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Taming the control of chronology in ancient agricultural structures in the Calchaqui Valley, Argentina. Non-traditional data sets

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ABSTRACT

The absolute chronology of the agricultural soil from organic matter has always been difficult to measure due to several reasons. In our work on the Prehispanic agriculture in the Calchaqui Valley – Argentina, however, an absolute chronology is necessary to distinguish the Inca prevalence of the previous agricultural structure. Instead of looking for a new dating methodology, we have used the 14C method trying to eliminate the error sources typical of soils. Thus, we have dated new types of agricultural structures, with the assumption that they would have worked as archaeological "seals". In the present paper we show that the dating of the beginning of the use of the Prehispanic agricultural systems has been successful.

1. Introduction

In the Calchaquí valley (Angastaco and Molinos basins), Northwest Argentina, the archaeological landscape is dominated by vast agricultural areas, with structures for the control of water and erosion, where irrigation canals, terraces and fields can be observed. This land makes up more than 400 ha., "guarded" by naturally protected sites, strategically placed. These *pukara* (a type of fortified site) are located on highly visible mesas which provided natural defense and easy control of nearby populations, productive areas and road networks. These settlements as well as the extensive agricultural areas recorded, which represent an enormous labor investment, may be chronologically consistent to the Late Intermediate Period (LIP[1]) – period marked by a demographic increase- but also to the Late Horizon (Inca Period). From this premise, several archaeological sites have been recognized as defensive in nature and war oriented as they have no easy access; they present parapets and enclosure walls, burning events or intentional destruction of buildings, pottery used for storage and lithic or metal materials used as weapons. This situation is not exclusive to the area since several scholars have mentioned an endemic conflict situation due to diminished resource availability caused by environmental stress around the Titicaca area which extended to the south before the expansion of the Inca state. Even though this is proposed as a general scenario, the particular events should be researched on a local basis.

The presence of the Inca in the region (*ca.* A.D 1400–1532) is reflected in six sites with different functions (administrative, productive, and defensive) and placed away from the former local settlements and agricultural areas. However, it is very likely that this production has been maximized with the introduction of agriculture and the enlargement of the surface area.

Advances in ancient agricultural studies have been important in latest years, researching about subjects such as cultural landscapes, labor investments, architectural facilities, irrigation systems, soil use and crops, among others (e.g., Albeck, 1992–1993, 2001, 2003–2005; Korstanje, 1996; Korstanje et al., in press; Quesada, 2006; Quesada and Korstanje, in press). Nevertheless, one of the difficulties of these studies has systematically been the need to date by absolute methods the different events related with agriculture (Korstanje and Cuenya, 2008). The condition of soils as open systems in permanent relationship with environment and climate events, make difficult to obtain accurate C14 dates, since we might not know what event or which moment of the process we are dating. If we add to this problem the circumstance that soils are periodically reused – even at ancient structures in modern times, we end understanding the second difficulty which is that

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[1] The Late Intermediate Period (LIP) for Northwest Argentina is also called Development Regional Period (DRP) (Nuñez Regueiro, 1974; Tarragó, 1978).

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edaphic-soil components may mix or move also vertical and horizontally. As a consequence, due to the need of getting good absolute chronologies for agricultural archaeological structures and since classical dating methodologies are not accurate for these scope, we explored other alternatives. We want to clarify that other types of sample for dating such as micro charcoals, phytoliths, land snails, and optical dating are not adequate in the cited contexts, because they require specific environmental conditions not present in this case. Generally, these conditions are not present either in most of the agricultural areas, where tilling and reuse of land are common practices that highlight the system dynamism.

In this article, we discuss this problem and we present radiocarbon datings done from a different new perspective, which has given good satisfactory results for the scopes here presented. We have cautiously looked for a type of agricultural structure that could have worked as an archaeological "seal", since this is the only premise that could assure us the interruption of soil interacting with the environment and with people. This situation only happens between an ancient soil surface is in contact with the base of a stone-structure that was never removed again, and that is enough thick to stop weathering and human disturbance. Thus, we have dated new types of agricultural structures, assuming that they would have worked as archaeological "seals", since we have found that the stone clearing heaps or "despedres" cover this role perfectly in the southern Andes.

2. Archaeological background

The area known as Northwest Argentina is delimitated by Bolivia on the North and Chile on the West, formed by Jujuy, Salta, Catamarca, La Rioja, Tucumán and Santiago del Estero provinces. The Atuel and Diamante rivers in Mendoza mark the southern limit, while the eastern one is given by the Subandean Hills of Santiago del Estero, Salta and Tucumán. As an archaeological or cultural region these limits go beyond the national boundaries, Jujuy province being included into the South-Central Area by Lumbrera's Andean area division (Lumbreras, 1981) together with Southern Peru, Bolivia's Andean region and Chile's Norte Grande. Meanwhile, the transversal valleys of Chile (semiarid North) and the rest of the Argentinean territory are part of the Southern Andes.

There is a grand environmental diversity in the Northwest Argentina which interlocks high terrains with low ones, and humid with semiarid spaces. Here, the state used different strategies to annex the territory. The Inca presence was intensive but occurred mainly in restricted productive and strategically located areas not previously used, being a clear example of territorial expansion. We do not know whether this intensification of production was achieved by the resettlement of local populations during Late Intermediate Period (ca. A.D 900–A.D 1400) or the introduction of new ones. In Quebrada de Humahuaca as well as in the North Calchaquí Valley, Santa María Valley and Bolsón de Andalgalá, the Inca built many installations in key interregional contact points closely located in areas where the local population was not very dense (D'Altroy et al., 2007; Raffino, 1983) (Fig. 1).

A brief review of settlement organization, public architecture, and agricultural intensification, from an archaeological perspective will help to sketch the nature of the societies that occupied the region before Inka rule. To judge from the available information, those societies ranged from acephalous, semi-sedentary groups to mid-range polities that exhibited some degree of political ranking, but no evidence of social classes. González (1983) has estimated that the largest polities of the Regional Developments period encompassed no more than 20,000 people, and most of the political entities may well have been substantially smaller. Nevertheless, ranked or perhaps even incipiently stratified societies were present in some locations, notably in the valleys in Northwest Argentina.

One of the more striking aspects of the regional settlement pattern in Northwest Argentina is a significant shift in settlement location that occurred about AD 1300 or a little before. In the Quebrada de Humahuaca, the Santa María and Cajón valleys, and the northern Calchaquí Valley, populations moved into larger, nucleated settlements, whose locations and construction often suggest that the inhabitants were concerned with defense. At the same time that local conflicts may have been escalating, interregional interaction was apparently increasing. Contacts across the Andes with Chilean societies appear to have grown, for example, as exhibited by an increase in the use of similar ceremonial paraphernalia that may have been associated with drug consumption (DeMarrais, 2001; Nielsen, 1996).

Major land improvement projects were also undertaken during the late pre-Inka era. In Cachi Adentro, a lateral valley feeding eastward into the Calchaquí River, the residents of Las Pailas and vicinity lived adjacent to about 500 ha of irrigated, drained, and terraced fields believed to have been largely developed during the LIP or Regional Developments Period. Similarly, the residents of Fuerte Quemado in the Santa María Valley lived next to about 500 ha of irrigated agricultural enclosures (Kriscautzky n.d.). In some cases, it is not clear how much of the intensification was indigenous and how much was stimulated or sponsored by the Inkas, since there were important Late Horizon occupations at some sites, as well. Even so, the scale of the pre-Inka populations suggests that notable land improvements and water management were needed to sustain life in the towns that had developed.

3. The methodology to study agriculture in the valley

The present study on the Prehispanic agricultural structures in the region embraces several lines of analysis. On the agricultural structures themselves, we are working on two lines. One includes an architectural and spatial analysis, considering agriculture as one of the central themes of daily life in the valley (Williams et al., 2005); the other is more comparative, including the analysis of soil properties and microfossils, and following the already proved methodology of multiple analysis of phytoliths, diatoms, starch granules, crisophycean and spherulites – among others- used for El Bolsón valley in the northwest of Argentina (Coil et al., 2003; Korstanje and Cuenya, 2008).

In this area, agricultural facilities are characterized by different structures such us andenes (Fig. 2) and "canchones" (big enclosures) constructed in stone, in order to diminish the slope and to keep soil and humidity in areas that from the beginning are not apt for cultivation. Part of the labours done in order to cultivate the landscape is maintenance the surface and subsurface from small and medium isolated stones, which are put together in areas that form small mounds or heaps called "despedres".

In this paper we only take into consideration the chronological problem. For this point, four sites that could be considered in the time range between LIP or Regional Development and Late Horizon or Inka Period were taken into consideration and grouped in pairs for comprehension purposes.

The first group is formed by the Gualfin 2 and Quebrada Grande 1 sites, which are close to each other on the right bank of Del Remate River and 1.3 km from an archaeological site with defensive characteristics (*pukara*) called Fuerte de Gualfin.

The *Gualfin 2* site is located on a southeast-oriented hillside with an average slope of 18–20%. It consists in a group of terraces covering 0.26 ha and separated by stone clearing heaps ("despedres") and some circular enclosures.

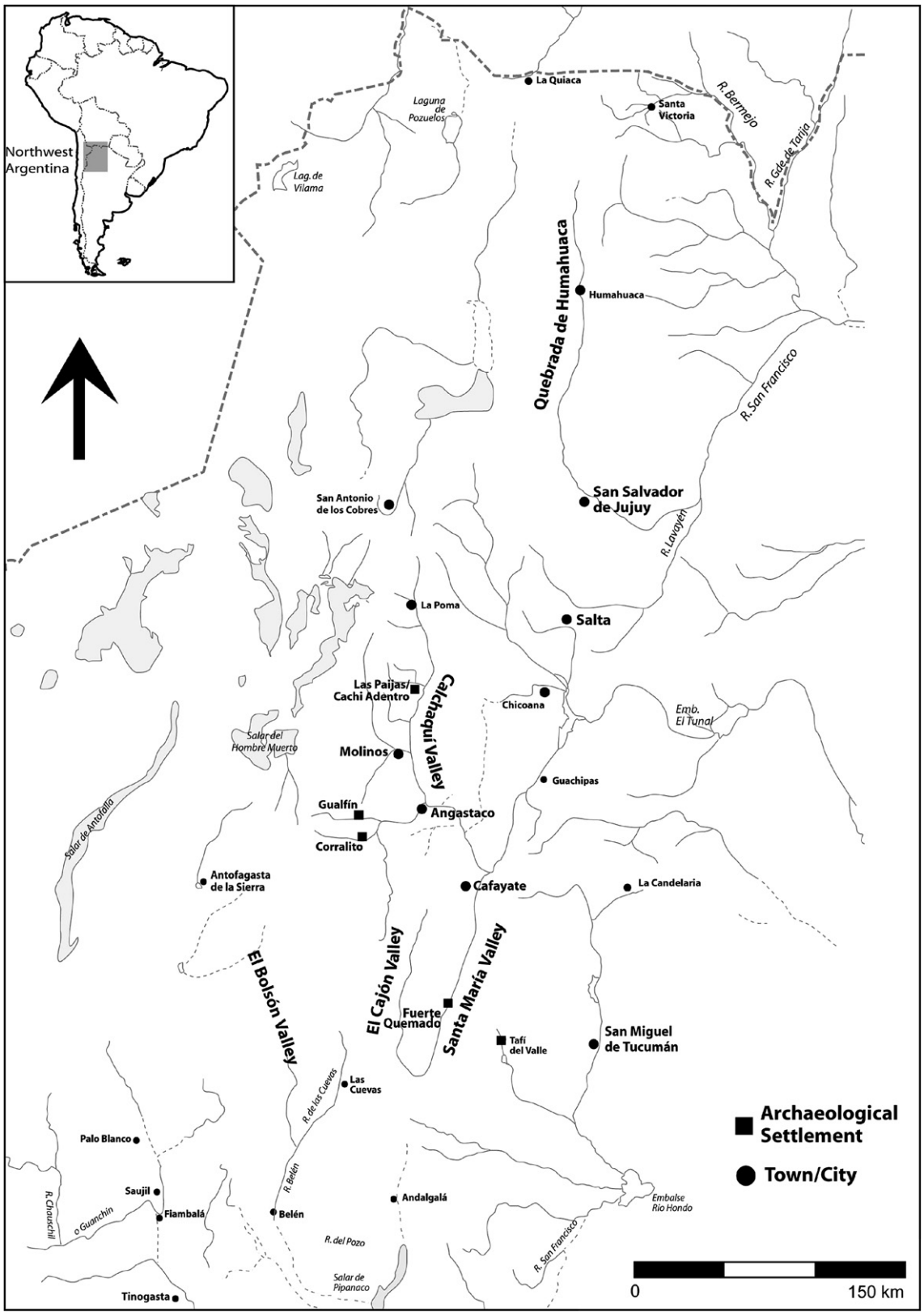

Fig. 1. Map of the area and mentioned archaeological sites.

Fig. 2. Agricultural landscapes.

The *Quebrada Grande 1* site is also located on the right bank of Las Cuevas River. Even though this site shares the same general architectural characteristics than Gualfin 2, it has a greater slope of 40%, in average.

The second group, formed by the *Corralito 4* and *Corralito 5* sites, is situated in the area called Corralito as well. They are away from the other two sites by 13.5 km, but close to each other on the left bank of Pucarilla River and on one of its tributaries.

The *Corralito 4* site is placed on a hillside with an average slope of 30%. It is formed by a series of terraced agricultural structures, stone clearing heaps and dwelling enclosures, the contemporaneity of which is debatable.

The *Corralito 5* site is placed on the left bank of a Pucarilla River tributary on a surface area with an average slope of 45%. Its regular distribution of walls and stone clearing heaps is one of the characteristics which differentiate it from the rest of the sites (Fig. 3).

4. Environmental and geological description

The studied area is characterized by a landscape of mountains and valleys where the main rivers of the region flow (Hongn and Seggiaro, 2001; Villegas, 2006). The geology is formed by granitic outcrops, neogenetic ignimbrites, quaternary sediment (fine sand, pelite and tuff interleaved into conglomerates) and fluvial deposits. This area presents an arid climate (about 250 mm rainfall annually), with scarce winter precipitations and a wide thermal range. These characteristics, and the resulting scarce vegetation, do not favour edaphic development. Therefore, the existent soil belongs to the Aridisol and Entisol Soil Orders, with profiles of the type A/C and/or A/Cr/R (Soil Taxonomy of USDA, 2006).

5. Soil functioning

Starting from the idea that the soil is an open, dynamic system, the result of the interaction of environmental forming factors such as the weather, inorganic material, precipitations and temperature), biota, topography and time, it is admitted that the soil is in continuous formation (Porta Casanellas et al., 1994; Fitzpatrick, 1996). This means that this system is being permanently modified, and thus, soil dating on organic matter is not completely certain, since we cannot establish which is the moment being dated. That is to say: it is difficult to determine the period the organic sample belongs to, as processes have continued their way, interacting with the organic matter contemporary and/or posterior to the intensive soil use.

6. An alternative to the chronology problem

Owing to the observed architectonic variability and the problem of determining the incidence of the Inca occupation in the region as a factor of change or intensification of agriculture, we found it essential to look for methodologies that could allow an absolute dating of the agricultural soils associated to structures. In the cultivation structures it is uncommon to find absolutely datable traces such as coal, carbonized seeds or bones (Goodman Elgar, 2002). This difficulty is also based in the fact that these traces may have been removed from their original matrix owing to the Prehispanic soil tilling and probable reuse of lands for long periods of time. Both situations are impossible to control and distinguish. This is why we disregarded the organic matter of sediments from the studied cultivation structures as dating material. Even when we can define pedologic horizons showing an intensive use of the lands in the past, dating would not be correct as the soil continues to be active, being an open system in constant evolution.

An adequate and technically possible alternative was dating a "sealed" archaeological event, that is, soil where the pedogenetic processes would not have continued or would have been minimized to the present. Samples under the walls of bench terraces were not the best alternative because lifting a wall generally implies digging foundations. Therefore, something ambiguous would be dated, prior to the wall itself. On the other hand, walls are relatively narrow so the activity of the soil under them could have continued owing to water percolation which favours paedogenesis.

Other cases of dating in agricultural environments with an archaeological "seal" are known (Zaro and Umire Álvarez, 2005). They are specific catastrophic events such as volcanic eruptions or stable anaerobic environments like peat bogs (Scharer et al., 2006), while the present paper shows the possibility of dating a type of well-known and common agricultural structure produced by the removal of stones from the soil to be cultivated and the corresponding accumulation of them.

7. Stone clearing heaps as agricultural structures

The Prehispanic type of structure called "stone clearing heaps" (or "despedres"), consists in the arrangement resulting from a basic agricultural action: the removal of small and medium-sized clastic material from the land to be sown, for a better radicle penetration in the soil (Fig. 3b).

A stone clearing heap is, then, the result of "clearing" an area. As a consequence of this action, an anthropic deposit of this material takes place in an area near the cultivation field but not destined to be sown. Thus, structures of different morphology and size are formed; being simple heaps along the edges of the cultivation areas the most common. In some cases, the lines of stone clearing heaps have been part of the organization of the agricultural space, having

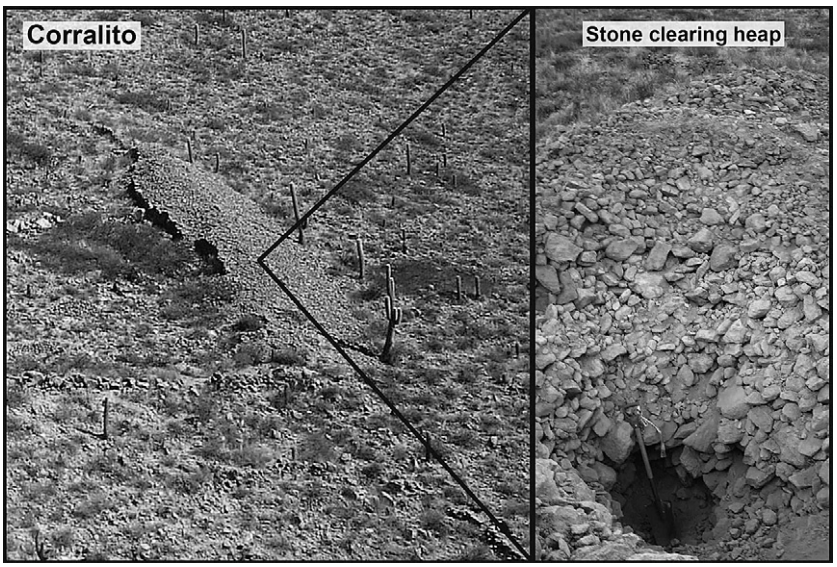

Fig. 3. a: "Despedres" at Corralito 5. b: Sampling organic matter at the bottom of the "despedre".

additional functions as "separators" of different agricultural areas organized in terraces (mainly in the case of cultivation terraces *sensu stricto* but also in some bench terraces).

So far, in Andean archaeology little attention has been paid to the stone clearing heaps in agricultural sites, owing to the supposition that they could only offer little information. At most, they were included in cartography as an additional element or mentioned in the general descriptions.

In the search for an appropriate methodology to date agricultural architecture (terraces, fields, etc), we observed that the stone clearing heaps had a fundamental property lacking in the rest of the agricultural structures: they were not reused with a complete removal, on the contrary, more stones were added on the existent surface area. This characteristic led us to consider that the soil under the stone clearing heaps must be contemporary to the starting of the agricultural work. Moreover, as this soil was sealed by a mass of loose superimposed stones, it would maintain a stability lacking in the cultivated soils, bearing in mind the semi-arid environmental characteristics of the area.

From this assumption (soil stability by archaeological "seal"), we have considered the possibility of obtaining radiocarbon data indicating when agricultural labor was starting to be done on the soil.

We could be tempted, after these premises, to date also the organic matter of the soils that are under the walls of the terraces or andenes itself. In a sense they are also "seals", but we do have some problems with this. First, for the construction of the andenes or stone walls people generally dig a foundation. Therefore, if the wall may be considered a seal, what we would date is a soil that is not contemporary with the construction of the terrace, but something before in time that we could not correlate with anything. Second, in the cases of the area under consideration we think that these walls may not work as a seal, since they are covering only a small soil surface (as small as wide is the wall), and this does not prevent this open soil system to continue functioning under this wall. Therefore, again we cannot have certitude of what we are dating.

8. Chronology discussion and results

It has been estimated from historical data that the expansion of the Inca Empire occurred in a very short period of time (Rowe, 1944; Päassinen and Siiriäinen, 2003). The archaeological data, however, does not reflect this situation, and shows a rather much longer historical process (D'Altroy et al., 1998, 2000 ms). According to Cabellós chronology, the Inca annexed the argentine territories *ca.* AD 1470–1480 during Topa Inca rule, sustained by some authors like Betanzos, Cieza and Sarmiento (Rowe, 1945: 271)[2]. Therefore, from the historical perspective, Inca dominion in the southern Andes lasted about 50–65 years.

The array of carbon dates from North of Chile and Northwest Argentina ($N = 120$) and the extent and diversity of the state installations indicate that the Inca were present earlier and invested substantially more effort in ruling the south than is acknowledged in most overviews. The archaeological data suggest that Inca dominion lasted a century or more. While that situation forces us to rethink the nature of Inca history, it also opens the door to understanding different stages of Inca annexation of the region and consolidation of control (D'Altroy et al., 1998 ms; Williams, 2007 ms).

To understand this situation regarding the agricultural development and intensification, four samples of sediments to date organic mater by the radiocarbon method (AMS) were taken from the bottom of a stone clearing heap in each one of the above mentioned sites. It was necessary to take out all the clastic material constituting the stone clearing heap up to the first soil-like level (Table 1).

These results show different moments of the Prehispanic agriculture and landscape use. It is interesting to point the dating of stone clearing heap 2 corresponding to *Quebrada Grande 1*. At first sight, due to its location and architectonic characteristics we could have considered it to belong to the Late Intermediate Period or Regional Development Period. However, during the survey we noted, on the one hand, the presence of three canals (two of which were abandoned) in different elevations on the hill slopes. This suggests an important long-term reuse of lands.

On the other hand, this is the least conservated site as compared to the rest. There are dry-stone walls which are of low height and

[2] Betanzos, Cieza and Sarmiento independently confirm that Tawantinsuyu's south frontier was established by Topa Inca close to Maule river, almost 250 km south to Santiago de Chile (Betanzos, 1551: cap. XXV; 1987: 160; Cieza 1553: cap lxi; 1986: 177; Sarmiento 1572: cap 50; 1943: 326).

Table 1
Chronological data (all on organic matter).

Stone clearing heap #	Site	Sample depth	Sample id	C14	2 Sigma calibration	13C/12C ratio
1	Gualfin 2	0.53 m	Beta – 232250.	700 ± 40 BP	Cal AD 1160 to 1270 (Cal BP 690 to 640) and Cal AD 1160 to 1270 (Cal BP 790 to 680).	−17.7‰
2	Quebrada Grande 1	1.10 m	Beta – 232251.	1240 ± 40 BP	Cal AD 620 to 690 (Cal BP 1330 to 1260).	−17.5‰
3	Corralito 5	3.00 m	Beta – 232249.	390 ± 40 BP	Cal AD 1400 to 1460 (Cal BP 550 to 490).	−19.5‰
4	Corralito 4	0.80 m	Beta – 232248.	590 ± 40 BP	Cal AD 1260 to 1310 (Cal BP 690 to 640) and Cal AD 1360 to 1390 (Cal BP 590 to 560).	−18.3‰

badly conservated manufacture. This sole visual perception would not have allowed us to think that the agricultural work started early in *Quebrada Grande* (Beta 232251. AMS 14C, 1240 +/− 40 BP- 2 sigma calibrations: Cal AD 620 to 690 (Cal BP 1330 to 1260). This information is coherent with the ceramic and rock art findings of the Middle Horizon or Middle Period (AD 500–1000) in *Tacuil*, 22.7 km north from this site.

The results of stone clearing heaps 1 and 4 corresponding to *Gualfin 2* and *Corralito 4* sites show a close temporality in the Regional Development Period (AD 1000–1400). This dating is coherent with the ceramic register, the agricultural architecture and the fortified Pukara-type sites located in the area (Williams, 2005; Williams et al., 2005; Cremonte and Williams, 2007).

The sample of stone clearing heaps 3 corresponding to *Corralito 5* is synchronic to the moment of the Inca occupation in the northwest of Argentina. It is interesting to note that the architecture of this site shows a planning in the stone clearing heap itself, which is controlled by a lateral wall built before the accumulation of the clastic material. This situation is not seen in any of the other three sites, being one of them, *Corralito 4*, only 200 m away from it.

Besides, the terracing walls are well-preserved being up to 1.50 m high and carefully built with selected stones. At the top of the terraces a canal was found, which would have watered this section of the site.

In general, it is assumed that the Inca intensified the agricultural production in several parts of the Empire with the preparation of great extensions of land for cultivation incorporating higher areas on hill slopes (Albeck, 1992–1993; Albeck, 2001). Planning is a recurrent feature in other cases of sites with Inca architecture such as the great agricultural site *Coctaca* in the Humahuaca gully in the northwest of Argentina, where also the stone clearing heaps show a systematization, especially those that could belong to the Inca occupation, in relation to building differences from the previous ones, such as their sediment granularity (Albeck, 2003–2005).

As a conclusion, we can say that the choice of new strategies on sampling for C14 dating in agricultural sites was highly satisfactory, avoiding soil reuse and dynamics biases. The results shown are coherent with what the architectural relative chronology suggested us but, more importantly, the subtle differences introduced by absolute chronology expanded our capacity to think about the dynamics in the construction and use of agricultural facilities in long time periods, including the changes introduced by Inca's expansion in the region.

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References

Albeck, M.E., 1992–1993. Áreas agrícolas y densidad de ocupación prehispánica en la quebradad de Humahuaca. In: Avances en Arqueología, vol. 2. Instituto Interdisciplinario Tilcara, Argentina, pp. 56–77.
Albeck, M.E., 2001. La Puna argentina en los períodos Medio y Tardío. In: Berberían, E., Nielsen, A. (Eds.), Historia Argentina Prehispánica, Tomo 1. Editorial Brujas, Córdoba, Argentina, pp. 345–388.
Albeck, M.E., 2003–2005. Sitios agrícolas prehispánicos: la búsqueda de indicadores cronológicos y culturales. Cuadernos del INAPL 20, 13–26. Buenos Aires.
de Betanzos, J., 1987 [1551–1557]. Suma y narración de los Inkas. Atlas, Madrid.
Cieza de Leon, P., 1986 [1553]. Crónica del Perú. Primera parte, 2da edición. Pontificia Universidad Católica del Perú. Academia Nacional de la Historia, Lima.
Coil, J., Korstanje, M.A., Archer, S., Hastorf, C., 2003. Laboratory goals and considerations for multiple microfossil extraction in archaeology. *Journal of Archaeological Science* 30, 991–1008. ISSN: 0305–4403. Academic Press.
Cremonte, M.B., Williams, V., 2007. La construcción social del paisaje durante la dominación Inca en el Noroeste Argentino. In: Nielsen, A., Rivolta, C., Seldes, V., Vázquez, M., Mercolli, P. (Eds.), Procesos sociales prehispánicos en el surandino. La vivienda, la comunidad y el territorio, Nro 1. Editorial Brujas, Córdoba, Argentina, pp. 207–236.
D'Altroy, T.N., Williams, V., Lorandi, A.M., Earle, T., Hastorf, C., Hagstrum, M., Russell, G., Sandefur, E., Calderar, M., Daniels, R., DeMarrais, L., 2000. Inka rule in the Northern Calchaqui Valley. Argentina. Journal of Field Archaeology 27 (1), 1–26. Boston University.
D'Altroy, T.N., Williams, V.I., Lorandi, A.M., 2007. The Incas in the Southlands. In: Burger, R., Morris, C., Matos, R. (Eds.), Variations in the expression of Inca power. Dumbarton Oaks, Washington, DC, pp. 95–143.
D'Altroy, T.N., Williams, V.I., Bauer, B.S., 1998. Inka Expansionism: A Comparison of Radiocarbon and Historical dates. MS.
DeMarrais, E., 2001. La arqueología del norte del valle Calchaquí. In: Berberian, E., Nielsen, A.E. (Eds.), Historia argentina Prehispánica. Editorial Brujas, Córdoba, pp. 289–346.
Fitzpatrick, E.A., 1996. Introducción a la Ciencia de los Suelos. Trillas, Madrid.
González, Alberto Rex, 1983. La provincia y la población incaica de Chicoana. In: Presencia hispánica en la Arqueología Argentina, vol. 2. Instituto de Historia, Facultad de Humanidades, Universidad Nacional Nordeste, Resistencia, pp. 633–674.
Goodman Elgar, M., 2002. Anthropogenic Landscapes in the Andes. A multidisciplinary approach to precolumbian agricultural terraces and their sustainable use. PhD. Dissertation. Jesus College, Cambridge.
Hongn, F.D., Seggiaro, R.E., 2001. Hoja Geológica 2566- III Cachi. Provincias de Salta y Catamarca. República Argentina. Programa Nacional de cartas Geológicas 1: 250.000. SEGEMAR, Buenos Aires.
Korstanje, M.A., 1996. Sobre la producción agrícolo-ganadera en el Formativo: Reflexiones para el camino. Actas y Memorias del I Congreso de Investigación Social: "Región y Sociedad en el NOA", Págs. 402–411. Facultad de Filosofía y Letras (UNT), Tucumán.
Korstanje, M.A., Cuenya, P., 2008. Arqueología de la Agricultura: suelos y microfósiles en campos de cultivo del Valle del Bolsón, Catamarca, Argentina. In: Korstanje, Babot, P. (Eds.), Matices Interdisciplinarios en Estudios Fitolíticos y de otros Microfósiles. BAR International Series, UK.
Korstanje, M.A., Williams, V., Cuenya, P., Villegas, P. 2008. La Dimensión Social de la Producción Agrícola en un Sector del Valle Calchaquí Medio. In: Korstanje, M.A., Quesada, M. (Eds.), Arqueología de la Agricultura: Casos de Estudio en la Región Andina Argentina. Universidad de Catamarca, in press.
Lumbreras, Luis G., 1981. Arqueología de la América Andina. Editorial Milla-Batres, Lima.
Nielsen, Axel, E., 1996. Demografía y cambio social en Quebrada de Humahuaca (Jujuy, Argentina) 700–1535 D.C. Relaciones de la Sociedad Argentina de Antropología 21, 307–385. Buenos Aires.

Nuñez Regueiro, V., 1974. Conceptos instrumentales y marco teórico en relación al análisis del desarrollo cultural del NO argentino Revista del Instituto de Antropología T (V), 469-190, Córdoba.
Päassinen, M., Siiriäinen, A., 2003. Andes Orientales y Amazonia occidental: ensayos entre la historia y la arqueología de Bolivia, Brasil y Perú. Universidad Mayor de San Andrés. Producciones CIMA, La Paz.
Porta Casanellas, J., López Acevedo Reguerín, M., Roquero De Laburu, C. (Eds.), 1994. Edafología para la Agricultura y el Medio Ambiente. Mundi-Prensa, Madrid.
Quesada, M., 2006. El diseño de las redes de riego y las escalas sociales de la producción agrícola en el 1° Milenio DC. (Tebenquiche Chico, Puna de Atacama). Estudios Atacameños 31, 31–46.
Quesada, M., Korstanje, M.A. Cruzando Estructuras: El Espacio Productivo Y Su Entorno Percibido Desde Las Prácticas Cotidianas. In: Albeck, Scattolin y Korstanje (Eds), El hábitat prehispánico. Arqueología de la arquitectura y de la construcción del espacio organizado, in press.
Raffino, Rodolfo, 1983. Los Inkas del Kollasuyu. Ramos Americana, La Plata. 2da Edición.
Rowe, J.H., 1944. An introduction to the archaeology of Cuzco. Papers of the Peabody Museum of American Archaeology and Ethnology 27 (2), 1–69.
Rowe, J.H., 1945. Absolute chronology in the Andean Aarea. American Antiquity 10, 265–284.
Sarmiento de Gamboa, P., 1943 [1572]. Historia de los Incas (edición de A. Rosenblat). Emecé ediciones, Buenos Aaires.
Scharer, K., Kashgarian, M., Zermeno, P., Kurdyla, D., 2006. What are we dating? An evaluation of chemical pretreatment methods for AMS 14C dating of peat. American Geophysical Union page 507+.
Tarragó, M.N., 1978. Paleoecology of the Calchaquí Valley, Salta Province, Argentina. In: Browman, D.L. (Ed.), Advances in Andean Archaeology. La Haya, Mouton, pp. 485–512.
USDA, 2006. Key to soil taxonomy by soil survey staff. EEUU, 10th ed.
Villegas, M.P., 2006. Teledetección arqueológica en el valle Calchaquí medio (Salta, Argentina. Licenciature Dissertation in Antrhopological Sciences, Facultad Filosofía y Letras, Universidad de Buenos Aires.
Williams, V., 2005. Provincias y capitales. Una visita a Tolombón, Salta, Argentina. Xama 15–18: 177–198. Mendoza.
Williams, V.I., Villegas, M.P., Gheggi, M.S., Chaparro, M.G., 2005. Hospitalidad e intercambio en los valles mesotermales del noroeste argentino. Boletín de Arqueología PUCP, 9, pp. 335–373. Lima.
Williams, V.I., 2007. Southern Empire Chronology: Some Questions about Inca Archaeology. Roundtable on Inka Chronology, workshop organized by Gary Urton and Terence N. D'Altroy, Dumbarton Oaks, May 19th, 2007, Washington D.C. MS.
Zaro, G., Umire Álvarez, A., 2005. Late Chiribaya agriculture and risk management along the Arid Andean Coast of Southern Perú, A.D. 1200–1400. Geoarchaeology: An International Journal 20 (No. 7), 717–737.