# 1. PHYSICAL ANALYSIS AS A METHOD FOR INVESTIGATING PREHISTORIC HABITATION SITES

Sherburne F. Cook

Whenever a group of humans inhabits a restricted area for more than a very brief period of time, they unavoidably leave an accumulation of material. Such deposits are not necessarily uniform from place to place. Nevertheless both the absolute and relative amounts of certain mound constituents furnish clues to the material culture, the corporal welfare and the ecological background of the group which has long since disappeared. In order to put this line of reasoning to a concrete test several of us in the San Francisco region have made a number of analyses of the physical components found in the habitation sites of central California. Most active has been the participation of Professor R. F. Heizer of the Berkeley Department of Anthropology, and Mr. A. E. Treganza of San Francisco State College.

In attacking great accumulations of midden refuse the exigencies of time and labor demand that the method of sampling be employed. The problem then becomes that of determining how extensive must be the sampling in order to obtain a reasonably true picture of the actual mound content. It is possible to arrive at a probable solution through the application of statistical theory. Mr. Treganza and I felt, however, that a somewhat higher degree of certainty was desirable. Accordingly we selected a small habitation site in the delta region of the lower Sacramento River, known as Petersen III, (Sol-3) and excavated the complete mound. By weighing, screening, washing and sorting the entire content, something over 80 tons, we determined accurately the total weight, the density and the relative amount of rock, shell, bone, charcoal and obsidian. Simultaneously we took a series of 113 small samples which we analyzed for the same components. It was then possible to compare true absolute values with those obtainable by sampling alone.

Recapitulating our results briefly we found that the total amount of material in the site had a dry weight of 48,600 kilograms. The mean density of 68 samples was 1.625. Hence the volume was 29.92 cubic meters. From geometrical approximations we computed the volume as 27.36 cubic meters. Hence with other sites, using reasonably careful geometrical methods, plus density determinations from samples, it becomes feasible to estimate total mass within an error of plus or minus 10 per cent.

The individual components, for example rock, were treated in two size categories. During excavation the mound material was passed through a 3/8 inch screen. The rock held by this size of mesh was subsequently weighed and found to equal 13.37 per cent of the total mound weight. Then each sample was similarly screened and the per cent of rock computed. The mean value for the samples was 12.66 per cent, or 0.71 per cent less than the actual value. Rock fragments of smaller diameter than 3/8 inch could not possibly be segregated from the entire mound mass. Hence the samples were relied on exclusively. The mean value for pieces less than 3/8 inch and larger than 1/8 inch was 27.62 per cent with a standard error of 1.62 per cent of the mean. Combining the two categories we found that the total quantity of rock in the mound weighed 19,589 kilograms within an error of approximately plus or minus 6 per cent. Similar results with bone, shell, charcoal and obsidian made it clear that the sampling method yields results of very reasonable accuracy.

A secondary question of some practical importance to archaeologists pertains to the size and number of samples which must be taken in order to ensure a satisfactory level of accuracy. The investigation at the Petersen site showed that if interest centers on a component which appears in large quantity and in a fairly fine state of subdivision, a series of samples 1 to 5 pounds in weight and 15 to 30 in number will yield a standard error of no more than plus or minus 10 per cent. Such an error is usually small enough for purposes of physical analysis. If the component is present in pieces of small size but low in total quantity it is feasible to accept a larger error of estimate in order to keep the total number of samples within practical bounds. If the component is in units of large size, such as artifacts, intact pottery, or in the extreme case burials, then the sample number may be kept relatively low but the individual sample must be of large dimensions, even many cubic feet in volume. The sampling for each component will therefore be determined by its probable frequency of occurrence and by the size of the units in which it occurs.

In the summer of 1947 Mr. Treganza and I sampled 20 habitation sites in California, ranging in location from Round Valley to the Central Valley to Santa Barbara, and in age from the earliest to the latest known cultures. As examples of the results obtained several components may be considered.

In the Central Valley, San Francisco Bay and Round Valley regions the rock content of the sites ranged from 2.90 to 52.13 per cent. There was a clear correspondence between the amount found in a site and the local availability of the material. Thus the lowest values were those for the mounds in the alluvial plain of the Central Valley, the highest those for the sites in Round Valley which bordered on stony hillsides. In the Central Valley which lacks native rock, the lithic content of both Early and Late culture sites was consistently between 3 and 6 per cent. Secondary evidence indicated that the stones had been gathered from local stream beds or had been imported from distant outcrops. Assuming that this commodity was used for the construction of hearths and for cooking food it could be concluded that approximately 4 per cent by weight of the mound represents the economic irreducible minimum with respect to rock. The presence or absence of the latter, therefore, must be regarded as an environmental factor in the life of the aboriginal peoples which has hitherto been largely overlooked. The high rock content of the hill sites, furthermore, bespeaks supra-marginal wealth which may or may not have been utilized by the inhabitants. The uniform conditions obtaining on the Central Valley floor with respect to two Late, two Middle, and three Early culture horizon sites leads to the inferences that (1) physiographic conditions and (2) cultural habits with reference to the use of rock did not essentially alter throughout the known archaeological past of the region. On the other hand the fact that one Oak Grove (SBa-16) and one Hunting Culture site (SBa-53) near Santa Barbara contained no more than 1 per cent of rock strongly indicates different domestic habits, since the area itself can furnish unlimited supplies of this material.

The analysis of animal bone brought to light wide variation ranging from 0.01 per cent at a Round Valley site (Men-382) to 0.62 per cent at site Sac 66 on the Mokelumne River. Moreover, qualitatively there were wide distinctions between types of bone: mammal, bird and fish. A futher examination of bone subdivisions is now in progress based on material collected from 10 sites by Dr. Heizer's summer class in 1949.

Closely allied with bone is shell. Nearly all the sites which have been investigated contain at least traces of this material, but the inter-mound variation is enormous: from 0.0009 per cent at the early valley site SJo-142 to 45.9 per cent at a shellmound in Richmond (CCo-275). This is a fifty thousand-fold difference and is, of course, accounted for by propinquity to or distance from sources of supply. Indeed the relative quantity of molluscan remains in a site is an excellent index to the fresh or salt water fauna existing near the prehistoric habitations regardless of the era in which they flourished.

One of the interesting features of the bone and shell analyses is the insight given us concerning the diet of the inhabitants. By means of data extant in the biological literature, supplemented by a few simple laboratory procedures it is possible to calculate from the weight of shell and bone how much flesh food the original animals could furnish. Then if certain necessary assumptions are made based upon the size and probable duration of a particular site the average meat and protein intake of the inhabitants can be estimated. Despite the enormous potential error in making these assumptions concerning population and time, the results turn out to be very reasonable indeed. Thus, realizing in advance that the aboriginal California diet must have been very low in animal food, at least according to our standards, we get for eleven valley and delta villages a mean of 25.8 grams of edible flesh per person per day, derived from vertebrates and molluscs. The corresponding value for two Santa Barbara sites is 33.6. The cumulative evidence, therefore, renders the probability quite high that the native inhabitants of the valley and coastal regions could count over the years on about an ounce of meat per day. This is only a first approximation but a very important one to the student interested in the material culture and functional life of the people.

Something can be learned by refuse analysis concerning not only the nutritional state of the prehistoric inhabitants but also their economy and industries. By way of example, most of the sites examined contained chips of obsidian, prima facie evidence of an artifact industry utilizing this material. The quantity varied considerably from 0.0001 per cent at Sac-43 to 0.008 per cent at Sac-104. The aggregate in an entire mound could be calculated, ranging from 2 kilograms at Sac-43 to 2,000 kilograms at Sac-6. From the distribution of the sites containing appreciable amounts Mr. Treganza was able to deduce that the obsidian working industry was most highly developed in the Central Valley and delta. Since the only local source of raw material was in Napa and Lake Counties there must have existed in aboriginal times a rather intensive trade flowing into the Central Valley. Furthermore the presence, as calculated from our analyses, of 4.6 kilograms of fragments in Sac-56 and 11.0 kilograms in SJo-68 indicates the existence of this trade relationship as far back as the earliest known cultures.

Another item of interest is baked clay, fragments of which occur in most central California mounds but which is very common in Sac-6. This site contains a total of 14.66 per cent of rock and clay together. Of this the clay constitutes at least 10 per cent, or approximately 3,000,000 kilograms. This clay is waste or scrap rejected during the fashioning of clay artifacts, an industry for which Sac-6 is widely noted. Working from the observed amount of waste it can be rather crudely estimated that the overall production must have reached approximately 2,000,000 artifacts and that to achieve this production, something like one to three million man-hours of labor must have been necessary.

Apart from specific information concerning individual sites it is possible to reconstruct from physical analysis some idea of the broad environment of prehistoric times. This remains true, even if that environment is at present radically different and even if no direct documentary or ethnographic data are available. Thus from the twenty-odd sites we have studied we could deduce that they encompassed four clearly distinct habitats. Thus the Central Valley mounds with their content low in rock, moderate in charcoal, high in fish and bird bone with traces of shell bespeak a river bank culture with much alluvial land, rich in aquatic food but without forest resources. The Bay region sites demonstrate the presence of a hilly or rocky terrain, with good wood supply and enormous reserves of food in the form of shellfish. The Mendocino County deposits with their huge residues of rock and charcoal indicate a hilly, brushy or forested region with chief dependence upon plant food and mammals. The Santa Barbara deposits show again a costal area where inland the topography and biota resemble the Bay region but where the aquatic fauna was different. This in turn seems to be reflected in cultural divergencies.

Not only geographical but temporal deductions may be made. Of these the most important is that the Central Valley habitat appeared to undergo no significant change with respect to living conditions from the inception of the earliest known cultures down to the advent of the white man.

Clearly such conclusions can be couched only in terms of the broadest generalities. As refinements in technique, however, permit us to draw finer and finer distinctions it should become feasible to derive a reasonably clear idea of many aspects of lost civilizations which elude conventional qualitative and purely descriptive examination. The examples just cited give a fair preliminary indication of the type of information which may be secured by subjecting midden deposits to a careful quantitative analysis.

## 2. OBSERVATIONS ON EARLY MAN IN CALIFORNIA*

Robert F. Heizer

More than forty discoveries of human skeletal reamins or man-made artifacts claimed as ancient have been made in California in the past century.[1] Not one of these has been unqualifiedly accepted by American archaeologists as constituting evidence of early man or the Paleo-Indian in the same sense that the foremost student of the subject, F. H. H. Roberts, employs the word.

The celebrated hoax in the form of the Calaveras skull, said to have come from the Pliocene gravels in a mine shaft near Altaville at a depth of 130 feet, was finally disposed of by the investigation of W. H. Holmes of the Bureau of American Ethnology about 1900. Not one of the numerous finds of chipped and ground stone implements claimed to have been recovered from the auriferous gravels of the Sierra Nevadas has been authenticated, yet as

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