

A CHRONOLOGY OF THE PRE-COLUMBIAN PARACAS AND NASCA CULTURES IN SOUTH PERU BASED ON AMS ^{14}C DATING

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ABSTRACT. The people of the Paracas and Nasca cultures, the creators of the famous geoglyphs, lived in the desert of the southern coast of Peru between about 800 BC and AD 650. The archaeological chronology of these cultures has been based almost exclusively on a sequence of ceramic styles. The absolute dating of some of the style phases was supported by a few radiocarbon dates (Rowe 1967). Here, we present an absolute chronology of the Paracas and Nasca cultures based on ^{14}C dating of more than 100 organic samples from settlement and tomb relics, as well as on material derived from geoglyph sites in the Nasca/Palpa region (south Peru). The main focus has been on Nasca period settlement centers near Palpa, Los Molinos and La Muña, the Paracas period site of Jauranga, and the Initial period site of Pernil Alto. Most of the ^{14}C samples were dated at the accelerator mass spectrometry (AMS) facility of the ETH Zurich (Switzerland). The targets were produced in the newly built graphitization line at the Heidelberg ^{14}C laboratory (Germany). Clay (adobe) bricks, which are quite a common building material in Peru, were successfully tested to be used for AMS ^{14}C dating of adobe architecture in Peruvian archaeology.

INTRODUCTION

Ceramic is quite a durable cultural product and in most prehistoric cultures it has a marked chronological sensitivity. Therefore, ceramics are widely used among archaeologists to arrange ancient cultures spatially and temporally (Eggert 2001). Since the dawn of archaeological ceramic analyses, they have been used not only as a source of cultural information, but also as a tool to create a relative chronology of archaeological complexes, especially at the beginning of the 20th century when radiometric dating methods were still lacking. Thus, the arrangement of the chronological phases of the Paracas and Nasca cultures, which began to be studied in these times, was until now based on the seriation of ceramic styles.

In Peruvian archaeology, the ceramic classification based on single attributes, as introduced by James A Ford (Rowe 1959; Menzel 1971), was adapted by Rowe (1959) for the seriation of ceramic material from the southern coast of Peru in order to create a master chronology for the pre-Hispanic cultures of Peru. Rowe created the so-called "similiary seriation." This method is based on a non-typological, non-quantitative ceramic analysis, and the assumption that changes within a culture, which will be also expressed in its ceramic style, develop step-by-step from simplicity to complexity (for more detailed information see Wetter [2005]). Menzel et al. (1964) published a ceramic chronology of the Paracas with 10 Ocucaje phases. The last phase of this Paracas chronology, Ocucaje 10, incorporates similar style elements as the first phase of the Nasca chronology, Nasca 1; thus, this transitional period is referred to as the Initial Nasca or Proto-Nasca (see Tables 1–3) (Reindel et al. 1999; Lambers 2004).

The Ocucaje sequence (Table 1) was established on the basis of a huge amount of material in museums and private collections lacking information on archaeological contexts. Very few scientific excavations of Paracas sites have been conducted on the southern coast of Peru, and several relative chronologies with different phase designations exist (Reindel and Isla Cuadrado 2001; Wetter 2005).

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Table 1 Schematic comparison of 3 relative chronologies of the Early Horizon for the southern coast of Peru (according to Wetter 2005).

	Menzel et al. (1964)	DeLeonardis (1997)	Reindel et al. (1999)
Early Intermed. period	Nasca 1		Initial Nasca
Early Horizon	Ocucaje 10		
	Ocucaje 9		Late Paracas
	Ocucaje 8		
	Ocucaje 7	Late Callango (Ocucaje 6–7)	Middle Paracas
	Ocucaje 6		
	Ocucaje 5		
	Ocucaje 4	Middle Callango (Ocucaje 3–8)	Early Paracas
	Ocucaje 3		
	Ocucaje 2		
	Ocucaje 1	Early Callango (Ocucaje 1–4)	
Initial period			

The ceramic chronology of the Nasca period faces the same problem as that of the Paracas phase because much of the pottery underpinning the classification is derived from looted sites and lacks a stratigraphic context. The first descriptions of Nasca ceramics and attempts at a relative chronology were published by Joyce (1912) and Uhle (1914).

During the last century, a number of archaeologists worked on a systematic chronology of the Nasca time based on ceramic analyses with respect to the decoration style, iconography, and vessel type. Silverman and Proulx (2002) give an overview on the different elaborations; the ones mainly used are shown in Table 2. At first, 2 major stylistic elements were distinguished, believed to show a cultural development (Uhle 1914; Tello 1917): the naturalistic "monumental" style and the more abstract "proliferous" style. A change in the attempts at a classification of the Nasca pottery was introduced with Rowe's (1959) similiary seriation. This method was applied to the Nasca pottery by Lawrence Dawson. He developed a style chronology of 8 (or 9) phases that are still in use today (Table 2). However, Dawson never published his investigations himself. A summary of the style sequence was published by Rowe (1960).

Table 2 Comparative summary of the Nasca ceramic styles and the correlation to the respective phases (according to Silverman and Proulx 2002).

Stylistic strains	Dawson (in Rowe 1960)	Gayton and Kroeber (1927)	Phases
Disjunctive	9	Y-2, Y-3	Wari
	8	Y-1	Wari (Loro)
Proliferous	7	B	Late Nasca
	6		
Transitional	5	X	Middle Nasca
Monumental	4	A	
	3		Early Nasca
	2		
Proto-Nasca	1		Initial Nasca

The relative ceramic chronologies of the Paracas and Nasca periods described above lack not only information on the archaeological context of the ceramic used to construct them, but they also imply a number of uncertainties. Silverman and Proulx (2002), for example, mention regional differences in ceramic style elements that may be misinterpreted as chronological stages. That this has to be considered carefully becomes clear when looking at the geomorphological complexity of the Rio Grande de Nasca Valley system (Figure 1). For instance, due to the strong morphological division in the area, styles could have been maintained at some places, while elsewhere new styles were already being developed. Furthermore, what is regarded as "chronological" can be an expression of the style of families or different social groups. Also, functional differences, e.g. between ceremonial and domestic use, can be falsely interpreted as chronological development (Wetter 2005).

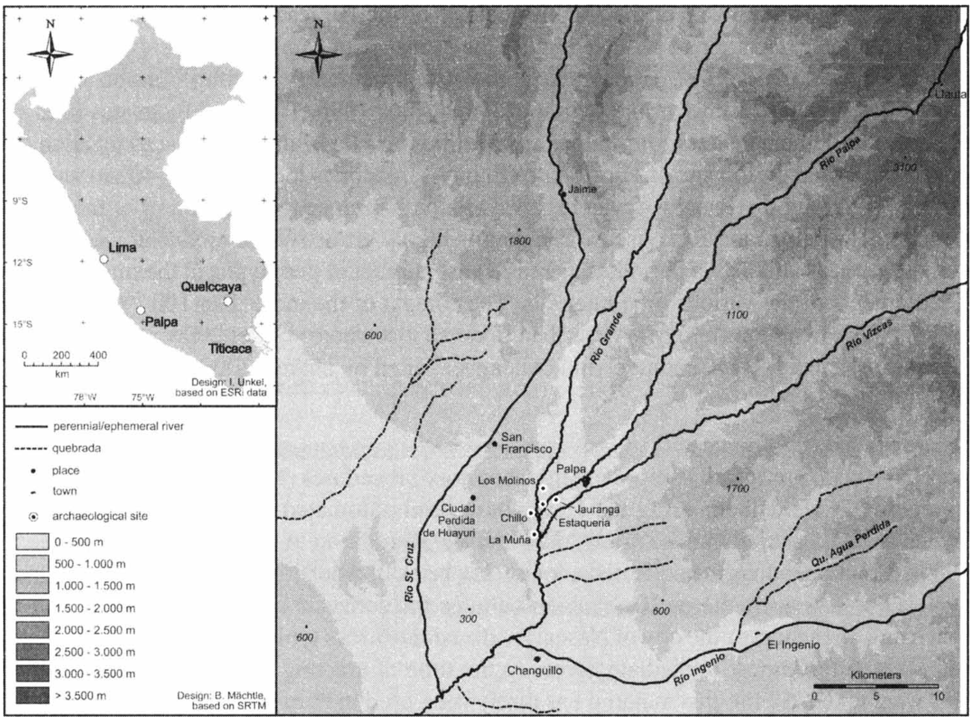

Figure 1 Map of the study area around Palpa

Recently, archaeologists of the German Archaeological Institute have been attempting to rework the existing Paracas (Wetter 2005) and Nasca (Hecht 2007) ceramic classification. The aim is to establish a classification that is based on a wide range of characteristics, such as the previously neglected ware type and pottery shape, and is derived from well-documented and well-stratified archaeological excavations. These new investigations are the relative-chronological framework for the numerical ^{14}C chronology of the Paracas and Nasca time presented below.

The existing attempts towards a numerical chronology of the Paracas culture are controversial (Velarde 1997). The onset of the so-called Early Horizon varies up to 900 yr depending on the author (Paul 1991). This conflict is based on ^{14}C dates that are either derived from less meaningful archaeological complexes or belong to locations like Chavin de Huantar that are far away from the centers of the Paracas culture and are parallelized by stylistic comparison (Burger 1981). In attempting to fix the end of the Paracas period and the start of the Nasca period, meaning the onset of the Early Intermediate period, the archaeological opinions vary less, but still up to 200 yr (Silverman 1991).

In the past, numeric or chronometric data of the Paracas and Nasca cultures were often derived from badly documented excavational contexts and were often ambiguous, making it difficult to classify archaeological remains from recent excavations in the Palpa region (Figure 1) (Reindel et al. 2003). Silverman and Proulx (2002) also emphasize the dire need for a well-documented, consistent, and calibrated ^{14}C chronology of that period, as they lack these requirements in the ^{14}C data published on Nasca issues so far (Rowe 1967; Disselhoff 1969; Ziolkowski et al. 1994).

ARCHAEOLOGICAL CONTEXT

The archaeological framework of the ^{14}C chronology of the Paracas and Nasca periods presented here is based upon excavations conducted under the guidance of Markus Reindel (German Archaeological Institute, DAI-KAAK, Bonn) and Johny Isla Cuadrado (Instituto Andino de Estudios Arqueológicos, INDEA, Lima) in the region of Palpa since 1996. The main focus has been on the Nasca period settlement centers near Palpa, Los Molinos and La Muña, the Paracas location of Jauranga, and the Initial period site of Pernil Alto (Figure 1). Palpa is located about 40 km north of the town of Nazca, along the Panamericana highway. Palpa lies close to the junction of the valleys of Rio Grande, Rio Palpa, and Rio Viscas. The area is highly attractive for archaeological investigations on the Paracas and Nasca period as there is a vast number of geoglyphs in the immediate vicinity of settlements of the various time intervals. The context of the more than 100 ^{14}C samples used to build the numerical chronology is described in detail elsewhere (Unkel 2006) and in the excavation reports of Reindel, Isla Cuadrado, and colleagues (cited by Unkel [2006]).

METHODS

Samples have been pretreated using standard laboratory procedures (Unkel 2006). The AMS targets were prepared in Heidelberg using the newly built semi-automated graphitization system (Unkel 2006), and were measured in the Zurich AMS facility. In addition to commonly used sample material (Table 3 in Appendix), we collected adobe (clay bricks). Adobe is a common building material throughout Peru, used by the pre-Columbian cultures for domestic and also for ceremonial buildings, such as Cahuachi near the city of Nasca. As the adobe bricks typically contain single-year plant material, they offer almost immediate access to the time of erecting the buildings from which the samples were taken. So far, this material has rarely been used in Peru for dating pre-Hispanic adobe architecture. By selective sieving (1-mm mesh size), we recovered organic fragments from the adobe, such as maize straw and charcoal pieces (Unkel 2006).

For ^{14}C age calibration, we used OxCal v 3.8 (Bronk Ramsey 1995, 2001). Although already applied in several fields of archaeology, Bayesian statistics have only rarely been used in the investigation of the pre-Columbian cultures of south Peru (Görsdorf and Reindel 2002; Michczyński et al. 2003). However, for building a coherent ^{14}C chronology this statistical approach is mandatory (Buck and Millard 2004).

The fundamental idea of Bayesian theory is that it is possible to quantify the probability of certain assumptions, events, or data sets under the condition of some prior or a priori information (Bayes 1763). This information can simply be the stratigraphic position of 2 single samples or can be extended to the affiliation of a group of samples to a certain phase. In the case of the Paracas-Nasca chronology, this would be the attribution of each sample to a certain ceramic phase (Figure 2), based on the excavational context and the association of organic sample material with ceramic finds.

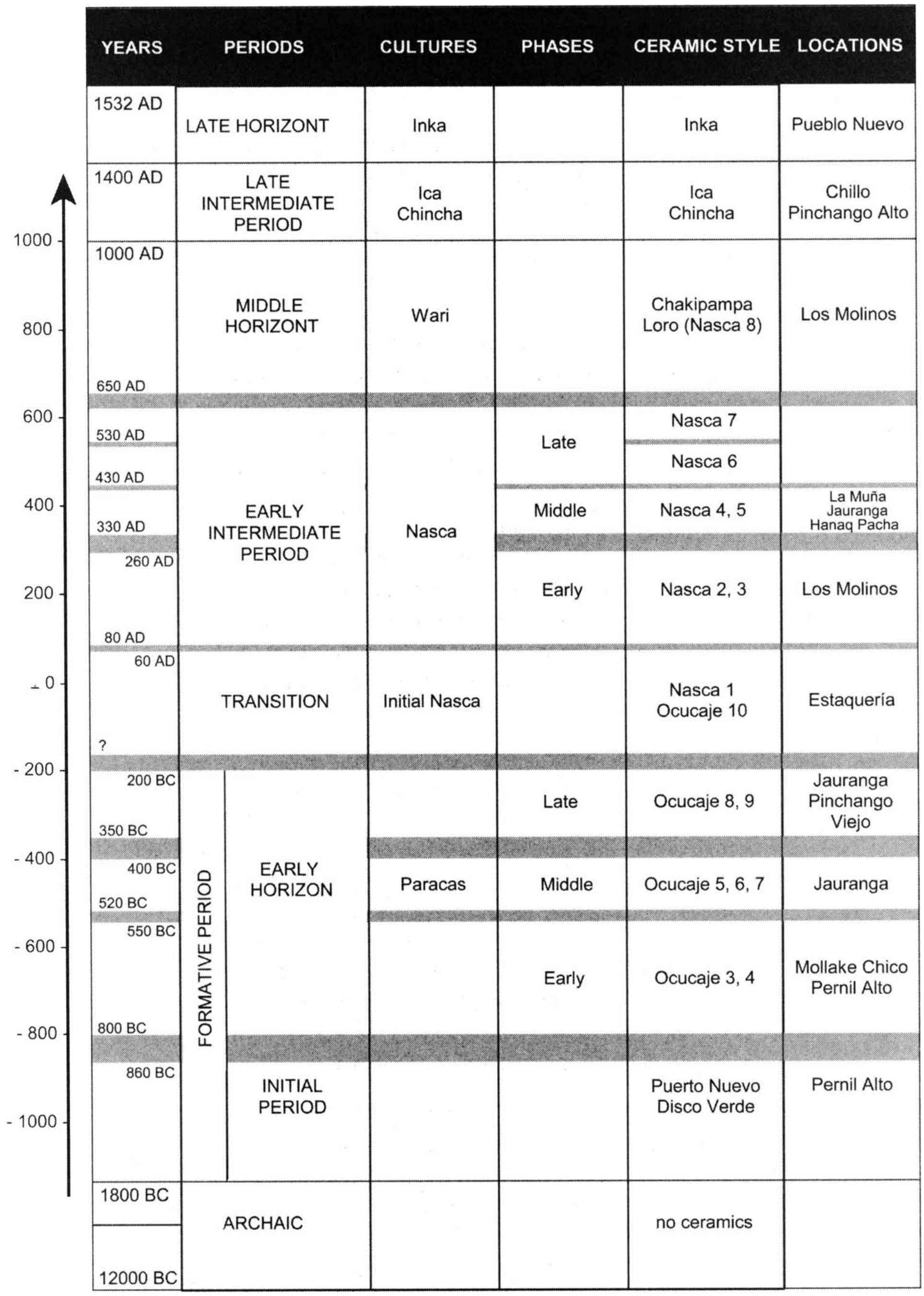

Figure 2 Chronology of the Paracas and Nasca cultures at the southern coast of Peru, based on our work on more than 100 ^{14}C dates of samples from ceramics-bearing excavation contexts in the Palpa area. Gray areas mark transitional zones between the single phases, caused by the overlap of the 1-σ probability intervals of each calculated phase. The pre-Paracas and post-Nasca periods are neither dated nor discussed here and are shown only for context purposes.

A first approach to build a Nasca chronology based on this Bayesian statistical approach was performed by Görsdorf and Reindel (2002) with 12 samples from well-documented excavations in Los Molinos and La Muña. They calibrated the ^{14}C ages with OxCal v 3.5 (Bronk Ramsey 1995, 2001) using the IntCal98 calibration curve (Stuiver et al. 1998).

In 2 aspects of the calibration, we slightly differ from the previous approach of Görsdorf and Reindel (2002):

- They applied a Southern Hemisphere correction of –24 ± 3 ^{14}C yr based on Stuiver et al. (1998), while we used a correction of –41 ± 14 ^{14}C yr after McCormac et al. (2002). We decided not to apply a larger correction of –55 ± 7.9 ^{14}C yr as suggested by the new calibration curve for the Southern Hemisphere, SHCal04 (McCormac et al. 2004), because McCormac et al. define the Southern Hemisphere as south of the thermal equator or south of the range of the Intertropical Convergence Zone (ITCZ). Our research area is located at 14°30′S, and we therefore assume to have a lower offset towards the Northern Hemisphere.
- Görsdorf and Reindel (2002) do not use statistical boundaries for their chronology model, neither for defining single phases nor for separating 2 phases that can be distinguished archaeologically. However, using boundaries is strongly recommended by Bronk Ramsey (2001), as modeled time spans without boundaries tend to spread disproportionately.

Both in Görsdorf and Reindel (2002) and here, the sum function of the OxCal syntax (Bronk Ramsey 2001) is employed for adding probability distributions of single samples to arrive at the best estimate for the chronological distribution of each Paracas and Nasca phase to be determined. It is important to note that the 1-σ range for a sum distribution gives an estimate for the period in which 68.2% of the events took place and not the period in which one can be sure with 68.2% probability that all of the events took place (Bronk Ramsey 2001). Due to this difference, it is possible that single samples, which were previously included in the statistical model of a Paracas or Nasca phase, ultimately end up outside the calculated phase after running the model (for further considerations on outliers see Buck and Millard [2004]).

DISCUSSION

The results of the modeled Paracas-Nasca chronology are summarized in Figure 2. Information on the samples used for the chronology is given in Table 3 (Appendix). The output of the OxCal model showing the probability distributions of the samples and the calculated phases can be found in Figure 3 (Appendix).

For the Initial period, preceding the Paracas phase, there were 11 ^{14}C samples from Pernil Alto (Figure 1) available to be included into the chronology model. Due to the archaeological context, they are all ascribed to the final phase of the Initial period. The end of this epoch is well defined by 7 dates for the last period of use of the site. We do not have information about the beginning and the duration of the Initial period (for details see Unkel [2006]). In fact, the sample of the Initial period can be perfectly used as the lower boundary of the Paracas chronology. The Early Paracas phase is represented by only 3 samples from the location of Mollake Chico near Palpa. We therefore have a first estimate of the time range of this phase; however, more samples, especially from the transition between the Initial period and Early Paracas, are necessary to narrow the error margins. Eleven samples are available from the Middle Paracas and 24 samples are available from the Late Paracas phase, providing a strong backbone for this time span. Up to now, all of these ^{14}C samples were excavated in Jauranga (Figure 1), yet a comparison with samples of the same period from Pernil Alto is expected soon. The Initial Nasca phase is represented by 6 samples, all derived from a single archaeological complex at Estaquería (Figure 1). Based on these few samples, the transition between the Paracas and Initial Nasca could not yet be modeled sufficiently (Figure 2). There still is an imprecise time gap between 200 cal BC (upper 1-σ boundary of the Late Paracas phase) and 50 cal BC (lower 1-σ boundary of the Initial Nasca phase), which has to be closed by ^{14}C samples from future excavations. The 5 samples from Los Molinos (Figure 1), which Görsdorf and Reindel (2002) used for a first approach to the Early Nasca phase, were also included in our Paracas-Nasca chronology model. The transition between the Initial Nasca and Early Nasca phase could be determined quite well, between cal AD 60 and 80 within the 1-σ uncertainty margins. The Middle Nasca phase is very well dated, based on 17 ^{14}C samples from different excavational contexts defining a time span between cal AD 260 and 430 (1 σ). Seven ^{14}C samples were used to determine the Late Nasca phase. Based on the style of the associated pottery in the archaeological context, all samples were ascribed to the Nasca 7 ceramic phase (compare Table 2). There were no ^{14}C samples available from the Nasca 6 phase. With the upper 1-σ boundary of the Middle Nasca phase at cal AD 430 and the lower 1-σ boundary of the Nasca 7 phase at cal AD 530, the Nasca 6 phase can be defined as a time gap of about 100 yr based on our data. However, further archaeological investigations on the Nasca pottery have to show if this phase definition is justified. The end of the Nasca time in our chronology is only defined by the upper 1-σ boundary of the Nasca 7 phase at cal AD 650.

CONCLUSIONS

More than 100 ^{14}C samples provide for the first time a stable numerical framework for the ceramic-derived periods of the pre-Columbian Paracas and Nasca cultures at the south Peruvian coast. The chronology model can easily integrate new ^{14}C data from our ongoing work, and it can be adapted to new archaeological findings due to its open structure based on the Bayesian approach of OxCal. The relative ceramic chronology of the Paracas (Wetter 2005) and Nasca (Reindel et al. 1999) cultures was confirmed by our numerical data. Furthermore, adobe (clay bricks) has been successfully dated with the AMS technique and was integrated into the chronology presented above.

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REFERENCES

Bayes TR. 1763. An essay towards solving a problem in the doctrine of chances. *Philosophical Transactions (1683–1775)* 53:370–418.

Bronk Ramsey C. 1995. Radiocarbon and analysis of stratigraphy: the OxCal program. *Radiocarbon* 37(2): 425–30.

Bronk Ramsey C. 2001. Development of the radiocarbon calibration program. *Radiocarbon* 43(2A):355–63.

Buck CE, Millard AR, editors. 2004. *Tools for Constructing Chronologies: Crossing Disciplinary Boundaries.* London: Springer-Verlag. 257 p.

Burger RL. 1981. The radiocarbon evidence for the temporal priority of Chavin de Huantar. *American Antiquity* 46(3):592–602.

DeLeonardis L. 1997. Paracas settlement in Callango, lower Ica Valley, 1st millenium B.C., Peru [PhD dissertation]. Washington D.C.: Catholic University of America.

Disselhoff HD. 1969. Früh-Nazca im äußersten Süden Peru, Provincia de Camaná (Dep. Arequipa). In: *Ver-*

handlungen des 38. Internationalen Amerikanisten Kongresses Stuttgart-München 1968. p 385–91. In German.
Eggert MKH. 2001. *Prähistorische Archäologie: Konzepte und Methoden*. Tübingen, Basel: Francke. 412 p. In German.
Gayton AH, Kroeber AL. 1927. The Uhle pottery collections from Nazca. *University of California Publications in American Archaeology and Ethnology* 24(1): 1–46.
Görsdorf J, Reindel M. 2002. Radiocarbon dating of the Nasca settlements Los Molinos and La Muña in Palpa, Peru. *Geochronometria* 21:151–6.
Hecht N. 2007. Eine befundorientierte relative Chronologie der Nasca-Keramik in Palpa [PhD dissertation]. Bonn: Rheinische Friedrich-Wilhelms Universität. In German.
Joyce TA. 1912. *South American Archaeology*. New York: G.P. Putnam's Sons. 292 p.
Lambers K. 2004. The geoglyphs of Palpa (Peru): documentation, analysis, and interpretation [PhD dissertation]. Zurich: University of Zurich. Abstract available online at http://www.dissertationen.unizh.ch/2005/lambers/abstract.html.
McCormac FG, Reimer PJ, Hogg AG, Higham TFG, Baillie MGL, Palmer J, Stuiver M. 2002. Calibration of the radiocarbon time scale for the Southern Hemisphere: AD 1850–950. *Radiocarbon* 44(3):641–51.
McCormac FG, Hogg AG, Blackwell PG, Buck CE, Higham TFG, Reimer PJ. 2004. SHCal04 Southern Hemisphere calibration, 0–11.0 cal kyr BP. *Radiocarbon* 46(3):1087–92.
Menzel D. 1971. Estudios arqueológicos en los Valles de Ica, Pisco, Chincha y Cañete. *Arqueología y Sociedad* 6:1–158. In Spanish.
Menzel D, Rowe JH, Dawson LE. 1964. *The Paracas Pottery of Ica: A Study in Style and Time*. Berkeley: University of California Press. 399 p.
Michczyński A, Eeckhout P, Pazdur A. 2003. ^{14}C absolute chronology of Pyramid III and the dynastic model at Pachacamac, Peru. *Radiocarbon* 45(1):59–73.
Paul A, editor. 1991. *Paracas Art and Architecture: Object and Context in South Coastal Peru*. Iowa City: University of Iowa Press. 455 p.
Reindel M, Isla Cuadrado J, Koschmieder K. 1999. Vorspanische Siedlungen und Bodenzeichnungen in Palpa, Südperu. *Beiträge zur Allgemeinen und Vergleichenden Archäologie (BAVA)* 19:313–81. In German and Spanish.
Reindel M, Isla Cuadrado J. 2001. Los Molinos und La Muña. Zwei Siedlungszentren der Nasca-Kultur in Palpa, Südperu. *Beiträge zur Allgemeinen und Vergleichenden Archäologie (BAVA)* 21:241–319. In German and Spanish.
Reindel M, Isla Cuadrado J, Lambers K. 2003. Die Arbeiten des Archäologischen Projektes Nasca-Palpa, Peru, im Jahr 2002. In: *Jahresbericht der Schweizerisch-Liechtensteinischen Stiftung für Archäologische Forschungen im Ausland (2002)*. Zurich and Vaduz. p 119–32. In German.
Rowe JH. 1959. Archaeological dating and cultural process. *Southwestern Journal of Anthropology* 15(4): 317–24.
Rowe JH. 1960. Nuevos datos relativos a la cronología del Estilo Nasca. In: Matos RM, editor. *Antiguo Perú: Espacio y Tiempo*. Lima: Juan Mejia Baca. p 29–45. In Spanish.
Rowe JH. 1967. An interpretation of radiocarbon measurements on archaeological samples from Peru. In: Rowe JH, Menzel D, editors. *Peruvian Archaeology: Selected Readings*. Palo Alto, California, USA: Peek Publications. p 16–30.
Silverman H. 1991. The Paracas problem: archaeological perspectives. In: Paul A, editor. *Paracas Arts and Architecture. Object and Context in South Coastal Peru*. Iowa City: University of Iowa Press. p 349–414.
Silverman H, Proulx DA. 2002. *The Nasca*. Kolata A, Snow D, series editors. Peoples of America series. Oxford: Blackwell. 360 p.
Stuiver M, Reimer PJ, Bard E, Beck JW, Burr GS, Hughen KA, Kromer B, McCormac G, van der Plicht J, Spurk M. 1998. IntCal98 radiocarbon age calibration, 24,000–0 cal BP. *Radiocarbon* 40(3):1041–83.
Tello JC. 1917. Los antiguos cementerios del valle de Nazca. In: Swiggett D, editor. *Proceedings of the Second Pan American Scientific Congress, Washington, USA*. Volume 1. Washington D.C.: Government Printing Office. p 283–91. In Spanish.
Uhle M. 1914. The Nasca pottery of ancient Peru. *Proceedings of the Davenport Academy of Sciences* 13:1–17. Davenport, Iowa, USA.
Unkel I. 2006. AMS-14C-Analysen zur Rekonstruktion der Landschafts- und Kulturgeschichte in der Region Palpa (S-Peru) [PhD dissertation]. Heidelberg: Universität Heidelberg. Available online at http://www.ub.uni-heidelberg.de/archiv/6311. 156 p. In German.
Velarde L. 1997. La transición Paracas-Nasca en el valle de Chincha. In: Chevalier A, Velarde L, Chenal-Velarde I, editors. *L'Amerique du Sud: Des chasseurs-cueilleurs à l'Empire Inca*. Actes des journées d'étude d'archéologie précolombienne. British Archaeological Reports (BAR) International Series 746. Geneva, Switzerland, 10–11 October 1997. Oxford: Archaeopress. p 63–77. In Spanish.
Wetter A. 2005. Paracas-Keramik aus Jauranga: Grundlagen zur Klassifikation formativzeitlicher Keramik der Südküste Perus [Master's thesis]. Bonn: Rheinische Friedrich-Wilhelms-Universität, Bonn. In German.
Ziolkowski M, Pazdur M, Krzanowski A, Michczyński A. 1994. *ANDES: Radiocarbon Database for Bolivia, Ecuador and Peru*. Warsaw and Gliwice: Warsaw University & Silesian Technical University.

APPENDIX

Table 3 The ^{14}C samples used for the Paracas and Nasca chronology. Calibration is based on IntCal98 (Stuiver et al. 1998) using a Southern Hemisphere offset of –41 ± 14 ^{14}C yr.

Nr	Invent. nr	Analysis nr	Type	Sample size (mg)	$\delta^{13}C$ (‰)	^{14}C age (BP)	St. dv. (BP)	1-σ age range (cal AD/BC)	Site	Sample material
1	27	ET369	AMS	91.105	–20.00	1675	49	340–540 AD	PAP-93	bone
2	55	HD-23212	GP	13,800	–23.62	1737	20	260–400 AD	PAP-79	wood
3	"	HD-23213	GP	7000	–24.64	1697	22	355–430 AD	PAP-79	wood
4	"	ET154	AMS	3.31	–24.60	1620	49	420–540 AD	PAP-79	wood
5	"	ET166	AMS	5.21	–23.30	1825	54	130–340 AD	PAP-79	wood
6	83	HD-23091	GP	2790	–24.27	554	35	1404–1437 AD	PAP-61	charcoal
7	"	ET122	AMS	5.6	–20.90	365	35	1510–1640 AD	"	"
8	84	HD-23123	GP	5430	–27.71	3470	21	1750–1685 BC	PAP-61	charcoal
9	90	HD-23977	GP	8600	–26.91	1512	14	560–640 AD	PAP-64B	wood
10	"	ET443	AMS	3.86	–28.60	1460	45	595–665 AD	"	"
11	109	HD-23978	GP	10,000	–25.21	1611	13	435–535 AD	PAP-64A	wood
12	112	HD-23621	GP	9580	–27.44	1484	18	603–644 AD	PAP-64A	wood
13	116	HD-23981	GP	10,000	–26.74	1562	12	535–600 AD	PAP-64A	wood
14	118	HD-23914	GP	10,500	–26.89	2835	19	1000–900 BC	PAP-266	wood
15	123	HD-23211	GP	9900	–25.52	1748	17	260–390 AD	PAP-79	wood
16	"	HD-23209	GP	10,400	–26.46	1744	16	260–390 AD	PAP-79	wood
17	"	ET124	AMS	5.7	–27.20	1620	40	430–540 AD	"	"
18	"	ET163	AMS	4.33	–24.40	1745	54	250–410 AD	"	"
19	131	HD-23782	GP	6400	–26.37	1499	23	560–645 AD	PAP-294	wood
20	133	HD-22851	GP	6700	–23.76	1705	28	340–425 AD	PAP-365	wood
21	"	ET114	AMS	3.0	–25.70	1735	45	260–420 AD	"	"
22	134	HD-23785	GP	2470	–27.41	1664	118	250–570 AD	PAP-365	wood
23	136	HD-23783	GP	4390	–25.00	1747	36	260–400 AD	PAP-365	wood
24	139	HD-23074	GP	4910	–26.68	1635	20	420–540 AD	PAP-379B	wood
25	"	ET121	AMS	6.2	–27.80	1575	40	430–600 AD	"	"
26	178	ET156	AMS	3.93	–22.40	2215	49	360–120 BC	PAP-150	charcoal
27	179	ET158	AMS	4.235	–30.80	2315	54	400–200 BC	PAP-150	charcoal
28	180	HD-23632	GP	5100	–23.02	149	23	1690–1730 AD 1810–1890 AD 1910–1920 AD	PAP-79	branches
29	181	ET185	AMS	27.285	–28.90	190	45	1670–1950 AD 1720–1780 AD	PAP-79	soil
30	182	ET175	AMS	11.3	–22.10	350	54	1490–1650 AD	PAP-79	soil
31	183	ET152	AMS	5.11	–11.40	500	49	1410–1480 AD	PAP-79	charcoal
32	184	ET131	AMS	3.7	–20.30	430	50	1440–1530 AD 1590–1630 AD	PAP-79	charcoal
33	185	ET180	AMS	6.625	–28.9	400	45	1470–1530 AD 1560–1640 AD	PAP-79	soil
34	186	ET153	AMS	4.71	–27.2	400	45	1470–1530 AD 1560–1640 AD	PAP-79	soil
35	187	ET179	AMS	6.77	–24.2	580	54	1320–1350 AD 1390–1440 AD	PAP-79	soil
36	189	ET174	AMS	7.55	–29.7	190	49	1670–1880 AD 1910–1950 AD	PAP-79	wood
37	190	ET181	AMS	19.69	–23.6	380	45	1480–1530 AD 1540–1640 AD	PAP-79	soil

Table 3 The ^{14}C samples used for the Paracas and Nasca chronology. Calibration is based on IntCal98 (Stuiver et al. 1998) using a Southern Hemisphere offset of –41 ± 14 ^{14}C yr. *(Continued)*

Nr	Invent. nr	Analysis nr	Type	Sample size (mg)	$\delta^{13}C$ (‰)	^{14}C age (BP)	St. dv. (BP)	1-σ age range (cal AD/BC)	Site	Sample material
38	191	ET177	AMS	3.315	–23.9	575	49	1320–1350 AD 1390–1440 AD	PAP-79	charcoal
39	193	ET178	AMS	5.115	–23.8	410	54	1450–1530 AD 1560–1630 AD	PAP-79	charcoal
40	194	ETH-30222	AMS	5.3	–20.7	1990	60	40 BC–130 AD	PAP-79	adobe
41	196b	ETH-30220	AMS	6.0	–20.4	2250	75	380–180 BC	PAP-79	adobe, charcoal
42	196a	ETH-30221	AMS	5.2	–22.2	1845	55	130–320 AD	PAP-79	adobe, straw
43	197	ET189	AMS	6.37	–23.4	1915	54	70–220 AD	PAP-79-1	adobe, straw
44	202	ET112	AMS	4.3	–18.80	1980	95	50 BC–220 AD	PAP-79-1	adobe
45	205	HD-23089	GP	1780	–18.57	669	38	1300–1395 AD	PAP-396	branches
46	"	ET115	AMS	6.8	–34.60	630	40	1305–1405 AD	"	"
47	207	HD-23087	GP	3130	–16.76	635	24	1305–1405 AD	PAP-396	straw, leaves
48	"	ET118	AMS	5.4	–9.40	515	35	1412–1448 AD	"	"
49	215	ET182	AMS	3.21	–13.30	605	45	1310–1430 AD	PAP-396	corn
50	219	HD-23085	GP	3320	–19.21	824	38	1220–1280 AD	PAP-396	wood
51	"	ET127	AMS	6.8	–17.00	805	40	1220–1285 AD	"	"
52	220	HD-24501	GP	2690	–23.24	904	42	1060–1250 AD	"	"
53	222	ET169	AMS	5.76	–25.00	1940	59	20–220 AD	PAP-93	charcoal
54	224	ET164	AMS	4.105	–13.70	2460	68	760–410 BC	PAP-150	charcoal
55	227	ET161	AMS	13.645	–25.00	1970	54	0–140 AD	PAP-93	adobe, straw
57	246	ET159	AMS	4.415	–5.40	1345	49	660–780 AD	PAP-379	corn
58	247	ET162	AMS	3.88	–25.30	1655	54	400–540 AD	PAP-379	textile
59	"	ET171	AMS	8.01	–25.90	1615	49	420–540 AD	PAP-379	textile
60	249	HD-23631	GP	2400	–9.16	1462	26	618–657 AD	PAP-379	corn
61	250	ET125	AMS	4.6	–14.90	2910	70	1190–920 BC	Mollake	textile
62	"	ET176	AMS	13.7	–14.70	2600	54	810–540 AD	Mollake	textile
63	251	ET128	AMS	3.9	–34.50	2495	45	760–410 BC	Mollake	seed, bean
64	289	HD-24232	GP	10,280	–24.84	2284	22	390–210 BC	PAP-150	charcoal
65	"	ET438	AMS	6.30	–28.2	2325	54	410–350 AD	PAP-150	charcoal
66	290	ET376	AMS	4.75	–25.6	2160	49	210–50 BC	PAP-150	charcoal
67	291	ET377	AMS	3.49	–27.0	2195	49	360–110 BC	PAP-150	charcoal
68	292	ET378	AMS	7.77	–26.3	2335	49	410–210 BC	PAP-150	soil
69	293	HD-24209	GP	9150	–26.09	2324	20	400–260 BC	PAP-150	charcoal
70	294	HD-24234	GP	28,900	–25.22	2283	22	390–210 BC	PAP-150	charcoal
71	296	ET379	AMS	4.73	–24.0	2450	45	760–400 BC	PAP-150	charcoal
72	297	HD-24264	GP	12,000	–22.55	2458	31	760–400 BC	PAP-150	charcoal
73	309	ET381	AMS	4.62	–24.5	2290	45	390–200 BC	PAP-150	charcoal
74	311	ET382	AMS	10.28	–22.8	2305	45	400–210 BC	PAP-150	soil
75	312	ET431	AMS	3.71	–25.1	2375	49	520–230 BC	PAP-150	soil
76	314	HD-24263	GP	8600	–24.19	2247	23	360–200 BC	PAP-150	charcoal
77	315	ET432	AMS	3.79	–24.7	2325	49	400–210 BC	PAP-150	soil
78	316	ET433	AMS	4.75	–28.7	2230	49	360–270 BC	PAP-150	soil

Table 3 The ^{14}C samples used for the Paracas and Nasca chronology. Calibration is based on IntCal98 (Stuiver et al. 1998) using a Southern Hemisphere offset of –41 ± 14 ^{14}C yr. *(Continued)*

Nr	Invent. nr	Analysis nr	Type	Sample size (mg)	$\delta^{13}C$ (‰)	^{14}C age (BP)	St. dv. (BP)	1-σ age range (cal AD/BC)	Site	Sample material
79	317	ET446	AMS	5.70	–31.9	2290	54	390–200 BC	PAP-150	charcoal
80	318	ET447	AMS	4.69	–30.6	2285	54	390–200 BC	PAP-150	charcoal
81	319	ET448	AMS	4.25	–26.7	2330	54	410–210 BC	PAP-150	charcoal
82	320	ET449	AMS	4.85	–26.7	2190	54	360–90 BC	PAP-150	charcoal
83	321	ET451	AMS	4.87	–24.0	2300	54	400–200 BC	PAP-150	charcoal
84	322	ET452	AMS	4.10	–21.1	2305	49	400–200 BC	PAP-150	charcoal
85	323	ET453	AMS	3.25	–25.9	2430	54	760–390 BC	PAP-150	charcoal
86	324	ET458	AMS	4.78	–21.6	2380	49	520–250 BC	PAP-150	charcoal
87	325	ET454	AMS	3.70	–24.1	2420	54	760–390 BC	PAP-150	charcoal
88	326	ET456	AMS	3.25	–26.2	2270	54	380–200 BC	PAP-150	soil
89	327	ET457	AMS	4.65	–21.1	2485	54	760–400 BC	PAP-150	charcoal
90	335	ET462	AMS	5.59	–24.4	2255	49	370–200 BC	PAP-150	charcoal
91	336	ET463	AMS	4.57	–26.8	2220	54	360–160 BC	PAP-150	charcoal
92	338	ET466	AMS	5.72	–22.6	2460	54	760–400 BC	PAP-150	soil
93	339	ET459	AMS	14.25	–26.4	2335	54	410–210 BC	PAP-150	soil
94	340	ET461	AMS	4.48	–23.3	2505	54	760–410 BC	PAP-150	soil
95	341	ET467	AMS	21.02	–22.3	2330	54	410–210 BC	PAP-150	soil
96	342	ET602	AMS	9.61	–22.2	2415	54	760–380 BC	PAP-150	soil
97	343	ET603	AMS	5.87	–27.1	2415	49	760–380 BC	PAP-150	charcoal
98	344	ET604	AMS	6.36	–25.5	2430	54	760–390 BC	PAP-150	charcoal
99	372	HD-24208	GP	10,420	–25.44	2878	19	1015–925 BC	PAP-266	wood
100	373	HD-24265	GP	10,000	–26.52	2840	24	1000–900 BC	PAP-266	wood
101	374	ET361	AMS	3.75	–26.40	2830	45	1000–840 BC	PAP-266	wood
102	375	ET386	AMS	6.74	–25.60	2840	49	1010–840 BC	PAP-266	wood
103	376	ET362	AMS	5.50	–28.50	2810	49	980–830 BC	PAP-266	wood
104	377	ET363	AMS	5.45	–25.80	1685	45	260–530 AD	PAP-266	wood
105	378	ET387	AMS	3.97	–23.70	2885	45	1110–910 BC	PAP-266	wood
106	379	ET358	AMS	3.52	–31.10	2790	49	970–830 BC	PAP-266	charcoal
107	380	HD-24415	GP	3010	–26.00	2889	18	1050–930 BC	PAP-266	charcoal
108	381	ET359	AMS	3.76	–28.50	2860	49	1050–890 BC	PAP-266	charcoal
109	382	ET383	AMS	3.96	–26.60	2925	49	1190–970 BC	PAP-266	seed, pumpkin
110	383	HD-24071	GP	6400	–26.08	2047	24	45 BC–50 AD	PAP-73D	wood
111	"	ET366	AMS	3.81	–28.50	1970	45	20–130 AD	PAP-73D	wood
112	384	HD-24072	GP	5840	–26.30	1992	16	20–80 AD	PAP-73D	wood
113	385	HD-24073	GP	5160	–25.88	2020	22	20 BC–65 AD	PAP-73D	wood
114	386	HD-24066	GP	3080	–27.60	2086	29	95 BC–5 AD	PAP-73D	wood
115	387	ET364	AMS	3.825	–29.20	2005	45	40 BC–90 AD	PAP-73D	charcoal

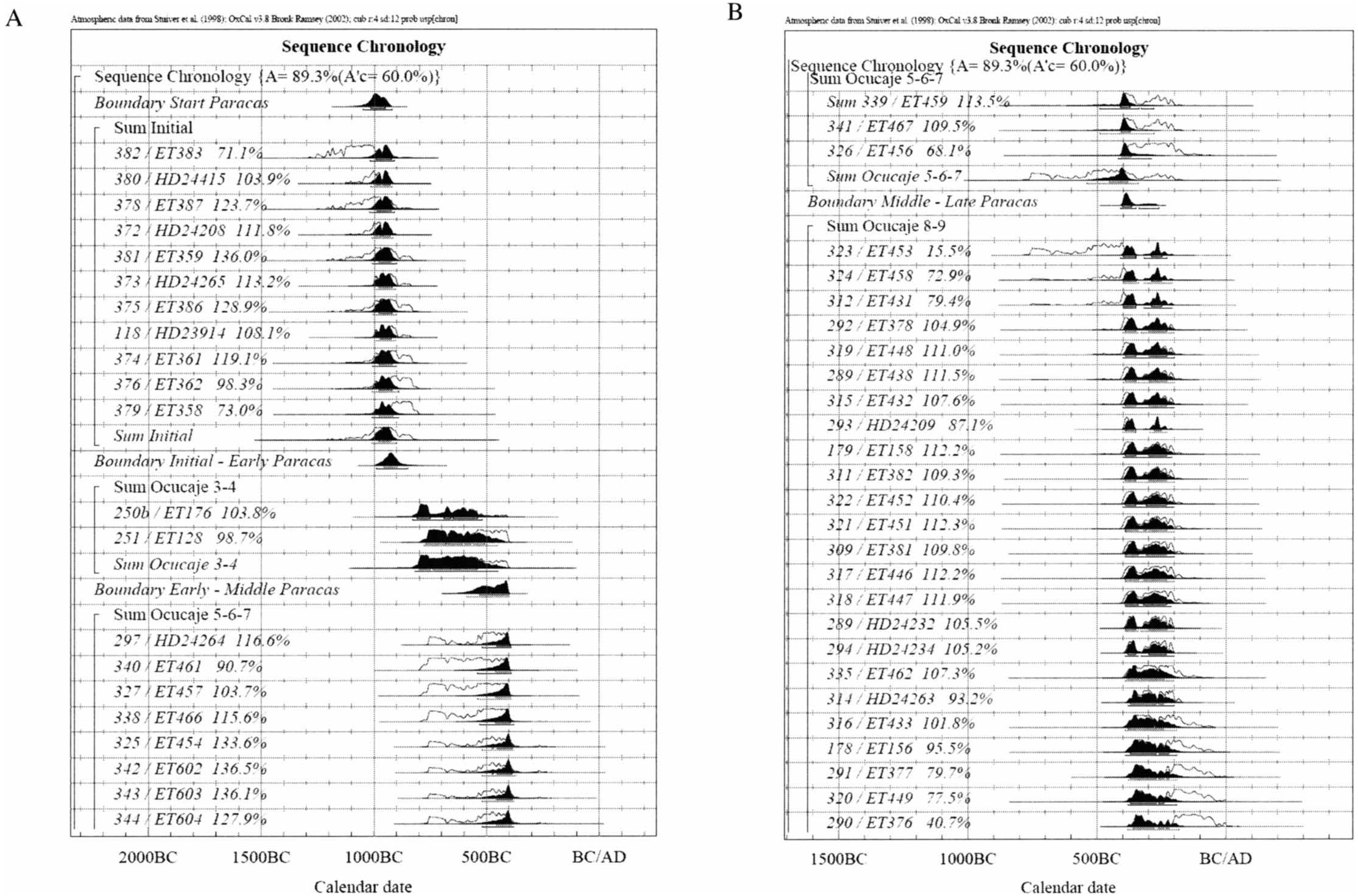

Figure 3A–B Paracas-Nasca chronology as modeled by OxCal v 3.8 (Bronk Ramsey 1995, 2001). The figures show the probability distributions of each sample and the different Paracas and Nasca phases.

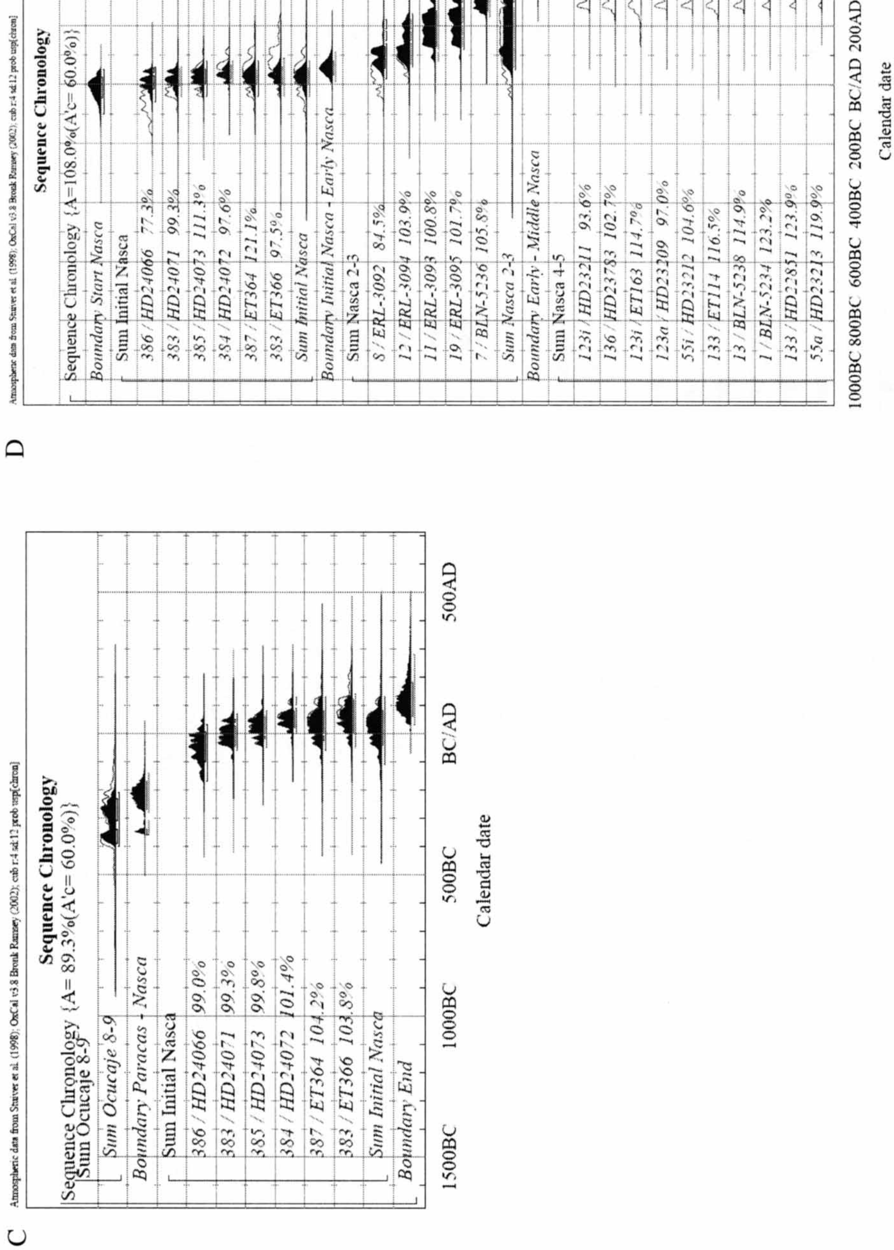

Figure 3C–D Paracas-Nasca chronology as modeled by OxCal v 3.8 (Bronk Ramsey 1995, 2001). The figures show the probability distributions of each sample and the different Paracas and Nasca phases.

E

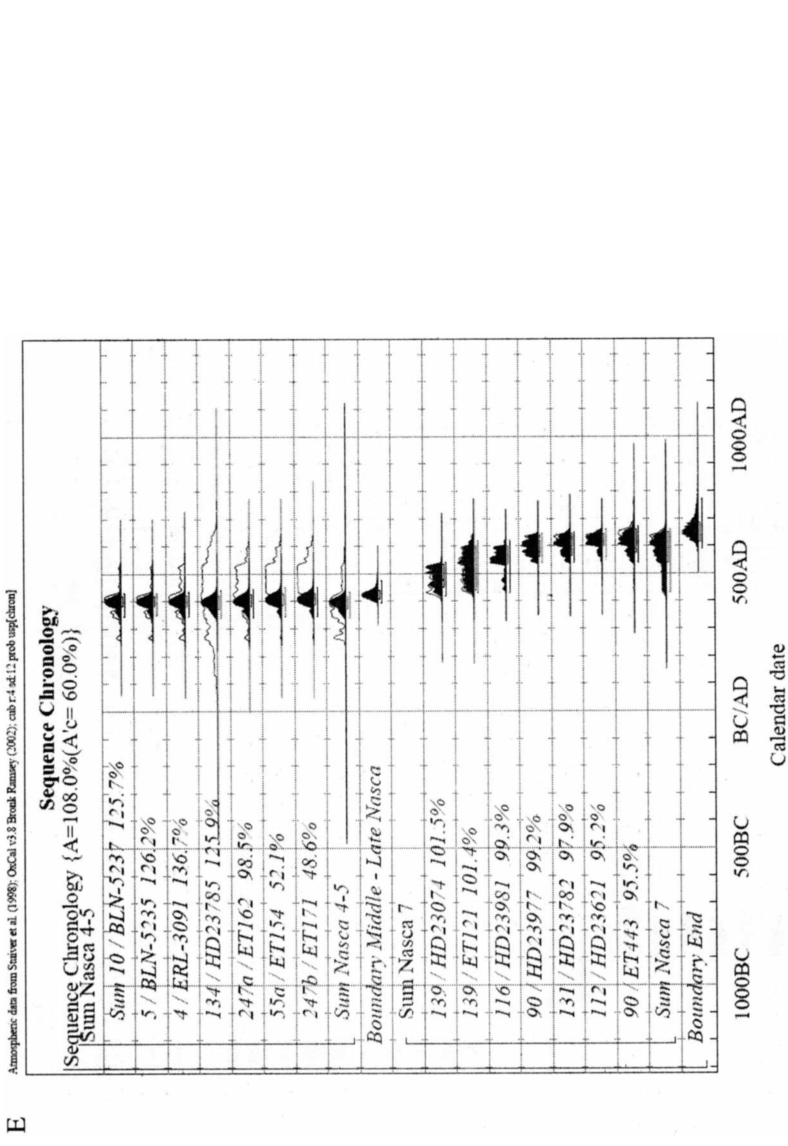

Figure 3E Paracas-Nasca chronology as modeled by OxCal v 3.8 (Bronk Ramsey 1995, 2001). The figures show the probability distributions of each sample and the different Paracas and Nasca phases.