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figg. 4 - tab. 1

Relationships between archaeology and landscape in two preandean valleys from northwest Argentina

Rapporti tra archeologia e paesaggio in due valli preandine dell'Argentina nordoccidentale

SAMPIETRO VATTUONE M.M. (*)(**),
NEDER L. (**)

ABSTRACT – The purpose of this research was to compare prehispanic settlement patterns as a response to geomorphological landforms. Two preandean valleys from northwest Argentina (Tafí and La Ciénega) were studied from the geomorphological and archaeological point of view. The prehispanic human occupation of these areas were belonging to Tafí Culture (360 B.C. to 800 A.C.), and the most significant difference are their altitudinal locations together with the geomorphological characteristics of each area. After to make a systematic photointerpretation of both areas, we construct a GIS using archaeological, geomorphological, and topographic information. We conclude that prehispanic settlements were adequate to different use preferences. La Ciénega valley, which dominant geomorphological landforms are erosion glacis were mostly used as cattle area, while Tafí valley was used for residential settlement as well as for agricultural exploitation.

KEY WORDS: Prehispanic settlement; Geoarchaeology; Northwest Argentina; Tafí Culture; GIS.

RIASSUNTO – Lo scopo della ricerca illustrata in questo articolo è quello di evidenziare la relazione tra la distribuzione degli insediamenti pre-ispanici e le forme del rilievo. A questo scopo è stata studiata la geologia e la geomorfologia di due valli pre-andine dell'Argentina nord-occidentale (Tafi e La Ciénega). L'occupazione antropica pre-ispanica di queste aree risale alla Cultura Tafi (da 360 B.C. a 800 A.C.), e le differenze più significative sono la loro quota e le caratteristiche geomorfologiche. A seguito di sistematica fotointerpretazione di entrambe le aree, le informazioni archeologiche, geomorfologiche e topografiche sono state inserite implementate in ambiente GIS. È apparso chiaro che le due valli, per le loro caratteristiche fisiche, erano adatte a differenti usi: la valle La Ciénega, in cui le forme del rilievo predominanti sono i glacis d'erosione, fu utilizzata prevalenetemente come area per il pascolo, mentre la valle del Tafi per uso residenziale e per uso agricolo.

PAROLE CHIAVE: Insediamenti pre-ispanici; Geoarcheologia; Argentina Nord-occidentale; Cultura di Tafi; GIS.

1. – INTRODUCTION

Tafí and La Ciénega valleys are located on the northwest of Tucumán Province – Northwestern Argentina (fig. 1). They are rich archaeological areas from the northwest of Argentina. They present one of the earliest agricultural settlements of the region and they had a long occupational period dated between 360 B.C. and 800 A.C. These occupations belong to Formative period. This period is defined by the appearance of permanent village settlements and the development of agriculture. After that, Tafí valley was scarcely occupied by Santa María Culture (about 1000 to 1400 A.C.).

The typical houses of Formative period are central circular patios (15 to 20 meters diameter) rounded by other circular smaller rooms (6 to 2 meter diameter). Tafí valley has also agricultural terraces while La Ciénega only has circular structures.

As these archaeological settlements were belonged to the same prehispanic culture, and they represent a long occupational and contemporaneous period, the purpose of this research is to compare prehispanic settlement patterns as a response to geomorphological landforms.

2. – STUDY AREAS

Tafí and La Ciénega valleys are located in the pre-Andean region of northwest Argentina. The first between 26º 45' and 26º 58' S, and between 65º 39' and 65º 48' W. And the second between

(*) CONICET
(**) Laboratorio de Geoarquelogía, Fac. de Ciencias Naturales. Universidad Nacional de Tucumán. Miguel Lillo 205. 4000 Tucumán. Argentina. E-mail: sampietro@tucbbs.com.ar.

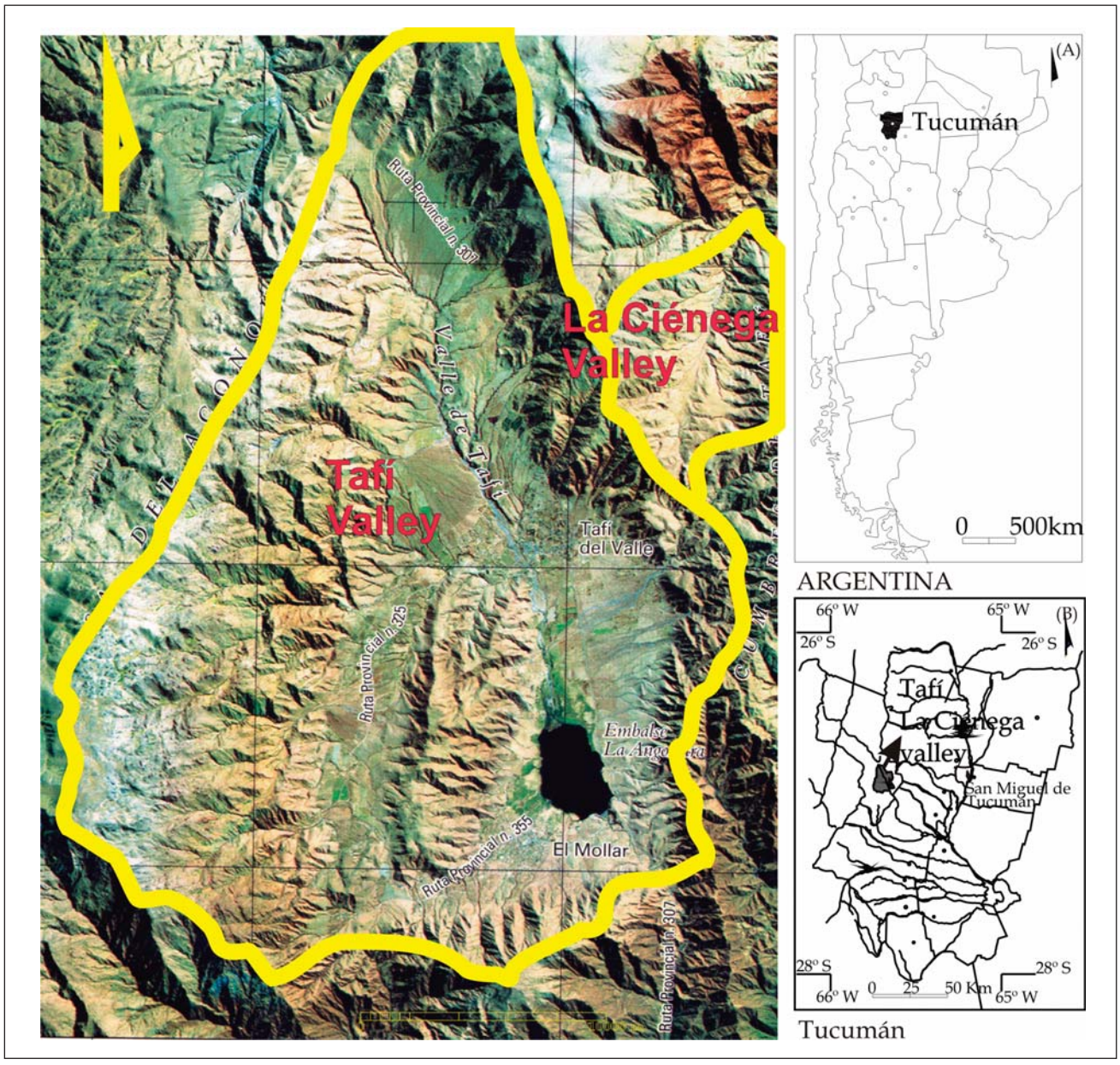

Fig. 1 – Location of Tafí and La Ciénega valley. Tucumán province, Argentina.
– *Ubicazione delle valli Tafi e La Ciénega. Provoncia di Tucumán, Argentina.*

26º 45' and 26º 50' S, and between 65º 38' and 65º 41' W (fig. 1). They are intermontane valleys which environmental conditions oscillate during Quaternary period. According to the research results obtained at Tafi valley, from the beginning of the Holocene until 7500 yr B.P., the climate was subhumid and warm. During the middle Holocene, it became cold and dry, but temperate and subhumid conditions were established around 3000 yr B.P. (Sayago & Collantes, 1991).

The Tafí valley is an elongated basin 1800–2300 m above sea level (m a.s.l.), with a median (N-S) floor slope of 18.8% (Bolsi *et alii*, 1992). The present climate is semiarid, with annual precipitations between 400 and 550 mm. Annual average temperature is about 13.1°C (Sesma, 1987). Most of the valley surface is covered by grass, which makes archaeological structures easily visible on aerial photographs.

La Ciénega valley is and elongated valley (28 km^2) formed by two river basins one that drains through the north and east until Tucumán plains, and the second one through the south and finished on Tafí river basin at Tafí valley. The bottom valley is located between 2500 and 2900 m a.s.l. As Tafí valley, it has a semiarid climate but they are not precise data on rain and temperature averages (fig. 2).

3. – CONCEPTUAL FRAMEWORK

To avoid conceptual problems related to different scholar formations we decided to introduce some definitions.

We understand by Formative Period the space of time comprised between 1000 B.C. and 1000 A.C. (according to TARTUSI & NÚÑEZ REGUEIRO, 1993; NÚÑEZ REGUEIRO, 1994). It is culturally characterized by the establishment of a disperse settlement pattern where each residential unit is formed by rooms related with a central or lateral patio. The economy was based on agriculture, the production was extensive. Communities were formed by gourp of 100 members where the structure was done by extensive families. Some groups show the development of copper and bronze metallurgy (SEMPÉ, 1994).

For the geomophological analysis we follow morphogenetic criteria (VIERS, 1973; VERSTAPPEN, 1977; VAN ZUIDAM, 1985) because we consider that it is better to our classifications. Especially considering that using these criteria each landform unit implies a specific formational process, dominant climate, and relief as fundamental modelling factors (SAYAGO & COLLANTES, 1991).

On the other hand, all concepts about genesis and geomorphological classification of piedmont landforms presented by VIERS (1973) were developed over the Argentinean Andean piedmont. So, it appears very useful to use it in a region with similar morphogenetic characteristics.

We distinguish according to their origins: a) structural denudational forms: integrated by denudational slopes; b) denudational forms: includes erosion, cone glacis and covered glacis; c) fluvial-alluvial forms: represented by alluvial fans, fluvial terraces, and river bed and alluvial plain.

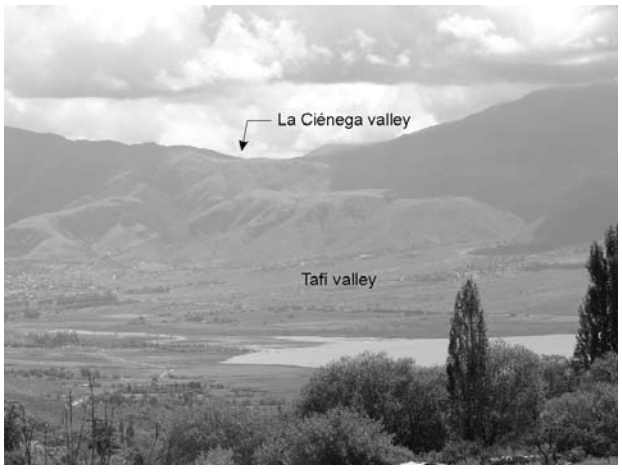

Fig. 2 – Panoramic view of both areas.
– *Vista panoramica delle valli oggetto di studio.*

Denudational slopes are defined as all slopes of contrary sense that limits a valley or a mountain affected by endogenous geological processes, as lithology and structure, and exogenous processes that produce the elimination of superficial weathered materials (COLLANTES, 2001).

VIERS (1973) defines erosion glacis as a sort of planed surface with a gradient between 2 to 8 %. According to VAN ZUIDAM (1976) it is a piedmont form characterized by being an extensive plane, gently undulating, affected by ravines and gullies. Normally it is developed on the foot of a structural relief.

Covered glacis are piedmont landforms relatively planes to undulating similar to erosion glacis but characterized by the presence of a clastic cover of approximately 15 m of thickness. This form was defined by VIERS (1973) as an erosion surface covered by an alluvial mantle so thick that it covers absolutely all substrate. VAN ZUIDAM (1976) defined it according to its superficial characteristics, as a flattening surface with a slope of 1-2 to 7 %, with smooth undulations.

Cone glacis are accumulation landforms defined by VAN ZUIDAM (1976) as a kind of accumulation glacis, of media extension; slope between 3 and 7 %, and with the shape of a cone or fan. They are developed in a relative small basin by fluvial activity and overland flow. This author points that, in general, they are landforms developed in the past because they show inactivity under the present environmental conditions; they also show a layer of materials with fine texture that covers the surface of the cone; the landform used to appear dissected by gullies; and some cones are cut by lateral erosion of main rivers after a recent incision period.

VERSTAPPEN (1977) has related the forms of fluvial origin with accumulation areas, like valleys and alluvial plains. There are still some doubts about which are the environmental factors that control the development of these forms, nevertheless there is no doubt about their complex and polygenetic nature (VAN ZUIDAM, 1985).

The literature about the genesis of alluvial fans is very vast, but all researches agree that it is a kind of landform that could be developed in very different environments. There is also coincidence about that they are characterized by the dominance of the deposition. They are formed by channelled fluvio-alluvial currents (highly competent and with severe fluidity) that emerge from a mountainous area and flows into a plain. As a consequence of this change of slope, the sediments are deposited generating this landforms with characteristic shape (COLLANTES, 2001).

There are different hypothesis about the genesis of fluvial terraces, and in general its origin is related with tectonic influence (local or regional), climatic changes or eustatic adjustments (BROWN, 1997).

River bed and flood plain are constituted by the sector over which the river actually flows, together with the plain that border it, and has been formed by the deposition of the materials transported by such river (CALMELS & CARBALLO, 1991).

4. – ANTECEDENTS

The entire area contains some of the earliest settlements in northwest Argentina. These settlements are particularly important because they represent the transition from hunter-gatherer to agricultural economies. However, little is known about them, especially about the relationship between environmental analysis and cultural responses.

During the final decades of the 19th century, menhirs (single upright crude monoliths), from Tafí valley, were described (AMBROSETTI, 1897; QUIROGA, 1899). These sculptures allowed archaeologists to relate these sites to the Tiahuanaco culture. Later papers noted the Prehispanic buildings dispersed across both valleys, which were described as agricultural terraces and residential units for Tafí valley (BRUCH, 1913; CANALS FRAU, 1953) and some of the most representative residential settlements for La Ciénega (QUIROGA 1899).

About Tafí valley, GONZÁLEZ & NÚÑEZ REGUEIRO (1960) completed the first systematic description of the archaeological remains found. They determined that the existing structures belonged to a specific cultural entity with particular characteristics, and named it the Tafí Culture (GONZÁLEZ & NÚÑEZ REGUEIRO, 1960). The Tafí Culture is 14C dated between 2296 ± 70 yr B.P. (GONZÁLEZ, 1962) and 1140 ± 50 yr B.P. (BERBERIÁN *et alii*, 1988).

These Formative Period settlements are characterized by pirca walls that can still be seen on the surface. Each settlement was formed by one to three big stone circles that have 10–20 m in diameter, surrounded by one to six, and occasionally more, circles that have 2–5 m in diameter. Each of these units was separated from the others by several meters (GONZÁLEZ, 1962; 1980).

Based on macroscopic artifacts, GONZÁLEZ & NÚÑEZ REGUEIRO (1960) established that the big central circles were places of daily domestic activities, such as milling, and also the place where the dead were buried. The small circles were rooms to sleep and to storage (GONZÁLEZ & NÚÑEZ REGUEIRO, 1960).

Using aerial photographs of the whole valley, SAMPIETRO VATTUONE (2002) simplified the building classification into two major categories: agricultural structures and circular rooms. The first category includes "despedres" (elongated mounds, with the same direction than slope, formed by stones removed from agricultural fields) and agricultural terraces (solid walls constructed perpendicular to slope). The second category could be divided into: simple circular rooms (one isolated structure), double circular rooms (two rooms with the same shape and dimensions constructed together), composite units (one big circle surrounded by smaller ones forming a household unit), and complex units (two or more big circles together with smaller ones forming a network where it is impossible to define restricted units).

By using geomorphological criteria to determine discrete sample units feasible for comparison, it was possible to identify landscape settlement preferences (SAMPIETRO VATTUONE, 2002). Cone glacis and alluvial fans were used for agricultural terraces and houses. Covered glacis and, in a lesser extent, erosion glacis were used exclusively for circular structures.

According to this settlement pattern, Tafí people had a segmentary society whose subsistence was based on cultivated plants and domesticated animals. The settlements were arranged according to some landscape preferences inside the Tafí valley area (SAMPIETRO VATTUONE, 2002). Apparently, no structure dominated any other. Houses were isolated and permanently occupied, with a dispersed settlement pattern. There is little evidence of centralization or specialization with the exception of the menhirs, agricultural terraces (BERBERIÁN *et alii*, 1988; SAMPIETRO & SAYAGO, 1998; SAMPIETRO VATTUONE, 2002), and a small ceremonial mound found in the valley (GONZÁLEZ & NÚÑEZ REGUEIRO, 1960).

There are little research antecedents about La Ciénega. Some archaeological excavations showed that, according to settlement pattern and recovered materials, the constructions present on this valley were also belonging to Tafí Culture and had relationships with other culture from the Tucumán plain (Candelaria Culture) (BERNASCONI DE GARCÍA & BARAZA DE FONTS, 1981-82).

Finally, CREMONTE (1996), by a visual interpretation of some aerial photographs, made a distribution map of the archaeological structures over landscape units. According to her, La Ciénega valley could be divided into five geomorphological areas: floodplain, alluvial zone, piedmont, colluvial levels, and high mountains.

According to her, floodplain corresponds to

the bottom valley, its sediments are inundated each summer season. Alluvial zone is the intermediate terrain area between floodplain and the sediments accumulated over piedmont. Piedmont level is a big area of gently slope formed by peneplained deposits. Into this piedmont there are also colluvial levels, defined as deposits of sediments dragged by pluvial waters that were accumulated on depressions and then peneplained forming almost horizontal surfaces (CREMONTE, 1996).

Unfortunately, the characterization of each geomorphological unit does not have uniform criteria. So, their limits are not easily established, and also there is not clearly established which were the formational factors. Using this classification together with the calculation of the X^2 test, CREMONTE (1996) established that archaeological units are not randomly distributed over the valley; they tend to be located on the areas with deeper soils, on the south and central area of the study area.

5. – MATERIALS AND METHODS

For the study of landscape appropriation and archaeological structure distribution we started by the systematic photointerpretation of altitude, geomorphology, hydrology, and archaeology. Aerial photographs at 1:50,000 and 1:10,000 scales were used. All maps were controlled by pedestrian survey of both areas.

Geomorphological studies of areas with archaeological settlements are important to understand the natural processes that took place on the settlement surface generation. Furthermore, it gives evidences about the natural resources potentially available for the past populations that could condition settlement distribution. Finally, it provides paleoenvironmental information that is fundamental to understand the dynamic of archaeological formation processes.

Geomorphological analysis was performed following the methodology proposed by VAN ZUIDAM & VAN ZUIDAM-CANCELADO (1979).

Archaeological structures were categorized according to their constructive characteristics and shape, following SAMPIETRO VATTUONE (2002).

Then, archaeological maps were associated with geomorphological maps trough the construction of a GIS using ILWIS 3.4 software (ITC).

In order to compare the distribution of the different kind of circular units identified in both valleys we performed some statistical analysis. After the characterization of each archaeological unit, according with their architectural shape (following SAMPIETRO VATTUONE, 2002), and assuming that all ancient structures were nearly contemporary, we calculated the distance to nearest neighbors (DNN). In all cases geomorphological units where taken as discrete sampling units.

The DNN method involves the analysis of the spatial distribution of points using distance characteristics between individual points on the map. The pattern is analyzed by calculating distances between individual points and between their first to sixth nearest neighbor points in the pattern. The results are tested against the expected distances in complete spatial randomness (CSR) (ITC, 2001).

This technique was used to examine the spatial pattern of the points on our maps. When the individual points are closer to each other they would be in CRS, a cluster pattern is indicated. If this is not the case, the pattern is more regular, or uniform (ITC, 2001).

6. – RESULTS

As we started by the comparison of the geomorphology of both areas, we established that the vegetal formation of both them is highland grasses. The visibility of surface traits is optimal for a good photointerpretation.

As we set on the introduction, both areas have important altitudinal differences. The bottom part of Tafí Valley is located between 1800 and 2300 m a.s.l., while La Ciénega has between 2500 and 2900 m a.s.l. The first region has the exposition to wet south winds, while the north part of La Ciénega Valley has south exposition, and the south part has north exposition (fig. 2).

In both cases, the landforms over which archaeological structures were lying were geomorphologically stable when the settlement started, that means that the landscape has had a great stability for at least the last 3000 years. During this time soil development processes were dominant. This is also evident by the visibility and degree of conservation of the standing buildings, dated between 360 B.C. and 800 A.C.

Geomorphologically, dominant landforms of Tafí valley are covered glacis, cone glacis, erosion glacis, alluvial fans and fluvial terraces (fig. 3). At La Ciénega, geomorphological units are mostly erosion glacis together with covered glacis, alluvial fans and inactive fluvial terraces (fig. 4).

Prevailing archaeological structures from Tafí valley are residential units on both categories (complex and composed units), accompanied by double units. These units are distributed mainly over covered glacis and in some degree over cone glacis and alluvial fans. There are some geomor-

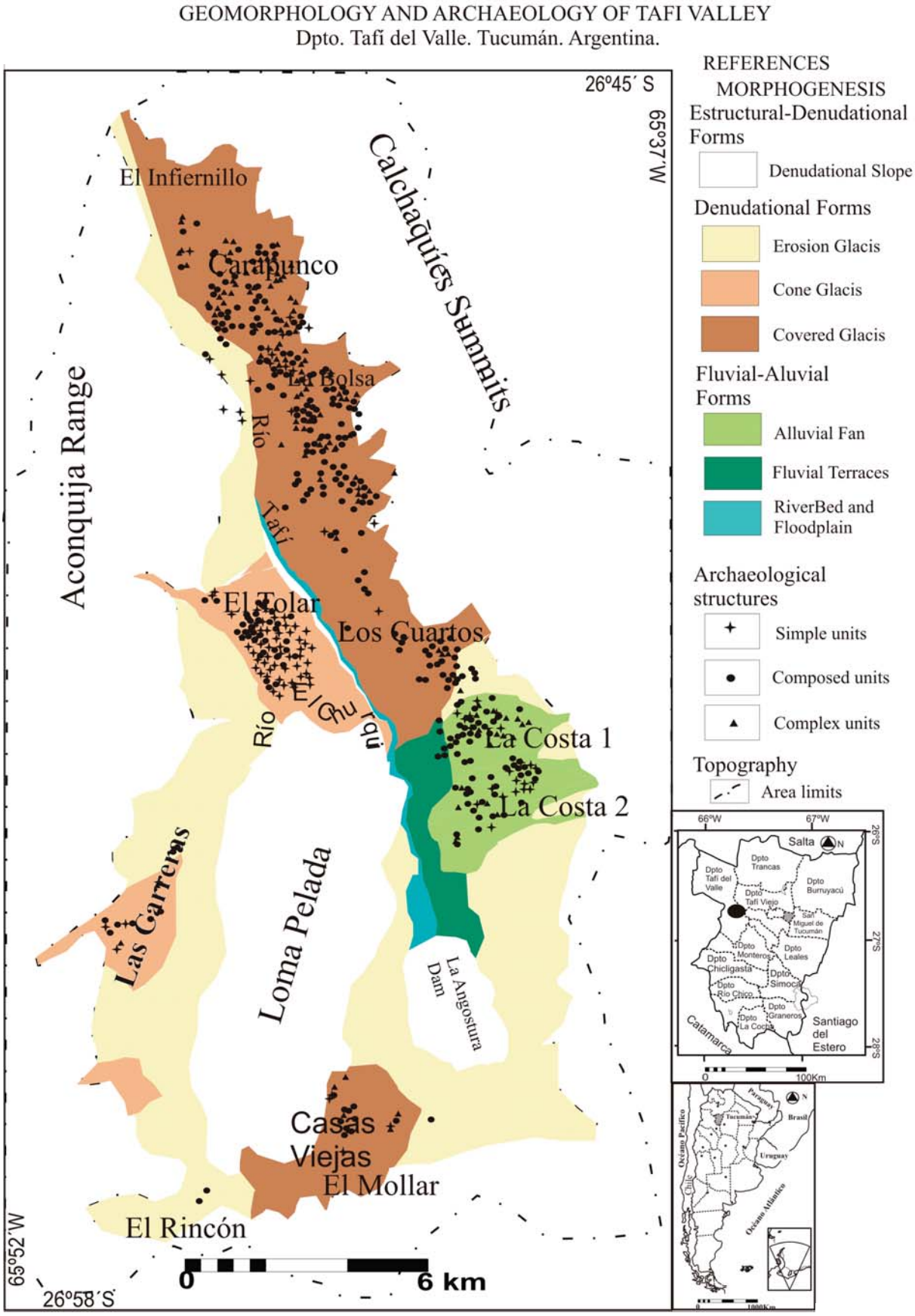

Fig. 3 – Geomorphology (simplified from COLLANTES, 2002) and archaeology from Tafí valley.
– Geomorfologia (semplificato da COLLANTES, 2002) e archeologia della valle di Tafi.

phological units used for agricultural purposes (alluvial fans and cone glacis), even both them have also residential units. Simple units, when they are present, are associated with agricultural fields and rise just 2 m of diameter (fig. 3).

The archaeological structures from La Ciénega are composed and complex residential units mainly lying over denudational slopes, erosion glacis and covered glacis. Simple units are over the same geomorphological units than the previous ones but they have different shape than the simple units from Tafí valley, they oscillate between 10 to 20 m diameter, and they are not associated to agricultural systematizations of the landscape. This is clearly showing that they have a different functionality as the landform over which they are settled (fig 4).

Statistically, it was observed that there exist tendencies about the internal arrangement of the circular structures inside each geomorphological unit. These results are resumed on table 1.

For Tafí valley, as it was observed by the occurrence of stone circles, on the case of landforms used for agricultural purposes little simple units tend to have regular distribution, while where the emphasis was focused on residential purposes composed structures have regular distribution.

We believe that the uniform distribution of simple units at cone glacis and alluvial fans is the intrasite expression of regional patterns described by SAMPIETRO VATTUONE (2002) for Tafí valley. Their distribution is a response to the agricultural function of the sites. If we accept that these units were directly associated with crop raising, they must be positioned to minimize travel distance and maximize the use of space. The distribution of other types of structures is subordinate to the agricultural function of the area. The same interpretation could be done for residential structures on the case of covered glacis.

On the case of La Ciénega valley, big simple units were specially located over denudational slopes and erosion glacis, while residential structures (composed and complex units) are mainly distributed over covered glacis. We believed that this is related to the facility to direct water to the settlements.

Statistically, covered glacis reached a regular distribution of residential and simple units. On the case of denudational slopes, just simple units are regularly distributed. The regular distributions is denoting the preferences of use of each landform, being the covered glacis equally used to residential and cattle purposes, while over denudational slopes grazing activities were prevailing.

7. – CONCLUSIONS

Comparing both valleys we established that the most significant difference was its altitudinal location together with the geomorphological characteristics of each area (fig. 2).

At Tafí valley cone glacis and alluvial fans were occupied with agricultural settlements, while covered glacis were mainly used for residential purposes. None important structures were distinguished over erosion glacis.

Tab. 1 – *Statistic results of distribution tests.*
– Risultati statistici dei test di distribuzione.

TAFÍ VALLEY				
Geomorphological unit	Structure type			
	Simple	Double	Composed	Complex
Cone glacis	Regular	Grouped	Random	-
Covered glacis	Grouped	Grouped	Regular	Grouped
Alluvial fan	Regular	Grouped	Grouped	Regular
LA CIÉNEGA				
Geomorphological unit				
	Simple	Double	Composed	Complex
Cone glacis	Regular	-	Grouped	-
Covered glacis	Grouped	-	Grouped	Random
Alluvial fan	Regular	-	Regular	-

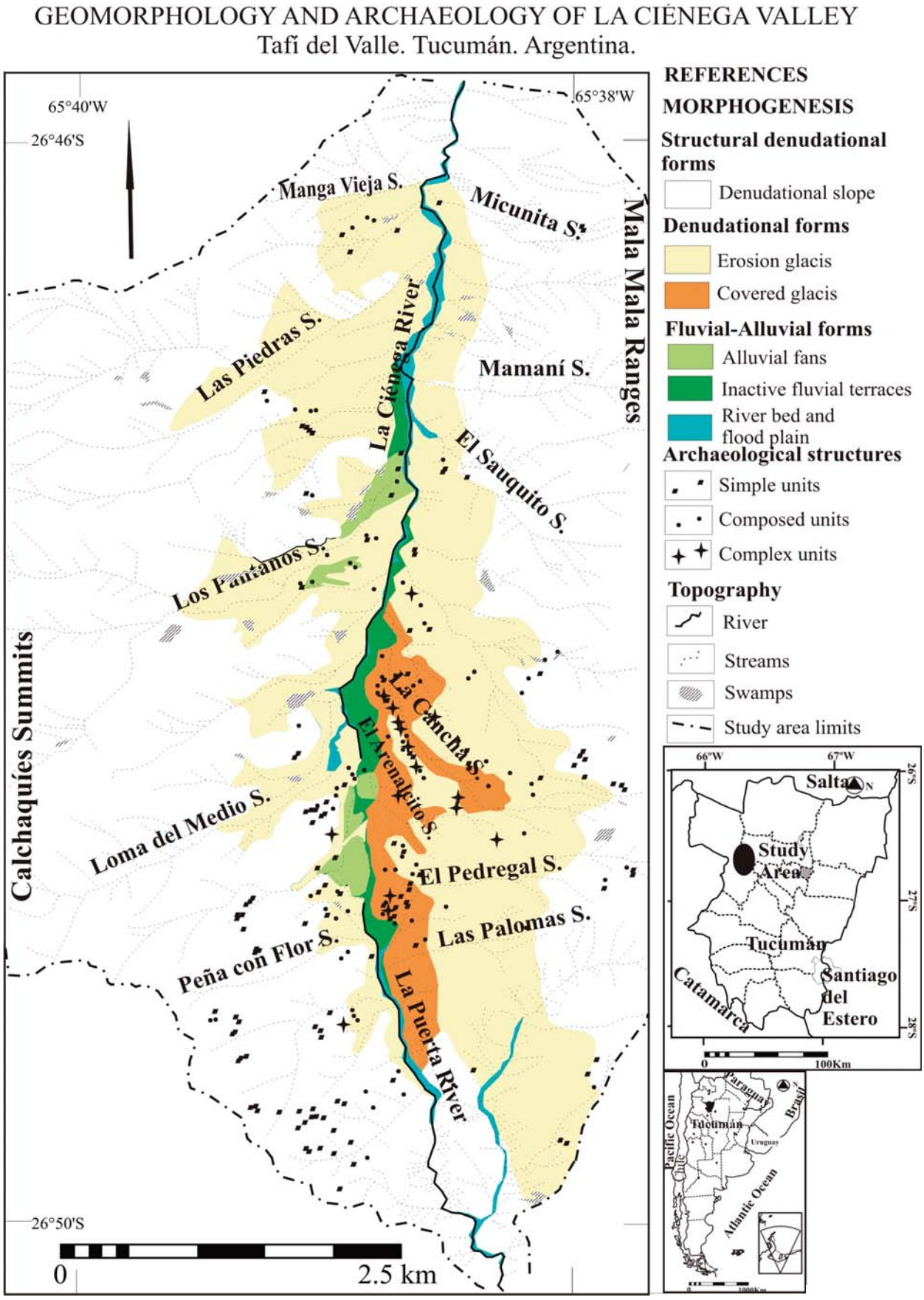

Fig. 4 – Geomorphology and archaeology from La Ciénaga.
– *Geomorfologia e archeologia della valle La Ciénaga.*

On the contrary, at La Ciénega valley the dominant landform is erosion glacis and the simple round structures settled there were very abundant.

Statistical analysis reinforced these ideas of landform characteristic – use preference, not just by the dominant shape of archaeological structures but also by the distribution of them on the landscape.

We conclude that prehispanic settlements were adequate to different use preferences. La Ciénega valley, which dominant geomorphological landforms are erosion glacis were mostly used as cattle area. The kinds of structures together with its distribution over landforms were oriented on this sense. While Tafí valley spatial appropriation was oriented to an intensive profit of agricultural soils.

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