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Pernil Alto: an agricultural village of the Middle Archaic Period in Southern Peru

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6 Dating and Chronology

The archaeological remains of Pernil Alto were arranged in a proper chronological order by integrating the stratigraphic information and the results of analyses from 70 radiocarbon samples.[13] The applied method consisted of four consecutively steps:

- The generation of an unrectified Harris diagram of all found features
- The separation of the features within the produced Harris diagram into the rough periods of "modern", "ceramic", "archaic" and "natural"
- The generation of a modelled radiocarbon chronology of the 70 radiocarbon dates
- The rectification of the stratigraphy of the Harris diagram using the modelled radiocarbon dates

The aim of the stratigraphic analyses of the archaeological remains was to generate a phased stratigraphy for the Archaic remains in Pernil Alto. This stratigraphy should include all Archaic features and reflect their contemporaneity within settlement phases in the sense of time slices. This was important given that not all features were covered by continuous layers and had less stratigraphic information. This was especially the case in the areas where the inclination of the spur and thus the erosion was stronger. From these areas radiocarbon samples were taken that were used to integrate those areas within a stratigraphy covering all Archaic remains.

6.1 Stratigraphy and Layers

In some areas of the excavation, particularly in the center of Units 5, 6 and AQ 46, large profiles could be documented (see Figure 22 for the location and orientation of the profiles). They provided the first insights into the stratigraphic sequence of the Middle Archaic occupation at the site. Since the excavation followed the natural or cultural layers and each context was excavated independently, the stratigraphic relations of each single context were known. Therefore, the profiles were mainly used to identify layers that could be linked between the excavation areas and thus form the basis for a unified sequence. It is important to mention that the depicted profiles are complete and thus include superimposed layers and contexts from the Initial Period.

Due to the cultural and natural processes mentioned in Chapter 5.3.6, some of the layers associated with the Middle Archaic occupation were partly destroyed or eroded. Therefore, not all contexts of the Middle Archaic Period were covered by continuous layers. This was only the case for about one-third of the excavation area (see Figure 22). However, due to the general positions in lower parts of the stratigraphy, the lack of ceramics and general cultural characteristics they were associated with the Middle Archaic Period.

The detection of continuous layers was good in particular in the southern part of the northern excavation area. The uppermost layer associated with the Middle Archaic occupation (layers 4038–4429–4377 in profiles a–d; see Figures 23 and 24) was relatively extensively distributed and thick. The thickness varied in general from 5 to 26 cm, with thicker parts in the planer areas and thinner parts in the more inclined parts. In some areas in the central part of the in the north of the excavation area the thickness reached even 46 to 52 cm. The material consisted of semi-compact, middle-fine soil of brown color, mixed with abundant middle-sized stones and charcoal remains in the area of Unit 5 (Feature 4038). Towards the southwest the color of the material changes to a brown-orange color in Unit AQ 46 (Feature 4377) and to a grey-orange color in Unit 6 in the south (Feature 4429). It was detectable in the excavation units 5, 6 and AQ 46 and superimposed by layers of the Initial Period. The connection between the layer parts in the different excavation units was done by evaluating the profile information. Based on this layer—which was unfortunately disturbed in the area between units 5 and 6 by a 1 m wide test trench from 2005 and not documented—a first stratigraphic sequencing was possible.

A further, subjacent layer (layers 4043-1/2–4437-2–4385 in profiles a–d; see Figure 23 and 24) was distinctly less thick and in parts disturbed, especially in the south of AQ 46. Yet it was possible to trace it over parts of units 5, 6 and AQ 46 and to verify its connec-

13 The method described here was already summarized in a paper given at the ICA 2012 in Vienna (Gorbahn 2013).

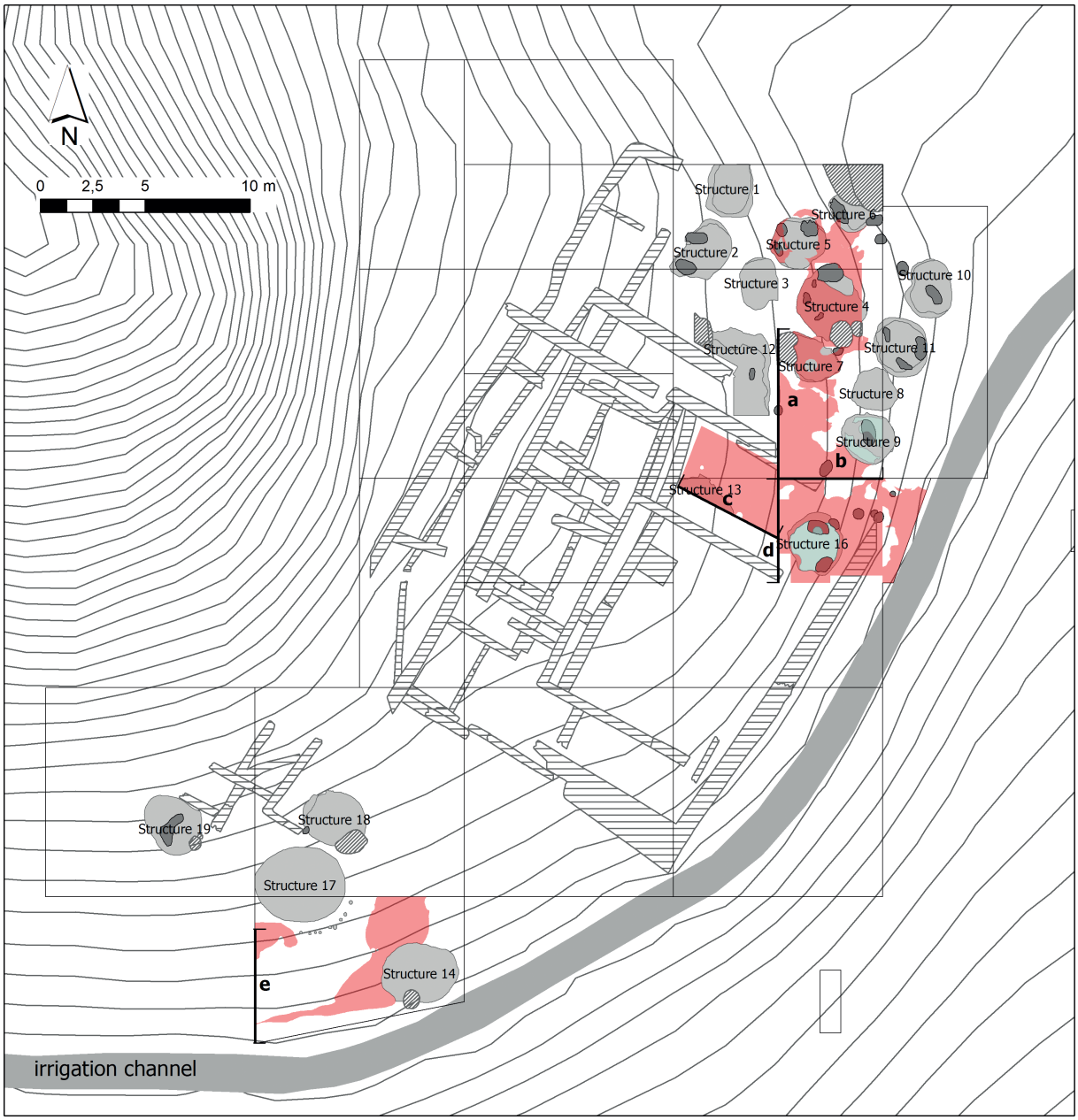

Figure 22: Plan of Pernil Alto with the location of profiles a–e. The areal distribution of continuous layers is depicted in red.

tion by using the excavation documentation. The thickness of the layer varied from 3 cm in AQ 46 to 11–19 cm in Units 5 and 6. The material of the layer was relatively heterogeneous and consisted semi-compact, middle-granular soil of grey-light yellowish color, mixed with abundant charcoal, small stones and plant remains in Unit 5 (Feature 4043-2). In the southeastern part the color was slightly more brown. In Unit AQ 46 (Feature 4385), the material was of grey color and was finer, but mixed with the same materials as in Unit 5. The material in Unit 6 (Feature 4437-2) consisted of fine, loose soil of greyish-brown-orange color, and was mixed as well with ashes, charcoal, some small stones and some bigger stones and abundant plant remains. In some areas of Unit 5 and 6, this material of the occupation layer was covered with a thin layer of 2–5 cm which was more compact and represented the remains of a use floor (Features 4043-1 and 4437-1) which was attached directly to the top of the filling material described before.

Further layers were stratigraphically connectable to those areal distributed layers, but were only detectable in smaller areal distributions and did not represent layers "covering" layers but were delimited and did

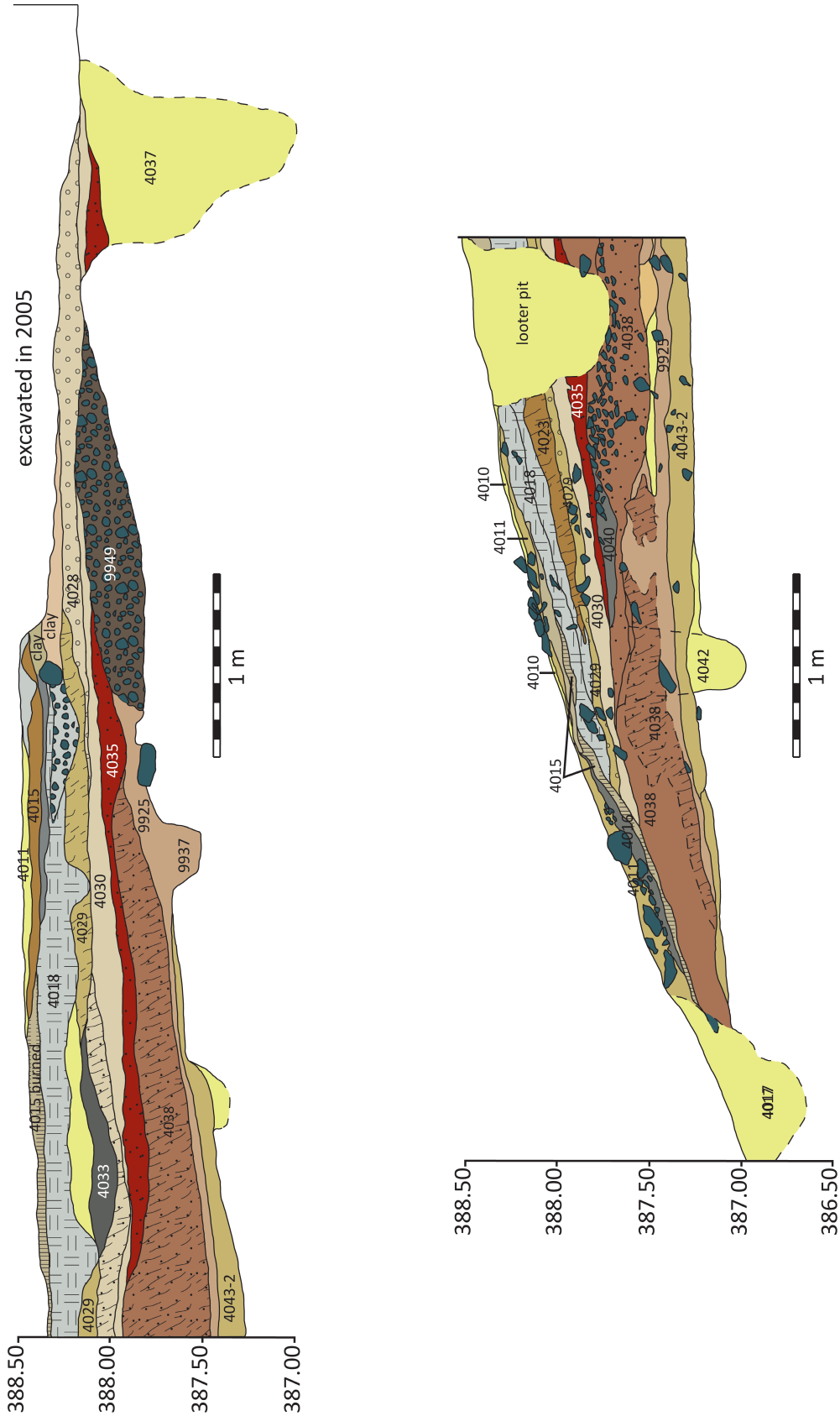

Figure 23: Profiles a (left) and b (right). Profile a is a west profile from unit 5. Profile b is a south profile from unit 5. See Figure 22 for exact location. (Middle Archaic remains by 4038).

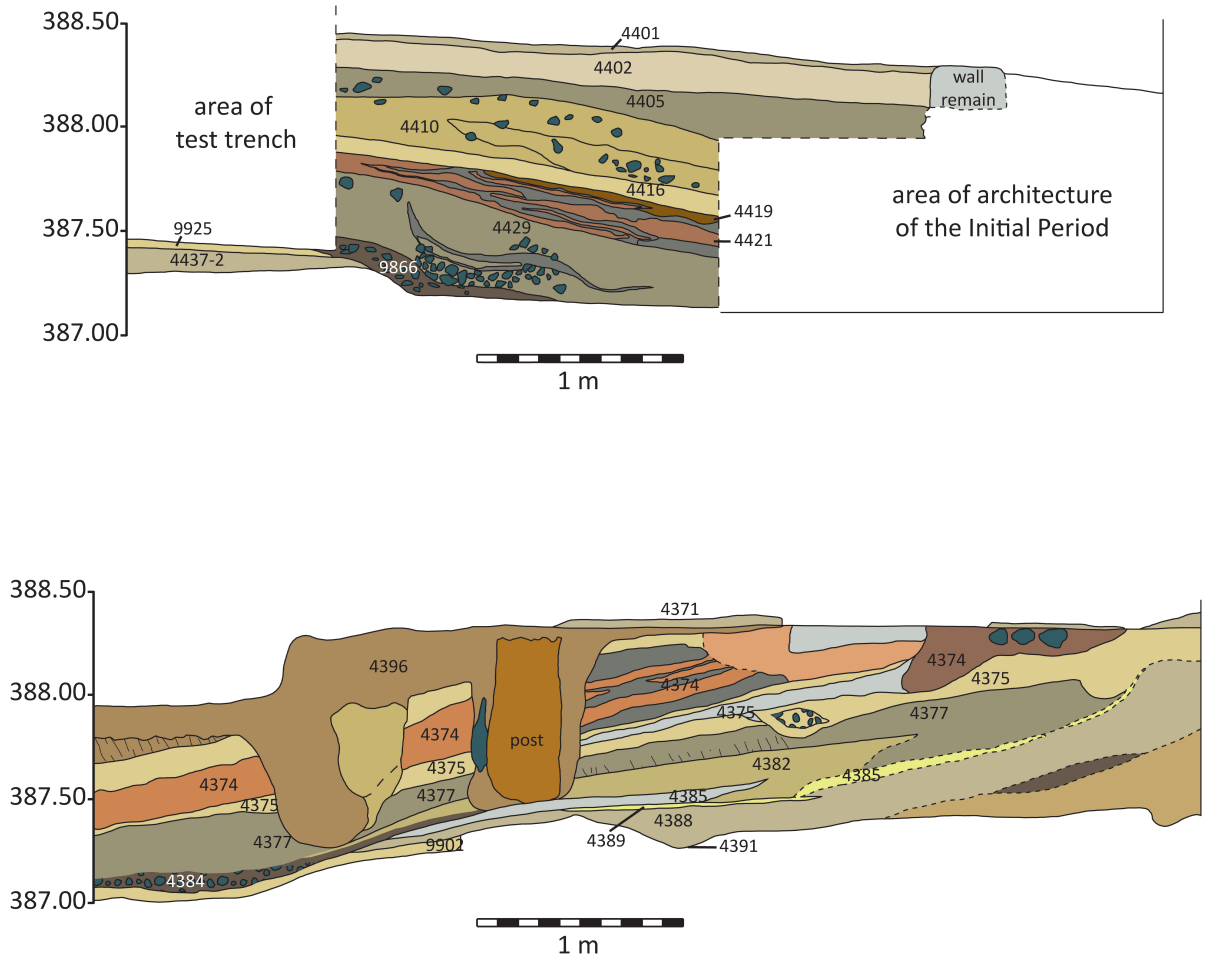

Figure 24: Profiles c (top) and d (bottom). Profile c is a west profile from unit 6 (view to the east). Profile d is a southwest profile from unit AQ 46. See Figure 22 for exact location.

not span over more than one excavation unit. They were located in superimposed or subjacent stratigraphic positions to the aforementioned layers but covered only smaller subareas. They were, strictly speaking, rather flat spots of occupation layers which were linked in a patchwork fashion. An example is layer 9925 which was documented in the area and the profiles of unit 5 (profiles a and b) but only in parts of unit 6 where it levels off (see profile c). About 1/3 of the excavation area which sought to investigate the Middle Archaic Period could be arranged in a layer-based stratigraphy based on the stratigraphic connection of the more areal distributed layers with those of more delimited distribution. All other excavated contexts were documented in their relations to this layer distribution, extending the stratigraphic information. The development of the chronology of the Middle Archaic occupation as described in the following sections was based on this stratigraphic information. Detailed descriptions of all smaller layers with their stratigraphic relations and locations can be found in the digital supplement.

By contrast, the preservation of layers was more problematic for the southern area of the excavation because of stronger effects of erosion (see Figure 25). Continuous layers associated with the Middle Archaic occupation were hardly detectable there.

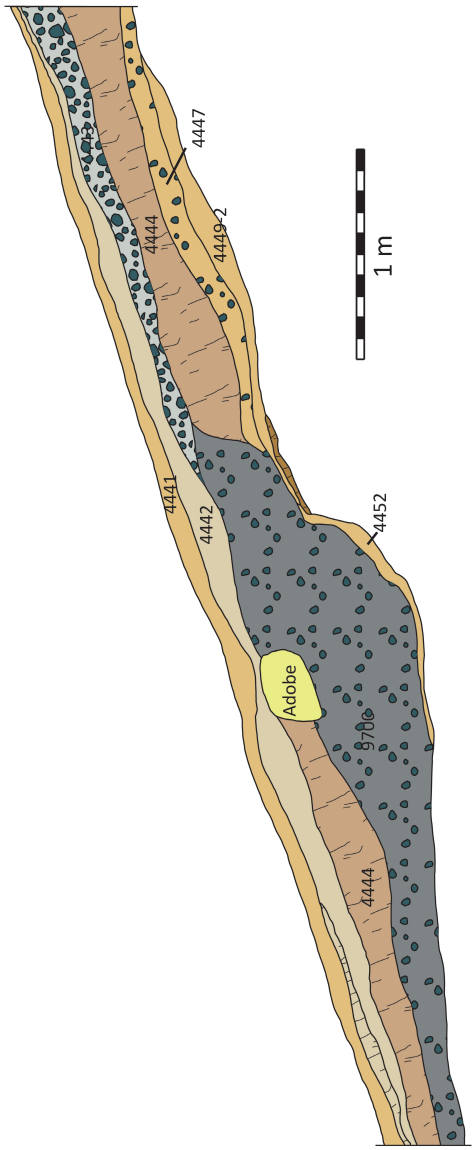

Figure 25: Profile e. Profile e is a south profile of unit 18. See Figure 22 for exact location. (The heights were not reported). Middle Archaic remains are associated with 4447, 4449-2 and 4452.

6.2 Harris diagram

Using the field drawings, all found features were put into a Harris diagram. The principles applied to this diagram were based on the principles established by Edward C. Harris (1989), but slightly modified because of the specific situation at Pernil Alto. The most important information for all features or context was the information of superposition. The computer program "Stratify 1.5" by Irmela Herzog was used to generate the Harris diagram. All features were registered in the program and the corresponding stratigraphic information was entered for all single features. The stratigraphic information was indicated as "younger than", "older than", "equal to", "forms one with" and "is part of". The information "younger than" and "older than" correspond to inferior or superior superposition. The information "equal to" corresponds to features that were stratigraphically in an equal position but did not form one feature. The information "forms one with" corresponds to features which are actually the same feature. This is, for example, the case for some layers that were excavated in different excavation units or campaigns and thus obtained different feature numbers. Those were determined as being one feature but the excavation information was not merged to preserve detailed information of, for example, artifact distributions. The information "is part of" refers to features that were arranged in groups within the diagram. This is, for example, the case for the structures (Chapter 6). The structures contained different features like fireplaces, use floors or burials. These were integrated into groups representing the structures (most of the structures were indeed represented by two groups, one for the use as dwelling and one for the use as burial areas).

The stratigraphic information was obtained from the field drawings. These were arranged in a sequence starting from the lowest documented surface. The stratigraphic information was added to the documented features and the next documented surface was analyzed. The main stratigraphic information was thus a clear superposition resulting from a layer or other features that were depicted on the next higher surface. Thus a pit that was shown on the documentation on the natural surface was determined to be younger than the natural surface. When the same feature had been documented already as being intrusive into a layer that was in a superposition, the pit was then given the information as being younger than this layer as well. Another important piece of stratigraphic information was clear intrusiveness into another feature, which disturbed the latter one. The intrusive feature was determined as being younger than that one that was disturbed by the intrusion. This was the case also when the intrusion or disturbance was only partial. By this method all features were successively integrated into the Harris diagram.

Originally, all pits were given two successive numbers in the Harris diagram, one for the pit itself and one for the pit filling. This corresponds to the method explained by Harris (1989). In the case of Pernil Alto this partition did not make sense, because the pits and their fillings were—with the exception of the large pits—chronologically not further distinguishable.

The remains of the occupation of the Initial Period were integrated into the Harris diagram in the areas in

which remains of the Middle Archaic occupation were reached. All other areas with remains of the Initial Period were not included. The included remains of the Initial Period were not studied in detail, but are displayed to generate a complete stratigraphy.

Some features extended beyond the borders of excavation units to reach into units and in some cases were excavated in different campaigns. This is especially the case for layers but in some cases also true for large pits. Accordingly, those features have different feature numbers in different excavation areas. However, given that they formed one single feature on the site, they were connected in the Harris diagram with an "=" symbol.

The resulting Harris diagram depicts all features in their strict stratigraphic position. It was extremely large and cannot be shown on standard paper sizes.[14] A digital version is included in the digital supplements. The stratigraphic information of each feature is given in the feature descriptions, also part of the digital supplements.

6.3 Problems in the generation of the Harris diagram

Some characteristics of the site made it slightly problematic to generate a Harris diagram that reflects the actual stratigraphic sequence. First, there was no separating culturally sterile layer between the two main occupation periods. Furthermore, some remains of the Middle Archaic occupation were partly disturbed by later intrusions of the ceramic period. Those disturbances were produced by intrusive pits and burial pits from the ceramic occupation, which disturb the archaic remains. Additionally, some leveling activities of the Initial Period occupation disturbed parts of the archaic remains. This is especially the case in the excavation units 5 and AQ 46 where levelings of the ceramic occupation disturbed layers of the Middle Archaic occupation (see Figure 26). There, some archaic remains were disturbed that were preserved in parts in AQ 46, but not in Unit 5. A further problem is produced by the topographic situation of the site. In the marginal areas some parts are relatively steeply inclined towards the fertile river valley. In these areas, a stronger erosion of cultural layers resulting from frequent convulsions, relatively frequent earthquakes in the area, and probably less frequent flooding events, can be assumed. Due to this kind of erosion, material remains of the different occupations could even have mixed with the

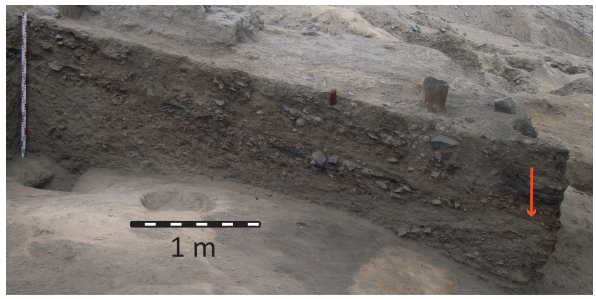

Figure 26: North profile of Unit AQ 46. The arrow marks the intrusion of the ceramic occupation that cut some indicated features of the Middle Archaic occupation.

marginal areas. Furthermore, the topographic situation with inclined parts in the marginal areas is in contrast to the "Law of Original Horizontality" (Harris 1989: 31 f.) as the layers in these parts do not tend to build horizontal expansions, but were deposited parallel to the natural inclined surface. These problems are considered in the next step, when the Harris diagram was separated into general periods.

6.4 Period separation of the Harris diagram

The Harris diagram generated displayed the strict stratigraphic position of the features. Thus, features of the occupation of the Initial Period appeared on the same stratigraphic level with features of the Middle Archaic occupation when the later ones were, for example, only covered with a few features of the Initial Period occupation in some parts of the excavation, whereas in other parts the stratigraphic sequence of the Initial Period was larger. Therefore, they appeared to be "contemporaneous", at least in a stratigraphic sense. This does not reflect the real temporal sequence of the site, as the two occupations were clearly distinguishable by the nature of their archaeological remains. Furthermore, the specific problems of the stratigraphic situation mentioned above influenced the design of the Harris diagram. Thus, in a next—more interpretative—step, the material of the features was analyzed and the Harris diagram was separated into the general periods "modern", "ceramic", "archaic" and "natural". All features containing ceramics or cotton remains and all features stratigraphically above them were assigned to the ce-

14 During a trial to prepare to print the resulting diagram it became clear, that even in a DIN A0 format—which is 118.9 cm to 84.1 cm—the digits of the boxes of the Harris diagram were not readable.

ramic Period. This includes the remains of the occupation of the Initial Period and the intrusive burials of the Paracas and Nasca Periods. The features that could represent mixed material produced by erosion were assigned to the ceramic occupation, as the separation of the findings or feature parts into the different occupations was impossible. All these features formed the ceramic period in the Harris diagram.

All features that were stratigraphically below the features of the ceramic Period, and in which no ceramic or cotton remains were found, were assigned to the archaic Period, which reflects the Middle Archaic occupation of the site. On top of the sequence, some features were assigned to be "modern" and reflect activities of the most recent past or at least material into which modern material was intrusive. This was the case for the first superficial layers, in which glass sherds and bottle caps, as well as animal dung was found. This superficial layer covered the entire site. Some looter pits that were intrusive into the archaeological remains were also detected but were mostly covered by the superficial modern layer. Thus, they were assigned to the ceramic occupation as their temporal situation is not absolutely clear (even though they are most probably "modern"), however they were certainly not of archaic origin. The natural surface was documented during the excavation. It contains several feature numbers depending on the excavation unit and excavation campaign. These feature numbers were summarized with new feature labels for each excavation unit. The resulting labels were referred to as "NaSu" (= natural surface), combined with the relevant excavation unit number to produce labels such as "NaSuU5" for the entire natural surface of excavation unit 5. All those natural surfaces were assigned to the period "natural," as they represented the natural and sterile surface of the spur that was covered by cultural remains.

The separation into "modern", "ceramic", "archaic" and "natural" was displayed in the Harris diagram using the Stratify program, and resulted in a stratigraphically rectified chronological sequence. Nevertheless, it was still too large to be displayed in paper form. Thus some features that were stratigraphically equal were summarized to groups in Stratify. The group assignment does not change the stratigraphic sequence but it provides a better design. Some groups were formed by small pits and post holes that were intrusive into the same surfaces and covered by the same material. Thus all were stratigraphically equal. Those groups were simply named "Group" and numbered. Some other groups reflect the stratigraphic situations within the large pits. This grouping was based on stratigraphic observations of the large pits. In the upper parts burials were deposited that were intrusive into lower features. Thus when intrusive burials were detected the large pits were grouped into stratigraphically higher groups with the burials, and other stratigraphically equal or younger features were grouped into stratigraphically lower groups. Those groups were labelled as "St" for structure, a number and an interpretative assignment, with "bu" for burial use and "dw" for dwelling use. The dwelling use is explained in Chapter 6. In one case an after-use of such a large pit was observed, and the concerning group was labelled with an "au". Thus, for example, the group that summarized the burial use of the structure 6 was labelled "St_06_bu". Those labels are given in the feature descriptions.

After this step, the stratigraphic sequence was separated into periods but the internal temporal sequence of the period of interest represented by the Middle Archaic occupation was still not well defined, as some features were covered by continuous layers while other were located in areas where layers had probably been eroded—due to the topography of the spur—or heavily disturbed by intrusions of the Initial Period occupation. To solve this problem, the 70 radiocarbon dates obtained from features clearly defined as being archaic or preceramic were used to rectify the inner structure of the Middle Archaic remains in the Harris diagram.

6.5 Modelled radiocarbon chronology

70 radiocarbon dates were obtained from features of the Middle Archaic occupation of Pernil Alto that were assigned to the above mentioned "archaic" part in the Harris diagram.

The radiocarbon measurements were conducted by the laboratories in Heidelberg, Germany (Hd), and Mannheim, Germany (MAMS) under the supervision of Bernd Kromer. As a control, some radiocarbon dates were given from this research group to a laboratory in Zürich, Switzerland (ETH). All datings are AMS-datings. The modelling of the radiocarbon dates was conducted in co-operation with Ingmar Unkel of the Institute for Ecosystem Research at CAU Kiel, Germany.

The measurements were arranged in their stratigraphic position and calibrated using the software OxCal 4.2 (Bronk Ramsey 1995, 2009) using the calibration curve IntCal09 (Reimer et al. 2009) with a southern hemisphere correction of −41 ± 14 years (based on McCormac et al. 2004). The structure, the radiocarbon dates with their radiocarbon ages, their origin, and material, as well as the results of the calibrated and modelled radiocarbon dates are given in Table 5.

Structure		Feature	Feature type	material	14C age	cal BP	mod BP	
Lab-Number						**σ-2**	**σ-2**	**A %**
Sequence Pernil Alto								
Boundary start Pernil Alto							5789–5583	
Phase 0								
Sequence Matrix 19								
Boundary Matrix 19 start							5728–5575	
Hd-26782		3167a	burned zone	charred leaves	5008 ± 43	5851–5603	5694–5571	65.4
Hd-26776		3167a	burned zone	charcoal	4930 ± 44	5717–5558	5649–5553	107.6
Hd-26775		3167a	burned zone	charred reed	4776 ± 42	5579–5320	5589–5453	93.6
Boundary Matrix 19 end							5584–5347	
Span Matrix 19							0–319	
MAMS-13584		9870	pit	charcoal	4787 ± 25	5569–5448	5569–5448	100
MAMS-13589-2		4486	disturbed burial	charcoal	4756 ± 52	5569–5326	5569–5327	100.1
MAMS-13568		4389	occupation layer	charcoal	4653 ± 23	5434–5281	5432–5305	95.8
Hd-30064		4391	filling layer	charcoal	4457 ± 22	5234–4937		
MAMS-13571		9901	pit	charcoal	4752 ± 24	5567–5324	5567–5325	100
MAMS-13566		4388	occupation layer	charcoal	4675 ± 22	5440–5295	5436–5309	102.8
MAMS-13567		4392	post hole	charcoal	4639 ± 23	5434–5266	5434–5301	73.8
MAMS-13590		4489	use floor	charcoal	4746 ± 33	5563–5318	5562–5320	100.8
Span Phase 0							205–405	
Boundary Pernil Alto 0/1							5334–5291	
Phase 1								
Phase Layer 4043-2/4437-2								
Co	Hd-28477	4043-2	occupation layer	seeds	4784 ± 33	5575–5463	outlier	
	ETH-38145			seeds	4821 ± 27			
Hd-28786		4043-2	occupation layer	charcoal	4666 ± 25	5438–5289	5321–5283	88.4
MAMS-13582		4437-2	occupation layer	charcoal	4625 ± 24	5432–5252	5314–5278	158.5
Hd-30125		4437-2	occupation layer	charcoal	4661 ± 25	5436–5286	5320–5282	101.2
Span Layer 4043-2/4437-2							0–34	
Phase Matrix 16 burial area								
MAMS-13588		4484	burial	charcoal	4637 ± 32	5435–5264	5317–5280	155.8
MAMS-13587		4438	double burial	charcoal	4614 ± 24	5430–5240	5311–5278	136
Hd-30136		4481-1	filling layer	charcoal	4646 ± 25	5433–5275	5318–5281	145.3
MAMS-13586		4482	burial	charcoal	4982 ± 24	5724–5600		
Span Matrix 16 burial area							0–32	
MAMS-13546		4308	burial	charcoal	4671 ± 24	5439–5292	5321–5284	76.8
Phase Matrix 02 burial area								
Co	Hd-26778	3227	burial	plant fiber	4614 ± 57	5439–5285	5321–5282	96.3
	Hd-26688			bottle gourd	4677 ± 31			
Hd-28636		3229	burial	vegetal	4638 ± 27	5433–5267	5316–5280	160.3

Structure / Lab-Number	Feature	Feature type	material	14C age	cal BP σ-2	mod BP σ-2	mod BP A %
Span Matrix 02 burial area						0–28	
Hd-28590	4099-2	filling layer	charcoal	4661 ± 19	5433–5290	5320–5284	102.9
MAMS-13550	4269	pit	charcoal	4617 ± 24	5430–5245	5312–5279	142.5
Phase Burial Group Unit 06							
MAMS-13579	4436	double burial	charcoal	4582 ± 25	5310–5059	5309–5275	84.2
MAMS-13589-1	4476	burial	charcoal	4618 ± 25	5431–5245	5313–5278	147.3
Span Burial Group Unit 6						0–25	
Span Phase 1						0–49	
Boundary Pernil Alto 1/2						5303–5266	
Phase 2							
MAMS-13553	4274	pit	charcoal	4584 ± 25	5312–5060	5293–5237	119.8
Hd-28784	4100	burial	charcoal	4522 ± 30	5274–5029	5288–5210	82.9
Hd-30133	9898	post hole	wood	4533 ± 24	5275–5043	5286–5216	105.9
MAMS-13595	4384	burned zone	seeds	4481 ± 27	5248–4970	5280–5196	44.3
Hd-30090	4382	occupation layer	charcoal	4553 ± 38	5296–5036	5293–5220	137.8
Co Hd-28508a	4045	fireplace	seeds	4614 ± 30	5308–5249	5295–5248	90.5
Hd-28508b				4596 ± 25			
Hd-28589				4604 ± 21			
Hd-28588	4044	fireplace	charcoal	4675 ± 25	5440–5295	outlier	
MAMS-12417	4042	burial	bean	4521 ± 24	5268–5036	5285–5208	78.2
Co ETH-38144	4042	burial	seeds	4669 ± 27	5305–5239	outlier	
Hd-28468			seeds	4656 ± 33			
Hd-28795			wood	4429 ± 31			
Co ETH-38147	4040	fireplace	seeds	4543 ± 26	5280–5046	5284–5218	126.3
Hd-28478			seeds	4547 ± 32			
Hd-28678			charcoal	4524 ± 25			
Span Phase 2						0–104	
Boundary Pernil Alto 2/3						5269–5150	
Phase 3							
MAMS-13592	9828	post	wood	4508 ± 25	5264–5024	5257–5110	96.1
Hd-30124	4431	occupation layer	charcoal	4501 ± 25	5263–5014	5256–5111	93.1
MAMS-13578	4435	burial	charcoal	4587 ± 24	5313–5067	5263–5079	21.9
Sequence Matrix 12 dwelling							
Boundary Matrix 12 dwelling start						5260–5126	
MAMS-13548	4320	filling layer	charcoal	4489 ± 23	5253–4992	5257–5121	83
MAMS-13545	4307-2	filling layer	charcoal	4558 ± 22	5296–5049	5255–5091	70.2
Boundary Matrix 12 dwelling end						5253–5090	
Span Matrix 12 dwelling						0–72	
Sequence Matrix 07 dwelling							
Boundary Matrix 07 dwelling start						5260–5128	
Hd-28572	4085	filling layer	charcoal	4480 ± 17	5239–4980	5256–5122	72.5
Hd-28679	4078	filling layer	charcoal	4556 ± 28	5295–5045	5255–5108	90
Boundary Matrix 07 dwelling end						5253–5097	
Span Matrix 07 dwelling						0–74	
Span Phase 3						0–119	
Boundary Pernil Alto 3/4						5248–5064	
Phase 4							
Sequence Matrix 12 burial area							
Boundary Matrix 12 burial area start						5230–5056	
MAMS-13547	4312	burial	charcoal	4507 ± 22	5260–5027	5225–5051	109.3
MAMS-13544	4306	fireplace	charcoal	4542 ± 22	5284–5045	5223–5043	78.7

Structure / Lab-Number	Feature	Feature type	material	14C age	cal BP σ-2	mod BP σ-2	mod BP A %
Boundary Matrix 12 burial area end						5222–5028	
Span Matrix 12 burial area						0–134	
Sequence Matrix 11 burial area							
Boundary Matrix 11 burial area start						5231–5057	
MAMS-13558	4279E	filling layer	charcoal	4546 ± 24	5287–5045	5226–5051	74.9
MAMS-13555	4280	burial	charcoal	4521 ± 23	5267–5037	5224–5042	107.1
Boundary Matrix 11 burial area end						5223–5027	
Span Matrix 11 burial area						0–132	
Sequence Matrix 08 dwelling							
Boundary Matrix 08 dwelling start						5230–5050	
MAMS-13556	4272E	filling layer	charcoal	4518 ± 25	5267–5033	5223–5045	104.6
Hd-28774	4088	filling layer	charcoal	4469 ± 26	5242–4955	5220–5034	92.7
Boundary Matrix 08 dwelling end						5219–5020	
Span Matrix 08 dwelling						0–136	
Phase Layer 4038/4429							
Hd-28602	4038	occupation layer	charcoal	4474 ± 25	5243–4962	5225–5029	103.4
Hd-28805	4038	occupation layer	charcoal	4495 ± 24	5259–5003	5225–5036	109.1
Hd-30123	4429	occupation layer	charcoal	4518 ± 25	5267–5033	5226–5042	105.3
Span Layer 4038/4429						0–144	
MAMS-13562	4376	fireplace	charcoal	4515 ± 23	5264–5033	5226–5042	105.6
Hd-30126	4440	storage pit	charcoal	4477 ± 26	5246–4966	5225–5030	106.5
MAMS-13557	4363E	filling layer	charcoal	4464 ± 25	5241–4947	5225–5024	86.3
MAMS-13554	4277	burial	charcoal	4459 ± 25	5240–4936	5225–5020	74.2
Span Phase 5						0–194	
Boundary Pernil Alto 4/5						5215–4985	
Phase 5							
Phase Matrix 06 afteruse							
Hd-30101	4061	pit	charcoal	4493 ± 37	5264–4969	5205–4953	85.9
Hd-30102	4058	burial	charcoal	4425 ± 35	5225–4843	5208–4900	101.1
MAMS-13538	4063	burial	charcoal	4552 ± 23	5292–5046	outlier	
Span Matrix 06 afteruse						0–126	
MAMS-13551	4266	burial	charcoal	4473 ± 24	5242–4962	5205–4954	110.7
MAMS-13552	4266	burial	charcoal	4681 ± 24	5443–5298	outlier	
Hd-26779	3223	stone conc.	charcoal	4376 ± 58	5219–4801	5208–4885	66
Span Phase 5						0–170	
Boundary end Pernil Alto						5200–4819	
Span Pernil						434–889	

Table 5: Structure and results of the radiocarbon model of the radiocarbon dates of the Middle Archaic occupation of Pernil Alto produced with OxCal. (Co marks radiocarbon samples that were combined using the "R combine" command in OxCal to produce one single radiocarbon date.)

Radiocarbon dates that were obtained from the same sample or originated from temporally restricted features were combined using the OxCal command "R combine" to produce single datings. The radiocarbon dates that were combined in this way were:

- Hd-28477 and ETH-38145: both taken from the same sample as a control
- Hd-26778 and Hd-26688: both taken from burial 12
- Hd-28508a, Hd-28508b and Hd-28589: the first two were taken from the same sample material as a control, and all three were taken from a fireplace (Feature 4045)
- Hd-28468, ETH-38144 and Hd-28795: the first two were taken from the same sample material as a control, and all three were taken from burial 29
- Hd-28478, ETH-38147 and Hd-28678: the first two were taken from the same sample material as a control, and all three were taken from a fireplace (Feature 4040)

The radiocarbon dates that were taken from samples from clearly restricted stratigraphical sequences and spatially restricted areas (represented by the fillings of the large pits) were assigned to sequenced groups using the "Sequence" command in OxCal. Each "Sequence" was started and ended with the "Boundary" command in OxCal. A "Span" command was added at the end of each "Sequence" to produce a modelled absolute span for the "Sequences" that reflects the time of use of the large pits. "Sequences" like this were assigned to the large pit and the filling of structure 19, the use as dwellings of the large pit of structures 7, 8 and 12, and the use as burial areas of structures 11 and 12.

When the radiocarbon dates represented temporal positions that were not from clearly sequenced situations but temporally close, they were arranged into phases using the "Phase" command of OxCal. This command expresses temporal closeness but not as strictly as the "Sequence" command. Situations like this were given in layers and burial areas from which different radiocarbon samples were taken. It was not clear which radiocarbon sample represented the first deposited or last deposited one. Thus, a sequence was not reconstructable. Nevertheless, it was assumed that they were deposited temporally close to each other and were assigned to "Phases". "Phases" like this were established for the use as burial areas of structures 2 and 16. The use as burial area of structure 6 was also established as a "Phase" but was named "after-use" in the modelling because burial 38 (Feature 4063) was located on the edge of the large pit of structure 6 and was disturbing it. Stratigraphically, the burial was equal to the internal burials of structure 6, but had to be separated from the clear use as the burial area of the structure. Thus the radiocarbon dates from this location were labeled as "after-use". The burials 54 (Feature 4436) and 56 (Feature 4476) were deposited in a small area in the excavation unit 6 and stratigraphically equal. Thus the radiocarbon dates obtained from them were assigned to one "Phase" labeled "Burial Group Unit 06". The radiocarbon dates from the layers 4043-2 and 4437-2 which represented the same layer stretching into different excavation units were assigned to one "Phase". The same was done with the radiocarbon dates from the layers 4038 and 4429 which also represented the same layer stretching into different excavation units.

All radiocarbon dates that were taken from a clear stratigraphic sequence in the site were arranged in the OxCal model, including the aforementioned sequences and phases when they were obtained from sequenced situations using the "Sequence" command in OxCal. The "Sequence" was labeled "Pernil Alto". Due to the preservation of the site and partial erosion a clear sequence was only given in the excavation units 5, 6 and AQ 46. The radiocarbon dates from these units were arranged in their stratigraphic position in OxCal. Then the sequence was subdivided into phases using the "Phase" command in OxCal. The subdivision into these phases was based on continuous occupation layers that were radiocarbon dated. Those layers were:

- 4043-2/4437-2, which formed one continuous layer in Units 5, 6, and AQ 46 with the feature numbers 4043-2, 4437-2 and 4385
- 4431, which was one continuous layer in Unit 6
- 4038/4429, which formed one continuous layer in Units 5, 6 and AQ 46 with the feature numbers 4038, 4377 and 4429.

Before and after these three phases, two additional phases were set in the model sequence. The first one represented features that were intrusive into the natural surface and were covered by layer 4034-2/4437-2. The phase added to the end of the sequence represented features that were intrusive into the surface of layer 4038/4429, and were covered by remains or layers of the ceramic occupation, but because of their inventories were assigned to the Middle Archaic occupation. Each of these sequential phases was started and ended with a boundary using the "Boundary" command in OxCal. Furthermore, the "Span" command was added to the end of the phases to produce time spans of their formation.

The large structures had a special position in the modelling. They were summarized as structures containing all internal features (e.g. filling layers, fireplaces, burials etc.) (see Chapter 6). Due to the features they contained and the internal stratigraphy, they were used at first as dwellings. Later—after their abandonment—burials were deposited in them. Thus their function can be separated into a use as both a dwelling and a burial area. This separation is reflected by the group assignments given in the Harris diagram and marked in the feature descriptions. "St_XY_dw" stands for use as a dwelling of a certain structure, "St_XY_bu" stands for the use as a burial area. In some cases, no burials were located in a structure (for example in structure 17), so there is no group representing the use as a burial area. In some cases, the function is not clear, as the structure was not excavated because they were covered by wall remains (removal not permitted by law) and was so dense that an excavation would have been too spatially restricted (in the case of structure 13). In one case an additional after use function was detected (in structure 16). Based on that information, the radiocarbon dates of the use as a burial area were assigned to a younger phase than those from the parts of the structure used as dwelling or the after use part, respectively.

Some radiocarbon dates did not match parts or all of these settings as they were extracted from locations of the excavation that were either not covered by continuous

layers, or where the layers were partly or completely eroded. This was, for instance, the case in the southern area of the Archaic occupation that was "separated" from the northern area by dense wall remains of the occupation of the Initial Period. Thus, several model iterations were accomplished in which the settings described above were slightly modified and thus stepwise integrated with the radiocarbon dates from the stratigraphic isolated locations until those could be added to the established phases in the model. In this way all radiocarbon dates from the Middle Archaic occupation were added to the model.

The result was a model with six overlapping phases in which the radiocarbon dates clustered and with modelled ages (mod BP) for all radiocarbon samples, spans and ages of the phases. These phases were labeled Phase 0–5. In the σ-1 calibration they dated as follows:

Phase 0: 5702–5299 mod BP with a span of 249–345 years
Phase 1: 5317–5278 mod BP with a span of 0–28 years
Phase 2: 5279–5221 mod BP with a span of 17–55 years
Phase 3: 5255–5175 mod BP with a span of 0–39 years
Phase 4: 5245–5000 mod BP with a span of 0–173 years
Phase 5: 5205–4944 mod BP with a span of 0–65 years

In the σ-2 calibration they dated as follows:

Phase 0: 5789–5291 mod BP with a span of 205–405 years
Phase 1: 5334–5266 mod BP with a span of 0–49 years
Phase 2: 5303–5150 mod BP with a span of 0–104 years
Phase 3: 5257–5064 mod BP with a span of 0–119 years
Phase 4: 5248–4985 mod BP with a span of 0–194 years
Phase 5: 5215–4819 mod BP with a span of 0–170 years

The datings for these phases were given by the boundaries added to the different phases. The oldest modelled date of a boundary programed before a phase in OxCal determined the beginning of a phase and the youngest modelled date of a boundary programed after a phase in OxCal determined the end of a phase. The spans were returned directly by the model in OxCal. The model has an agreement of 63.3 % and the overall agreement lies at 69.9 % in OxCal, which reflects the statistical validity of the model and the calibration. The model was thus statistically accepted.

Within these phases, Phase 0 has a relatively wide span and was not represented by a layer. The radiocarbon dates assigned to this phase were taken from features that were covered by layers or features dated to the next phase, which was Phase 1. As the excavation of the Middle Archaic occupation was executed in two areas on the site, separated by an area that was densely covered with wall remains of the Initial Period, it could be the case that this first phase could be further divisible into more phases with information from remains of the Middle Archaic occupation that are still covered with later ceramic layers and remain unexcavated. Thus this first phase was labelled as "Phase 0" to mark its distinctness from the other phases (Phases 1–5) which represent clearer occupation phases of the Middle Archaic Period. Phase 0 can therefore be understood as a long beginning phase or a "pre-use" phase.

Phase 2 had to be inserted into the model because the addition of the radiocarbon dates to the older Phase 1 or the younger Phase 3 was statistically rejected by the modelling. There is a very restricted and non-continuous layer assigned to this phase (Feature 4382). Thus, Phase 2 could represent a very short occupation phase, or the layer remains of this phase were removed by later occupations.

Phase 5 represents probably an additional after-use phase that is not connected to a layer but is represented by features intrusive into the uppermost remains.

The plotted dates are depicted in Figure 27.

Two radiocarbon dates had poor statistical agreements of less than 60 % in the radiocarbon model. Date MAMS-13595 from Feature 4384 received an agreement of 44.3 % and date MAMS-13578 from burial 52 received an agreement of 21.9 %. None of these dates was assigned to a subordinate phase or sequence but just to one of the large phases represented in the occupation phases. Thus even though receiving a relatively low agreement they remained in the overall model.

Nine of the 70 radiocarbon dates had to be treated as statistical outliers, whose material represented mostly older material that was deposited in younger features (old wood effect). An exception is the radiocarbon date of Hd-30064 from Feature 4391 which is too young for Phase 0. This date is maybe the result of bioturbation into Feature 4391 which is stratigraphically clearly a part of Phase 0, but was only partly excavated because the larger part of it was covered with wall remains. Some explanation is needed for the treatment of the radiocarbon samples ETH-38144, Hd-28468 and Hd-28795 as outliers. These three samples were all taken from burial 29 (Feature 4042) but their combination was statistically rejected in OxCal. Furthermore, their position in the model received—depending on which radiocarbon sample was used—relatively poor agreements. This could be explained with the specific shape of the calibration curve IntCal09 (Reimer et al. 2009) in the corresponding section. Therefore, all three radiocarbon dates were treated as outliers and a new radiocarbon date (MAMS-13550) was produced on the finding of a uncarbonized Lima bean from the feature. This new radiocarbon date represents the date of a short living species and obtained furthermore a very high agreement (78.2 %) in the model. Thus it was integrated into the model while the other three dates from the same feature were treated as outliers and were not included in the modelled results.

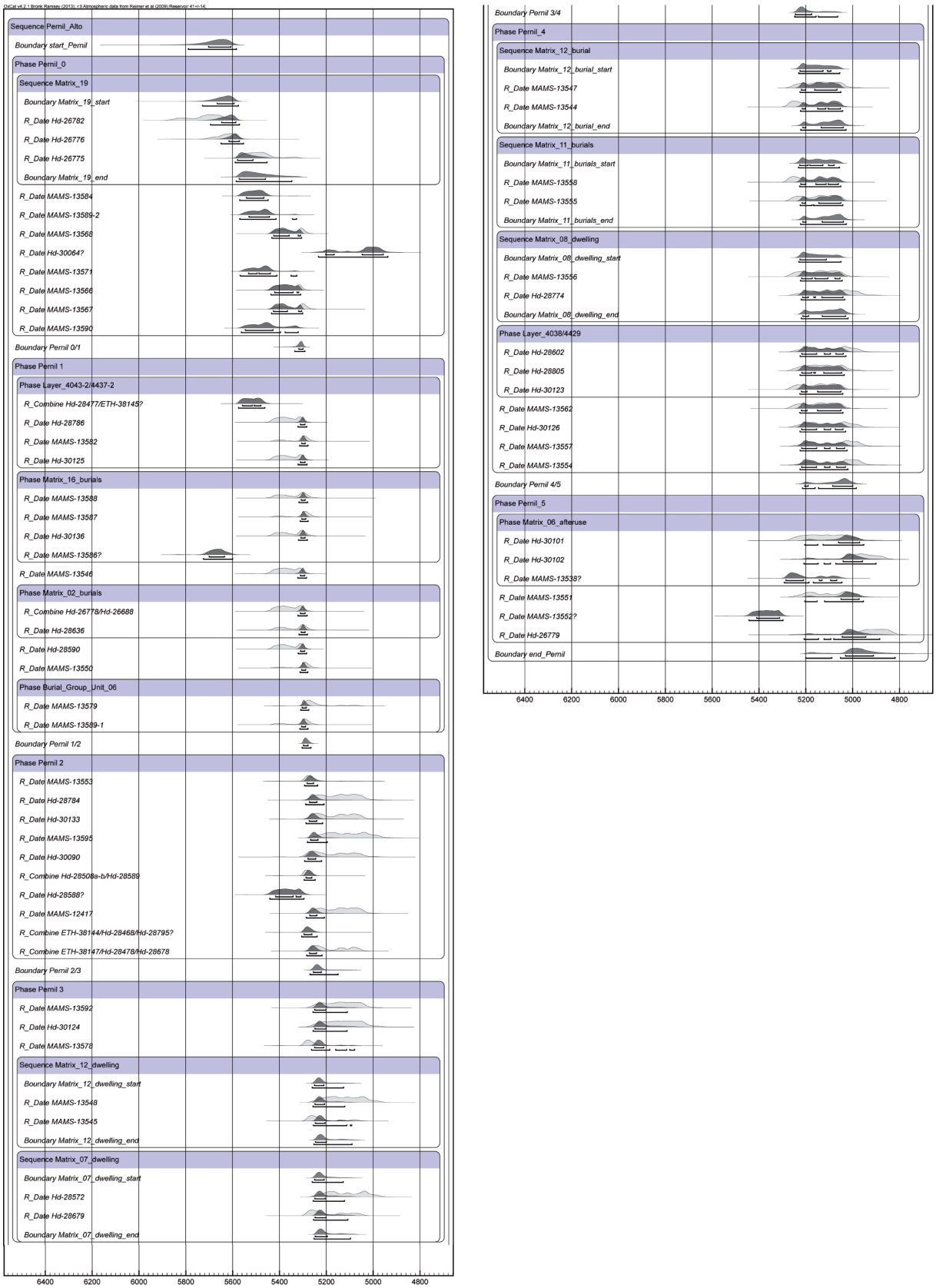

Figure 27: The plotted model of the radiocarbon dates.

6.6 Rectification of the stratigraphy using the modelled radiocarbon dates

It was clear by the results of the radiocarbon model that not all features that appeared on the same levels in the Harris diagram were in fact contemporary. This was a result of the specific topographic situation on the spur and the disturbances produced by the later ceramic occupation of the site. Thus, in the next step the Harris diagram was rectified using the phases established in the radiocarbon model. First, all radiocarbon dated features were marked in the Harris diagram. Features which formed one feature with dated features but had been given different feature numbers because they were excavated during different campaigns, were assigned to the same phase as their dated counterparts. In the case of layers, it was assumed that all features that were located stratigraphically below them and were covered by them dated to the prior phase and were thus dated to it. This was reflected by the largest part of the radiocarbon datings however in some exceptions—when this assignment was contradicted by a direct radiocarbon date—this rule could not be applied. In these cases, the assignment was determined by the radiocarbon dating. The same procedure was applied to features that were not covered by continuous layers of the Middle Archaic occupation. The phase assignment of the features in parts without continuous layers was determined by their stratigraphic relation to features that had been given a phase assignment by the radiocarbon modelling. If they were stratigraphically below an expanding feature—like a restricted layer—they were assigned to the next older phase. By this manner the covering feature determined the stratigraphic location of each feature.

This method follows stratigraphic principles and is therefore logical. But it does not necessarily reflect in all cases the real temporal development. If, for example, a burial that was clearly of Middle Archaic origin was located in a part of the site that was, for topographic reasons and resulting erosion, not covered by a Middle Archaic layer but covered by a layer in which ceramic fragments were found, then this burial was dated to the last phase of the Middle Archaic occupation established by the radiocarbon model (Phase 5). But, if this burial was dated directly by a radiocarbon date, then the burial was assigned to the according phase of the radiocarbon model which could be an older phase. In this way the radiocarbon model was used to rectify the Harris diagram and helped to assign the different features to the established phases. Rectifications like this were applied to all stratigraphically related features.

In some exceptions the clear structural alignment of some stratigraphically different features determined the assignment of those features. This was for example the case in the small post holes associated with dwelling 17 in the southern part of the excavation. There, small post holes clearly originated from one single structure—in this case a dwelling. But they were covered by different features (3146, 4447, and 4458) which would have produced a separation into different phases. Thus, the stratigraphically oldest feature of this structure determined the phase assignment of all the other features of the structure.

As explained above, the structures were in some cases—depending on remains they contained—separated into usage as a burial area and usage as a dwelling. Those separated usages were used for the phase assignment as well in the rectification of the Harris diagram. Thus, when the intrusive burials were dated to a phase by the radiocarbon model, the older usage as a dwelling was assigned to the prior phase. When, on the other hand, only remains of usage as a dwelling were dated by the radiocarbon dating, then the usage as a burial area was assigned to the next following phase. This separation was approved by the radiocarbon model in the cases when remains of both usages were radiocarbon dated.

By this method of rectifying the Harris diagram, all features of the Middle Archaic occupation were assigned to a phase. For the rectified Harris diagram and the phase assignments for all features, listed in the feature descriptions, see the digital supplements.

It should be noted that the phases do not reflect concrete occupational levels or narrow temporal moments of the Middle Archaic occupation, but have to be understood in the sense of time-spans or time-slices that are chronologically not further divisible under the given circumstances and with the given information. Nevertheless, through this method it was possible to establish an internal chronology for the Middle Archaic remains, even though it is relatively coarse.

The phase assignments of the dwellings, burial areas and burials are given in Table 6. The relatively sparse distribution of the dwellings in Phases 1 and 2, in burial areas in Phases 0 and 2, and of burials in Phases 0 and 2 is prominent. It should be recalled at this point that in the center of the site an area was so densely covered with walls of the Initial Period that the excavations did not reach Middle Archaic remains. Nevertheless, it can be assumed that the Middle Archaic occupation included this area and that dwellings, burial areas and burials of the concerning phases are also located there.

Phase	Dwellings	total	Burial areas	total	Burials	total
0	02, 13, 16, 19	4	0	10, 60	2	
1	09	1	02, 16	2	12, 15, 43, 54, 56, 57, 58, 59	8
2	04, 05	2	09	1	29, 34	2
3	07, 11, 12, 17	4	04, 05	2	18, 19, 20, 21, 22, 23, 24, 33, 52	9
4	06, 08, 10, 18	4	11, 12	2	45, 46, 47, 48, 50	5
5	01, 03, 14	3	06, 10, 18	3	35, 36, 37, 38, 39, 41, 55	7
total	18		10		33	

Table 6: The assignments of the dwellings, burial areas and burials to the different phases.