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12 Further results

12.1 Caries ratios

Caries are a dental disease which increase in close association with carbohydrate consumption. "[C]arious lesion frequencies from a variety of archaeological settings show a link between degree of carbohydrate consumption, especially domesticated plants, and elevated caries frequencies" (Larsen 2002: 123). The higher the carbohydrate consumption, the higher the amount of detectable caries on human remains of that group. Therefore, caries ratios are a good indicator of the carbohydrate content of the diet of the group and provide information about the corresponding subsistence. However, not only the pure content of carbohydrate influences the prevalence of caries, but also the processing of the food. Uncooked or less processed foods produce, in general, lower caries ratios than more processed foods, despite the same carbohydrate content because the mastication of harder foods contributes to the cleaning of the teeth (Powell 1985, cited after Tomasto Cagigao 2009: 26).

Elsa Tomasto Cagigao (2009) analyzed the caries ratios of prehispanic populations of the Palpa area. Her analysis included remains of the Paracas culture (2790–2210 BP), the Nasca culture (2210–1310 BP), and the Middle Horizon (1310–1160 BP). (The dates given here represent the actual chronology of the Palpa valley, established by Unkel et al. 2012). She also included some remains of the Preceramic occupation of Pernil Alto. Due to the fact that she did her analyses at an early stage of the excavations at the site, she was only able to include the remains of five individuals, two of which were children, one an adult female, and two adult males with a total of 97 teeth (Tomasto Cagigao 2009: 22). Out of these, 70 were from the adults and thus appropriate for further studies. The caries ratios of the different populations were then analyzed. The results showed that the caries rate at Pernil Alto was 25.7 %, whereas the caries rates of later populations—represented by a much higher amount of in total 1607 teeth—were of between 42.7 % and 45.8 % (Tomasto Cagigao 2009: 103). Even though the amount of analyzed teeth was relatively low for the Preceramic period, the results were statistically valid.

Thus, the caries rates of the population at Pernil Alto were distinctly lower (about half as high) than those of later populations whose subsistence was based on agri-culture with a large amount of maize consumption. Based on comparative studies (Hillson 2008), Tomasto Cagigao states that even though the caries ratio at Pernil Alto is lower than those of later agricultural societies, it is distinctly higher than those of hunter-gatherer groups and pre-agricultural groups around the world (Tomasto Cagigao 2009: 144). She assumed that more detailed studies about the alimentation of the population would help to explain the ratio.

With the results on the subsistence of Pernil Alto presented previously, this is now possible. The caries rate of Pernil Alto represents a higher rate than a pre-agricultural population, but a lower one than those of maize-incorporating later economies. This can be explained by two main arguments: First, the most important carbohydrate-containing plant which was cultivated and probably consumed at Pernil Alto was sweet potato, which has a carbohydrate content of 25–28 % (Brücher 1989: 7). Maize, in contrast, has a much higher carbohydrate content of about 74 % (USDA 2015), depending on the strain. Thus, the consumption of sweet potatoes instead of maize would result in distinctly lower caries rates as less carbohydrate is consumed. Second, Pernil Alto is still preceramic and thus no ceramic vessels were available for the settlers to process the consumed plants, as was later possible for populations using ceramics. This probably resulted in different methods of processing which made some modes—especially cooking and the production of liquid—not really impossible, but more complicated for the population at Pernil Alto. Thus, a higher amount of harder alimentation can be assumed for the Preceramic than for later societies. This probably influenced the caries rates contributing to the lower amount.

Hence, the results of the caries rates fit well with the information about subsistence at Pernil Alto which was predominantly based on cultivated, domesticated plants—developing diachronically through the occupation phases—but incorporated plants with distinctly lower contents of carbohydrates (which were furthermore processed without using ceramics) than in later societies. Therefore, the caries rates can be interpreted as reflecting a diet which was already based on produced plant alimentation, but lacking maize and the use of ceramics.

12.2 Strontium analyses

A total of 20 samples were taken from 16 of the 35 individuals of the Middle Archaic occupation at Pernil Alto for Strontium-Isotope analyses. Four individuals were sampled two times for control reasons. The sampling and the later analysis were conducted by Stefan Hölzl, Christian Dekant, and Susanne Rummel from the Bavarian State Collection of Paleontology and Geology, Munich, Germany. The method applied by them is described in Horn et al. (2008) as already mentioned in Chapter 2.3.6.

Sr-analyses aim to measure the ratio between Strontium 86 and 87 (Sr86/87). This ratio can be measured in human and other remains from archaeological context since Strontium is embedded and recorded in organic structures. The Sr86/87 ratio can then be compared with Sr86/87 ratios measured in the natural environment. The Sr86/87 ratios of regional environments show fine but distinguishable differences. The ratios represent therefore "fingerprints" of definable areas. A Sr86/87 ratio from human remains of an archaeological context which differs from the natural Sr86/87 ratio of the surrounding area could have been caused by two factors: First, the individuals was non-local and lived—at least during the time of the formation of the measured body part—during a larger period of its life in an area which was not the area where it was finally buried. Second, the majority of the food consumed by the individual was of non-local origin and imported from other areas, since Strontium is absorbed with the consumed food. If, in contrast, the Sr86/87 ratio measured in human remains corresponds to the Sr86/87 ratio in the surroundings of their finding location, it can be assumed that the living area, the origin area of the consumed food, and the burying area of the individual were identical. The method is described here very briefly. Details are given in the previously cited literature.

The aim of the analyses conducted at Pernil Alto was to clarify if the population was local or non-local. A local origin is interpreted as clear evidence for a sedentary population in contrast to a non-local origin as evidence for a mobile population.

Three major areas were distinguishable in the working area of the northwestern part of the Rio Grande basin from differences in the Sr-Signals. Those were (1) a coastal strip of about 30 km width, (2) the Andean foothills up to altitudes of about 1500 m a.s.l., and (3) the highland areas in higher zones until the catchment area of the Rio Grande. The data basis for this distinction cannot be presented here in detail since a detailed presentation is planned by the working group of Stefan Hölzl. However, the three areas were defined on the basis of a total of 212 samples, of which 6 originated from human remains of archaeological contexts from the coastal area, 69 originated from human remains from various archaeological sites from the Andean foothills, and 15 were modern environmental samples that originated from the same area. Finally, 91 samples defined the highland area and were taken from human and wood remains. Only the 31 samples taken from Pernil Alto will be presented here in detail and then compared to the Sr-signals from the three mentioned areas. The comparison data of the three defined areas is therefore only presented by boxplots and not in detail. However, this presentation offers enough possibilities for the interpretation of the samples of Pernil Alto. The samples of Pernil Alto were composed of the 20 samples taken on the remains of individuals mentioned before. All were taken on tooth remains, preferably enamel. Five samples were taken on other archaeological remains, and six further samples were taken from the modern surrounding of the site.

The samples taken from human remains are listed in Table 54 with context information and measurement results. Table 55 list the further samples with measurement results, material and context information.

Sample	Feature	Burial	Phase	age class	Sr87/Sr86	σ2 min error (%)
101	3978	18	3	infans 1	0.706643	0.0079
102	3983	20	3	prenatal	0.706997	0.0022
103	3980	19	3	infans 1	0.706975	0.0041
104	3985	21	3	infans 1	0.706786	0.0024
105	3988	22	3	infans 1	0.706919	0.0034
106	4100	34	2	adult (male)	0.70639	0.0029
107	4087	33	3	infans 1	0.706811	0.0029
108	4042	29	2	infans 1	0.706241	0.0031
109	3979	24	3	infans 1	0.706529	0.0082
111	4062	37	5	infans 1	0.707187	0.0061
112	4064	39	5	infans 1	0.706187	0.283

Sample	Feature	Burial	Phase	age class	Sr87/Sr86	σ2 min error (%)
113	4283	48	4	juvenile/adult (female)	0.70707	0.005
114	4482	57	1	infans 1	0.706401	0.0028
115	4312	46	4	infans 1	0.706359	0.0053
116	4476	56	1	prenatal	0.70735	0.0083
1456	3978	18	3	infans 1	0.706502	0.0022
1457	3980	19	3	infans 1	0.707145	0.0025
1458	3985	21	3	infans 1	0.707036	0.0096
1459	3988	22	3	infans 1	0.7069	0.0022
1460	3991	23	3	infans 1	0.706796	0.0024

Table 54:   List of samples from human remains for Sr-isotope analyses and measurement results.

Sample	origin	material	Sr87/Sr86	σ2 min error (%)
P1006001a	arch. (Feature not documented)	wood	0.706326	0.002
P1006001b	arch. (Feature not documented)	wood	0.706202	0.0038
P1006001c	arch. (Feature not documented)	wood	0.706145	0.0029
P1006001d	arch. (Feature not documented)	wood	0.706215	0.0025
P1006002a	modern surroundings	wood	0.706104	0.002
P1006002b	modern surroundings	wood	0.706719	0.0019
P1006002c	modern surroundings	wood	0.707468	0.0024
P1006002d	modern surroundings	wood	0.706643	0.0019
p802001	modern surroundings	andesite	0.70707	0.0035
p802002	modern surroundings	wood	0.707223	0.0042
pernilgeweihweiss	Feature 3167c	antler	0.706933	0.0025

Table 55:   List of samples from other archaeological contexts and the modern surroundings and measurement results.

The comparison of the Sr86/Sr87 ratios of the individuals of Pernil Alto with the Sr86/Sr87 ratios of the three defined areas distinctly shows that the former correspond to the ratios of the area of the Andean foothills and are different from the areas of the coast and the highlands (see Figure 112). This is also the case for the modern comparison samples from the site area. However, the other sampled archaeological material from the site had a distinctly lower ratio than the individuals and the modern samples, and shows similarities to the highland area. This result cannot be explained satisfactorily at the moment. Furthermore, the context information of the regarding samples was not documented and thus, the samples could also originate from contexts of the Initial period of the site.

If one assumes a cyclic mobility which would include stays of more or less equal lengths in the highlands, the Andean foothills and the coast of the working area, then a mixed signal could be produced in the range between the lower signals from the highlands and the higher signals from the coast, and therefore more or less close to

the signal of the Andean foothills. However, a Sr86/Sr87 ratio produced by such an assumed mobility pattern—which was documented for example for the Preceramic period on the Andean west flank of Northern Chile (Núñez/Hall 1982; Núñez et al. 2010)—would differ more from the signal of the Andean foothills in the working area than the ratios from the individuals of Pernil Alto actually do (Christian Dekant, personal communication). Such a cyclic mobility pattern can thus be excluded for the population of Pernil Alto as the ratios are not of a mixed signal origin.

Therefore, the individuals at Pernil Alto were from the area of the site on the Andean foothills, they lived there, consumed local food, and were eventually buried where they had lived. The Middle Archaic population can be interpreted as a local population which did not move to other areas. This interpretation is however only applicable to the population of Phases 1–5. There are no results for individuals of Phase 0. Thus, a higher mobility for the population of this first settlement phase is possible.
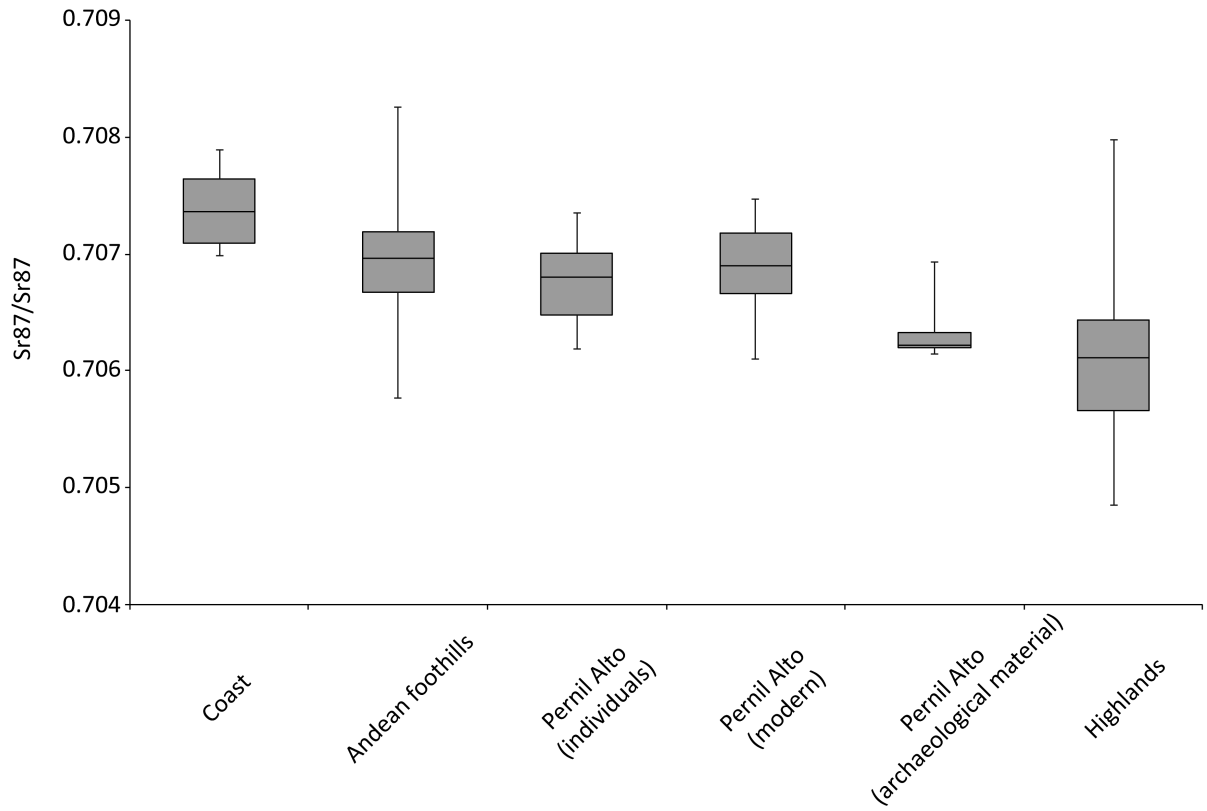
Figure 112:   Boxplot diagrams of the Sr86/Sr87 ratios based on the measurements from Pernil Alto and the three major areas.