the other hand, influence could be unconscious and modifications not directed to a certain end, e.g. chemical signatures over residential floors. Considered in this way, soil can be categorized into types like other kinds of artefact, i.e. technologically, chronologically and in relation with its techno- and socio-functions. This is possible by making an analytic approach to the subject, evaluating indicative chemical values from soils and comparing the same variables under different archaeological contexts, and by considering also archaeological artefacts (Daigle 1996). Through this, we identify activity areas, sectors where there was constant human activity. These areas are established and kept in use because they have some environmental features that make them particularly profitable for a given social group. In a specific cultural context, activity areas tend to be reused until the environment changes or the benefit to the human group is reduced (Daigle 1996).

Landscape analysis was done following the criteria of Sayago and Collantes (1991): the basic sampling area is the geomorphological unit because of the spatial homogeneity of its features; pedological and environmental data are common to the entire surface, and with their analysis it is possible to have a dynamic perception of the palaeoecology. A pedological perspective for archaeological research is important because: a) pedogeomorphological researches are compatible in scale with archaeological studies at a regional level, especially geochronology, palaeoenvironmental reconstruction and landscape evolution; b) in the intra-site context, many pedological and archaeological features are similar in scale; c) pedological formation processes have the same temporal magnitude as archaeological formation processes (Holliday et al. 1993).

Human activities carried out over occupational surfaces and through agriculture leave chemical signatures (Eidt 1984, 1985; Fernández et al. 2002; Roldán and Sampietro 2003; Roldán 2004; Sampietro and Vattuone 2005) that are deposited by inhabitants in a systematic, homogeneous and unconscious way (Schlezinger 1999).

Laboratory data interpretation is made through the comparison between soil profiles from different archaeological contexts and through ethnographic analogies (Wells et al. 2000). Finally, they provide important information to reconstruct land use through time (Entwistle et al. 2000; Jaiyeoba 2003).

One of the most important indicators of human activity is organic phosphate. This chemical compound becomes rapidly insoluble; phosphate accretion is quantifiable many centuries after the activity, except if the soil was eroded (Eidt 1984, 1985; Wells et al. 2000). Phosphate concentration is variable according to the characteristics of the activity undertaken. When organic fertilizer is introduced into agricultural soils it is possible to find high values of this component. On the contrary, if agricultural soils are used over time without any external contribution, land tends to become exhausted (McManamon 1984). Other chemical elements important to evaluate the characteristics of agricultural exploitation and the productive capacity of soils and palaeosols are calcium, and

disposable iron, manganese and copper (Roldán and Sampietro 2003; Roldán 2004; Sampietro and Vattuone 2005).

Ethnopedological studies carried out over the world (Barrera-Bassols and Zinck 1998), and particularly in the Andean region (Sandor and Eash 1995; Sandor and Furbee 1996), show that there are complex knowledge systems about the hierarchical organization of the soil mantle. Local populations tend to recognize morphological attributes for soil classification that are dynamic, symbolic and utilitarian; complex classification systems are constructed based on differences and resemblances; and there exist universal criteria in all ethnopedological classification systems.

In the Andean region in general, and in our study area in particular, landscape manipulation is a practice achieved over centuries through the construction of agricultural terraces and raised fields. Both systems implied the manipulation of the earth to create adequate physical conditions and to maintain agricultural systems in production. People had a deep and complex comprehension of soil formation processes, and this was related to its spiritual value (WinklerPrins and Barrera Barassols 2004).

Northwestern Argentinean archaeological evidence points to the existence of these systems prior to Spanish arrival. In many cases the sociocultural disruption produced by the destruction of prehispanic social systems resulted in the loss of traditional knowledge and the abandonment of productive lands. From the agrarian point of view these lands are still in this condition, as is evidenced in Puna region (Tchilinguirian and Olivera 2000), Santa María valley (Sampietro Vattuone and Neder 2006) and Tafí valley (Sampietro Vattuone 2002), among others.

Andean idiosyncrasy in Northwest Argentina and the Pachamama cult

Pachamama (or Mother Earth) is conceived in the Andean region as resident in the earth and contributes to nature's well-being. Given that agriculture is an extension of nature, Pachamama also pays attention to it, specially controlling climate and soil fertility. Pachamama veneration probably is one of the most antique religious manifestations in South America. It corresponds to a conception in which the earth is considered a living sacred being. During Inca times this veneration changes from the earth to the sun. The previous religion survived in popular adoration of 'huacas' (local expression of the sacred). With the Spanish conquest, the old gods recovered their pre-eminence and the sun, as divinity, was replaced by the Christian god (Santander 1962). Until the colonial period, there were special ritual sites for the reverencing of Pachamama in the chacras (small farms). In the Argentinean Andean region, she was honoured in agricultural plots, at springs, in areas close to the houses and inside mines, until the beginning of the twentieth century, preserved in the Andean region as a farming cult within the familial group (Gentile 1999). The Calchaquí valley populations were dominated by force during the conquest and later colonization resulting in the loss of social memory through the disappearance of collective activities (Racedo 2005).

At present, the Pachamama cult has a diverse presence in Argentinean territory. Families from Humahuaca and Puna prepare and make offerings on 1 August with

ceremonies and foods. In the Calchaquí valleys, families and neighbours share cattle activities. In Humahuaca and Calchaquí valleys, as well as Bolivia and Peru, the individual and daily practice is to offer to the earth (Pacha) the first gulp of any drink on every day of the year (Racedo 2005).

Methodology

Residential activity areas, and agricultural activity areas, in different geomorphological settings were examined. Pedological descriptions were focused on the El Tolar site because of its location in the middle of the valley and due to its agricultural focus. These excavations were complemented, for comparative purposes, with profiles described from outside the archaeological sites. Twenty-eight soil profiles were described and sampled[1] (Figs 1 and 3).

Soil profiles and prehispanic agrarian production

The twenty-eight soil profiles showed the same tendencies in their soil development, independently of the geomorphological units and archaeological context, being composed of two well-differentiated edaphic cycles: the actual soil and a well-developed palaeosol. In the case of profiles described in residential contexts it was possible to identify the presence of a very anthropized 2bA horizon, while in agrarian profiles and in those soils without anthropic activity an erosive discordance was determined by the disappearance of a 2bA horizon (Sampietro Vattuone 1994, 2002; Roldán 2004).

Eighteen soil profiles of one landform from Tafí valley examined the impact produced by agrarian practices. All profiles showed the same pedological discordances: soil compaction, soil darkening, organic phosphorous concentration, structural variations and organic matter altered values that indicate the presence of a well-defined palaeosol with features of anthropic activity (Roldán et al. 2006). Figure 5 contains the field description and some laboratory results of a typical profile described close to the wall of one agricultural terrace located in the middle part of the landform, while Figure 6 shows the results obtained from the patio of a residential unit, close to the previously cited profile. From the agricultural point of view, the palaeosol shows optimal morphological and chemical characteristics for the good development of plants in the agricultural terraces: lightly acid pH, bulk density with acceptable values, good texture, good structure, organic matter with good quality, calcium values not very high and adequate available micronutrient concentrations (iron, manganese and copper). Nevertheless, porosity tends to be scarce, probably as a result of soil tilling, but the compaction was not enough to develop a 2bAp horizon (Roldán 2004).

Due to the loss of soil minerals by agricultural activity, organic fertilizer was added, establishing a strong relationship with agricultural lands and production. It is pertinent to consider that agricultural activities would be facilitated by the humid climatic conditions dominant during the Formative period in the valley (Sampietro Vattuone 1999).

Depth/ cm	*Horizon*	*Macromorphology*	*Pedochemistry*
0–19	A	Dark brown (10YR 3/3) ; sandy loam; coarse granular; abundant roots; gradual boundary to	
19–29	2bB	Brownish black (10YR 3/2); sandy loam; moderated weak prisms; few clay coatings; many roots; gradual boundary to	
29–48	2bBC	Grayish yellow brown (10YR 4/2); sandy loam; moderated weak prisms; few roots; abrupt boundary to	
48-70+	2bC	Dull yellowish brown (10YR 5/3); sandy loam; fine granular; few roots	

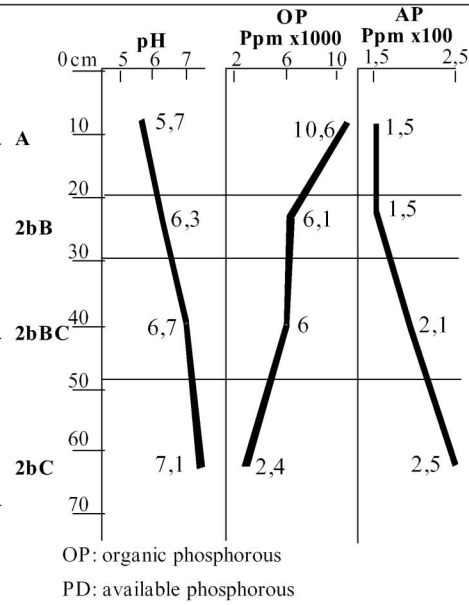

Figure 5 Field description and pedochemistry of the agricultural terrace soil profile, close to terrace wall.

Discussion

It is important to emphasize the presence of menhirs oriented to the earth cult, especially associated with the ceremonial mound from El Mollar (Ambrosetti 1897), within agricultural fields, domestic spaces, corral entrances and near to graves. These menhirs have anthropomorphic, zoomorphic and phallic representations and the earliest Andean documents associate them with propitiatory life-giving practices (García Azcárate 1996).

Another important matter is the intensive construction of agricultural structures on specific geomorphological units as reflected by the environmental knowledge of the area in association with the propitiatory practices undertaken at the menhirs (Sampietro Vattuone 2000–2). Studies made on Chicha Soras valley from the Central Andes showed that pedological features associated with soil management through the construction of agricultural terraces are: (1) intensification of edaphic processes; (2) clay translocation and clay-coating formation; (3) seasonal flood capitation that produces new solid incorporations to the agricultural soil; and (4) moisture concentration favoured weathering of soil components (Kemp et al. 2006). Related to features linked to soil quality, in the same soil profiles from Chicha Soras valley, it was established that, according to pH, organic carbon concentration, and total and available phosphate, results are similar to those obtained in our work. In the opinion of the authors the abandonment of farming fields was not produced by a decay of soil fertility. Chemical soil evidences also showed the addition of organic fertilizers as manure (Branch et al. 2007).

Depth/ cm	*Horizon*	*Macromorphology*	*Pedochemistry*
0–9	A	Dull yellowish brown (10YR 4/3); sandy loam; coarse granular; abundant roots; clear boundary to	
9–20	AC	Brown (7.5YR 4/3); sandy loam; moderated strong subangular blocky; gradual boundary to	
20–35	2bA	Dull yellowish brown (10YR 4/3); sandy loam; moderated irregular blocky; gradual boundary to	
35–95	2bB	Dull yellowish brown (10YR 4/3); sandy loam; weak irregular prisms; wavy gradual boundary to	
95–130+	3bB	Dull yellowish brown (10YR 5/4); sandy loam; weak irregular prisms	

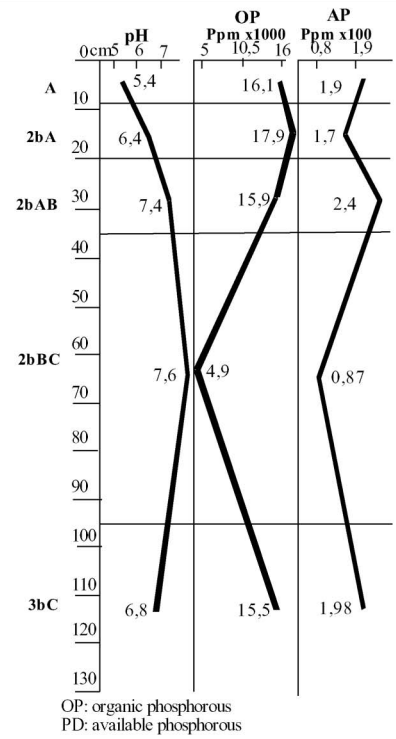

Figure 6 Field description and pedochemistry of the residential soil profile, centre of the patio.

Micromorphological evidence from prehispanic raised field systems at Hacienda Zuleta (Ecuador) suggests that the presence of clay and silty clay textural pedo-features may be related to agricultural activity. These observations also indicate that the orange/brown or red/brown clay could be related to animal manuring while the silty clay can be attributed to soil disturbance associated with tillage activity. These results showed clear evidences of soil improvement and its remnant responses over the centuries (Wilson et al. 2002). In Argentinean Puna, at the Bajo del Coypar archaeological site (Catamarca province), agricultural soil and water quality were analysed in a prehispanic farming area composed by farm squared plots delimited with smooth earth boundaries over the middle Punilla river terrace and agricultural terraces in middle slopes of the surrounding hills (Tchilinguirian and Olivera 2000). These settlements are accompanied by a complex irrigation system (Olivera 1988; Olivera and Elkin 1995). According to radiocarbon data, the beginning of the settlement started around the beginning of Formative period, *c*. 3000 BP and lasted to *c*. 1000 BP, some evidence suggests that site occupation extended through Inca and Spaniard-indigenous times. The results showed that prehispanic agricultural exploitation applied an appropriate technology according to soil characteristics, trying to optimize agricultural efficiency in the basin (Tchilinguirian and Olivera 2000).

The management of the study area reflected fundamental matters related to landscape and soil manipulation through the realization of agrarian constructions and the enrichment of soils with the addition of organic fertilizers. These activities might include a re-signification of productive spaces through their maintenance and the performance of ceremonies linking earth, production and phallic monuments in close spatial association with farming areas.

Conclusion

Communities living in harsh environments, with scarce soil and water resources and low temperatures, have developed complex systems for the management of productive lands. This is also mediated by complex belief systems that bring social security to the group. In the case of Calchaquí valleys, and more specifically in the Tafí valley, this system has lasted until the present through the annual offerings to the Pachamama.

From an archaeological point of view, the relationships between man and earth are deep and have important manifestations at a constructive level as well as the symbolic and pedochemical. Agrarian archaeological structures in the Tafí valley (dated from the beginnings of the Christian era through to AD 1000) show the elaboration of a collective terrace complex, with the incorporation of specifically idiosyncratic features, such as the presence of menhirs in agricultural fields. The landscape reveals a deep knowledge of productive capacity, or at least the potential, of each geomorphological unit during the past. This is reinforced by the knowledge of agricultural techniques for the stabilization of slopes and to concentrate sub-surface water flow as well as maintain agricultural soil fertility.

Finally, it is important to link the presence of highly significant ritual elements, connected to fertility and production, like menhirs are integrated into the agricultural fields. Taking these features together, there is a deep integration of Pachamama worship through time in this meridional Andean region. We have no doubt about the existence of a developed understanding of soils and landscape. This system is slowly coming to light through the application of a range of analytical techniques and approaches. Together with the evaluation of different source data it will, in the future, improve our perspectives on the meaning of earth and life in this region.

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Note

1 Soil profile descriptions were made according to standard procedures taking bulk samples of each horizon (Soil Survey Staff 1999). Laboratory analysis of bulk samples examined the following: texture variations were evaluated with dry sieve and using the Bouyoucous (1936) method; pH with glass pHmeter; organic matter with the Walkley and Black method (1946); available, total and organic phosphorous through the application of the Fiske and Subbarow method (1925); carbonates by reaction with 10 per cent chloride acid; calcium with the complexiметric method (APHA-AWWA-WPCF 1992). Given the interest in evaluating the agronomic characteristics of agricultural soils, the bioavailability of iron, copper and manganese were determined with the methods proposed by Roldán et al. (2006).

References

Ambrosetti, J. B. 1897. Los monumentos megalíticos del valle de Tafí (Tucumán). *Boletín del Instituto Geográfico Argentino*, 18: 1–3.

APHA-AWWA-WPCF 1992. *Métodos normalizados para el análisis de aguas potables y residuales*, 17th edn. Madrid: Editorial Díaz de Santos.

Barrera-Bassols, N. and Zinck, J. A. 2003. Ethnopedology: a worldwide view on the soil knowledge of local people. *Geoderma*, 111: 171–95.

Berberián, E. E., Nielsen, A. E., Argüello de Dorsch, E., Bixio, B., Spalletti, L. A., Salazar, J. A. and Pillado, E. L. 1988. *Sistemas de Asentamiento Prehispánicos del Valle de Tafí*. Córdoba: Comechingonia.

Bouyoucos, G. J. 1936. Direction for making mechanical analysis of soils by the hydrometer method. *Soil Science*, 42: 225–30.

Branch, N. P., Kemp, R. A., Silva, B., Meddens, F. M., Williams, A., Kendall, A. and Vivanco Pomacanchari, C. 2007. Testing the sustainability and sensitivity to climatic change of terrace agricultural systems in the Peruvian Andes: a pilot study. *Journal of Archaeological Science*, 34: 1–9.

Bruch, C. 1911. Exploraciones arqueológicas en la provincia de Tucumán y Catamarca. *Revista del Museo de La Plata*, 5: 1–19.

Carrizo, J., Cano, S. F. and Soler Nixdorff, M. M. 1997. Recursos vegetales comestibles en el valle de Tafí durante el período Formativo: análisis arqueobotánico del sitio Casas Viejas-EL Mollar (S Tuc Tav 2). *XII Congreso Nacional de Arqueología Argentina*, 1: 65–9.

Daigle, R. P. 1996. Soil as artifact: soil chemistry from the Levi Jordan plantation in Brazoria County, Texas. Master's dissertation, Houston University, TX.

Eidt, R. C. 1984. *Advances in Abandoned Settlement Analysis: Applications to Prehistoric Anthrosols in Colombia, South America*. Milwaukee, WI: Centre for Latin American Studies, University of Wisconsin.

Eidt, R. C. 1985. Theoretical and practical considerations in the analysis of anthrosols. In *Archaeological Geology* (eds G. Rapp Jr., G. Gifford and J. A. Gifford). New Haven, CT: Yale University Press, pp. 150–90.

Entwistle, J. A., Dodgshon, R. A. and Abrahams, P. W. 2000. An investigation of former land-use activity through the physical and chemical analysis of soils from the Isle of Lewis, Outer Hebrides. *Archaeological Prospection*, 7(3): 171–88.

Fernández, F. G., Terry, R. E., Takeshi, I. and Eberl, M. 2002. An ethnoarchaeological study of chemical residues in the floors and soils of Q'echi' Maya house at Las Pozas, Guatemala. *Geoarchaeology*, 17: 487–519.

Fiske, G. H. and Subbarow, Y. 1925. The colorimetric determination of phosphorous. *Journal of Biological Chemistry*, 66: 375–400.

García Azcárate, J. 1996. Monolitos-huancas: un intento de explicación de las piedras de Tafí (Rep. Argentina). *Chungara*, 28: 159–74.

Gentile, M. E. 1999. *Huacca Muchay – Religión Indígena: Religión, creencias, juegos. Área andina argentina, prehispánica, colonial, actual*. Buenos Aires: Instituto Nacional Superior del Profesorado de Folklore.

Gómez Cardozo, C. E., Chocobar, F. and Piñero, C. 2007. El montículo de Casas Viejas: un espacio sagrado. In *Paisajes y procesos sociales en Tafí del Valle* (eds P. Arenas, B. Manasse and E. Noli). Tucumán, Argentina: Editorial Magna, pp. 111–34.

González, A. R. 1961–4. Nuevas fechas de la cronología argentina obtenidas por el método del radiocarbón (V). *Revista del Instituto de Antropología*, 2–3: 289–97.

González, A. R. 1962. Nuevas fechas de la cronología arqueológica argentina obtenidas por el método de radiocarbón (IV): resumen y perspectivas. *Revista del Instituto de Antropología*, 5: 303–31.

González, A. R. 1980. *Arte precolombino de la Argentina*. Buenos Aires: Filmediciones Valero.

González, A. R. and Nuñez Regueiro V. A. 1960. Preliminary report on archaeological research in Tafí del valle, N.W. Argentina. *34 Internationalen Americanisten Kongresses*, 34: 485–96.

Holliday, V. T., Ferring, C. R. and Golberg, P. 1993. The scale of soil investigations in archaeology: on effects of scale on archaeological and geoscientific perspectives. *Special Paper de la Geological Society of America* (eds J. K. Stein and A. R. Linse), 283: 29–37.

Jaiyeoba, I. A. 2003. Changes in soil properties due to continuous cultivation in Nigerian semiarid Savannah. *Soil & Tillage Research*, 70: 91–8.

Kemp, R., Branch, N., Silva, B., Meddens, F., Williams, A., Kendall, A. and Vivanco, C. 2006. Pedosedimentary, cultural and environmental significance of paleosols within pre-hispanic agricultural terraces in the southern Peruvian Andes. *Quaternary International*, 158: 13–22.

McManamon, F. B. 1984. Discovering sites unseen. In *Advances in Archaeological Methods and Theory*, Vol. 7 (ed. M. B. Schiffer). New York: Academic Press, pp. 233–92.

Oliszewski, N. 2004. Estado actual de las investigaciones arqueobotánicas en sociedades agroalfareras del área valliserrana del noroeste argentino (0–600 d. C.). *Relaciones de la Sociedad Argentina de Antropología*, 29: 211–27.

Oliszewski, N. 2007. El recurso maíz en sitios arqueológicos del noroeste argentino: el caso de la Quebrada de los Corrales, El Infiernillo, Tucumán. *Treballs d'Etnoarqueologia*, 8: 123–45.

Olivera, D. E. 1988. La opción productiva: apuntes para el análisis de sistemas adaptativos de tipo Formativo del Noroeste Argentino. *IX Congreso Nacional de Arqueología Argentina*, 83–101.

Olivera, D. E. and Elkin, D. 1995. De agricultores y pastores: el proceso de domesticación en la Puna Meridional Argentina. *Zooarqueología de camélidos*, 1: 95–124.

Quiroga, A. 1899. La ruinas de Anfama, el pueblo pre-histórico de la ciénega. *Boletín del Instituto Geográfico Argentino*, 17: 4–6.

Racedo, J. 2005. Ayer y hoy de una fiesta comunitaria: La Fiesta Nacional de la Pachamama en Amaicha del Valle. *Voces, hechos y memorias*, CERPACU, 5: 5–14.

Rapp, G. Jr. and Hill, C. L. 1998. *Geoarchaeology*. New Haven, CT, and London: Yale University Press.

Roldán, J. 2004. Efectos antrópicos del uso del suelo durante el Formativo en el valle de Tafí. Undergraduate dissertation, Facultad de Ciencias Naturales, National University of Tucumán, Argentina.

Roldán, J. and Sampietro, M. M. 2003. Agricultura prehispánica en el NOA – valle de Tafí, Tucumán. *VIII Jornadas de Ciencias Naturales del Litoral y I Jornadas de Ciencias Naturales del NOA, Salta, Agroecología*, 93.

Roldán, J., Sampietro Vattuone, M. M. and Vattuone, M. A. 2006. Técnicas analíticas para el estudio de los suelos de sitios agrícolas prehispánicos. *Primer Congreso Argentino de Arqueometría*. Santa Fe, NM: Universidad Nacional de Rosario, pp. 60–9.

Sampietro Vattuone, M. M. 1994. Uso del espacio y manejo prehispánico de suelo y agua en el cono del río Blanco, Tafí del valle. Undergraduate dissertation, Facultad de Ciencias Naturales, National University of Tucumán, Argentina.

Sampietro Vattuone, M. M. 1999. Propuesta para un modelo climático del Formativo en el valle de Tafí. *XIII Congreso Nacional de Arqueología Argentina*, 30–1.

Sampietro Vattuone, M. M. 2000–2. Geoambientes y sitios arqueológicos formativos del valle de Tafí. *Cuadernos del Instituto Nacional de Antropología y Pensamiento Latinoamericano*, 19: 599–611.

Sampietro Vattuone, M. M. 2002. Contribución al conocimiento geoarqueológico del valle de Tafí Tucumán (Argentina). Doctoral dissertation, Facultad de Ciencias Naturales, National University of Tucumán, Argentina.

Sampietro Vattuone, M. M. and Neder, L. 2006. Geoformas y arqueología del piedemonte occidental de Cumbres Calchaquies (Tucumán – Argentina). *III Congreso Nacional de Geomofología y Geología del Cuaternario*. Cordoba, Argentina, pp. 943–54.

Sampietro, M. M. and Vattuone, M. A. 2005. Reconstruction of activity areas at a Formative household in Northwest Argentina. *Geoarchaeology: An International Journal*, 20(4): 337–54.

Sandor, J. A. and Eash, N. S. 1995. Ancient agricultural soils in the Andes of southern Peru. *Soil Science Society of America Journal*, 59: 170–9.

Sandor, J. A. and Furbee, L. 1996. Indigenous knowledge and classification of soils in the Andes of southern Peru. *Soil Science Society of America Journal*, 60: 1502–12.

Santander, J. L. 1962. Sacrificio y ofrendas en el culto a la Pachamama. *Folclore americano* (Lima, Perú), 10: 31–67.

Sayago, J. M. and Collantes, M. M. 1991. Evolución paleogeomorfológica del valle de Tafí (Tucumán, Argentina) durante el Cuaternario Superior. *Bamberger Geographische Schriften*, 11: 109–24.

Schlezinger, D. R. 1999. Organic phosphorus and elemental ratios as indicators of prehistoric human occupation. *Journal of Archaeological Science*, 27: 479–92.

Soil Survey Staff 1999. *Keys to Soil Taxonomy*. Blacksburg, VA: Pocahontas Press.

Tchilinguirian, P. and Olivera, D. E. 2000. Aportes edáficos para el estudio de campos agrícolas arqueológicos Bajo del Coypar, provincia de Catamarca. *Cuaternario y Ciencias Ambientales*, 4: 51–5.

Viers, G. 1973. *Geomorfología*. Barcelona: Oikos-Tai.

Walkley, A. and Black, L. 1946. An examination of the degradational method for determining soil organic matter and proposed modification of the cromic acid titration method. *Soil Science*, 37: 29–38.

Wells, E. C., Terry, R. E., Parnell, J. J., Hardin, P. J., Jackson, M. W. and Houston, S. D. 2000. Chemical analyses of ancient anthrosols in residential areas at Piedras Negras, Guatemala. *Journal of Archaeological Science*, 27: 449–62.

Wilson, C., Simpson, I. A. and Currie, E. J. 2002. Soil management in pre-hispanic raised field systems: micromorphological evidence from Hacienda Zuleta, Ecuador. *Geoarchaeology*, 17: 261–83.

WinklerPrins, A. M. G. A. and Barrera-Bassols, N. 2004. Latin American ethnopedology: a vision of its past, present, and future. *Agriculture and Human Values*, 21: 35–52.

WinklerPrins, A. M. G. A. and Sandor, J. A. 2003. Local soil knowledge: insights, applications, and challenges. *Geoderma*, 111(3–4): 165–70.

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