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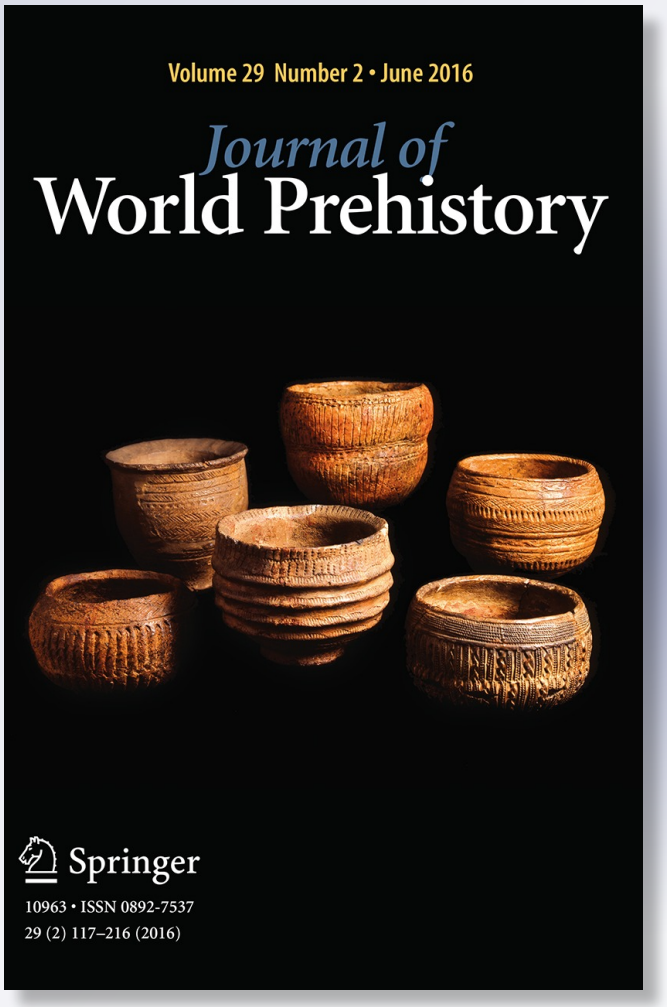

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Fire Events, Violence and Abandonment Scenarios in the Ancient Andes: The Final Stage of the Aguada Culture in the Ambato Valley, Northwest Argentina

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Abstract Understanding how archaeological sites are abandoned is a vital part of archaeology. This paper explores abandonment as a phenomenon in a worldwide context, particularly in relation to sites with evidence of fire, and with a special focus on the South-Central Andes. I evaluate the patterns from an area of the Argentinian Andes and discuss the disappearance of the Aguada Culture, one of the central cultures in Argentinian pre-history, using evidence from the core area the Ambato Valley. I conclude that environmental factors were not the sole or determining source of stress, but rather part of a social–environmental dimension in which several factors combined to push a society into a vulnerable situation. In terms of the abandonment of the Aguada settlements in the Ambato Valley, the study shows that frequent forest fires might have played a role, but based upon the regularity of such events as seen in the sediment history, it is unlikely that these were the only factor in the process of abandonment of the valley.

Keywords Abandonment · Fire · Microcharcoal · Aguada Culture · Ambato Valley · Northwest Argentina

Introduction

The Aguada Culture is one of the best-known cultures in the archaeology of Northwest Argentina. This southern Andean cultural complex developed a presence in the Ambato Valley between the fourth and tenth centuries AD (González 1961–1964, 1998; Pérez Gollán 1991). This culture is known for (amongst other things) its rich iconography, which

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includes feline motifs, shamans, warriors, fantastical beings and trophy heads on its typical black incised/engraved ceramic. The importance of the Aguada Culture in the development of Andean pre-Hispanic indigenous societies has been upheld by Alberto Rex González, known as the father of modern archaeology in Argentina. González, who first defined this culture (1961–1964, 1998), argued that it represented the highest point of development of the cultures of the Argentinian Northwest during the Middle Period. This period is now referred to in the archaeological literature as the Regional Integration Period (Pérez Gollán 1991, 1994). It can be characterized by (among other traits) the circulation of goods with high symbolic values (hallucinogenic substances, textiles, and metallic plates) between different societies in northwestern Argentina, with integration on a broad regional scale among the autonomous social groups which predominated in earlier times. González drew attention to a possible connection to the Tiwanaku culture area in the Middle Horizon because of various similarities in cultural development and the contemporaneity of the Aguada Culture. Central to the development of this society was the core area in the Ambato Valley (Catamarca province, northwest Argentina). The first proposed explanation for the disappearance or abandonment of this culture was by González, who argued for violence and ecological deterioration of the environment as possible causes. Two more recent discussions of the abandonment of the area have been presented by Gordillo (2013) and Gordillo and Leiton (2015). Archaeological data, accumulated over years of excavation in the area, have provided a robust body of evidence and information, with several contexts interpreted as scenarios of abandonment that affected multiple archaeological sites associated with this society. Several of these large sites, including Piedras Blancas, Martínez 2, and La Iglesia de Los Indios (sometimes referred to as La Rinconada), also showed signs of fire associated with the abandonment. Recent fieldwork suggests that these events may have been simultaneous, or almost simultaneous, a perspective strengthened by ^{14}C dating (Laguens 2006a; Marconetto et al. 2014; Lindskoug 2013). This hypothesis regarding the proximity of the events is further strengthened by the presence of burnt *chañar* fruits (*Geoffroea decorticans*) at both Piedras Blancas and La Iglesia de Los Indios, indicating that fires must have occurred close to their harvesting time, typically December through March. These fruits must be processed shortly after harvesting because they cannot be stored for a long time before starting to rot. This indicates that both sites were burned in the period from December to March (Marconetto et al. 2009). Was this a coincidence? Were both sites burned at the same time? The aim here is to discuss the concept of abandonment and its uses in archaeology, first in a general way, moving on to other examples from northwest Argentina, and then discussing and analysing the archaeological contexts from our study area, the Ambato Valley. I will consider various factors that may have led to abandonment—social, economic, political, ideological, symbolic, and natural. I will also focus on the evidence of violence, which has been argued to have been a cause of the abandonment process.

These archaeological contexts led us to investigate the possibility that extensive forest fires or wildfires could have occurred in the area at the time of occupation, and that this might be one reason for the area's abandonment (Lindskoug 2010, 2013, 2014; Lindskoug and Marconetto 2014; Marconetto and Lindskoug 2015). However, it was clear to us from the beginning that the real reason for abandonment was most probably not forest fires, but rather that these fires were the last of a long series of strains that had put the Aguada society in a vulnerable situation. Marconetto (2009, 2010) has obtained evidence of a drought at the time of abandonment of the valley, which further inspired us to investigate the possible relationship between abandonment and forest fires. However, we do not believe that only natural causes were involved in the abandonment process. Social,

cultural, and ideological factors—perhaps from both inside and outside the society—must also have played a role, together pushing Aguada society into a fragile position.

Cultural–Chronological Development in the South-Central Andes

While the Andes is most famous for the Inca Empire in the central Andes, earlier developments in this area and the south-central Andes were essential to the development of this empire that stretched from Ecuador, through Peru and Bolivia to northern Chile and northwestern Argentina. The south-central Andes is a place of great regional variety, with many highly developed prehistoric societies, the most famous being the Tiwanaku. Other regions of this area are, however, less well known outside the extensive Spanish literature. Several important developments took place in this area, including the domestication of several plant and animal species, along with metallurgical production. The archaeological record from the area is very rich, and elaborate stone sculptures, ceramics and textiles, among other goods, were produced here. Several different cultural chronologies and conflicting periodizations have been developed for this area. The main one in use was developed by John Rowe, with three different Horizons (Early, Middle and Late) and intermediate periods, based on ceramics from the south coast of Peru; the other is stage-based and was first developed by Luis Lumbreras. It is not my aim to discuss them here [see, for example, Stanish (Stanish 2003) for discussion]. The south-central Andes is a region that stretches from southern Bolivia through northern Chile and northwestern Argentina. It is characterized by the high, snow-clad mountaintops and valley systems of the Andean mountain chain, and includes a wide variety of ecosystems, both dry areas—like the Atacama desert, one of the driest places in the world where the world's oldest mummy-complex, the Chinchorro culture, developed (Arriaza et al. 2008; Rivera 1991)—and *Yungas*, rain forest areas with a range of natural resources, including the jaguar often depicted in the rich iconography of the region. Also characteristic of the Andes is the high plateau, called *Puna* in Argentina or *Altiplano* in Bolivia, located above 2500 m asl, with extensive grassland suited to llama pasturing and cultivation of potatoes, a staple crop in Andean cuisine for thousands of years. The Andes is also an area rich in minerals. Both gold and silver were extracted alongside other minerals, and metallurgy developed, leading to the production of elaborate bronze objects. The area has a diverse fauna, including the condor, pumas, flamencos, camelids (guanacos and vicunas), American rhea and foxes, found throughout the Andean mountain chain. Several large lakes are located high in the Andes, the most famous being Lake Titicaca. The cultures that developed around this lake had access to excellent arable land for tuber production and both fish and reeds were extracted by the local population. Reeds were used both for constructing boats and houses and to make various tools (Hastorf 2008). The first traces of humans in the area date to 10,000 BP and relate to hunter-gatherer societies occupying cave shelters high up in the Andes; some of the earliest dates come from Argentina and include Inca Cueva IV, Huachichocana III and Quebrada Seca 3 (Dillehay et al. 1992; Aschero 2010). This Paleo-Indian period is followed by the Archaic period (10,000–3500 BP), characterized by the growth of mobile forager groups and, at the end of the period leading into the Formative Period, several innovations which led to the first sedentary settlements and other innovations such as experimentation with domestication of plants and animals [see this text (Aldenderfer 1989) for a further discussion on the Archaic period]. Around 4000 BP, sedentary societies based on agricultural, lacustrine, riverine, and wild resources started to

develop and settle in the Titicaca Basin (Stanish 2003). Early evidence for the cultivation of a few plant species, including tubers and maize, can also be found in the area (Pearsall 2008); other early evidence of plant cultivation comes from northwest Argentina between 4000 and 1500 BP (Lema 2014). The domestication of llamas (*Lama glama*) and alpacas (*L. pacos*) may have started as early as 7000 BP (Stahl 2003; Yacobaccio 2004). Guanacos (*L. guanicoe*) and vicunas (*L. vicugna*) were domesticated into llama and alpaca alongside the guinea pig (*Cavia porcellus*, or *C. aparea porcellus*). Communication between distant areas was conducted by means of llama caravans which helped to distribute (along with other products) ideas and persons (Browman 1980; Núñez and Dillehay 1979; Nielsen 2013). Coastal resources from the Pacific Ocean are found on both side of the Andes, while products from the eastern mountain slopes are found on the western side of the Andes, showing that communication between the different areas was common.

During the Formative Period (1500 BC—AD 475) in the Titicaca basin we find the first evidence of more permanent settlements and small ceremonial centres, transforming and exploiting the landscapes in new ways. This period see the first examples of social stratification in the area, together with an investment in both plant cultivation and animal husbandry, leading to the development of small civic–ceremonial centres with growing political power, followed by Tiwanaku expansion in the area (Hastorf 2008). This period of Tiwanaku expansion has been denominated the Middle Horizon and is more or less contemporaneous with the Aguada Culture in northwest Argentina. The influence can be seen on, for example, ceramic vessels, textiles and stone sculptures throughout the area.

The only state-like society that arose in the area was the Tiwanaku (Tiahuanaco). For many years the precise nature of Tiwanaku society (whether it was a religious centre or a state society) and its expansion has been a topic of discussion. I will not pursue this discussion here but refer readers to the relevant literature, for example Browman (1980); Kolata (1993); Janusek (2004); Stanish (2002, 2003); and Goldstein (2007). However, Tiwanaku had a great influence on later cultural development in the area before the expansionist Inca Empire, which extended from its centre in Cusco, Peru, into Ecuador, and parts of northern Chile and Argentina. Around 200 AD, Tiwanaku had established itself as a powerful political entity in its nuclear area. Around 600 AD, Tiwanaku started its expansion in the Titicaca basin, which reached its maximum around 900 AD or slightly earlier; soon after this it began a slow decline as a regional entity (Stanish 2002, 2003; Janusek 2004; Kolata 1993; Hastorf 2008; Goldstein 2007; Stanish et al. 2005). After the fall of Tiwanaku, the area is characterized by small regional entities that develop until the expansion of the Inca Empire around 1420, which abruptly finishes with the arrival of the Spaniards in 1532 and the subsequent conquest of the Inca Empire by the Spanish.

There is evidence of interaction across the whole region since the arrival of the first humans, but to different degrees during different time periods. On the northern Chilean coast around Arcia, the Chinchorro Tradition develops from 7500 to 2500 BP, a society based on marine resources that created the world's first mummies in the dry Atacama Desert (Arriaza et al. 2008; Arriaza 1995). Later developments include the Altiplano Tradition (3000–0 BP) (Rivera 1991, 2008). The most important centre in Chile during this time was San Pedro de Atacama, an important trade outpost during the Tiwanaku expansion and key figure in the regional interaction and long-distance trade in the region according to several researchers (Browman 1984; Torres and Conklin 1995; Núñez Atencio 1992, 1996). Cultural practices and goods from both southern Bolivia and Tiwanaku have been found at the San Pedro oasis, alongside goods from northwest Argentina, including objects from the Aguada Culture. However the importance of San Pedro was been questioned by Stovel (2008), especially since the identification in recent

years of a lot of new centres with exotic products from distant parts of the region. However, San Pedro was an important trading outpost where llama caravans from distant parts of the region interacted and where both ideas and products were exchanged.

Several models have been developed to demonstrate the different trade networks, contacts and interaction in the south-central Andean area, the most famous being Murra's vertical archipelago model (Murra 1972); others are Van Buren's (1996) critique of this model, Browman's (1980) Altiplano model and Núñez and Dillehay's rotary mobility model (Núñez and Dillehay 1979).

Northwest Argentinian Prehistory: An Introduction to the History of Archaeology in the Area

The Argentinian Northwest is the best known and most investigated area in Argentina; however, outside Argentinian archaeology it is less renowned. One reason for this may be that many publications are in Spanish, and the large English-speaking academic community does not often read or cite publications in this language, sticking to general overviews by foreign archaeologists working in the area. Several overviews of the cultural history of the area have been published (González 1979; González and Pérez Gollán 1972; Tarragó 2000; Berberián and Nielsen 2001; Raffino 2007; Williams et al. 2007). Since the initiation of work in the area by Alberto Rex González, the development of a framework of evolution and development has been the main goal in terms of creating regional chronologies and structuring the area's cultural history. A separation between hunter-gatherers and sedentary societies, along with the nature–culture division, can be seen as a result of the influence of González's evolutionary view of archaeology. González had a massive influence on theories regarding the Aguada society and the collapse or disappearance of the Aguada culture, as discussed below, and he introduced a new way of practising archaeology in the area, along with a new way of thinking about and interpreting the archaeological record, departing from earlier attempts to create a chronology and apply the cultural homogeneity long present in northwest Argentinian archaeology. González created a prime example of the North American school of culture-historical archaeology in Argentina (Politis and Gollán 2008). He outlined a cultural development based upon an evolutionary perspective associated with cultural diffusion, which recognized the Central Andean area as the centre for the diffusion of culture and civilization into less developed areas such as northwest Argentina (Dillehay 2012; González 1961–1964, 1972, 1977, 1979, 1998; González and Pérez Gollán 1972; Tarragó 2003). He argued that it was necessary to study the indigenous cultures in the area in order to understand their geographic distribution and relationships with the environment (González and Pérez Gollán 1972). This new organization of northwest Argentinian cultural areas helped him to organize the region's diverse cultures into an evolutionary scheme and to connect this peripheral area to more central cultural developments in the Central Andes. According to this scheme of local cultural development, different, local adaptations to the environment could arise in peripheral areas. This would later become central to González's argument about the reasons for the disappearance of the Aguada culture. He shared the perspective of Vere Gordon Childe (1892–1957), that changes associated with progress are generated by the environment. It was not until 1988 that Gonzaléz began to use environmental deterioration as an explanation for the end of the Aguada. Later ideas about the archaeology of northwest Argentina came to change the evolutionary viewpoint espoused by González by applying a materialist

approach to cultural development. However, González's ideas are still highly relevant and are frequently applied to the area's history.

This materialist viewpoint in northwest Argentinian archaeology was developed in the late 1970s by Victor A. Núñez Regueiro (1978), a disciple of González. Núñez Regueiro wrote:

> The geographic environment, indirectly influencing the objects of production, conditions Man and becomes one of the essential (though not determining) factors in his development. Before agriculture appears, human groups are restricted to consuming food, and they must thus integrate dynamically, in an almost direct manner, with the ecological system of which they form part. With the advent of agriculture and livestock breeding, food production begins. … Thus nature and sociocultural groupings enter into a permanent dialectic play which gradually modifies both, giving rise to different ecological systems and sociocultural formations. (Núñez Regueiro 1978, p. 461)

With respect to the new mode of production in the producing phase he argued that 'An essential change began to occur with the introduction of agriculture … For the first time Man achieved a break from his absolute dependence on natural resources for subsistence. … an increase of population became possible' (Núñez Regueiro 1978, p. 466). This demonstrates Núñez Regueiro's view of the importance of the environment for cultural development in northwest Argentina. It also shows the significant role that the environment played in several central discussions about cultural development and how these ideas affected the view of northwest Argentinian archaeology over a long period. Several of these topics are still central to discussions about the region. These perspectives can be related to the theoretical view of different nature/culture concepts, and are based upon the separation in our modern Western ontology between nature and culture. Theories about cultures and societies as predatory on nature have also been advanced by several scholars working in the area, and this trend is particularly noticeable in the chronological schemes developed for the northwest. In this same work, Núñez Regueiro (1978) developed a new periodization for the northwest. Inspired by Luis Lumbreras, a Marxist-materialist view was adopted and the modes of production in each phase are the basis for the scheme. The chronology is divided into three stages: the Foraging Stage (13,000–500 BC); the Producing Stage (500 BC–AD 1536); and the Stage of European Trade Expansion (post-1536). The relevant stage for the Aguada culture is the Producing Stage, which is further divided into four periods (Núñez Regueiro 1978):

- Archaic Period (500–200 BC)
- Formative Period (200 BC–AD 1000)
- Regional Development Period (1000–1480 AD)
- Imperial Period (1480–1536 AD)

The Ambato Valley: Environmental Setting

The Ambato Valley is located in the province of Catamarca in northwest Argentina, in the Andean cordillera. The valley runs north to south, with the Ambato or Manchao mountain range to the west (4050 m asl) and the Sierras Graciana–Balcosna range to the east (1850 m asl). The valley's southern limit is the Catamarca Valley, and the northern boundary the Altos de Singuil highlands. The Los Puestos River (*Río de Los Puestos*) runs

north to south across the fluvial plain that forms the floor of the valley, with the river's name later changing to *Río del Valle* (Fig. 1).

The valley forms part of the geological province called the Northwest Pampeanas Ranges (*Sierras Pampeanas*), an area characterized by narrow valleys alternating with high mountain ranges and forests. The geological formations in the valley include El Portezuelo/Ancasti, Concepción, and Coneta, along with alluvial deposits on the valley floor. The geological components include the basement rock, mainly banded gneisses, migmatites and schist outcrops, which are often intruded by pegmatites and tonalite–granodiorite bodies. Quaternary sediments along with small relict areas of Tertiary sedimentary rock fill the intermontane valley (Blasco et al. 1994). The principal components of the El Portezuelo/Ancasti formation are constituted by the metamorphic basement formed in the Early Precambrian–Palaeozoic period and include granular gneisses and migmatitic banded gneisses, gneissic schists, or mica-rich gneisses, composed of quartz, plagioclase, biotite, sillimanite and/or cordierite (Blasco et al. 1994, p. 19). The quaternary sediments correspond to the Concepción (Pleistocene) and Coneta (Holocene) formations. The sediments grouped in the first level of the piedmont are composed of fanglomerates and correspond to the Concepción formation. The second level of the piedmont is the Coneta formation, which is composed of fanglomerates, sands, and silts (Blasco et al. 1994).

The region forms part of both the 'Monte' and 'Chaqueña' phytogeographical provinces (Cabrera 1976). The valley is characterized by a warm continental climate, with annual precipitation ranging from 500 to 800 mm, mainly occurring as localized summer rains (November–March). It is noteworthy that the area is a border zone with other phytogeographical provinces with different characteristics. To the northwest, it borders the *Prepuna*

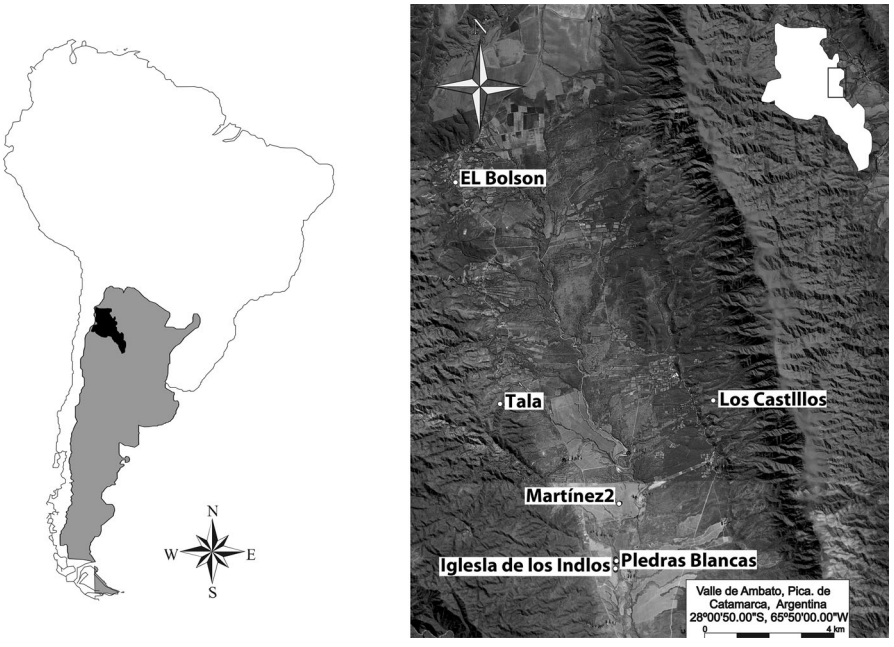


Fig. 1 Map of South America, with close-up showing the Ambato Valley with major localities (El Bolson, La Tala and Los Castillos) and archaeological sites with evidence of fire (Martínez 2, Piedras Blancas and Iglesia de Los Indios)

and *Monte* phytogeographical provinces (Cabrera 1976), and towards the northeast it adjoins the extreme southern end of the *Yungas*, the (Selva) Tucumano–Boliviana jungle/rainforest of the Amazonian Dominion.

The characteristic vegetation of the valley is arranged in 'belts' or 'bands', each with its own particular structure and composition. The first band corresponds to forest features (*bosque serrano*) and is followed by a band of shrubs and grasses. At higher altitudes the woody taxa disappear, replaced by an almost pure grassland (*pastizal de altura*). The altitude ranges occupied by each band vary as a function of latitude and longitude and also in response to microclimatic conditions, especially in relation to the orientation of the slopes (Morláns and Guichón 1995). The western and eastern slopes of the valley have different vegetation because of the differences in the precipitation that the two mountain ranges receive. Since the Ambato Valley is located in a transitional zone between two different phytogeographic regions it contains species from both zones. However, there is a clear difference between the vegetation on the western slopes of the valley and that on the eastern slopes.

De la Orden and Quiroga (1997) created a physiographic classification that divides the valley into several areas, although the landscape has changed since this classification was created. Today, agricultural activity—principally the large-scale cultivation of walnuts—has largely transformed the valley, especially the southern part. This has accelerated the deforestation of the native species, a process exacerbated by the use of heavy machinery in other agricultural activities. This means that the vegetation surveys of the 1990s are no longer applicable to some parts of the valley, and in many places the native vegetation has been totally replaced, with only small relic patches surviving. The use of heavy machinery and ploughing to clear new agricultural land has also damaged or totally destroyed some archaeological sites in the valley.

The Archaeological Landscape in the Ambato Valley

More than 700 archaeological sites, including agricultural terraces and structures for animal herding and settlement units, have been recorded in the Ambato Valley, around 130 of which are settlement units. Most of the residential units are found on the fluvial plain, between the first and second terraces of the Los Puestos River, between approximately 1050 and 1090 m asl. The agricultural terraces are located on the third natural terrace and in the piedmont area. In the area between the agricultural terraces, the landscape is also dotted with residential units (Assandri 2007; Figueroa 2010). The sites recorded are concentrated in the southern part of the valley, but this probably reflects the fact that this area has been more intensively surveyed than the northern part. The residential sites are usually rectangular but have different sizes and compositions. A settlement unit can be composed of various rooms, internal patios, and semi-roofed galleries in a number of configurations, making up a diverse and complex settlement pattern in the valley. The spatial aspects of these settlement units have been analysed by Assandri (2006, 2007) and Assandri and Laguens (1999), who proposed the existence of a hierarchical distribution of space with very complex sites and other smaller sites with a simpler composition.

Assandri's (2005, 2006, 2007, 2010) analysis of the location and concentration of archaeological sites on the valley floor allowed division of the settlements into three groups or villages based on the size and complexity of the sites. The study of the concentration and distribution of the residential units used cluster analysis (with the programs SPSS and K-means, applying the nearest neighbour as a measure of distance), and an analysis of the intervisibility of the sites was also performed. Assandri concludes that each village or

concentration is organised around 'very large units', associated by a relation to neighbours of the first order (large units) and later to medium units and small units.

According to Figueroa (2008, 2010), the agricultural terraces found on the hillsides can be classified into three different types: (1) straight hillside terraces (*terrazas de ladera recta*) and contour hillside terraces (*terrazas de ladera contorno*); (2) cross-channel (*terrazas de cauce*); and (3) box or rectangular stone structures (*estructura de caja o rectángulo de piedra*) (Fig. 2). The surveys conducted by Figueroa (2008, 2010) also demonstrated the existence of various channels that lead from the slopes down to the fluvial floodplain. Some of them seem not to be associated with agricultural terraces found on the slopes, but instead convey water down to other areas on the floodplain. It has been suggested that these reflect a transversal use of the valley as some historical documents have shown, which is true in many other ethnographic cases in the Andes. The water channels and arroyos can define the most important circulation routes for people and goods, including the use of various different ecological areas for cultivation and herding (Pazzarelli 2012; Villafañez 2010, 2013).

Figueroa (2010) first argued that irrigation was not used in these prehistoric agricultural terrace systems. However, in a more recent study, Zucol et al. (2012) argue for the use of irrigation in the same structures. The need to irrigate agricultural terraces suggests drier conditions or a more extensive agricultural system. If these were related to a drier period, as some palaeoenvironmental studies have indicated (Marconetto 2009, 2010), this would lead to an increase in fires in the area. This indicator of a more extensive use of water must be further investigated, especially in terms of why and when the system was developed.

Fig. 2 The landscape of the Ambato Valley with agricultural terraces in the background, after a big wildland fire in December 2009

There could be many reasons, including population expansion and a greater need of food products, an increase in surplus production for elite segments of society to support trading networks, or water deficiencies caused by environmental degradation, as proposed by González (1998). I suggest that this increase in irrigation is related to a drier period affecting the Aguada society in the Ambato Valley and that the water channels were used to irrigate agricultural areas. During surveys in the valley and the adjacent Balcosna Valley, several structures were found that served as water reservoirs and these must have had an agricultural purpose. Some of these structures found in Balcosna still function. Associated with this change in the use of the landscape are the fire regimes linked to drier periods.

However, this division of past landscapes into domestic space, agricultural areas, and the natural environment reflects our own perception of the world. Based upon ethnographic work in the area, Pazzarelli (2012) has suggested a division of the past landscape in the Ambato Valley into *entrepircas* (between the drystone walls) and *entremontes* (between the hills/Monte vegetation). These divisions are associated with local concepts and the present-day use of space in the valley. The local use of the space can be seen as a living one, which distributes the landscape between these two categories.

Chronology of Some Archaeological Sites in the Ambato Valley

The Formative Period is represented in the valley by two mound sites, El Altillo and Martínez 3, although most sites in the valley have been radiocarbon dated (Table 1) and are chronologically situated between the sixth and eleventh centuries AD. This period corresponds to the development of the Aguada culture in the Ambato Valley and is known as the Regional Integration period according to Pérez Gollán (1994). The radiocarbon dates associated with the fire regimes are also discussed in Marconetto et al. (2014). The end of the valley's occupation was first dated to around 1000 ± 100 AD (Gordillo 2005; Marconetto 2007). However, new analysis and calibration of the radiocarbon dates has established that the event most probably took place no later than 900 AD (Marconetto et al. 2014). We based this interpretation not just on the radiocarbon dates, but mainly on the stratigraphic relationships between different objects in Compounds F and G at the Piedras Blancas site. This site was affected by fire and a collapse of the roof that sealed the archaeological deposits, as discussed below. We argued that through our use of the Harris Matrix stratigraphic method we were able to correlate the events better. We based our interpretations on the stratigraphic relationships of the objects and correlation of the radiocarbon dates, which seem to largely diverge in time. By analysing the inconsistencies between the radiocarbon dates and certain events clearly identified in the detailed stratigraphic record, we were able to obtain a point of control between the events and the possible dates obtained from radiocarbon dating (Table 1). Our study, Marconetto et al. (2014), suggests that dated bone material seems to display a greater consistency than dated charred plant material with a short biological lifespan, in this case *chañar* fruits used to date the final occupation of the valley (Table 1). The chañar fruits might, however, indicate the time of the year when the fire took place since they cannot be stored for a long period. We think that the high quantities of microcharcoal present in the sediments might have affected some of the samples, and we base this assumption on our analysis of microcharcoal.

Table 1 Radiocarbon dates from archaeological sites in the Ambato Valley

Structure	Material	Labcode	14C age BP	Calibrated age						Δ 13 C	F
				1 sigma		% Probability	2 sigma		% Probability		
				Low	High		Low	High			
Piedras Blancas, Compound F	Wattle 1	LP-1241	1000 ± 70	1024 AD	1155 AD	68.2	975 AD	1224 AD	95.4		
Piedras Blancas, Compound F	Wattle 2	LP-1257	920 ± 70	1046 AD	1085 AD	17.5	1030 AD	1270 AD	95.4		
				1110 AD	1118 AD	2.6					
				1131 AD	1225 AD	48.1					
Piedras Blancas, Compound F	Pot organic residue	AA82323	1281 ± 33	722 AD	740 AD	10.2	688 AD	753 AD	26.3	−12.2	0.8526 ± 0.0036
				770 AD	868 AD	58	759 AD	886 AD	69.1		
Piedras Blancas, Compound F	Hearth branch	AA82324	1273 ± 49	720 AD	742 AD	9.2	674 AD	898 AD	92	−21.6	0.8534 ± 0.0052
				770 AD	883 AD	59	920 AD	944 AD	3.4		
Piedras Blancas, Compound F	Camelid bone	AA93888	1320 ± 44	674 AD	779 AD	66.6	665 AD	871 AD	95.4	−11.5	0.8485 ± 0.0047
				794 AD	798 AD	1.6					
Piedras Blancas, Patio G	Chañar fruit 1	LP-2175	1200 ± 50	784 AD	787 AD	1.4	724 AD	739 AD	1.2		
				825 AD	841 AD	6.4	770 AD	994 AD	94.2		
				862 AD	978 AD	60.4					
Piedras Blancas, Patio G	Chañar fruit 2	AA93886	1269 ± 35	773 AD	880 AD	68.2	687 AD	894 AD	95.4	−25.5	0.8539 ± 0.0037
Piedras Blancas, Patio G	Chañar fruit 3	AA93885	1330 ± 35	684 AD	772 AD	68.2	660 AD	826 AD	92.3	−24.4	0.874 ± 0.0037

Table 1 continued

Structure	Material	Labcode	14C age BP	Calibrated age						Δ 13 C	F
				1 sigma		% Probability	2 sigma		% Probability		
				Low	High		Low	High			
							849 AD	862 AD	3.1		
Piedras Blancas, Patio G	Camelid bone	AA93887	1316 ± 44	676 AD	780 AD	62.9	666 AD	875 AD	95.4	−12.7	0.8489 ± 0.0047
				792 AD	805 AD	5.3					
Piedras Blancas, Compound C	Hearth	LP-1223	1370 ± 70	650 AD	775 AD	68.2	606 AD	883 AD	95.4		
Piedras Blancas, Compound H	Charcoal from burial (intrusive)	LP-1269	1230 ± 80	773 AD	904 AD	49.7	674 AD	994 AD	95.4		
				914 AD	970 AD	18.5					
Piedras Blancas, Compound H, structure 1	Camelid bone	AA82322	1309 ± 43	680 AD	782 AD	59.3	670 AD	878 AD	95.4	−11.2	0.8496 ± 0.0046
				790 AD	810 AD	8.9					
Piedras Blancas, Compound H	Maize	AA82325	1488 ± 33	600 AD	650 AD	68.2	562 AD	660 AD	95.4	−12.1	0.8309 ± 0.0035
Piedras Blancas, Compound H	Burial tooth	AA82326	1509 ± 43	574 AD	644 AD	68.2	469 AD	480 AD	0.8	−10.3	0.8287 ± 0.0045
							534 AD	664 AD	94.6		
Piedras Blancas, mound 1	Dispersed charcoal	LP-1105	1040 ± 50	994 AD	1047 AD	35	975 AD	1163 AD	94.9		
				1084 AD	1136 AD	33.2	1169 AD	1175 AD	0.5		
Piedras Blancas, mound 2	Dispersed charcoal	LP-1090	1340 ± 40	675 AD	726 AD	41.2	656 AD	826 AD	92.5		
				738 AD	770 AD	27	840 AD	862 AD	2.9		

Table 1 continued

Structure	Material	Labcode	14C age BP	Calibrated age						Δ 13 C	F
				1 sigma		% Probability	2 sigma		% Probability		
				Low	High		Low	High			
Iglesia de los Indios	Chañar fruit 1	LP-932	840 ± 55	1202 AD	1278 AD	68.2	1050 AD	1078 AD	2.5		
							1146 AD	1300 AD	92.9		
Iglesia de los Indios	Chañar fruit 2	LP-1206	930 ± 40	1050 AD	1078 AD	17.5	1040 AD	1224 AD	95.4		
				1146 AD	1212 AD	50.7					
Iglesia de los Indios	Trunk undeterminated 1	H 7004	1260 ± 40	774 AD	885 AD	68.2	687 AD	898 AD	91.6		
							920 AD	944 AD	3.8		
Iglesia de los Indios	Trunk undeterminated 2	GIF 9413	1420 ± 50	613 AD	690 AD	63.7	585 AD	773 AD	95.4		
				752 AD	761 AD	4.5					
Iglesia de los Indios	Trunk, *Alnus*	GIF 9412	1180 ± 45	884 AD	984 AD	68.2	778 AD	994 AD	95.4		
Iglesia de los Indios	Trunk, *Phoebe*	LP-464	1650 ± 75	391 AD	556 AD	68.2	258 AD	299 AD	4.2		
							318 AD	614 AD	91.2		
Iglesia de los Indios	Trunk, *Phoebe*	Beta 79180	1250 ± 60	723 AD	740 AD	5.4	686 AD	974 AD	95.4		
				770 AD	896 AD	58.9					
				924 AD	937 AD	3.9					

Table 1 continued

Structure	Material	Labcode	14C age BP	Calibrated age						Δ 13 C	F
				1 sigma		% Probability	2 sigma		% Probability		
				Low	High		Low	High			
Iglesia de los Indios	Trunk, *Acacia* 5 cm	LP-1199	1230 ± 40	779 AD	895 AD	64.1	722 AD	740 AD	2.6		
				926 AD	935 AD	4.1	770 AD	979 AD	92.8		
Iglesia de los Indios	Full carbonized post	LP-495	1710 ± 45	264 AD	275 AD	3.8	257 AD	300AD	10.1		
				332 AD	434 AD	60.5	317 AD	535 AD	85.3		
				494 AD	506 AD	3.9					
Iglesia de los Indios	Dispersed charcoal 1	H 7005	1380 ± 40	655 AD	708 AD	52.5	640 AD	778 AD	95.5		
				747 AD	766 AD	15.7					
Iglesia de los Indios	Dispersed charcoal 2	LP-481	1800 ± 80	179 AD	189 AD	2.4	79 AD	529 AD	95.4		
				213 AD	404 AD	65.8					
Iglesia de los Indios	Bone	LP-1225	1220 ± 80	777 AD	904 AD	47.5	682 AD	996 AD	94.4		
				912 AD	971 AD	20.7	1006 AD	1015 AD	1		
Iglesia de los Indios	External rings *Prosopis*	LP-1754	1200 ± 60	783 AD	979 AD	68.2	716 AD	1017 AD	95.4		
Martínez 2	Post	LP-444	1690 ± 80	340 AD	536 AD	68.2	235 AD	600 AD	95.4		
Martínez 2	Wattle	LP-1317	990 ± 70	1025 AD	1160 AD	68.2	982 AD	1225 AD	95.4		
Martínez 2	Charcoal	LP-558	1510 ± 70	544 AD	655 AD	68.2	428 AD	679 AD	95.4		
Martínez 3	Charcoal	LP-553	1700 ± 60	336 AD	442 AD	47.9	251 AD	547 AD	95.4		
				452 AD	461 AD	2.9					

Table 1 continued

Structure	Material	Labcode	14C age BP	Calibrated age						Δ 13 C	F
				1 sigma		% Probability	2 sigma		% Probability		
				Low	High		Low	High			
				484 AD	532 AD	17.4					
Martínez 3	Camelid bone	AA93889	1458 ± 44	606 AD	663 AD	68.2	553 AD	688 AD	95.4	−13.4	0.8340 ± 0.0046
Martínez 1	Trunk	LP-461	1770 ± 90	214 AD	429 AD	68.2	90 AD	100 AD	0.6		
							124 AD	540 AD	94.8		
El Altillo	Branch	LP-474	1900 ± 70	79 AD	245 AD	68.2	17 AD	348 AD	94.4		
El Altillo	Dispersed charcoal, *Prosopis* sp.	LP-1329	1390 ± 80	624 AD	776 AD	68.2	566 AD	885 AD	95.4		
El Altillo	Charcoal, *Prosopis*sp.	LP-1331	Modern								
Terrazas Los Varela	Camelid bone	AA93890	1312 ± 43	680 AD	780 AD	61.6	669 AD	874 AD	95.4	−12.2	0.8493 ± 0.0046
				792 AD	806 AD	6.6					

OxCal v4.1.7 Bronk Ramsey (2009); r:5. Atmospheric data from Reimer et al. (2009); "ShCal04.14c"

LP (LATyR, UNLP, conventional date); AA (Arizona, AMS); H (Heidelberg); GIF (Centre des Faibles Radioactivites del CNRS); Beta (Beta Analytic Inc.)

The Aguada Culture in the Ambato Valley

Since the 1990s a number of investigations have been conducted in the area, mostly related to social inequality and how new roles took shape in the Ambato Valley. It has been suggested that after the beginning of the fifth and sixth centuries AD important changes occurred in the lifestyles of the region, ultimately manifested in the development of the culture called La Aguada. These changes were characterized by the emergence of new power relations among people, material culture, and the environment, and these were materialized in various types of social differences. These topics have been the object of various studies (see, for instance Assandri 2007; Assandri et al. 1991; Dantas 2010; Fabra 2005, 2007; Figueroa 2010; Gastaldi 2010; González 1998; Gordillo 1995, 2009; Laguens and Bonnin 2005; Bonnin and Laguens 1996; Laguens 2004, Laguens 2006a, b; Marconetto 2008b; Pazzarelli 2006, 2012; Pérez Gollán 1991, 1994, 2000; Pérez and Heredia 1975; Espósito 2009). For an excellent discussion of the history of the research related to the Aguada culture and the Ambato Valley, see Gastaldi (2010, Chapter 1), and for the history of Osvaldo Herdia's work see Bonnin (2010).

Abandonment in Archaeology

Studies of abandonment in archaeology have followed two different lines of analysis. The first relates to the study of the formation processes of the archaeological record and is linked to the work of Michael B. Schiffer; the second looks at abandonment as a social phenomenon. Several concepts of abandonment have been developed by Schiffer (1972, 1985, 1995, 1996) in his studies of the formation of the archaeological record, and he describes behaviours and processes such as curate behaviour and scavenging along with different kinds of artefact assemblages such as primary, secondary and *de facto* refuse. The aim here is not to analyse the processes of abandonment that led to the formation of the archaeological record in the manner developed by Schiffer, but to look at abandonment as a social phenomenon. Both the spatial and the temporal scale affect the way we interpret the behaviour of abandonment in the archaeological record, and certainly this is also tied to the social and cultural context. In archaeology, abandonment of sites and regions has been closely linked to scenarios of warfare, mass migrations, collapse, and natural disasters. These concepts are all defined here for the discussion of our case study, and I discuss some of the studies that have given shape to the debate in this field. I emphasise that I view abandonment as a process and not as an event. The archaeological record from our study area is rich with evidence of sites which at first sight appear to reflect a rapid abandonment scenario associated with fire events. The aim here is to combine this information with information about past wild fire regimes in the Ambato Valley in order to analyse the abandonment patterns.

Abandonment Versus Collapse

Abandonment and *collapse* are concepts that have been widely used in popular science about the downfall of civilizations and cultures, and this is also true in the field of archaeology. Cameron (1993) has stated that 'abandonment conjures up images of catastrophe, mass migration, and environmental crisis. Archaeologists are not immune to the "disaster movie" mind set.' (Cameron 1993, p. 3). This perspective can also be observed in

the many papers and publications touching on collapse and abandonment in Mesoamerica, such as in the case of the Mayan collapse (Culbert 1973; Inomata and Webb 2003). Even the names used in the periods and chronology in the Mayan area give us a hint of this: Preclassic, Classic, and Postclassic, with further internal divisions such as, for an example, the Terminal Classic, also tied to an evolutionary scheme of birth, rise, and decline of societies and cultures. There are also archaeological sites in the American Southwest which provide good examples of abandonment (Schlander and Wilshusen 1993), including several cases with evidence of fire. And, of course, there is Pompeii, one of the most famous cases of collapse and rapid abandonment, used in the now-classic discussion between Binford and Schiffer (Binford 1981; Schiffer 1985) about the 'Pompeii premise'. This discussion includes several theoretical foundations for consideration of abandonment processes, involving their different views on the formation of the archaeological record. Schiffer argued that the archaeological record was not a closed cultural system, but that it reflects a past behavioural system. Binford and other 'new archaeologists' were accused of treating archaeological remains and objects as static once they entered the archaeological record.

Several comprehensive studies of abandonment have been published, including a volume edited by Cameron and Tomka (1993) and another edited by Inomata and Webb (2003). Several of these studies focused on the use of historical, ethnographic, and ethnoarchaeological research and data to understand abandonment processes. I propose that archaeology is in many ways an attempt to understand what happens at a site after its abandonment. First one has to consider what abandonment actually is and when a site gets abandoned. Is abandonment a normal process in the development of a settlement? In many ways, archaeological sites are reused or reoccupied. As archaeologists digging at a site we in some sense occupy the site once again, and some sites are reused over long periods, especially in agricultural areas such as those in the Andes, where agricultural terraces first constructed during prehistoric times, sometimes several thousand years ago, are still in use today. Sometimes people reoccupy sites after only a short time span, although they do not use the sites in the same ways as the former occupants. One such example is Petra in Jordan. When the site was rediscovered in 1812 by the Swiss explorer Johann Ludwig Burckhardt it was populated by local Bedouins. Their use of the site was different to that of the first occupants, but the site was still in use. It certainly had not been forgotten or abandoned, and the Bedouin people still populate the area around the archaeological site today. Tiwanaku in the Andes is another example of an archaeological site which is still used: when Evo Morales was elected president in 2006, he used the site to conduct the presidential ceremony. This event reinforced Tiwanaku as a symbol for indigenous movements in Bolivia, as Morales's presidency emphasised a new line in Bolivian politics. Many sites are only partially abandoned, and people—either the previous owners or scavengers—may go back to pick up things left behind. This is especially true in hunter-gatherer societies that move between different seasonal camps, since old camps are often reoccupied.

Abandonment (of a site) may often be seen as a gradual process. Where this is not the case, the term *rapid abandonment* may be applied. Collapse, on the other hand, is often seen as a fast process where areas or cultures collapse and disappear as indicated by Middleton (2012). Collapse can in fact be a slow process, brought about by social, economic, and political (i.e. cultural) factors as well as environmental. In many cases it is a complex human–environmental scenario with many different aspects, as discussed in several papers in McAnany and Yoffe (2010), for example. An area is not always abandoned after a collapse but can continue to be populated, as, for example, in the Mayan area.

However, when we refer to collapse in archaeology the predominant paradigm is environmental collapse, and according to Middleton this obscures our recognition of the dynamic role of social processes in human societies. I therefore use a definition similar to Middleton's and define collapse here for analytical purposes as a fast process tied to natural forces, in contrast to abandonment as a slow process that can be both naturally and culturally determined. In the present case I do not argue for a collapse of the Aguada society in my study area, but rather disintegration and abandonment of the area. I base this primarily on the ^{14}C dates obtained for the area that show that occupation extended over a prolonged time period (Marconetto et al. 2014) (Table 1). Thus I class a settlement or a site as abandoned when it is not permanently settled by a group, since in this case we are not dealing with mobile hunter-gathers who might return in the following season or after a couple of years to resettle a site, but with people who base their livelihood on agricultural production and herding (Dantas and Figueroa 2009; Figueroa 2008, 2009, 2010; Figueroa and Dantas 2012; Figueroa et al. 2010). However, some sites in the study area may have been occupied temporarily, for example in connection with llama herding, but since none of these are found on the valley floor or show evidence of fire they are excluded from this discussion.

Concepts and Scales in Abandonment

Abandonment can be analysed at both a micro- and macro-scale. Many archaeological studies of abandonment and collapse display confusion about scale, and therefore it is vital to define this concept first. All archaeological sites are abandoned: it is the scale—both temporal and spatial—that is important (Cameron and Tomka 1993). At what level did the abandonment take place: activity area, structure, settlement, or entire region? The first task when analysing abandonment is to establish the spatial scale. As Cameron (1993) argues, not all archaeological sites are abandoned in the same way, in terms of speed, planning, or anticipation of return. In some societies—including hunter-gatherers, pastoralists, swidden agriculturalists, and some sedentary agriculturalists—the abandonment of settlements is part of a subsistence system (Cameron 1993). The second step is therefore to evaluate the temporal scale of the abandonment. The next step is to establish the manner in which the site was abandoned: partially or completely, or with an expected return to retrieve things left behind? The circumstances of the abandonment must then be determined as mentioned above, and the speed of abandonment should also be considered. In a rapid abandonment the inhabitants tend to leave more things behind. Rapid abandonment is often associated with warfare or with natural disasters such as volcanic activity, earthquakes, or floods. These factors are all associated with economic and least-effort models, but ritual abandonment must also be considered, since not everything can be explained with economic models, especially in the archaeological record. For example, there are ethnographic examples of ritual closing of structures after the death of certain individuals, which involved both burning and closing of structures (James and Lindsay 1973), or sometimes the burning of the possessions of the dead (Tola 2006; Kopenawa and Albert 2013). Furthermore, the things people bring with them may be of sentimental rather than economic value. Sometimes abandonment is linked to particular segments of a society, and analysing socio-political contexts can help us understand the context for a crisis in a given society. If we can come closer to understanding the cultural context of the abandonment, this can lead us to a better understanding of both symbolic and ideological reasons for abandonment.

Classic Explanations of Abandonment on a Large Scale

Often abandonment can be associated with acts of violence, in the form of uprisings against the upper class or elite structures, and including internal and/or external warfare. These conflicts can arise for a variety of causes, with classic examples in archaeology including struggles over water resources and agricultural land. Other classic explanations for this kind of conflict include population growth, natural disasters, dry periods, volcanic eruptions, flooding and the like. These can lead to warfare or to large-scale migrations. Some of these situations might cause abandonment of a site or an entire region, but we have to consider that multiple factors may also have been involved. Ethnographic and modern examples of abandonment of large areas, regions, or valleys indicate that people do return to their lands or homes after natural disasters like landslides, floods, and volcanic eruptions (Oliver-Smith 1991, 1977). However, drought seems to persist for a much longer period in people's minds. A region that has been exposed to drought for several years becomes infertile, and people do not return to these places as quickly as they might to a place that has been exposed to the other natural disasters mentioned (Harrington et al. 2009; IPCC 2012; Spring 2012; Barnett and Adger 2007; Reuveny 2007; Scheffran 2011). It must also be considered that a landslide or an earthquake may last for minutes or a couple of hours, while a drought may last for decades. In the case of the abandonment of the Ambato Valley, theories about the abandonment have made connections with natural factors, in terms of a deterioration of the environment and increased warfare because of resource shortages and an uprising of the non-elite class against the elites. However, these explanations have taken ecological deterioration as a starting point (González 1998).

Floor Assemblages

To understand the abandonment patterns of a site we must first determine when occupation began, and, having established this, when residential use ended. If we analyse the abandonment of individual structures we have to understand how the structures are treated at abandonment. Are things removed? Are construction elements removed to be re-used in other contexts? What natural processes start to refill the structures after they are abandoned, and when do these occur? When do stone columns and roof constructions collapse? Are they intentionally destroyed? What is left on the floors? Are the surfaces clean, or are broken objects and trash left behind? These questions must be addressed so that we can understand what happened during abandonment of an individual structure. The analysis of floor assemblages is one of the key issues for the understanding of abandonment behaviour at a single structure. Stevenson's (1982) study of the abandonment of historic mining camps was pioneering in this field. Several hypotheses of how floor assemblages are constituted have also been advanced, some using ethnoarchaeological research and data to understand behaviours at abandonment (Joyce and Johannessen 1993; Tomka 1993), and studies based on archaeological data are also common (Schlander and Wilshusen 1993; Lightfoot 1993; Montgomery 1993). Of course, the studies by Schiffer (1972, 1985, 1995, 1996) on site formation processes have also have been influential in this field, along with Binford's (1979, 1981) studies on curation behaviour and other methodological and theoretical concepts. Ceramic refitting sequences from floor assemblages have also been part of these studies (Brooks 1993), where higher refitting sequences reflect less sweeping of the floors. 'Clean floors' with artefacts in place and many personal objects have accordingly been seen as indicating an anticipated return, while an abundance

of trash on the floor is taken to imply a gradual abandonment with no return expected (Stevenson 1982; Lightfoot 1993). Aside from location and quantity of trash, other indicators that can help us understand the abandonment process of a structure are objects left in their place of use (that is, do we find many small objects left behind?); reconstructed ceramic objects; and the presence of many heavy or cumbersome lithic objects, such as mortars and pestles, inside structures. These may also be a reflection of the means of transporting objects after the abandonment and the distance to the next site or dwelling. Filling material in the structures can be another indicator: does it contain abundant ceramic fragments? Can we find signs of later reoccupation?

As Schlander and Wilshusen (1993) have argued, when trying to understand more fully the behaviour at the abandonment of a structure, analysis of floor assemblages and artefact weights can give us insight into the type of abandonment or abandonment strategies (for example, whether the move is short or long distance; whether absence from the structure is long-term; whether a return can be expected or the structures were permanently abandoned). They argue that the treatment both of the roof and of the floor assemblages will look different based upon these types of factors. The move distance and time of absence will affect the number of objects left behind. This includes reusable elements of the roof construction and also floor assemblages, since these assemblages may reflect the ability to transport cumbersome or heavy artefacts such as mortars or large ceramic urns. According to Schlander and Wilshusen (1993), structures with burnt roofs, for example, tend to contain the heaviest floor assemblages. They use the total weight of the floor assemblages as a simple measurement because it provides a clear summary of the total amount of material remaining on a floor after abandonment. They divide these materials into four categories: ceramics, ground-stone artefacts, flaked-stone tools, and debitage.

Evidence of Fire and Abandonment: Accident, Natural Causes, or Ritual Practice?

Evidence of fire in the archaeological and geological records can provide specific clues as to why sites or even regions were abandoned. Microcharcoal extracted from sedimentary sequences or sampled from archaeological sites can give us information on biomass burning and can be used as an indicator of past fire events. Marlon et al. (2008, p. 697) have stated that '[f]ire is a key earth system process affecting ecosystems, land-surface properties, the carbon cycle, atmospheric chemistry, aerosols and human activities.' Studies of this type can give us indications about abandonment on a regional scale, but if we want to examine it on a more local scale or at a specific site we have to ask ourselves different questions.

Why are structures deliberately burnt down? Burning does not allow the inhabitants to reuse the construction material, which suggests permanent abandonment of the structure. Reasons for this might include warfare, insect infestation, ritual closing, and burial practices (Cameron 1990; Verhoeven 2000; Wilshusen 1986; James and Lindsay 1973). As argued by Schlander and Wilshusen (1993), burning structures is a costly enterprise, in terms of the work invested on roof constructions, consumption of valuable resources, the hazards it can present to other nearby structures, and permanent closure of the site. Cameron (1990) has studied abandonment practices for pit-structures in the Four Corners region of the American Southwest, especially those associated with burnt structures. She concludes that burning was common in the area but that there was great variation in the manner in which it was done. Her data suggests great variability in the way the pit-structures were abandoned, based upon indicators including floor assemblages, material

found in the infill of the structures, dismantling of the roof construction before the fire, reuse of the structures, and the quantity of trash left behind before or after the fire. Sometimes it also seems as though the burnt pit-structures were used to gather trash after the burning. She suggests that depending upon the context, several of the burnt structures could be associated with ritual abandonment, but in some cases she also argues that burning could have been linked to insect infestation, as there are ethnographic examples of structures being burnt to eliminate insects and other pests. According to Cameron (1990) there were two ways of abandoning structures in the area. The first was for the inhabitants to move away, taking personal belongings with them and dismantling part of the roof, and the second was for the structures to be burned, most probably intentionally, with many items left behind on the floor. Verhoeven (2000) has argued for close links among death rituals, fire, and abandonment as transformers of both human and material life in Neolithic sites in the Near East. According to him, ritual practices of intentionally burning settlements can be associated with mortuary rituals in the area, with the settlements afterwards abandoned. However, we have not found burials or human remains inside the compounds in our study area that can be linked to both fire and the abandonment of the structure. So what kind of evidence for abandonment and fire does exist closer to our study area?

González's View of the Disappearance of the Aguada Culture

As stated by Pérez Gollán and Heredia (1987, p. 176), there is no evidence of a late occupation in the Ambato Valley, and we are still far from having a solid explanation for this (cited in Gastaldi 2010, p. 54). Perhaps we have not been able to identify the late occupation in the valley, or perhaps for some reason the valley was depopulated, with the people either moving elsewhere or being exterminated. One of the scholars who has worked on the Aguada culture for the longest and who has published extensively about it is Alberto Rex González (1918–2012), who also first defined this culture as such (González 1961–1964). González (1998) argued that the Aguada culture had three different principal nuclei with multiple different geographical sectors, including the Hualfín and Ambato Valleys and the southwest sector of the La Rioja and San Juan provinces. He divided the Aguada culture into three different periods, in line with his evolutionary view of the historical process related to the Aguada culture and to northwest Argentina's pre-Hispanic past. His first phase reflects the formation of the Aguada culture, the second its cultural peak, and the third and last phase its decline, much like an evolutionary life cycle. These evolutionary ideas of González can be associated with his training in the US under Julian Steward at Columbia University and to Steward's cultural ecology approach. González (1979) argues that a considerable cultural impoverishment took place across northwest Argentina after the Aguada culture. Further, he believed that this disappearance was rapid and that after the fall of the Aguada culture there seems to be an archaeological lacuna for around 150 years, before the subsequent appearance of the Belén and Santa María cultures. González saw this as a period of regression and cultural decadence, especially in the technical qualities of the ceramics. This crisis, decadence, or 'cultural lacuna' after the fall of the Aguada can, according to González (1979), be dated to 850–1000 AD, based on the few radiocarbon dates available at the time for northwest Argentina. González and Pérez Gollán (1972) argued for a warlike hypothesis for the disappearance of the Aguada culture, involving clashes between the Aguada and other lowland cultures. In several of their works (González 1979; González and Pérez Gollán 1972, for example) they propose that any

relationship with the cultures from the lowlands, either from the Chaco region or the *Yungas*, could be seen as interrupting the evolutionary process of development in the Andean *valliserrana* area.

In later works, González (1998, p. 16) argued that the elements that contributed to the definition of Aguada as a culture included a uniformity in religious ideology in its final dispersion, followed by an abrupt and almost total disappearance. He states that the final integration depended on random, interacting causes beginning with ecological deterioration and the replacement of the Aguada culture with new cultures belonging to the Late Period. He believed that this disintegration must have been rapid, perhaps taking less than a century. González (1998, p. 275) further argued that ecological causes, including climate deterioration and a major alteration in climate conditions, were behind the fall of the Aguada culture, giving the example of the hydraulic constructions produced by Aguada society, which, he argued, required more favourable conditions of use than those of today. This hypothesis is mainly build upon evidence from the Tiwanaku area and the investigations of Ortloff and Kolata (1993); like them, González (1998) argues that the rainfall and the thermal gradient might have been the same in Bolivia and northwest Argentina. However, another reason for the disintegration of the Aguada society might have been the lowland people from the east, who, according to González, had a predatory nature indicated by the historic chronicles (González 1979; González and Pérez Gollán 1972). However, González (1998) also argued that the ecological deterioration caused by drought must have had a catastrophic effect not only on the hydrological system implemented by the Aguadas, but also on their political–religious organization, by eroding the authority of the shaman-priests and the socio-political system they supported. The collapse of this important element of the system caused a chain reaction, which made the society more vulnerable to attacks from the outside. This ecological–climatic deterioration must also have led to an increase in attacks by people from the lowland tribes of the east in pursuit of food supplies.

Another consequence of this climatic deterioration would have been lowering of the groundwater level, causing the extensive *algarrobo* (*Prosopis* sp.) forests to dry out and disappear, giving way to *barreales* (a dry area with sparse vegetation in the Andean mountain range). Algarrobo forest had been of the utmost importance for the Aguadas, because of both their harvesting of the seeds for food preparation and their use of the wood for firewood and in carpentry (González 1998, p. 275). The burning and destruction of the large ceremonial site La Rinconada may, according to González, mark the final stage of the peak of the Aguada culture. He argues that the burnt settlements found in excavations by Inés Gordillo at La Rinconada demonstrate that the final occupation of the site ended violently, although he found it difficult to say whether this was because of internal warfare between the Aguada chiefs (*señoríos*) or attacks by 'predatory people from the east' (González 1998, p. 42). The decline can also been seen in the ceramics and iconography, with traces of this disintegration manifested both in style and typology (González 1998, p. 280). The ideological–symbolical deterioration of the society is reflected in changes in styles and iconography, and this can be seen in several sectors in the Aguada area (González 1998, p. 78). Although González lays out evidence for the formation of a chain reaction, the bottom line is that climate change drove cultural change, and here the influence of Steward's cultural ecology in González's ideas about Aguada society is very evident. These ideas of abandonment are of central importance and will be evaluated in relation to factors other than ecological disaster. However, the main focus will be on past fire regimes that might have been involved in the process(es) and placed Aguada society in a vulnerable position that opened up the way to abandonment. Thus I will discuss not only

ecology, but also several social, political, and symbolic factors that might have influenced this scenario. With this in mind I hope to deviate from the climatic determinism so commonly relied upon in archaeology as the prime cause/mover of the rise and fall of past cultures.

Evidence of Fire and Abandonment in Archaeological Sites in Northwest Argentina

Several archaeological sites in northwest Argentina show signs of fire. These include, for example, site D-1 in the Alamito (Núñez Regueiro 1988), and several examples with burnt roof constructions from the La Ciénaga locality in the Hualfín Valley, including Lajas Rojas (Compound 4), Cerro Colorado (Compound 36), and Loma de Ichanga (Compound 6) (Valencia et al. 2010). In the Ambato Valley itself, several sites show signs of fire and collapse of the roof construction in multiple structures/compounds, for example, the already mentioned Piedras Blancas, La Iglesia de Los Indios, and Martínez 2 sites, leading to an interpretation of rapid abandonment after a fire event. Objects and artefacts left in situ also provide clues about the abandonment. Chañar fruits (*Geoffroea decorticans*) found at both Compound G in Piedras Blancas and Structure 5 at La Iglesia de Los Indios suggest that these sites most probably were abandoned between December and March, or in April or May at the latest. These fruits were also found in other archaeological contexts associated with the Aguada, as according to González (1998, p. 54) a large quantity of burnt chañar fruit was recovered in Levels 1 and 2 at Site N°1 in Costa de Reyes, located in the extreme south of Catamarca province near the border with La Rioja province. A 3 m trench was opened and at least five different layers were identified, with two radiocarbon dates obtained. Level 3 returned a radiocarbon age of 420 ± 120 AD, while Level 5 provided an age of 230 ± 100 AD. As mentioned above, chañar fruits ripen from December to March and must be picked during this season. According to ethnobotanical studies in the region the fruits must be processed shortly after harvesting, since they cannot be preserved for long before starting to rot. Chañar fruits are normally processed into other forms, including alcoholic beverages.

The other archaeological context with evidence of fire and abandonment close to our study area is in the Hualfín Valley. One of the structures with evidence of fire there is at the Loma de Ichanga site, Compound 6. Here two ceramic vessels were crushed by the collapse of the roof. The compound is a small structure measuring approximately 4 × 4 m. Several burnt parts of the roof construction were found during excavation, however, the absence of the central posts has been considered evidence of prior removal of the posts before abandonment of the site (Balesta and Wynveldt 2010). No evidence of warfare has been found at the site, except for perhaps the burnt roof. Since there are other contemporaneous sites with evidence of fire in the area, an abandonment ritual is suggested, related to a planned regional abandonment. The sites in the Hualfín region present clean floors, with some fruits and seeds and some corn cobs. The ceramics are associated with the 'Belén Negro sobre Rojo' type. What further suggests a planned regional abandonment is the possible transport of the posts and also the presence of some burials associated with the burnt structures (Balesta and Wynveldt 2010). However, this site is from the Regional Development Period and therefore later than the Aguada sites in the Ambato Valley.

The Archaeological Sites with Evidence of Fire in the Ambato Valley

The archaeological sites discussed here are those where evidence suggests they may have been affected by fire, namely La Rinconada (LR) also known as La Iglesia de Los Indios (IDI), Piedras Blancas (PB), and Martínez 2 (M2). Both La Iglesia de Los Indios and Piedras Blancas are very large sites, according to the classification made by Assandri (2007), and large sectors of the sites have been affected by fire.

La Rinconada (Also Known as La Iglesia de Los Indios)

La Rinconada (or La Iglesia de Los Indios), is located about 300 m away from Piedras Blancas. The first excavations was carried out in 1977 and directed by Alberto Rex González, and since 1988 excavations at the site have been directed by Inés Gordillo (Gordillo 2009). The site has been analysed in several publications (Gordillo 1995, 2005, 2006, 2007a b, 2009, 2013; Gordillo and Ares 2005; Gordillo and Buono 2005; Gordillo and Hoyos 2006; Gordillo and Solari 2007; Marconetto and Gordillo 2008; Gordillo and Leiton 2015). It is located on the floor of the Ambato Valley on the second terrace of the Los Puestos River. The site comprises 28 different structures and enclosures, including a large mound structure with ramps and a large open space or plaza (see figure 4.7 in Gordillo 2009). It has only been partially excavated, but the materials recovered include a range of ceramic vessels, lithic tools, metal objects, burnt seeds and plant material (including burnt tree trunks and part of the roof), and both human and animal bones, as well as some bone artefacts. The radiocarbon dates obtained from the site place it in the range 200–1200 AD (Table 1); however, most of the dates are clustered around 600–1000 AD. Several of the excavated enclosures show signs of burning in the form of burnt posts and parts of the roof constructions. In these contexts numerous artefacts have also been recovered, often with indications that the burning and collapse of the roof have sealed the objects in situ. For example, in structure E7 (E = structure, in Spanish *estructura*) excavation revealed a burnt trunk from the roof construction, which had fallen onto a ceramic vessel and shattered it (see figures 6.3 and 6.4 in Gordillo 2009). The structures with signs of fire and roof collapse at the La Iglesia de Los Indios site are E4, E5, E7, and E15. No sign of reoccupation after the fire event has been found in any of the structures.

Structures with Evidence of Fire (E4, E5, E7, and E15)

E4 is a semi-rectangular roofed structure, measuring 6 × 7 m and with an internal area of approximately 42 m^2, with four double stone walls (for further description see Gordillo 2009). E4 shows many similarities with E7 and the archaeological record from this enclosure shows an occupation floor covered with in situ objects impacted by the collapse of the roof during a fire (see figures 7.2 and 7.3 in Gordillo 2009). Many objects show clear signs of contact with fire (Gordillo 2009). The subsurface layers below the floor of this structure contained a few cultural inclusions in the sediments, but above the floor no evidence of reoccupation was found. Both ceramic materials and metal objects were found during the excavations, along with lithic objects used for grinding; ornaments; bone tools; and animal bones. Five radiocarbon dates in structure E4 indicate a time span of 1200–1700 BP (Table 1). As discussed by Gordillo (2009), a major problem with the radiocarbon dates from this structure is the large time span. The ceramic materials

recovered were highly fragmented and dispersed, and signs of fire on several ceramic pieces show that they may have been fragmented before the fire and not as the result of the collapse of the roof.

E5 corresponds to a large structure with an irregular shape because it is surrounded by several other structures that make up its walls. The internal area is around 588 m^2. E5 has only been partially excavated, but it is also a context with burnt roof structures, including posts, branches, and wattle (see figure 10.5 in Gordillo 2009). At least some parts of the structure had been roofed. One of the tree trunks from the roof construction was identified as Laurel de la Falda (*Cinnamomum* sp.), a tree which does not grow in the valley but in the Western *selva* forest around 50 km northeast of the site. This suggests that the wood used for the construction must have been specially selected and transported to the site, pointing to connections between the valley's inhabitants and other ecological regions. This trunk was only burned externally, which indicates that the intensity of the fire was not extreme. During the excavations a minimum of 12 ceramic vessels were recovered, some of which were broken by the collapse of the roof and contained parts of chañar fruits (endocarps) that may have been burned during the fire (see figure 10.5 in Gordillo 2009). Two radiocarbon dates were obtained from these: 840 ± 55 and 930 ± 40 ^{14}C years BP. These dates were obtained on material with a short biological life span and an annual life cycle, indicating that the abandonment of the site took place somewhere between 1000 and 1200 AD. Since these fruits must be processed shortly after harvesting, as mentioned above, these dates must indicate an event that took place in connection to the burning of the structure. However, in E5, another radiocarbon date obtained from the external rings of a trunk from *Prosopis* sp. provided a date of 1200 ± 60 ^{14}C years BP. The strange location of the trunk suggests that the tree may have been alive during the fire and may have been burned in the last phase of the occupation. However, this is not consistent with the radiocarbon dates obtained from the chañar fruits of the same structure (Gordillo 2007a, 2009). As discussed by Gordillo (2007a), this may be due to the large range of the calibrated ages, or the trunk might have been a post and the date might be incoherent because of the old wood effect.

E7 is a compound roofed structure with a slightly trapezoidal shape and an internal area of around 38 m^2. The walls consist of stone columns with rammed earth and some individual stones. As stated above, in E7 the fall of a burnt tree trunk from the roof crushed a ceramic vessel during the fire, and the deposits both above and below the layer with the burnt roofing material lack evidence of human occupation before or after the roof collapse (see figures 6.3 and 6.9 in Gordillo 2009). The radiocarbon dates from this structure correspond to M9 and M11 [M9 and M11 = samples (Spanish *muestra*) 9 and 11 in Gordillo's numbering] and indicate an age of around 1200 BP (1260 ± 40 and 1230 ± 40 ^{14}C years BP) (Gordillo 2009) (Table 1).

E15 corresponds to a roofed structure with an inverted L-shape, with maximum internal dimensions of 9 × 4 m. It also shows signs of having been affected by fire, with several of the artefacts recovered from the structure heavily damaged by the intensity of the fire. As in the other structures just described, an abundance of material from the roof structure was found, including posts, wattle, branches, straw, and mud *torta* (a *torta* is a big piece of compressed clay used in the construction of mud-walls), all burnt and associated with ashes and burnt sediments. The radiocarbon date from a post provided a date of 1710 ± 45 ^{14}C years BP. Since the floor of the structure did not contain many artefacts, Gordillo argues that the absence of materials may reflect the final removal of the artefacts, which, along with the destruction of a large ceramic vessel in situ, is probably related to the abandonment of the site (Gordillo 2009).

Martínez 2 (CatAmb002)

The Martínez 2 site was excavated over three field campaigns in 1974, 1975, and 1976. It is located on the floor of the valley to the north of the Piedras Blancas site and close to the sites Martínez 1, 3, and 4, around 50 m south of Martínez 4 and 100 m from the Los Puestos River. The site has an area of approximately 716 m^2, and according to Assandri's classification it corresponds to the category of large units. It is composed of two sectors with enclosures separated by a central patio and attached galleries, and the overall unit is trapezoidal (Juez 1991). The two sectors are located to the west and east of the patio (see figure 6.70 in Gastaldi 2010). The western part is composed of three enclosures from north to south. Attached to the eastern part of these enclosures is a roofed gallery about 2.5 m wide and open to the east (see figure 6.71 in Gastaldi 2010). The eastern sector of the site is composed of at least three enclosures and a possible fourth, which also run north–south. This sector also presents a roofed gallery on the western wall open to the west (see figure 6.75 in Gastaldi 2010).

Excavations were carried out in both sectors, both in the roofed structures and the open galleries, and these excavations revealed a gradient between the roofed structures and the galleries. The floors in the roofed structures are around 0.9 m deep, while the galleries have floors around 0.7 m below the surface, which means that in many cases one has to descend a small step from the gallery area to enter a roofed structure (Gastaldi 2010).

Three radiocarbon dates have yielded a broad time span, with ages between 300 AD and 1200 AD (Table 1). However, this range might reflect the types of dated materials as well as the old wood effect. If the materials with shorter biological time spans are selected, which would correspond to the last occupational phase of the site, the time span is narrowed to 1000–1200 AD. A perimeter wall made of double stone (*pirca*) rows seems to have surrounded the site. The inner walls were made of rammed earth (*tapia*), alternating with stone columns. Attached to some of the walls there are benches of rammed earth, which seem to have been used to store ceramic vessels and other artefacts. Other architectural features found during excavations included hearths and postholes. Several complete but fragmented ceramic vessels were also found, along with other ceramic materials, including a ceramic pipe; carbonized tree trunks; camelid and human bones; bone artefacts; lithic grinding tools; metal objects; burnt mud and wattle from the roof, including charred stems (probably *simbol* grass—*Pennisetum frutescens*); bricks (*panes*) with white paint; large mica fragments (*placas de mica*); and pieces of raw clay. The archaeological context for the site shows that the collapse of the roof structure and columns crushed several ceramic vessels placed on benches and close to the hearths (Gastaldi 2010; Juez 1991; Pazzarelli 2012). Gastaldi (2010) has analysed the ceramic vessels from this site, including their type, usage, and life history. The high number of items found in the enclosures, together with the burnt wattle, presents a scenario of rapid abandonment of the site, where the people left many of the artefacts in situ (see figures 6.70 to 6.75 in Gastaldi 2010).

Piedras Blancas

According to Assandri's (2007) classification Piedras Blancas is a very large site, which includes several compounds (*recintos* in Spanish) and a mound construction. It had roofed structures, open areas, and semi-roofed galleries (Fig. 3). The site is rectangular in shape and measures approximately 100 m east–west and 80 m north–south. Like the other burnt sites, it is located on the valley floor, and it is around 300 m north of La Iglesia de Los

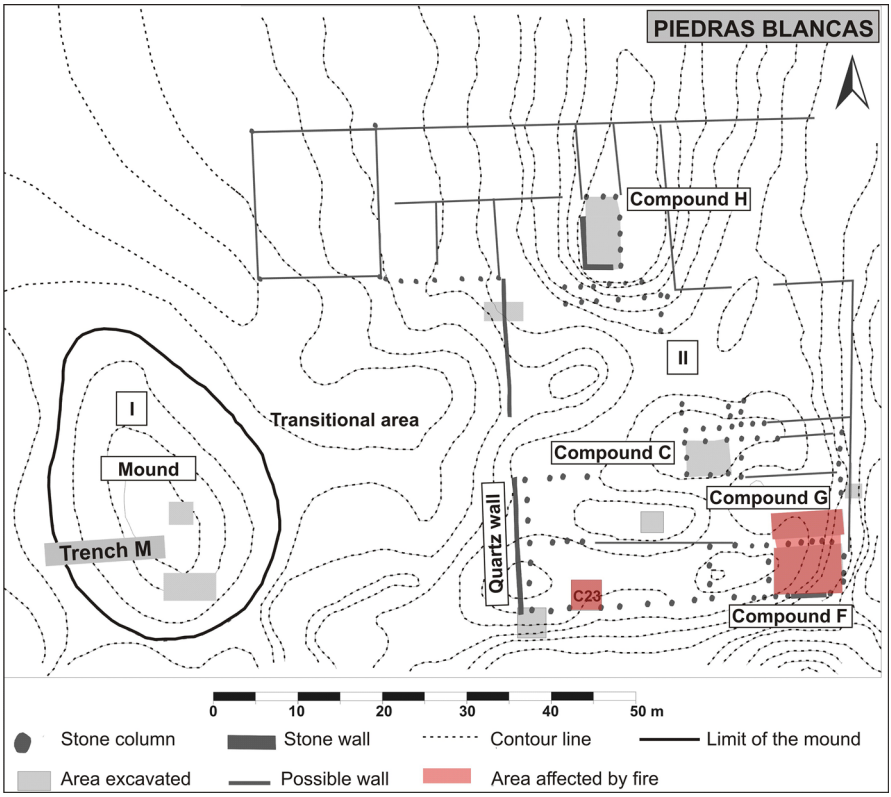


Fig. 3 Map of the Piedras Blancas sites with areas affected by fire

Indios and 100 m west of the Los Puestos River on the second river terrace. The site is delimited by a small temporary stream around 100 m to the north. The site was first recorded during archaeological surveys carried out in 1993. It is an open-air mound site, with high-visibility constructions and low obtrusiveness. The site has been divided into two parts, Sector I and II. Sector I corresponds to the open mound area and Sector II, to the east, corresponds to an area with structures with stone walls, including walls made of stone columns and rammed earth. Seven compounds are identified (B, C, E, F, H, I, and J), along with three internal patios that connect with the rooms (A, D, and G), and the galleries (G). In between Sectors I and II there is a transitional depressed area, with little in the way of archaeological materials. To access Sector II one has to pass a white wall made of quarried white quartz stones, which have given the site its name (Piedras Blancas means white stones in Spanish). This wall is approximately 39 m long (north–south) and in its central part there is a gap of 7 m, which has been interpreted as the access to the site (Caro 2006). The site has only been partially excavated over the course of seven field campaigns (November 1996, May and October 1999, November 2000, November 2004, March and April 2005, and October and November 2008). The excavated contexts have been analysed in several works, most recently by Gastaldi (2010), Pazzarelli (2006, 2012) and Lindskoug (2013). The structures with evidence of fire associated with the collapse and abandonment of the Piedras Blancas site are Compounds E, F, and G (Fig. 3). In the case of Compound

E, only a single small square unit, C23 (*Cuadricula 23* = Square 23) has been opened next to the southern wall during an excavation in 1999. Here a beam was found crushing a ceramic vessel along with some wattle, most likely from the roof construction.

Piedras Blancas: Compound H (Recinto Alto)

Compound H, sometimes called *Recinto Alto* (upper enclosure), is an enclosure measuring 4 × 8 m. Parts of the walls are made of stones and other parts with rammed earth and stone columns (see figures 4.22 and 4.23 in Lindskoug 2013). The site has a complex stratigraphy, and the northern part has a section which probably corresponds to a formative occupation of the site, while the rest corresponds to the Aguada occupation (Pazzarelli 2012; Gastaldi 2010). In this northern section an articulated camelid neonate was found, with two maize cobs deposited next to the body (see figures 6.79 to 6.86 in Gastaldi 2010). The archaeological record from this site demonstrates dynamics related to activity areas associated with different practices and dimensions of a complex social life, where rituals formed part of the construction process for the compounds. Besides the camelid neonate, another 'foundational burial' was discovered in the southwest area of the compound close to the wall. This consisted of a human infant buried in a pit. For a fuller description see Cruz (2004, 2006). Two other infant burials were found in this compound. During excavation, two occupation floors were identified, along with several structures interpreted as hearths, some of which might have been used in association with metallurgy (Gastaldi 2010; Marconetto 2008b; Pazzarelli 2012; Espósito and Marconetto 2008). Four radiocarbon dates were obtained for Compound H (Table 1), the oldest one indicating a formative occupation of the site and others indicating that the structures remained in use and were reconstructed to be adapted to new purposes.

A charcoal concentration was found on the occupation floor in the southern part of the structure. It was at first thought that this was part of the collapsed roof structure; however, further excavation and analysis of the materials showed that it corresponded to a hearth. An even larger charcoal concentration was found in the northern part of the same compound, and again this was not part of the roof but a deposit of large charcoal pieces associated with the large hearth found in the northern part of the compound. More dispersed charcoal was found only in the southern sector, probably indicating that only part of the structure was roofed. However, no trunks or posts were found, which suggests that the entire structure burned and no parts of the roof construction were preserved in the archaeological record. On the other hand, the multiple large hearths found in the northern part of the structure might have been used in craft production, which strengthens the interpretation that this part of the structure had no roof. Besides charcoal, both ceramic vessels and lithic tools were found on the occupation floor (Pazzarelli 2012). Many artefacts were found in the excavations, presenting a scenario of abandonment with objects still in place in the enclosure, including some whole ceramic vessels that were probably broken during the structure's collapse and abandonment. For further analysis of the objects found during excavation see Gastaldi (2010) for the ceramic vessels, Pazzarelli (2012) for the lithic grinding tools, and Dantas (2010) for the animal bones. Several ceramic vessels were associated with a structure made of flagstones and could be reassembled to more than 90% of their original composition. These flagstone structures were probably used to store the ceramic vessels (Gastaldi 2010) (see figure 4.26 in Lindskoug 2013).

Piedras Blancas: Compounds F and G

Compound F, sometimes called *Recinto Sudeste* in Spanish (the southeast compound), along with the annexed Compound G, has revealed a rich archaeological record that has enabled the most detailed reconstruction of the site's fire events and abandonment patterns. It has a rectangular shape and measures about 7.5 m long east to west and about 6.5 m north to south. It consists of a roofed room with a small entranceway in the northern wall from the area with a gallery (Compound G) (Fig. 3). The entranceway consists of a small step with a difference of 20 cm between the inner and outer floor levels. To the west and south, a perimeter wall made of rammed earth with stone columns delimits the site. The walls that surround the entranceway are made of rammed earth and are covered with a white plaster layer on the inside, while the exterior walls are painted a reddish colour in part of the gallery area.

Excavations began in this sector of the site in 1999 and square excavation areas labelled A and MF were opened, with further areas opened during later excavations. In the most recent excavations of the area we applied the Harris Matrix method of stratigraphic excavation (Harris 1979), as used by the Museum of London Archaeology Service (Spence 1994) and modified by us: see Gastaldi (2010). The name of the stratigraphic unit (abbreviated as UE in Spanish) consists of the enclosure letter followed by the stratum number. For example, stratigraphic unit 15 of Compound F = FUE15. The total surface excavated in this compound is now about 46 m^2, with 56 stratigraphic units identified (Fig. 4). These units were defined as collapsed stone and rammed earth walls with stone columns (FUE5, FUE6, FUE13, FUE9); cumulative strata showing signs of mixing by aeolian action and rodent activity (FUE1, FUE2, FUE3, FUE4, FUE14); roof-fall events in the compound (FUE7, FUE8, FUE15); a compacted floor (FUE17 = FUE12 = FUE30); hearths (FUE29, FUE18, FUE21, FUE32); and fire pits (FUE19, FUE22, FUE33, FUE35). There were also some vertical stratigraphic units, such as a continuous stone wall, a rammed earth wall, and a rammed earth wall with stone columns (southern wall, eastern wall, and western wall). Four post support structures were also found, with carbonized trunks in their interiors (FUE39, FUE44, FUE49, FUE54). From the analysis of the stratigraphic matrix, it can be determined that, as with Patio G, the end of the site's occupation is marked by the burning of the roof and its collapse on to the objects that were being stored on the compacted floor beneath it, or that were being used there at the time (FUE12 = FUE17 = FUE30) (Fig. 5). As examples of some of these broken objects, in stratigraphic units FUE25 and FUE26 there were two whole vessels, which spilled their contents of white liquid paint into the surrounding area (Gastaldi 2010). Another vessel (B52 in Fig. 5), which has signs of carbonization on its exterior, was recovered broken at the side of a hearth (FUE18 and FUE19). An organic residue sample was obtained from the interior walls of this vessel and dated (Table 1). The floor also contained a stone structure with two vessels stored in its interior. These were completely destroyed by the fall of one of the roof's main beams (Fig. 5, FUE26 and FUE24).

Via an entranceway and a 0.20 m step, the floor in Compound F is connected to floor GUE21 of Patio G, where a vessel containing the chañar fruits was recovered (Figs. 6, 7). In terms of Harris's stratigraphic principles, this would be referred to as a period interface, a surface with contemporaneous usage. In spite of this stratigraphic clarity, where the end of occupation is marked by the collapse of the roof and the destruction of objects and structures that were in use at the time, the results obtained by dating some of these contexts have been dissimilar and contradictory (Marconetto et al. 2014).

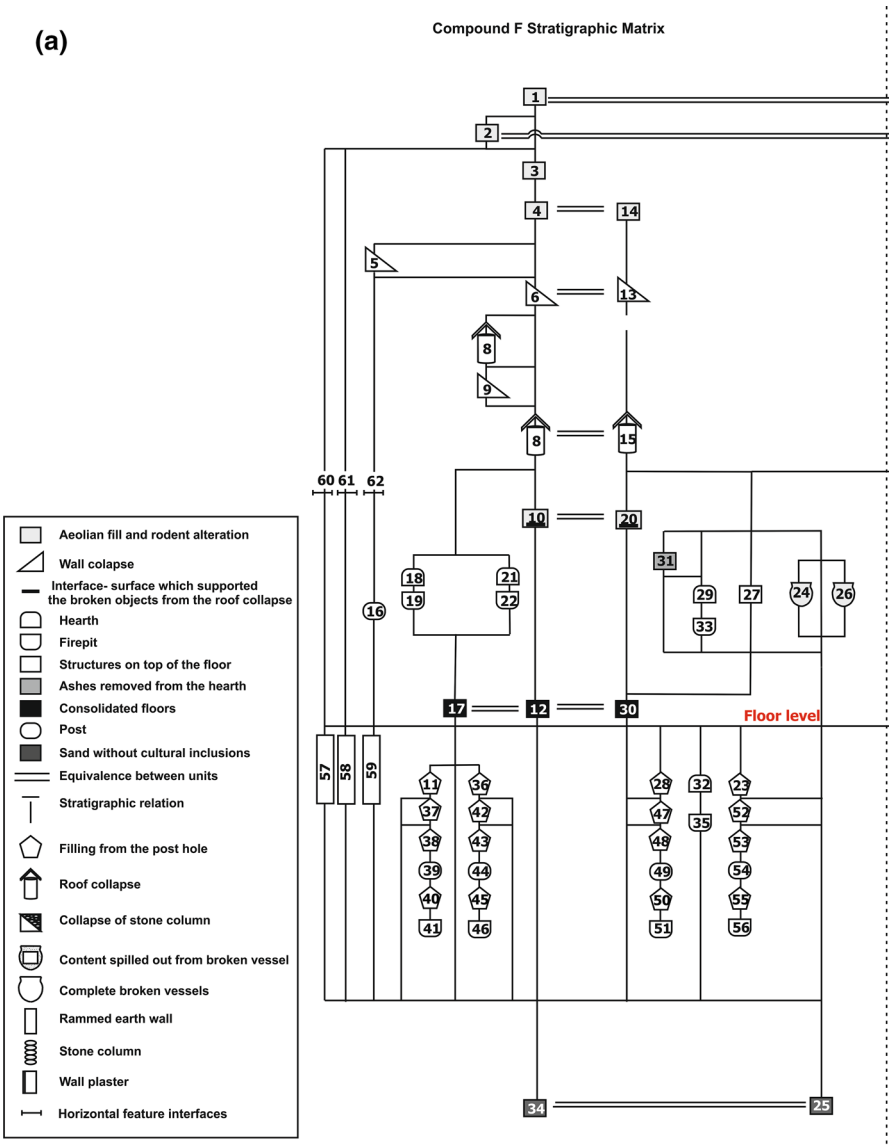
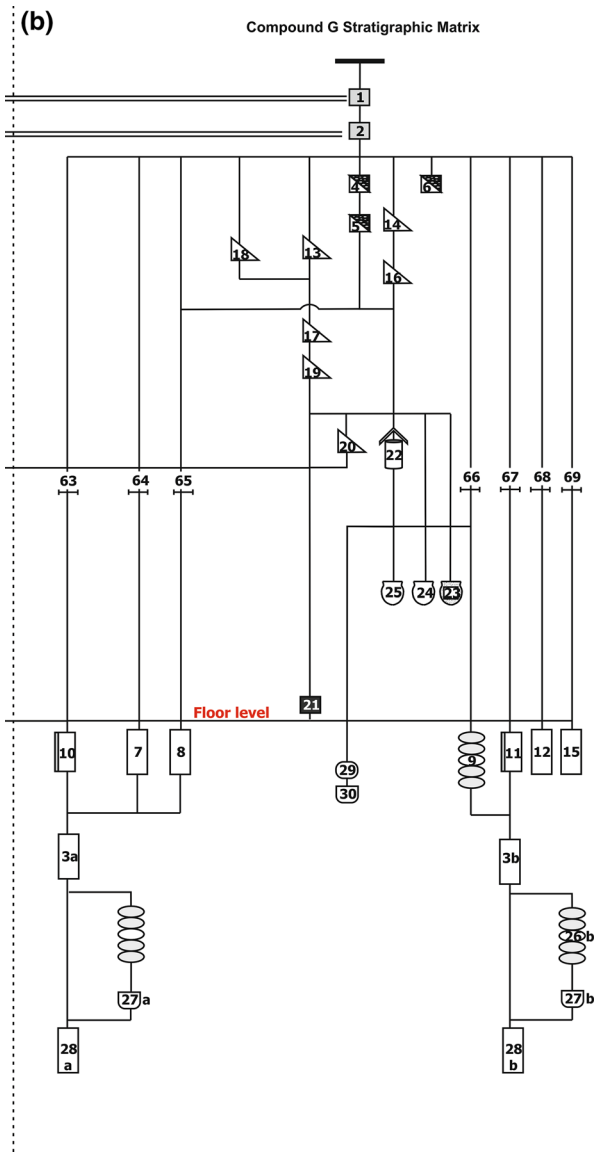


Fig. 4 **a** Stratigraphic matrix for Compound F; **b** Stratigraphic matrix for Compound G

Compound G consists of an open space (Patio G) with a gallery and is adjacent to Compound F. Both of these areas show evidence of having been affected by a fire, which ended the occupation of the site. During excavations in these areas in Compound G we have so far identified 35 stratigraphic units including horizontal strata such as collapsed walls (GUE5, GUE13, GUE14, GUE16, GUE17, GUE18, GUE19, GUE20); a collapsed roof (GUE22); spilled contents of vessels (GUE23); and compacted mud floors (GUE21) (Figs. 4, 6). Vertical strata were also identified, such as rammed earth walls with stone

Fig. 4 continued



columns and multiple successive construction phases (GUE3a, GUE3b, GUE7, GUE8, GUE9, GUE10, GUE11, GUE12, GUE15, GUE26a, GUE26b, GUB27a, GUB27b, GUB28a, GUB28b), and structural support posts for a gallery roof (GUE29, GEU30). We have also identified vertical interface elements, such as a cut in the earth for construction of the Compound F floor (FUE34). From these excavations it can be determined that this was an open space (patio), which had a gallery-type roof, 2 m wide and at least 7.5 m long, against the main perimeter wall that surrounded the site. Since excavations have not yet been completed to the north, this space could in fact be even longer.

At least 14 large ceramic vessels decorated with painting and modelled faces (Pazzarelli 2012) were found stored below the gallery roof, either on a low earthen bench or on the patio floor against the wall that separates Patio G from Compound F (Figs. 5, 6). These vessels were broken in situ on the floor (GUE21) and were covered by materials from the collapsed gallery roof (GUE22) and walls (GUE20, GUE16, GUE19) (Fig. 5). One of the vessels, crushed by GUE22, contained over a thousand carbonized *Geoffroea decorticans* (chañar) fruits (GUE23). This vessel was defined as a separate UE since it was possible to reconstruct it completely (Fig. 6). In addition, the contents were still inside when the vessel was crushed, so these could be associated with it (Marconetto et al. 2009). Several radiocarbon dates have been obtained from both Compound F and Patio G (Table 1), and these seem to indicate an occupational span of several 100 years. These dates and the problems with them have been discussed in another work (Marconetto et al. 2014).

These contexts, like those at Iglesia de Los Indios, have left us with an abundance of carbonized plant materials including chañar fruits, tree trunks and branches, grasses, and wattle from the roof constructions. These materials provide a unique insight into life in the Ambato Valley just before abandonment of the settlements. As a consequence of the fire or fires that affected all of these sites, a large amount of plant material has been preserved, which is somewhat exceptional for sites in northwest Argentina. This material has been very useful as a source of information about the food resources, construction techniques, and building materials used by the past inhabitants of the area (Marconetto 2008b), and in constructing a chronology (Marconetto et al. 2014) and allowing a better understanding of the processes involved in the abandonment of the area (Lindskoug 2013).

Another indication of the short occupation period of the settlements is the good condition of the wood used in the construction of the compounds. According to Marconetto (2008a), almost a hundred wooden posts and beams have been recovered from the sites excavated in the Ambato Valley. Her studies of the wood from Piedras Blancas (Marconetto 2008a, b) found very little evidence of insects attacking and eating the wood used in the construction. This indicates that the wood selected for use in the constructions was in good condition and that the structures did not stand for a long time before the fire event or events occurred.

An Abandoned Landscape or a Society in Disintegration?

In the last few years we have investigated different aspects of the final phase of Aguada occupation in the valley (Pazzarelli 2012; Marconetto 2009, 2010; Marconetto and Laguens 2016; Lindskoug 2013; Lindskoug and Marconetto 2014; Marconetto et al. 2014, 2015; Gastaldi 2012), including what happened during the abandonment of the valley. This variety of contexts with evidence of fire in the Ambato Valley is what led to the initiation of research on past fire regimes in the area. Were these fires related to abandonment of the area? Did they directly initiate it? Which processes might have had the most influence over these events? Was it in fact a long process that led to this final stage of occupation in the area? Several sites had evidence of fire and we wanted to investigate whether there was any relationship between the fires in the last phase of occupation and the possible abandonment of the valley after these fires. One aim has been to study the nature of possible wildfires in the area. Three key factors led us to investigate this relationship between the final occupation of the valley and wildfires: (1) the archaeological sites with evidence of fire, (2) the presence of drought in the final phase of the occupation, and (3) the

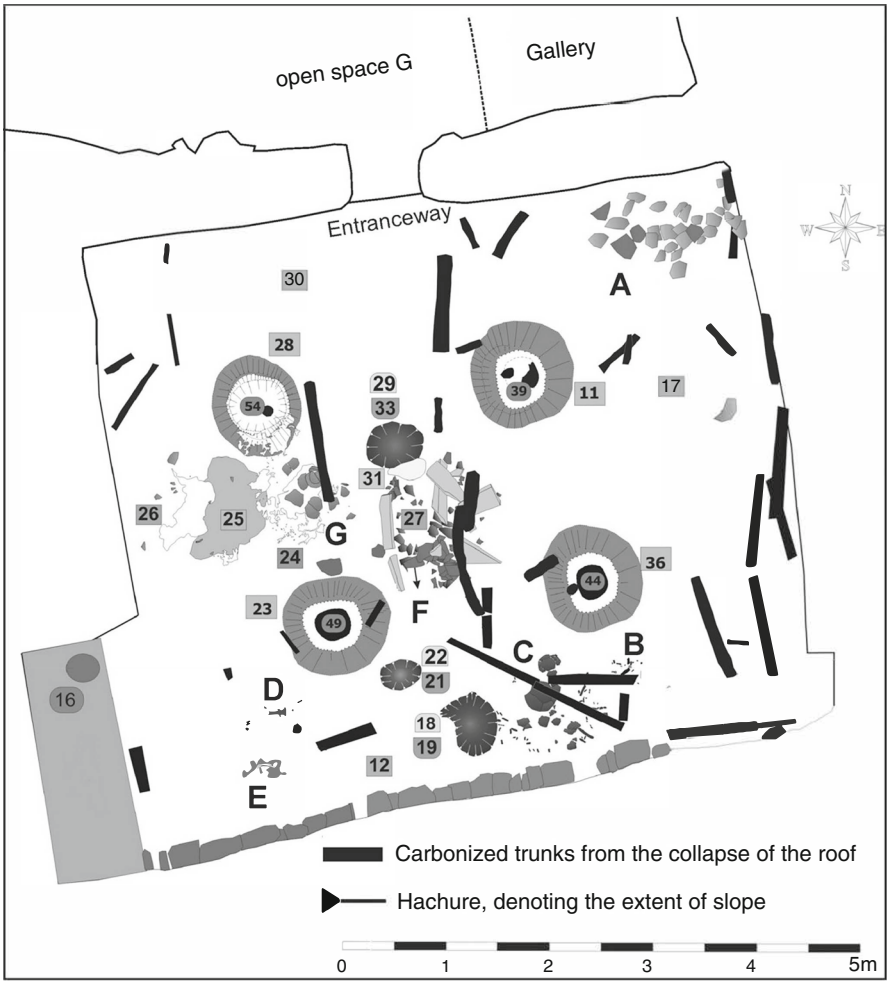


Fig. 5 Plan of Compound F with objects broken by the fire and collapse of the building: (*A*) ceramic vessel; (*B*) broken red ceramic dish; (*C*) ceramic vessel (B52); (*D*): pipe; (*E*) camelid pelvis; (*F*) globular vessel with soot similar to B52; (*G*) ceramic vessel with spilled contents of liquid white paint

lack of evidence for occupation later than 900–1000 AD. I wanted to test the hypothesis of an unfavourable environment in this last phase of the occupation and to analyse the possible environmental causes that had been proposed for the abandonment. However, I was also always aware that the causes of this event may not have been solely environmental, but that socio-political, cultural, and ideological factors might also have played an important role in the last phase of the occupation of the area.

The evidence for an unfavourable environment was mainly linked to earlier research by Marconetto (2009, 2010), which had indicated the presence of drought during this final phase of the occupation of the Piedras Blancas site. Earlier, González (1998) had also argued for an ecological deterioration in the final phase of the Aguada society, based upon palaeoenvironmental studies from Lake Titicaca in Bolivia. Furthermore, data from the

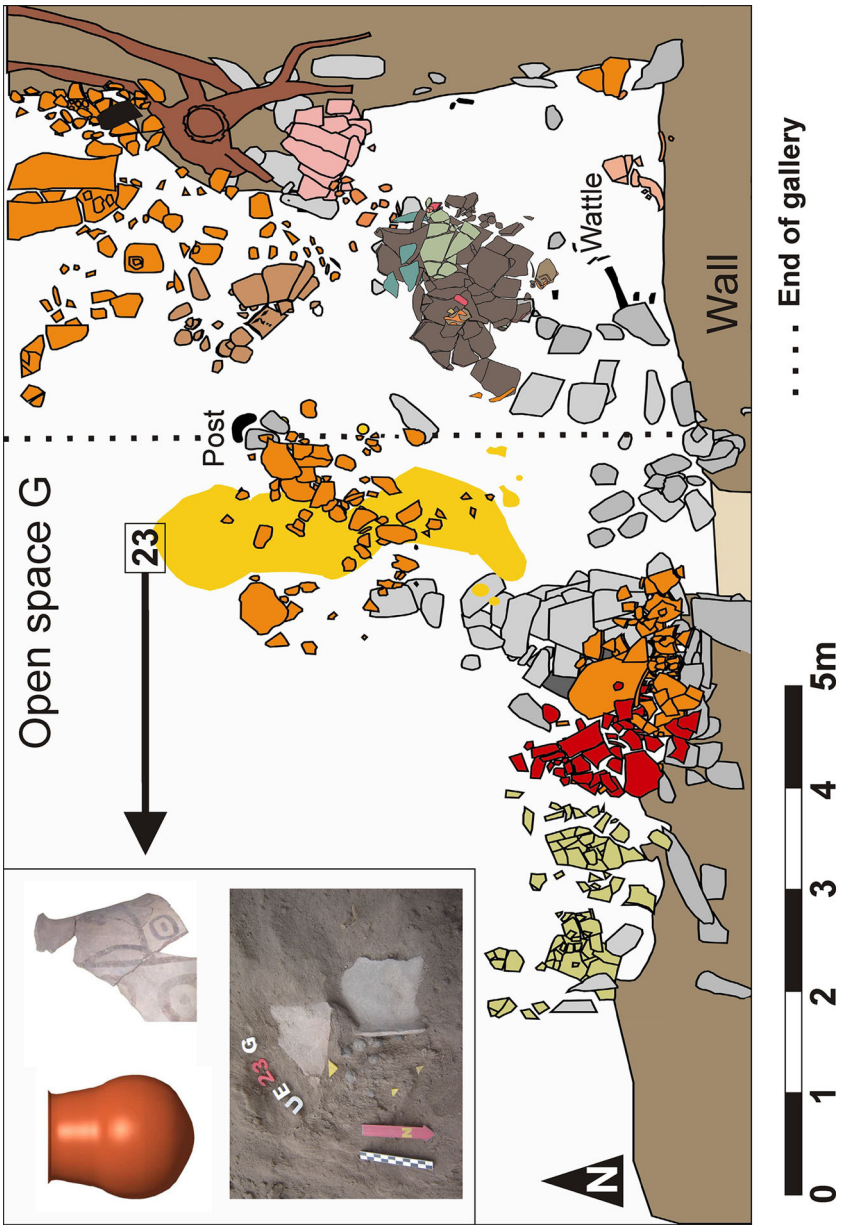


Fig. 6 Plan of Open Area G and Gallery with objects broken by the fire and collapse of the building

Fig. 7 Archaeological contexts from Compound G, with ceramic fragments from the abandonment of the structure

three sites with evidence of fire and rapid abandonment (Martínez 2, Piedras Blancas, and Iglesia de Los Indios) was seen as important to understanding the abandonment. It had been suggested that these sites could have been burned as the result of conflict or warfare, or in relation to a possible drought (González 1979, 1998; González and Pérez Gollán 1972), but the existence of extensive forest fires was another possible scenario suggested (Marconetto and Laguens 2016). We wanted to analyse whether there was a connection

between fires and the possible abandonment, and whether fire was perhaps a key factor in the abandonment process? Could we find some sort of pattern?

To begin to address these questions, we used microcharcoal particles recovered from soil samples as an analytical tool. This allowed us to analyse past wildfires and determine whether there was a relationship between the past fire regimes, both frequencies and sequences, and the abandonment of our study area. I developed new techniques and methods based upon earlier ones to study past fire regimes, adapted to our study area and using microcharcoal particles as our principal tool (Lindskoug 2010, 2013, 2014, 2015; Lindskoug and Marconetto 2014; Lindskoug and Mors 2010; Marconetto et al. 2014; Marconetto and Lindskoug 2015).

Key Factors for Fire Present in the Ambato Valley

The conditions for fires were present in the Ambato Valley. Ignition sources existed, both natural, in the form of lightning strikes, and anthropogenic. Increasing human activity in the area would have made the anthropogenic sources increasingly common. In the case of the Ambato Valley there is high biomass availability, with a dominance of forest on the valley floor and on the lower hillsides, while higher up on the hillsides grasslands dominate. The natural vegetation must have been a highly available source of fuel for the fires, with all of the different fuel sizes present in our study area: fine, medium, and coarse. Some areas, especially the grasslands higher up on the slopes, have abundant fine-sized fuel and are therefore highly flammable. In these areas fire would have spread very quickly. The climatic conditions must have increased the risk of fire immensely, especially since there was a drought in the final phase of the occupation. Although low precipitation during drought does not increase the biomass (fuel load), it affects the available fuel in the area by causing the vegetation to grow slowly. However, drought also affects fuel availability by making the existing biomass drier, so the total available fuel in the area increases. If wetter years were present prior to the drought detected in the final phase, there would have been a larger accumulation of biomass and an increased amount of fuel in the area. When a fire hit it could have been devastating because of this large biomass build-up. Regular fires are necessary to prevent large biomass accumulations that can later create extensive fires with great intensity and severity. The burned chañar fruits excavated at both the Piedras Blancas and Iglesia de Los Indios sites show that fires occurred during the southern-hemisphere summer, which also coincides with the rainy season in the area. However the chañar is one of the first fruits to ripen, usually before the first summer rains at the end of the dry period. This suggests that the structures were burned down at the end of the dry season or the beginning of the rainy season. This seems unusual, and we think that this is one key factor for understanding what happened at the site. It points to the fact that the fires might have been deliberately started, or else to the presence of recurring wildfires in the area. However, whether these were crown fires, surface fires, or ground fires cannot be determined from our present evidence of the past fire regimes in the area, and we stress that further studies of past vegetation are needed to help us obtain more information on the past fire regimes. For example, pollen studies might show whether colonization of burned ecosystems by invasive plants may have occurred once in a while. This would strengthen the hypothesis of recurring fire regimes in the area and help determine whether fires were started deliberately. However, our evidence at the moment points to the fires being part of a recurring cycle. As in so many other places, fire is part of the ecosystem in the Ambato Valley, and it was present in the lives of the valley's past inhabitants as well.

Recurring Fires in the Ambato Valley

The data on past fire regimes has been obtained through studies of sediment samples from 17 stations across the valley, indicating both the frequencies and sequences of past fires (Lindskoug 2013; Lindskoug and Marconetto 2014). These studies indicate that the Ambato Valley has been regularly affected by fires for at least 4500 years. This figure is based on the oldest radiocarbon date acquired so far for our study area, from a soil sample in the central part of the valley (Station 17). It is clear that recurring fires were part of the area's ecosystem in the past, just as they are today. Once in a while a large fire hits the valley, as was the case in December 2009. These large fires have a major impact on the local population. Several years after the 2009 fire it is still part of the daily conversation and firmly rooted in the local memory. In some areas it can take several years for the vegetation to recover, even longer when there are years with little precipitation. In some locations the fire scars are visible for an extended period, as seen during our 2010 field campaign. Marconetto (2008b) has shown that past vegetation in the area was similar to that present today. The fire scars must have been visible in the landscape for a long time, probably even longer during the final phase of the Aguada occupation because of the drought, and it must have taken a long time for the vegetation to recover.

An earlier study (Lindskoug 2013) shows that all parts of the valley, northern, southern, eastern, western, and central, were affected by recurrent fires with different frequencies, intensities, and severities. This is also true of the different zones in the valley, with archaeological sites on both the fluvial floodplain and the prehistoric agricultural terraces in the piedmont zone affected by recurrent fires. It is possible that forest fires might have burned some of the settlements and sites to the ground. Key factors linked to the burning of the sites include biomass availability and drought, both present in the final phase of the occupation. Vegetation and biomass levels in the area are high, which would have increased the risk and frequency of fires. Ten AMS radiocarbon dates was obtained in order to more precisely date the fire events (Lindskoug 2013). Although four came back as modern, the other six results made it possible to better position the past fire regimes chronologically. However, we still need more ^{14}C dates in order to better correlate the fire regimes with the last phase of occupation in the valley, and to determine whether the frequency of fires was higher in this final phase.

The Perception of Fire

The presence of recurrent fire regimes in our study area led us to reflect upon different ideas about how we perceive environment and landscape. Our Western perceptions in many ways trap us inside a traditional explanatory framework for our surroundings. Identifying this as an ethnocentrism or anachronism should free us to think about fires in new ways, both as part of a landscape phenomenon, and in terms of what fire is or can be. How did the fire affect vegetation, environment, and the human population in the area?

Since recurrent fires were part of the surroundings, how did people experience them? Our perceptions of the landscape and environment are certainly different from those of the past inhabitants of the area. We experience our surroundings in multiple different ways according to our social and cultural values. As argued by Boia (2005), social and cultural factors influence how we perceive our reality, and this is also historically specific. Although we can only speculate about how the inhabitants of the Ambato Valley once perceived their surroundings, we can be certain that our perceptions and theirs diverge in

several ways. If the landscape is perceived differently according to historical context, we can at least be sure that the fires were not a new phenomenon for the Aguadas in the final phase of the valley's occupation. Was fire seen as part of the landscape or the environment, an integrated element of the surroundings? I argue that fire must at least have been an integral part of the life of the Aguadas, both fire used at a domestic level and wildfires, since fires were present both before and after the Aguada settled in the area. Our results show that fires were recurrent in the area for at least 4500 years. If fires were part of the landscape and environment, they can hardly have been the factor that made the inhabitants leave the area, since the fires were present long before their arrival. However, the presence of fires could have been one factor among several, or even a determining factor if a drought was present.

What kind of fires typically affected the area? Can these fires be fitted into contrasting categories, as for domestic and wild fires? Were they 'natural wildland fires' started by lightning strikes, for example, or were they 'cultural domestic fires' started by human action, whether accidental or intentional? Could they have been domestic fires for activities such as cooking, ceramic production, or metallurgy, that then got out of hand, or fire used for hunting or agricultural activities? It is also possible that natural wildfires without human control or involvement were responsible. However, fires started by humans, intentionally or not, which have got out of control, can be seen as wildfires: it is not always the ignition source that determines whether a fire is wild or domestic. I would argue for that it is more correct in this case to speak of controlled or uncontrolled fires. We do not know whether the inhabitants categorised fires as wild/domestic or controlled/uncontrolled. Perhaps neither, as these concepts are tied to a Western ontology based on modernity, where we separate nature from culture. As argued by Descola (2013), the absence in many societies of a notion homologous to the modern idea of 'nature' is not a semiotic question; this also applies to the contrasting notions of wild and domestic. Descola argues that nothing is more relative than common sense, above all when it refers to the perception and use of inhabited space. The fires could have been seen as an integral part of the landscape, as a type of purification, as a punishment from some spirit, ancestor, or god, or as something completely different which we cannot even imagine, perhaps tied to the complex social and cultural ideology of Aguada society. We need to consider how our perception of the past influences the interpretation of the data, and perhaps ethnographic studies can help us gain new perspectives on perceptions in other cultures, and therefore come closer to an understanding of the past perceptions in our study area.

Fire in the Agricultural Terraces

Returning to the results of earlier analysis (Lindskoug 2013), a point that deserves consideration is the presence of microcharcoal particles in the agricultural terraces. The microcharcoal counts reveal high levels of such particles—along with several other types of microfossils—in the pre-Hispanic agricultural terrace systems (Zucol et al. 2012). Some of the microfossils observed have dark, spherical biomineral bodies and were found in a depositional matrix with high levels of fine organic matter. These might be microcharcoal particles with low birefringence that are associated with possible fire events, but also with soil formation, where the organic materials have been transformed to dark, fine occluding organic matter (Alejandro Zucol, personal communication 2013). However, these microfossils may be associated with ashes, because of similarities with ashes studied (Lindskoug and Mors 2010), and the microcharcoal particles with fire events. The presence of the palm phytoliths as reported by Figueroa (2010) may be another indication of possible fire events,

since palm trees may be early colonizers of burned areas after fires. However, more analysis is needed to confirm the possible link between the dark, fine occluding organic matter, microcharcoal particles, possible fire events, and practices linked to agricultural production in the valley. I do not yet know whether the evidence of fire can be related to domestic fires, such as cultural practices in which crop residues were burned after production finished, or whether ashes were used to fertilize the area as in some ethnographic examples. These fires could also represent wildfires started either by natural factors or anthropogenically but accidentally. In any event, the agricultural terraces work as sediment traps and can be used to study past conditions. These terraces can also yield important insights into agricultural practices, although these can mix the sediments, which can complicate the use of terraces as sources of paleoenvironmental indicators. Agricultural production in the final phase of the occupation needs to be studied more closely because it can give us important clues to the abandonment of the area.

Disintegration or Abandonment of the Ambato Valley: The End of the Aguada Occupation

Radiocarbon dates from several sites in the valley indicate that occupation of Aguada sites ceased at around 900–1000 AD (Table 1). One of the objectives of this paper is to analyse the possible scenarios related to this putative abandonment, and to try to develop a sequence for it. This rapid and complex process probably requires a multifactorial explanation. Palaeoenvironmental information has been used to try to understand the processes that led to end of occupation in the Ambato Valley by the Aguada culture, and to test the hypothesis of an unfavourable environment. Was the valley in fact abandoned? Or are we witnessing the disintegration of a society in a vulnerable position? Did the fire regimes somehow affect these processes?

The investigations have yielded some interesting results suggestive of what might have happened in the final phase of the valley's occupation (Lindskoug 2013). Many different hypotheses about the final occupation of the valley have been advanced, based upon the few excavated sites in the area. Explanations range from warfare to vulnerability brought about by environmental stressors, including drought and over-population. There may be several reasons for the abandonment of the Ambato Valley, and it must first be determined whether it really was an abandonment. We need to establish whether the archaeological sites with signs of fire are indeed related to the last phase of the occupation or the abandonment. They might perhaps be related to a ritual abandonment of the structures, as several ethnographic examples suggest. For example, in the Chaco area the Tobas have elaborate rituals when someone dies (Tola 2006), and from the Amazon region there is evidence that at the death of a person his or her house and belongings are destroyed and in some cases burned down (Kopenawa and Albert 2013).

Another point to consider, as argued by Marconetto and Laguens (2016), is that in northern Argentina abandonment has been treated as a 'natural' change in the historical development of local societies. They argue that gradualist conceptions in the dominant schemes of cultural chronology have centred attention on the genesis or emergence of new cultural entities and a search for links with past societies, rather than on the processes that led to the disintegration or disappearance of these societies as socio-political units. This is related to the evolutionary view of the prehistory of northwest Argentina, and it implies a natural transition within a historical chronological scenario. We agree with this view, and

argue that it is necessary to identify and analyse the different processes that could have contributed to such events—a complex task. In continuing to analyse the last phase of the occupation and possible abandonment of the area, I will discuss the relationship between fire and abandonment in the Ambato Valley and how this has been seen in earlier studies of the Aguada culture, as this is significant here. Aspects to consider include: whether we are confronting an abandonment or a society in disintegration; whether the landscape was totally abandoned after the Aguada occupation; why the sites were burned, and whether this was related to the abandonment; whether abandonment was the result of wildfire; whether this was a crisis, regional or local; whether sites were burned intentionally; whether there was internal or external conflict; and how social and political factors contributed.

The Abandonment: Disaster or Collapse?

I emphasize that environmental causes do not exclude social dimensions, since cultural variables affect groups' responses (Maskrey 1993; Blaikie et al. 1996; Ensor et al. 2003). Disasters are seen as typically affecting a region or area for a brief time span. Analysing our ^{14}C dates and the results of the microcharcoal studies I argue that the Ambato Valley was not struck by a disaster that led to the abandonment, and the disaster scenario of extensive wildfires is also highly unlikely based upon research on the fire regimes (Lindskoug 2013; Marconetto et al. 2014), which shows that throughout the occupation of the valley it was regularly impacted by wildfires and that the inhabitants must have learned to live with this constant threat, especially during periods when drought or high quantities of available biomass rendered fires more frequent. The archaeological contexts described do not show evidence of a disaster scenario either: many objects were left inside the houses when they were burned down, but no occupants seem to have died in the flames, since no bodies were found inside the structures. Many objects, including the chañar fruits and the white paint ready for use, do suggest a rapid abandonment, but not as a consequence of a wildfire, volcanic eruption, earthquake, flood, or other disastrous event. The only disasters likely to occur in our study area are wildfires, so we can rule out these other possible natural disasters. Although the Piedras Blancas site is located close to the Los Puestos, this river could never have completely flooded the area rendering it uninhabitable, and while earthquakes would have been possible they would not have led to great infrastructural damage to a society of agro-pastoralists such as the Aguada in the Ambato Valley. If the Aguada were used to living in an area with frequent wildfires they would not have given up so easily if their houses were burned down: they might have abandoned their burnt houses, but certainly not the whole valley. There must have been another reason for this abandonment, possibly connected to a drier period and the effects on a society that depended on agriculture and herding. Several ethnographic examples have shown that short-term abandonment of areas is often connected to disasters like volcanoes or landslides. However, longer-term abandonment (as in the Ambato Valley, since no reoccupation seems to exist), is often connected to drought, which makes the zone inhospitable for as long as it continues. This can cause people to change their life ways and dependency on specific types of crop production, and can lead to migration to new areas.

Most discussions of the abandonment of the Ambato Valley have focused on the total abandonment of the entire valley; rapid, unplanned abandonment has been suggested, an idea with which I agree. These views have been based mainly on the archaeological record and the evidence of fire from the sites in the valley. However, the scale of this abandonment must first be established: did it affect the whole valley at once, or just some sites?

Until now, the abandonment theory has been based on only a few excavated sites, and we need to take account of the more than one hundred archaeological settlement sites that have been recorded in the whole valley, not including agricultural terraces with adjoining areas with isolated structures. We will have to evaluate the valley as a whole and the abandonment pattern, or the process that led to this abandonment, in addition to individual sites. There may be a problem related to sampling of the sites. The absence of traces of later occupation after the Aguada might be because such traces have not been identified, rather than because they do not exist, and I therefore stress that more research is needed. Few sites have been excavated although many have been recorded during survey, and only three show evidence of fire and rapid abandonment. The sites with evidence of fire are Piedras Blancas, Martínez 2, and Iglesia de Los Indios. In total, around ten sites out of more than seven hundred have been excavated. I argue that we cannot base our understanding of the abandonment in the final phase on these three sites with evidence of fire. We need to excavate more sites, including smaller ones in other parts of the valley, to determine whether a similar pattern is present. In March 2013 we started to excavate a smaller site called Cerco de Palos 065 (CP065). During this first field campaign no evidence of a fire event could be associated with the abandonment of the structure; however, excavation will continue, since we did not reach the occupation floor in the structure and there is still a possibility that such evidence will appear. Any new evidence from the excavation will need to be analysed to see if any pattern in the abandonment process is discernible. If we have more evidence, especially from smaller sites in the area, we will be able to assess whether these sites have abandonment patterns similar to those of the larger sites with evidence of fire.

Drought in the Final Phase of the Occupation

The present evidence shows signs of drought in the final phase of the occupation (Marconetto 2009, 2010). It is not certain whether this is related to the abandonment. It seems very possible that it might be one of several factors leading to it, but I stress that we still need more evidence related to earlier and later droughts. It is possible that there were droughts in other phases of the Aguada occupation, and we do not know how these affected the society. There may have been drier periods when the first settlements were established in the zone. During the last part of the occupation, there is also some evidence for a population increase (Assandri 2007; Assandri and Laguens 1999); this, along with drought, could have led to a critical point, with no possibility of increasing the capacity to sustain the population present in the valley. The irrigation system seen during the last part of the occupation may offer another potential explanation (Zucol et al. 2012). It may have been related to a drought, or may have been only a technical advance to increase surplus for use in exchange or to feed elite segments of society. It may be that the society was in an already vulnerable position and the drought was the final push that led to abandonment. However, abandonment of an area is a critical and final decision, and the conditions in the new area must be better if one decides to leave. At any event, we have evidence that drought was present in the final phase of the occupation, and we thus need to obtain more evidence about different periods with drought, in order to continue to reflect upon the relationship between drought and the abandonment of the area.

If drought was one of the reasons behind the abandonment, as suggested above, can the two be correlated? Evidence for drought comes from burned chañar wood recovered from archaeological contexts at the Piedras Blancas site. This evidence shows that the trees were cut down during a drier period. The chañar is not used for posts or larger beams, which are

usually made from more durable woods such as the *algarrobos* or *quebrachos*, which can survive for centuries. The chañar wood therefore probably relates to a short-term use closer to the time that a particular structure was constructed and commissioned. However, the wood from the posts, typically *algarrobos*, may have been reused, with a long interval between felling date and its last constructional use. Because the structures studied may not have been newly built, chañar is a potentially good source of information about drought and abandonment However, a few decades can easily pass between the cutting down of the tree for construction and the burning of the structure. In terms of discussion of abandonment, a few decades can change the whole picture. So while the droughts, fire, and abandonment can be correlated, if the fires were not natural there might not be a connection between the abandonment of the valley and the abandonment of the Piedras Blancas site or the other sites with evidence of fire. If the fires were accidental or connected to ritual abandonment or termination rituals at the compounds, social and cultural factors played a role in the abandonment of the sites with evidence of fire, but not in the abandonment of the valley, which might have been ultimately connected to the drought.

As argued by Schlander and Wilshusen (1993), 'abandonments are part of a general process of adjustment between local populations, local conditions, and regional conditions.' (Schlander and Wilshusen 1993, p. 85). These authors argue further that when abandonments occur they are local events, with houses abandoned and regions depopulated. To investigate abandonment related to drought, variability in regional environmental conditions must be studied in order to understand what is happening at a regional scale, although this does not exclude a local perspective. We now need to look for support for the idea that it is drought that caused the abandonment in our study area.

The drought scenario might have had other ecological consequences beyond affecting the fire regimes. If fire regimes intensify in dry periods this leads to greater erosion in an area such as the Ambato Valley that would have already been experiencing problems with both wind and water erosion. This in turn would necessitate an increase in irrigation systems, and/or cause a depletion in arable soil and other local resources such as firewood and pasture land. Another problem that could have affected the inhabitants of the Ambato Valley during a drought was a decline in agricultural yields. Normally there are two ways to deal with this: intensification or abandonment. Stone (1993) has discussed this using ethnographic and historical examples, making insightful observations about abandonment patterns connected to this phenomenon. He presents examples of different cultural groups that take advantage of each other's cultural preferences. One group abandons its land and migrates to open up new land, which they only use for a short period of time until the labour input grows too big. They then move away to find new land to exploit. The other group's cultural preferences included intensification, and they often moved in after the first group but stayed to increase production. For them, the need to move into new land areas arises only with expansion of the family (Stone 1993). This will lead to interesting abandonment patterns, and it is an especially interesting model of behaviour when agricultural production is declining. However, there is no evidence that another cultural group took over after the abandonment of our study area. The decision to abandon one place requires that resources or conditions be more favourable elsewhere. Another question is where the inhabitants of the Ambato Valley went. Abandonment must be a solution to a problem. The youngest ^{14}C dates from Aguada sites come from several sites in La Rioja (Callegari and Gonaldi 2005, 2006), both from sites in the central part of the Vinchina Valley and the central sector of the Antinaco Valley. We have several ^{14}C dates from around 1000–1400 AD from these areas. Could the inhabitants have migrated and moved to new areas? We also have Aguada sites in Tucumán in the *Yungas* forest area, close to the

Escaba dam (Pantorrilla and Núñez Regueiro 2006). While we only have one ^{14}C date from a burial in this area, which yielded a conventional date of 1420 ± 60 years BP (LP-1571), I would stress that more research and more ^{14}C dates are needed in order to evaluate this area as a possibility. However, the single ^{14}C obtained does not indicate a late occupation in this area. There is a possibility that the Aguadas migrated from the Ambato Valley, but we still lack good evidence of this possible migration and we need to investigate further. The sites in La Rioja have the youngest ^{14}C dates so far, and these may indicate a possible move into this area. However, there are also older dates in the area that point to an occupation at the same time as the Ambato Valley, so the idea of a move into this area is not fully supported.

Wildfires and the Abandonment

Wildfires appear to have been a feature of our study area for a long time. However, if they were related to the abandonment, several factors do not fit into the broader picture. Research has shown that fires have been a regular occurrence in the region for at least 4500 years (Lindskoug 2013; Lindskoug and Marconetto 2014), and probably even longer, with different zones of the valley affected differently. The first inhabitants of the valley must have colonized an area that was impacted by regular fires. Some areas seem to have experienced more intense and severe fires—whether natural or anthropogenic—based on the microcharcoal evidence (Lindskoug 2013), and their inhabitants must have learned to live with this. Since available biomass in the area is high—one key factor leading to fires—they must have been accustomed to the fact that once in a while fires destroyed vegetation, agricultural crops, and probably also settlements. Drought may also have been an exacerbating factor.

Since we have a landscape that, in a sense, is shaped by the fire ecology of the area, it can be said that the vegetation and environment adapted to these fires along with the human inhabitants. Some of these natural wildfires might have burned down some of the settlements (or parts thereof). If we look at the *Monte* vegetation in the area, there is enough biomass available to burn down several structures when a wildfire hits the area. Although the climatic conditions were not the same as today, the natural vegetation has not changed very much according to other studies done in the area (Marconetto 2008b). Conditions conducive to fire must have existed at the time of the abandonment since we have evidence of a drought at this time. The high erosion levels in some parts of the valley, as evidenced by the organic material analysis, also suggest a link with fire in some periods, especially since in two out of three stations sampled for microcharcoals we see LOI and microcharcoal particle curves that seem to follow a similar pattern (Lindskoug 2013). One possible scenario might have been drought, giving rise to more fires, followed by higher erosion, and more problems with agricultural production. All these are factors that might make people abandon an area. We can also link fire, heavy rains, landslides, and soil erosion in a similar scenario. Drought following the rainy season turns vegetation into fuel that can be consumed in wildfires, as argued by Westerling and Swetnam (2003), which in turn promotes soil runoff and landslides. Several problems then arise when the rains return after extensive wildfires, as discussed by Cannon et al. (2001), especially in terms of landslides and erosion. A mixture of all of these possibilities could have influenced the decision to move away, or at least they would have put a strain on the society or put it in a vulnerable position. We therefore need to expand our investigation of erosion and wildfires in the Ambato Valley.

Fire and Ritual Abandonment of Structures

The final phase of the occupation is represented by three archaeological sites with evidence of fire and no signs of later occupation. The question is whether this constitutes an abandonment (rapid or gradual), or a disintegration or collapse of the Aguada society. It has been argued, based on the present state of the evidence, that there was a rapid abandonment of the three sites, but in my opinion, the evidence so far is not strong enough to allow us to extrapolate from these three sites to the whole valley or region. I stressed above that we only have evidence from ten excavated sites in the valley out of a total of more than one hundred settlement sites recorded. Was the abandonment somehow related to fires? It has been suggested that the burned sites represent evidence of warfare, but burning is not necessarily associated with violence: fire can in many ways been seen as a type of purification. We have many ethnographic examples of this, both from the Amazon region and from the Grand Chaco (Tola 2006; Kopenawa and Albert 2013). For example, the Tobas in the Grand Chaco are afraid of the reanimation of the dead (Tola 2006). They call the dead *lqui'i* (sometime translated as soul or spirit, although its significance is wider and includes animals, for example). When someone died the body was burned, so that the deceased could not come back to life or be transformed into a non-human being to haunt the living in various ways. The body was burned on the day of the death and the fire could not be extinguished for an entire day (Tola 2006). According to Karsten (1932, p. 194, cited in Tola 2006) a fire made the harmful spirits stay away from the humans. When a person died, all his or her belongings, including clothes and weapons, were buried and often burned as well. This is not because the dead were thought to need their belongings, but because of a fear of the predatory nature of the dead, whose clothing and weapons should not be used or saved, to preclude their returning to look for them. According to Karsten (1932, p. 196, cited in Tola 2006), to stop the dead from coming back it was also common to purify the village with smoke and to destroy the house and all the objects that had been in contact with the dead person, and in many cases entire villages were abandoned when someone died. Similar rituals are also found in some parts of the Amazon region, where when someone dies all of their belongings are burned so that they do not make the living remember with sadness those who have died (Kopenawa and Albert 2013).

This kind of ritual termination of a house or structure is also present in other parts of the world, and from the American southwest we have several examples of archaeological data and burned sites and contexts that may indicate this. For example, Wilshusen (1986), has analysed the abandonment mode of Pueblo pit structures along the Dolores River and concluded that structures associated with a high degree of ritual significance and usage were purposefully burned down at the time of abandonment. In other structures with less ritual significance, people were confined inside and the roof brought down over them, and structures with the least ritual significance seem to have been left to deteriorate without interference. It is clear that these structures were burned intentionally because experimental studies of similar houses show that these pit-structures, built of earth with a wooden roof, are difficult to set on fire. Very intense heat or fire must be applied for a number of hours in order for the roof to catch fire and fully ignite (Wilshusen 1986). This is of interest to us because the houses in Ambato are also built of earth—rammed earth with stone columns—with a wooden roof, although they are not pit structures. A wildfire might not cause them to ignite unless high amounts of biomass were present. If we look at the available fuel and biomass close to the compounds in our area, it seems that ignition most certainly could have happened, unless the area around the settlements was kept barren with

little vegetation present. The hearths inside the houses are not likely sources for causing a post to catch fire accidentally and burn the structure to the ground.

The fact that we have evidence for recurrent fires and drought, as well as archaeological contexts with fires, might conceal the evidence of practices related to burning at the time of the abandonment. I stress that if ritual termination of the structures took place in the Aguada society in the Ambato Valley, then the wildfires affecting the area once in a while might have covered up the evidence for this.

Abandonment Patterns and Floor Assemblages

Floor assemblages can be helpful in the study of abandonment patterns. Return does not seem to have been anticipated in sites in the Ambato Valley, at least not for the settlements affected by fire. Usable artefacts may have been removed, structures may have been dismantled, and building materials transported to the new settlements. The dispersed dates from some trunks at the Iglesia de Los Indios site might indicate the possibility of the reuse of timber, poles, beams, and posts in the constructions in Ambato, especially given the use of long-lived types of wood for posts (see further Marconetto 2008b; Marconetto and Gordillo 2008).

Returning to the floor assemblages, if we have a clear picture of them, we can start making regional comparisons to understand abandonment patterns. However, these studies require further effort, and are beyond the scope of this research. I stress that to make these types of regional comparison we still lack a lot of information from our area and neighbouring areas regarding population patterns during the Aguada occupation. There is a possibility of population growth at some point, according to Assandri and Laguens (1999). Questions remain as to whether it put a strain on the society, whether there was an expansion of agricultural and herding production, and if so, whether this was related to population growth, harsher environmental conditions, or an elite desire to use the surplus production in exchange networks to obtain exotic status products, or to some other cultural or social need not yet identified.

Returning to the floor assemblages, in the case of the compounds with fire in the Ambato Valley, the Piedras Blancas, Martínez 2, and La Iglesia de Los Indios sites all produced several mortars and pestles found in their use locations, or very close by in the case of the pestles. We also found liquid white paint ready for use in one compound in Piedras Blancas. Objects with marks of intense burning are another indicator of burning of the structures. No estimates have yet been made, but several of the objects found during the excavations had soot marks from burning, and many ceramic fragments also show these signs, although this is probably related to their use as cooking utensils. I argue that new lines of evidence are required for this and that continued investigation is needed to help us understand the abandonment.

The evidence we have so far paints a picture of a rapid abandonment of some structures in the valley, but there is no evidence of mass migrations, for example. I consider the two most likely options were either that structures were intentionally burned down in some kind of closing ritual or else they burned down by accident. Several posts are located close to the hearths, which could have led to the incineration of the structure. However, this is not likely, since the posts are thick and experimental studies show that in order to produce an intense fire like the one that burned down the compounds, they would need to have been exposed to several hours of intense fire. We have no evidence yet that wildfires might have struck the sites, although the possibility does exist as discussed above. The things left inside, the chañar fruits for example, might have been part of the ceremony of leaving the

structure. If the inhabitants did live with a constant threat of wildfire, they could have built protection and created firebreaks or fire lines.

The Difference Between the Abandonment of the Hualfín Valley and of the Ambato Valley

In northwest Argentina the sites in the Hualfín Valley display similarities with the abandonment pattern from the Ambato Valley. Several structures in the Hualfín area have been found with evidence of fire linked to abandonment and also of possible war-like activities. These similarities make a comparison between the two regions worthwhile, although the sites from the Hualfín Valley are later than those in the Ambato Valley and display other differences. First, if we look at the quality of the wood at the time of the fire, in the case of Piedras Blancas the wood was in good shape, with a low presence of insect infestations and absence of fungal damage indicating a short use of the settlements. There is also a low incidence of damage caused by the action of xylophage insects in the trunks used in constructing the roof and galleries. The presence of insect burrowing in the wood is an indicator of dead wood. In the case of both Piedras Blancas and Iglesia de Los Indios, evidence of an insect belonging to the longhorn beetle family *Cerambicidae* (*Coleoptera*), known in Spanish as *talacorero*, has been found in the wood used in the constructions. The presence of a *talacorero* species was also identified in the sediments associated with the collapse of the roof. This was interpreted as meaning that the insect infestation represented an attack after the wood was used in the construction (Marconetto 2008a, b). This indicates that the wood was in good condition at the time of the fire and that the fire event and the abandonment caused by it were not widely separated in time. According to Valencia (2007), the wood from the sites in the Hualfín Valley is full of insect infestations and shows signs of being rotten and in very bad shape. This would indicate that the structures were in bad condition at the time of the abandonment or that the fire actually took place several years after the abandonment, so the wood used in the construction had time to disintegrate as a result of biological attacks from both insects and fungi. However, in a later article Valencia et al. (2010) state that the wood was in good condition. Thus according to which data we consider, there could have been a fire event linked to the abandonment as in the case of the Ambato Valley, or these events could have been separated by a long time span. The floor assemblages also differ. In the case of Piedras Blancas and the other sites in the Ambato Valley, the assemblages are rich, with many objects found on the floors. In the Hualfín Valley the floor assemblages are poorer with fewer objects, although the structures themselves are also smaller than those in the Ambato Valley. This also seems to indicate that in the case of the sites in the Hualfín Valley the fire events happened some time after the abandonment of the sites, leaving time to collect objects and for insects to damage and nest in the wood used to construct the roof. It therefore seems that we have clear differences in the abandonment patterns in the two regions. Violence has also been put forward as one of the reasons behind the abandonment in the Hualfín Valley.

Indicators of Violence in the Aguada Culture: Violence and Abandonment of the Ambato Valley

One very common explanation of abandonment, put forward by several scholars working on this topic, is violence and warfare. This factor has also been suggested in the case of the Ambato Valley (González 1979, 1998; González and Pérez Gollán 1972 and the Hualfín Valley (Balesta and Wynveldt 2010; Valencia et al. 2010). Evidence has been found to

indicate the use of violence, associated with signs of possible warfare, in the abandonment process. Indicators and evidence of violence and warfare from archaeological contexts can be found through the study of iconography, architecture, and human remains. Bones can show direct evidence of warfare, for example, in the form of trauma and embedded weapons, and some authors have in fact argued that these skeletal data are the only reliable evidence for warfare (Cordell 1989, cited in LeBlanc 1999). However, the archaeological record can provide us with other types of evidence. Iconographic evidence is found on ceramics or wall paintings, depicting violent actions, warfare, and scenes of sacrifice. Architectural indicators from settlement pattern data, like defensive walls or strategic location of settlements in easily defended positions, can indicate warfare, while burned sites and bodies lacking formal burial may be other indicators of war (LeBlanc 1999, p. 44). In Mesoamerican contexts, ritual violence in architecture has been linked to ball courts (Swenson 2003). Violence is a worldwide phenomenon apparent in most cultures; it can occur in many forms and settings—family/domestic, political, urban, ethnic, gender, and between social groups. Violence is always perpetrated by 'the other'. Often violence is related to warfare and inter-society conflict; it might be used to conquer new territories and people or to extract tribute. Ritual violence is another form, associated with religious activities, as in the Andes where *tinku* is practised. The roots can be traced back at least to colonial times in historical documents, and there is evidence that similar events took place during Inka times. Modern *tinku* can be found over a wide area in the Andes and varies a great deal from region to region; examples of *tinku* have been documented from Ecuador, Peru and Bolivia. Most often it is described as a ritual battle fought between different communities, moieties, or kinship groups. The *tinku* takes place on set dates and in association with other rites and festivities. Blood is of high ritual significance in the *tinku*; the blood of the participants wets the ground in which the fighters are later buried. The energy and blood used in the *tinku* fertilize the earth and are eventually returned to the people (Topic and Topic 1997). The majority of the battle takes place between men, but young women sometimes participate in the ritual fight. Whole families come to the event to watch and there is a festive atmosphere. Food and drink are brought and consumed, often alcoholic beverages such as *chicha* (Arkush and Stanish 2005). The modern fighters put on their best clothes and sometimes special types of dress are used (Topic and Topic 1997). The two fighting sides use traditional weapons such as slingshots, *boleadores*, clubs and whips. The fighting can be very violent and serious injuries are common, with deaths reported. The winning side in a *tinku* battle will enjoy a prosperous year, and this is the most common explanation by the participants for why the *tinku* is held. The winning side does not gain territory or any other kind of tribute (Topic and Topic 1997; Arkush and Stanish 2005). Evidence that has been interpreted as indicating warfare, such as defensive sites and iconography showing fighting, could in fact indicate ritual battle rather than actual warfare, as argued by Arkush and Stanish (Arkush and Stanish 2005, p. 10), although warfare at any scale can be highly ritualized, including the killing of enemies or the capturing of goods, people, or land. Use of defensive sites can also have ritual aspects, as historical sources have indicated.

The complex Aguada iconography is dominated by images of felines, warriors and trophy heads, and violent scenes are often depicted on the ceramic vessels. The image of a person interpreted as a warrior and/or the sacrificer (priest/shaman) is a common theme in the iconography (González 1998; Leoni and Acuto 2008, p. 593; González 1972). According to González, 'The warrior/trophy-head/feline trilogy shared part of a religious structure that, even though we cannot understand it in its details, possessed an iconography so rich that it speaks for itself. The elements depicted on the surface of the vases are

repeated again and again, and show a high degree of stability in their formal appearance; no doubt their symbolic meaning was clear to the people of Aguada, even though it is obscure to us.' (González 1972, p. 135). He states that the iconography shows that the Aguada was a violent society. According to him the dismembered human remains found in La Rinconada are evidence of human sacrifice. However, he was not sure whether the Aguada society was war-like, with a warrior organization. He means that the two-scepter character, well known not only in the Aguada culture but all over the Andean region, as well as the sacrificer character, might be gods, rather than warriors. He states that although in some of the representations these characters might be holding weapons, this might not represent warlike tendencies but instead be related to sacrificial rites. The god might be holding weapons only metaphorically, without the cultural support of a warrior organization (González 1998, p. 158). However, he did believe that the Aguada extensively practised bloody rites with human victims, but that it could not be determined whether these victims reflected war-like practices or whether they were from the same ethnic group or from other groups. There is only one iconographic representation of two Aguada 'warriors' fighting, in which one has an arrow embedded in his back (González 1998, figure 129). Some of these weapons found in the Aguada iconography have recently been interpreted as possible plants (Marconetto 2015).

The most common weapon found in the Aguada iconography is the *tiradera* or atlatl (González 1998, p. 137), with other weapons depicted in the iconography including axes and darts. Several figures represented in the iconography with elaborate headdresses are seen holding trophy heads and scenes of sacrifice are displayed (see for example figures 112 and 127 in González 1998). Metal axe blades with feline motifs have also been found, and feline-related themes and motifs are common, including jaguars, human figures with feline heads, and anthropomorphized felines. The iconography of the Aguada culture has not only been found on ceramics, but also on wooden artefacts and metal ornaments, including bronze, gold and copper artefacts (Leoni and Acuto 2008; González 1998). González argues, 'The human figures depicted are of different kinds: warriors, with rich headdresses, carrying weapons in their hands, mainly spearthrowers and darts; the two-scepter character, well known in the Andean area; the sacrificer character, a warrior with an axe in one hand and a trophy head in the other; warriors with felinic masks; human figures with felinic attributes; felinic figures with tattooed faces, felinic spots, felinic jaws, incurved crests as nose ornaments' (González 1972, p. 133; see also figures 21, 22 and 23 in González 1972). A ceramic fragment shows a scene that has been interpreted as a sacrifice scene, as a victim is carried away apparently to be sacrificed, although he certainly might be carried away for many other reasons (see figure 2 in Laguens and Gastaldi 2008).

According to González and Pérez Gollán (1972, pp. 113–114) there is evidence of violence and warfare from a fortified village called Asampay in the Hualfín Valley, which has evidence of fire and where many of its defenders were dead and decapitated, although this site dates to the Regional Development Period. They argue that the village might have been attacked by people from Santiago del Estero since some of the bone arrows found are a type normally associated with this area, different from the arrows normally found in the Hualfín area.

González (1998, p. 136) further argued that the disappearance of the Aguada might have been related to the violent behaviour of their neighbours from the plains of Santiago del Estero and other tribes from the forested *selva* areas. He states that these 'predatory peoples, aggressive and fearful with their poison arrows were certainly one of the causes of the disappearance of Aguada' ('pueblos depredadores, agresivos y temibles por la ponzoña

de sus flechas que fueron, seguramente, una de las causas de la desaparición de Aguada' González 1998, p. 136 [original in Spanish]). González argues using historical accounts of the Lules and the evidence for the Asampay site that these eastern tribes were responsible for the disappearance of the Aguadas, although I would argue that we need more evidence to support this idea.

As discussed by Pazzarelli (2012, p. 23), for González the origin of the Aguada was to be found in the Andes and was related to a high Andean civilization (culture). He saw the societies around Aguada, from the 'lowlands', as warlike and predatory, and to him every relationship with the societies in the lowlands, or from the Chaco, or from the Yungas area, was a factor that interrupted the continued development in the Andean *valliserranan* zone. This relates to the evolutionary thinking prevalent in archaeology and how Andean high cultures are seen as producers and controllers of nature, while hunter-gatherers are predators of nature and more dependent. However, we do not posses much evidence to support such views, although González's arguments for this war-like explanation were strengthened by the discovery that a fire had struck the La Iglesia de Los Indios site.

Although the iconographic evidence gives us a picture of a war-like and violent society, the built environment in the area does not seem to demonstrate conflict. Many of the settlements related to the Aguada culture show no defensive structures or fortified compounds and the settlements are often found on valley floors, locations that are difficult to defend (Assandri 2006; Leoni and Acuto 2008, p. 595). This evidence seems to depict a society very different to the one found in the iconography.

Other possible indicators of violence in the Aguada society have been identified on skeletal remains. Cut marks found on human bones have in some cases been interpreted as evidence for human sacrifice. Isolated craniums have been found in the site of La Rinconada and one possible explanation is that they are trophy heads (Cruz 2006; Gordillo and Solari 2007; Juez 1991). González (1998) has also suggested that evidence of fire was a sign of violence, although it is not clear why this must be the case. Even if the fires were intentional, they might have been completely unrelated to violence. As discussed above with examples from the Chaco and Amazon, ethnographic examples show us that fire can be used for purification, and it can also be related to ritual abandonment of a structure and have nothing to do with violence.

Structures with evidence of fire associated with termination rituals have also been found in the Mayan area (Inomata 2003). Several structures at the site of Aguateca had been burned intentionally at the time of abandonment, and this evidence has also been connected to a warfare scenario. However, we still have no evidence to support such an interpretation in the Ambato Valley, as we do not think that the burning there is an indicator of warfare in our case. The termination rituals at Aguateca were probably performed to seal off and close structures at the time of abandonment, a behaviour in this case related to uncertain times and warfare (Inomata 2003). If warfare was the case in the Ambato we do not have evidence for the building of defensive structures, and we also have not found any human remains that can be associated with the abandonment of any of the structures. However, the possibility should not be ruled out. Perhaps people did not have time to construct any defensive structures and had to flee before the attackers arrived, therefore also leaving many things behind at the compounds.

I have noted that violence is a worldwide phenomenon found in both modern and prehistoric societies. It takes place between different actors, from the state level to the domestic level, and affects all genders and age groups. The prehistoric record can help us

to understand how violence and warfare affected different prehistoric societies at different levels both horizontally and vertically. Various indicators, such as iconography, architecture, settlement pattern data, and skeletal trauma, inform us of violence in society, but care must be taken and the more indicators of violence that can be identified the stronger the case for violence and warfare. As discussed above, the presence of some indicators of violence does not necessarily mean that a society was violent towards other societies, but might indicate that an ideology was present where violence could be a means to control people and populations, or that violent elements were used in ideology. I do not think that violence and warfare was part of the abandonment process in the case of the Aguadas, since there is still too little evidence to support this idea.

Final Words and Future Directions

This research has produced many answers, but also several new questions about fire and the final phase of occupation of the Ambato Valley, and these questions will guide us in our future investigations in the area. There is a need to fine-tune the methods applied and to obtain more radiocarbon dates in order to achieve an even better understanding of the past fire sequences and fire regimes. New palaeoenvironmental data about the final phase of the occupation of the area is needed, in order to fully understand what happened, and studies are currently under way (Marconetto et al. 2015). We still need to expand our research in this field, and to carry out new excavations in other types of structures and smaller settlements units in the area. We also need to ask ourselves about the evidence for the final phase of occupation of the valley. Is the Aguada occupation really the last phase of occupation? Maybe we have not yet succeeded in identifying later occupational phases in the valley. We have more than one hundred archaeological sites identified in the Ambato Valley, not including agricultural terraces, but only about ten sites excavated, and of these only three with evidence of fire. Can these three sites really be used as evidence for regional abandonment or for the abandonment of the whole valley? I would argue that they cannot. Instead, I would stress that we need to excavate more sites to see what the abandonment pattern looks like for these and for other type of sites, such as smaller settlements in other parts of the valley and structures in the piedmont area. These are locations that should be prioritized in new excavations. With more data on the valley's occupational history we can determine whether there are more sites with evidence of fire and with evidence of drought. This will open up for new lines of evidence for future research, which could help us gain further insight in the last occupational phase of the Aguada society in the Ambato Valley.

We should also focus on obtaining more information about the vegetation history so that we can use it to better understand the fire regimes in the area. This is in fact the next step in our research and already underway, using Normalized Difference Vegetation Index (NDVI) models to calculate past biomass in the area; we will also initiate pollen analysis to obtain more palaeoenvironmental information (Marconetto et al. 2015). This information will be crucial for continuing our work with the analysis of past fire regimes in the area. With the new data on past vegetation that the projected new pollen studies should provide, we will be able to cover the whole Aguada occupation in the area. We will also develop even stronger evidence about biomass availability, which will help us recreate the past fire regimes and compare them to the vegetation patterns in the area. More research on the

effects of fire on native flora in our study area should also be extremely helpful as we continue our investigations.

The evidence so far indicates that wildfires created by human actions or natural causes did not end the Aguada occupation in the Ambato Valley, although it is possible that some settlements were abandoned because of fire. It seems likely that the people inhabiting the area were accustomed to the existence of 'natural' fires, since they occurred in the area prior to the first occupation. The people who inhabited the Ambato Valley over 1500 years ago lived in an area with constant risk of wildfires, and this is true today as well. We can see clear variations between different areas of the valley, if divided into north, south, central, west, and east, although I found that the fire regimes seems to have followed a similar pattern in the different areas (Lindskoug 2013). The central part, where most of the archaeological sites are found today, had been affected along with agricultural areas in the piedmont zone. The inhabitants must have learned to live with fire both as a resource and as a threat. If in the future we are able to find concurrences between fires and the drier periods in the final phase of the valley's occupation, we can take another step closer to understanding the processes that led to the abandonment. Perhaps there was not a large production of biomass during this time because of the low moisture levels, but large quantities of available fuel must have accumulated in earlier times. If the vegetation has not changed too much it can give us an indication of how large fires might have affected broad areas, by comparison with modern fires such as the one in December 2009. However, it is likely that the vegetation coverage has changed somewhat, and in earlier times there was probably a denser vegetation cover in the valley. Complementary pollen studies might help us to resolve issues like this.

I continue to emphasise that environmental factors were not the only ones that had an effect on a society under stress. Environmental factors are not a determinant, but are instead part of a social-environmental dimension in which several factors must have worked to push the society into a vulnerable situation. I would argue that social factors might have been important in the process, as also suggested by other authors (González 1998; González and Pérez Gollán 1972; Marconetto and Laguens 2016). Natural and social/cultural factors can cause instability or stress within a society and work as a catalyst for pre-existing problems. This can lead to increased conflict in both the social and natural realms, such as conflicts over land, internal conflicts between different groups in a society, and even external conflict with other groups occupying the same area or nearby regions. These factors (natural and cultural/social) affect one another in a complex system that creates tensions internal to the society, as well as within the ecosystem (the natural environment) occupied by both human populations and their natural resources. In terms of the abandonment of the Aguada settlements in the Ambato Valley, the study shows that frequent forest fires might have played a role, but based upon the regularity of such events as seen in the sediment history, it is unlikely that these were the only factor in the process of abandonment of the valley.

If the inhabitants of the Ambato Valley lived with the presence of natural fires for a long period of time, then it probably was not fire that made them leave the valley. We must therefore continue our search for the possible reasons, although it remains likely that drought was one of several factors that would have led to the final abandonment of the valley around a 1000 years ago. The fact that we still have no evidence for reoccupation of the sites may reflect the severity of the situation faced by the Aguada society in the Ambato Valley.

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