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thesis entitled

TESTING DIETARY CHANGE AT
THE PITHOUSE TO PUEBLO TRANSITION

presented by

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has been accepted towards fulfillment
of the requirements for

M.A. degree in Anthropology

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Date 12/6/96

TESTING DIETARY CHANGE AT THE PITHOUSE TO PUEBLO TRANSITION

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Anthropology

1996

ABSTRACT

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By

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Archaeologists frequently investigate subsistence strategies of past populations. In the prehistoric United States southwest, the archaeological record indicates that, approximately 1,000 years ago, there was a shift in habitation patterns from pithouses to pueblos. It has long been assumed that an increase in sedentism and maize dependence accompanied this change. Stable isotope analysis of human skeletal materials from two sites in central New Mexico failed to demonstrate any significant directional trends. This study, then, did not support the traditionally-held view that sedentism and maize dependence differentiated pithouse and pueblo dwellers 1,000 years ago in central New Mexico.

To my family, for their loving and generous support.

ACKNOWLEDGEMENTS

I would like to thank Drs. Lovis, Ostrom, Rautman and Sauer for their support throughout this study. Dr. Lovis helped me understand statistical analysis of small populations. Without this guidance I would still be on the starting blocks with this publication. He helped teach me to question my assumptions about archaeological theory and its application to dietary analysis.

Dr. Ostrom provided superior laboratory facilities and training in stable isotope sample preparation. She recognized that I was relatively inexperienced in lab work and kindly assigned a graduate student, Shawn Clouthier to help compensate for this. Many thanks are due to both.

Without Dr. Rautman, this study never would have been undertaken. Her faith in me to help supervise the burial excavations, carry out the sample preparation and analyze the results has been limitless. I am grateful for this confidence in my abilities and all of her guidance during these last few years.

My colleagues, both within and outside the Department of Anthropology, have also been invaluable resources. For this, I must recognize the contributions of Amy, John-Paul, Brian, Bill, Susie and, most especially, Liz and Bryan. Special thanks to Laura for her eleventh hour help!

I would also like to acknowledge the contributions of Jerry Voss, both to my professional and personal development. I admired his courage, strength and intellect. At my best, I hope to follow his example. He will not be forgotten.

Finally, I would like to express my sincere gratitude to Norm and Eileen Sauer for all of their support (above and beyond the call of duty) during my time here at M.S.U.. I feel as though I owe a great deal of my success (as well as 150 Francs) to their care and guidance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

In the southwestern United States, prehistoric Native Americans faced the challenge of living in an arid desert environment. The archaeological record indicates that approximately one thousand years ago the habitation pattern of these people underwent a change (Cordell 1984; Wills 1988). Prior to about 1000 A.D., the people of the region inhabited pit structures, "non-contiguous buildings with the floors excavated below the ground surface" (Gilman 1987: 538). Sediment, anywhere from a few inches to a meter or more, was removed from an area of ground and a superstructure, made of wood and dirt, was placed over this pit. By about the end of the first millennium A.D., these pithouse dwellings were replaced by pueblos; "above ground, multiple roomed structures with adobe, stone or masonry walls generally aggregated into a community" (Gilman 1987: 546).

Archaeologists have traditionally assumed that the pithouse to pueblo transition was accompanied by an increase in sedentism and maize dependency (eg., Cordell 1984). The latter of these propositions can be tested by assessment of the diet in pre- and post-transition populations. This thesis will evaluate the stable isotope composition of bone organic matter from ten individuals to determine if a dietary change accompanied the pithouse to pueblo transition.

Dietary Change During the Pithouse to Pueblo Transition

Several studies have addressed evidence for dietary change associated with the pithouse to pueblo transition. Gilman (1987) looked at the physical properties of pit structures and pueblos and their use in modern populations. From these ethnographic data, she noted several trends, applied them to prehistoric populations in the southwestern United States, and predicted how these characteristics should appear in the archaeological record. She suggested that three general conditions are associated with modern pit structure use and, by extension, prehistoric use as well: a non-tropical climate during the season of use, a biseasonal settlement pattern, and a reliance on stored food--again during the season of use (Gilman 1987). These are contrasted to pueblos in an effort to define the nature of the differences between populations that inhabit the two types of living structure.

Gilman demonstrated that pit structures are used for habitation primarily during cold months among ethnographic pithouse-using populations. Pithouses are thermally efficient, preventing heat loss through the ground and resisting wind-related temperature loss (Gilman 1987). Due to their susceptibility to vermin infestation and flooding, however, they are generally not inhabited in the warm months. Pueblos, on the other hand, with thick walls that absorb heat during the day and radiate it at night, are thermally efficient year-round (Gilman 1987).

Pithouse populations commonly gather locally available foods during the summer and store them in nearby uninhabited pithouses and adjacent storage pits. They then use the pithouses as living quarters only during the winter when food resources are scarce (Gilman 1987). Puebloan populations show a similar biseasonal settlement pattern, but some portion of the population usually inhabits the pueblo year-round (Gilman 1987).

For pithouse-using groups, accumulation of food stores for winter becomes a primary goal during the summer. Presumably, puebloan people would have less time to hunt (relative to pithouse dwellers) as their dependence on cultivated foods increased. Thus, they would rely on stored food (primarily maize for southwestern United States populations) for longer periods of time than would pithouse dwellers (Gilman 1987).

In addition to the examination of the physical properties of pithouses and pueblos, analyses of ceramic typologies, lithic microwear, cut marks on faunal remains and relative amounts of food remains recovered at sites also help reconstruct diet. Rocek (1995), for example, questioned the assumption that the transition from pithouse to pueblo was invariably accompanied by an increase in agriculture and sedentism. His research centered around comparative analyses of flotation samples from a pithouse (the Dunlap-Salazar Site) and a pueblo (the Robinson Site), both in the Sierra Blanca region of south-central New Mexico.

Flotation analysis involves separating plant remains from a soil sample by agitation and suspension in water or a chemical bath, and analyzing the contents that float to the surface. Maize pieces and seeds (the light fraction) float while small bones and lithics (the heavy fraction) sink and are recovered in a 1/8" screen at the bottom of a barrel.

Rocek (1995) evaluated the degree of reliance on agriculture relative to gathered foods during the time of site occupation by considering the ubiquity of maize in flotation samples, and the amount of maize relative to other edible plant remains at the site. Neither of these commonly used measures provided any statistically significant differences between the two sites (Rocek 1995). Rocek's studies, then, suggest that the subsistence practices of the prehistoric inhabitants of these pithouse sites may not have differed significantly from those of pueblo dwellers, at least during the time of site occupation.

Clearly, the conflicting results of Gilman's ethnographic and architectural study and Rocek's flotation sample study indicate that the question of subsistence strategy before and after the pithouse to pueblo transition remains unresolved. Did puebloan populations rely more heavily on maize agriculture than pithouse dwellers? The answer may lie within the bones of these ancient peoples. When human remains are available, analysis of the organic fraction of bone can provide direct evidence of long-term paleodietary practices through the evaluation of stable isotopes of carbon and nitrogen.

Stable Isotope Analysis and Applications to Human Paleodiet

Isotopes are forms of an element that are distinguished by differing numbers of neutrons. Analysis of the ratio of the stable isotopes of carbon and nitrogen in bone collagen can be used to assess diet. When the food sources exploited by a population are isotopically distinct, an analysis of stable isotopes (including carbon and nitrogen) may be used to assess dietary differences (van der Merwe et al. 1981). Certain types of plants differ in the amounts of C^{13} they incorporate during photosynthesis. C_3 plants (temperate plants, including most trees, fruits, nuts and cultivated roots and tubers) incorporate less C^{13} and have lower δC^{13} values (1‰) than C_4 plants (tropical grasses, such as sugarcane, sorghum, some amaranths and also maize) (Vogel and van de Merwe 1977; DeNiro 1987; Katzenberg 1992). Since these isotopic differences are reflected in skeletal levels of C^{13} in consumers of these plants, it is possible to determine the relative contributions of C_3 and C_4 plants to the diet.

Isotopes of nitrogen provide information on the trophic level of foods consumed (DeNiro and Epstein 1981; Ubelaker et al. 1995). Certain plants fix nitrogen directly from the air while others rely on ammonia and nitrates in the soil. Nitrogen fixers include certain types of bacteria and blue-green algae that are commonly associated with legumes. Nitrogen isotope values can distinguish plants which utilize nitrogen fixation from those that do not. Isotope values are typically lowest in legumes, relative to other plants and within food webs they increase with trophic level (DeNiro 1987; Schoeninger et al. 1990; Katzenberg 1992). Consequently herbivores and people who eat vegetarian diets display lower nitrogen content in their bones than consumers whose diet includes more animal protein.

A number of bioarchaeologists have used stable isotope analysis to help reconstruct diet patterns of past populations (Vogel and van der Merwe 1977; Katzenberg and Kelley 1988; Schoeninger et al. 1990; Ubelaker et al. 1995). Dietary patterns such as marine versus terrestrial food sources, cultivated versus wild foods and relative maize dependence have been distinguished with stable isotope studies (van der Merwe et al. 1981; Schoeninger et al. 1990; Schwartz and Schoeninger 1991). One interesting study utilizing stable isotope research is found in Schoeninger et al.'s (1990) study of Georgia coastal native populations.

Schoeninger and her colleagues performed stable isotope analysis on three populations: precontact preagricultural, precontact agricultural and contact agricultural. A directional trend (decreasing δN^{15} and increasing δC^{13} values) indicates an overall decrease in marine food consumption and an increased dependence upon maize (Schoeninger et al. 1990). These results are consistent with other archaeological evidence for subsistence shifts in the region.

The Kite Site Pithouse Village and Pueblo de la Mesa

The two sites analyzed in this study, a pithouse (the Kite Site Pithouse Village) and a pueblo (Pueblo de la Mesa), were excavated in the Salinas region of central New Mexico. Both sites proved rich in artifacts, and two small skeletal samples were unearthed (Rautman 1990; Rautman 1993). Stable isotope analysis should help confirm whether a change in subsistence strategy accompanied the pithouse-to-pueblo transition in this area. In the southwestern United States, as elsewhere, the most prevalent C_4 plant cultivated was maize. Therefore, according to most models of the pithouse to pueblo transition, one would expect that puebloan populations would be more dependent on maize; hence, one might expect their isotopic signatures to indicate a greater level of dependence on C_4 plants relative to pithouse populations.

Analyses Performed

This study examines human bone chemistry from the Kite Site Pithouse Village and Pueblo de la Mesa to determine whether a change of diet is detectable. All of the human bone recovered from the two sites were inventoried and the discrete burials were separated. To minimize sampling error, only elements associated with discrete, articulated burials were analyzed. Age, sex and visible pathologies were assessed. The laboratory procedures which follow are those of Ostrom and colleagues (1990) and are fully explained in Chapter 3. One rib from each of the Pueblo de la Mesa burials along with five rib samples from the Kite Site burials were analyzed in the Michigan State University Department of Geological Science's Stable Isotope Laboratory.

The equations used to express isotopic data are as follows:

$$\delta C^{13} = [(C^{13}/C^{12}{}_{sample})/(C^{13}/C^{12}{}_{standard}) - 1] \times 1000‰,$$

$$\delta N^{15} = [(N^{15}/N^{14}{}_{sample})/(N^{15}/N^{14}{}_{standard}) - 1] \times 1000‰.$$

The standard for carbon is Peedee Belemnite, a marine carbonate fossil from South Carolina. The standard for nitrogen is atmospheric air. Reproducibility of these measures made by dynamic flow measurements is 0.2‰.

The isotope ratio values that are measured by the mass spectrometer are not a direct indicator of the isotopic signatures of the organism's food sources. However, isotopes are differentially incorporated into tissues in a predictable manner. This is known as fractionation. The equations used to express these differences are as follows:

$\delta C^{13}_{collagen} = \delta C^{13}_{diet} + 5‰$, and

$\delta N^{15}_{collagen} = \delta N^{15}_{diet} + 3‰$

Thus, the carbon isotope value of a consumer differs by 5.0‰ relative to its diet (Chisolm 1989). There is 3‰ increase in the nitrogen isotope value of the consumer relative to its diet (Schoeninger 1989). If this shift in fractionation is accounted for, isotopic signatures of human bone collagen can provide information regarding long-term dietary habits of a population. These fractionation factors have been added to the raw data analyzed in this study.

Stable isotope analysis has already been performed on the Kite Site specimens at the University of Calgary (Katzenberg and Kelley 1988). For reasons of consistency of sample preparation and instrumentation, only results obtained from the M.S.U. laboratory will be analyzed here.

Null Hypotheses

The expected trend in these populations is a shift toward increased reliance on maize over time. The following null hypotheses will be used to evaluate these trends:

1. There is no significant difference in the mean δC^{13}

value between the pithouse sample and the pueblo sample.

2. There is no significant difference in the mean δN^{15} value between the pithouse sample and the pueblo sample.

If there was an increase in the utilization of C_4 foods between the periods of occupation of the Kite Site and Pueblo de la Mesa, then the δC^{13} values should become less negative through time. The δN^{15} values should decrease through time if the change in subsistence also resulted in an increased dependence on maize relative to gathered foods and thus a decrease in trophic level.

Organization of this Volume

The following chapter consists of a geographic and historic description of the Salinas region of New Mexico. The two sites in the study are discussed in detail and osteological analysis of the two skeletal populations will be presented. This section includes burial descriptions, sex determination, estimation of age at death, determination of the minimum number of individuals represented and pathology diagnosis or description of unusual osteological features noted in the material. A written inventory with interpretive comments is included in this section. A complete skeletal inventory of each burial (with comments) is provided in Appendix A.

Chapter 3 discusses the methods of stable isotope analysis. The theories behind and applications of stable isotope analysis, along with methods of sample preparation and laboratory procedures undertaken, are then discussed. This chapter presents the findings of the analysis. Conclusions about the differing subsistence patterns of the two populations are based upon this evidence and analysis of these data are in Chapter 4. This final chapter also presents general conclusions based upon this study and suggestions for future work in this region of the American Southwest.

Chapter 2

SITE PLACEMENT AND BURIAL DESCRIPTIONS

Skeletal Analysis

This chapter reports on the analysis of skeletal populations from the Kite Site Pithouse Village and Pueblo de la Mesa. Each burial is described, including a description of elements present (for a complete list, see Appendix A), sex, age, cranial and postcranial pathologies and anomalous features. Any pathologies found on the specimens are described and attempts are made to explain the origin of the condition.

Some of the Kite Site specimens (the pelvis of Feature 9, mandible of Feature 19 and the crania of Features 9, 14, 19, 23 and 25) were treated in the field with a mixture of Duco cement and acetone to prevent breakage (Rautman 1990). The Pueblo de la Mesa specimens were not treated in the field.

Once in the lab, teeth and broken fragments of bone were refit. Care was taken, however, to avoid gluing any specimen that might be used for stable isotope analysis. A single coat of clear nail polish was applied to the teeth, where necessary, to prevent fragmentation and loss of enamel.

A minimum number of individuals was determined by examining the burial bones for duplication of elements. In several instances, relative size of the elements indicated that (in adults) two non-duplicated bones were from different individuals.

The sex of the specimens was identified based upon visual examination of the crania and pelves (Stewart 1979; Phenice 1969). Other features, including measurements and visual observation of general robusticity, were examined to support these determinations. Due to the problematic nature of sex identification of subadults, pubic bone morphology was not used to determine the sex of individuals under the age of about fifteen. However, sex of two of the subadult pueblo specimens (Burials 2 and 3) was tentatively assigned. It was noted in lab that these two individuals showed different stages of dental development, but their long bones were similar in length. Since females physically mature sooner than males, as reflected in long bone lengths, it is assumed that the individual with the more developed dental arcade is male, while the other is female (Hunt and Gleiser 1955; Bailit and Hunt 1964; St. Hoyme and Iscan 1989).

The age of specimens under the age of about eighteen was assessed by dental development and eruption (Fazekas and Kosa 1978; Ubelaker 1989). For adults, age assignment was more difficult. Several methods of age assessment were used: pubic symphysis metamorphosis, dental attrition, and degenerative changes. The adults are classified into three general categories: young adult, middle adult and late adult. The category "young adult" includes individuals displaying complete fusion of all epiphyses, little or no degenerative changes, and a Scott score of under 25 on mandibular dentition. The Scott (1979) method involves assigning a score to molars that reflects the state of attrition seen in each of four quadrants. "Middle adults" are characterized by a greater degree of mandibular dental attrition (Scott scores between 26 and 35) and the presence of degenerative change in the postcranial skeleton. "Late adult" skeletons manifest marked dental attrition on mandibular molars (Scott scores over 36) and more severe degenerative changes.

Pathologies, occupational stress markers or other unusual skeletal lesions or features were described. Diagnoses of the conditions which caused these abnormalities will be discussed (Ortner and Putschar 1981).

The Salinas Region

The Salinas region of New Mexico takes its name from the abundant salt stores of the nearby saline playa lakes. This resource was the basis of exchange between the Spanish and Native Americans when the Spaniards designated the area the Salinas administrative province. Today, the Salinas area refers to all of Torrance and the eastern part of

Socorro county (Rautman 1990).

The upland areas of this region are generally pinyon-juniper forests. The lower elevation areas are grasslands with sage, rabbit bush and yucca plants. Cholla and other cactus are common in the region (Rautman 1990). It is assumed that cacti such as these were consumed by the prehistoric inhabitants of the region. For this reason, a dried piece of unfertilized cactus was collected and subjected to stable isotope analysis in an attempt to match it to signatures seen in the bone specimens analyzed.

The Salinas region was continually occupied throughout prehistory and history. Paleoindian sites are located around the Estancia basin along the shores of the ancient lakebeds. Three subsequent periods of occupation of the region by surface surveying and excavations at Gran Quivira including: a Pithouse Period, dating from about 800 to 1200 A.D.; the Jacal Period, dating from about 1100 to 1350 A.D.; and the Pueblo Period, dating from about 1300 to 1675 A.D. (Caperton 1981).

The Kite Site Pithouse Village

All of the site information about the Kite Site pithouse village (LA-38448) derives from Dr. Rautman's dissertation (Rautman 1990) and personal communication. The Kite Site is located in a pasture 0.8 km northwest of the

Gran Quivira mission unit of the Salinas National Monument. Aeolian transport of sand has covered the pithouse depressions. However, numerous pithouses have been exposed due to the formation of an arroyo, beginning in the 1930's (Rautman 1990). The Kite Site was first tested in 1982 by Pat Beckett of C.O.A.S. Publishing and Research, Las Cruces, and Regge Wiseman of the Museum of New Mexico. This excavation was undertaken to salvage the artifacts from one eroding pithouse. At this time the site was dated to about 900 to 1250 A.D. by the ceramic types present (Rautman 1990).

Dr. Rautman, directing an excavation from the University of Michigan, took over work at the Kite Site in the summer of 1986. At this time two distinct areas were discovered: the pithouse village (LA-38448) and a small square pueblo (LA-199). The excavations focussed on the pithouse site and unearthed 7 burials and numerous scattered, disarticulated human bones and fragments.

Several pit structures were described at the Kite Site. The 1982 Museum of New Mexico/C.O.A.S. Publishing excavation identified one pit structure. The 1986 field project identified and excavated another pit structure in which three burials were found. A multi-room, above ground, jacal structure was also found. This surface structure was constructed over a deep pit structure where four burials had been placed. A rich midden, yielding much cultural material, but no human bone was excavated. In addition, the arroyo had exposed several other pit structures (Rautman 1990).

Two occupational phases were assigned to the Kite Site based upon the findings of the 1986 excavation. The pithouses were first constructed and inhabited, then, during a later occupation, the jacal surface structures were constructed. Some of these surface structures were built on top of midden-filled pithouses. No evidence exists to determine whether or not some pithouses were occupied in this later period. Similarly, no evidence suggests continuous occupation of the site.

Kite Site Burial Descriptions

A complete skeletal inventory, including sex identification, age estimation, pathology diagnosis and determination of the minimum number of individuals represented, was prepared for each of the Kite Site specimens (Table 2.1). These skeletons were previously examined and analyzed by J. Homer Thiel, a University of Michigan undergraduate student, in 1987. Descriptions of the burials _in situ_ were taken from his report. Where my findings disagree with his, I have noted the source, if identifiable, of the discrepancy.

Table 2.3 - Kite Site Burial Summary

Feature	Sex	Age
9	Female	Young adult
14	Female	Late adult
19	Undetermined	7-11
20	Female	Late adult
23	Female	Late adult
24	Male	Middle adult
25	Female	Middle adult

Feature 9 Burial Description

Provenience: 510E, 500N, Level 7, inside a small discrete pit feature contiguous with Structure 2

Minimum Number of Individuals: One

Sex: Female

Age: Young adult

Cranial Pathologies/Anomalies: None noted.

Postcranial Pathologies/Anomalies: Preauricular sulci are present on both ilia.

The remains are well preserved in comparison to the other Kite Site specimens. A few of the bones are fragmentary and the skeleton is almost complete. Parts of the cranium, vertebral column and upper limbs are the only missing elements.

Visual examination of the hip bones (including preauricular sulci) indicates that this individual is female. Age is estimated from the externally fused sacrum and hip bones. The pubic symphysis is beginning to show some metamorphic changes.

Feature 14 Burial Description

Provenience: 513.80E, 500N, Level 6, in an antechamber inside a pithouse (Structure 2)

Minimum Number of Individuals: One

Sex: Female

Age: Late Adult

Cranial Pathologies/Anomalies: The inner surface of the cranium is irregular and eroded. This is the result of taphonomic changes in the bone, rather than a pathological process. There is evidence for chronic temporo-mandibular joint disease on the left occipital condyle. Dental attrition on the maxillary teeth is extreme. In addition, the teeth show some evidence of linear enamel hypoplasia, indicating a period of nutritional stress or disease in childhood. There is one large occlusal carious lesion on one of the isolated mandibular molars.

Postcranial Pathologies/Anomalies: There is some lipping present on the vertebral bodies. The left olecranon process also shows lipping that is characteristic of an arthritic reaction.

The bones are poorly preserved and fragmentary. Only the anterior facial skeleton, including the maxilla and maxillary dentition, is present. The cranial vault and mandible were not recovered. Some of the vertebrae and ribs are absent. The appendicular skeleton is missing the arms below the elbows and legs below the knees. According to Thiel (1987), root intrusions and rodent disturbance account for some of the breakage of bones.

Visual examination of the cranium and hip bones indicates that this individual is a female. This determination disagrees with that of Thiel. In his report, he cites robust muscle attachments as reasoning for assignment of male to this specimen. However, the pubic bone clearly fits all of Phenice's criteria for a female (Phenice 1969). Since these prehistoric specimens are all generally robust, the Phenice criteria are more appropriate for sex identification. The age estimation derives from the fact that all epiphyses are fused, severe dental attrition is noted (Scott score of 38) and some degenerative changes have begun to develop.

Feature 19 Burial Description

Provenience: 512E, 501N, Level 10, on the floor of a pithouse (Structure 2)

Minimum Number of Individuals: One

Sex: undetermined

Age: 7 to 11 years

Cranial Pathologies/Anomalies: None noted.

Postcranial Pathologies/Anomalies: No postcranial remains were recovered.

This is an isolated skull. Most of the calvarium is present along with the mandible, but the facial skeleton is absent.

This specimen is aged by examining the mandibular dental development and eruption. Since it is a subadult, sex cannot be assigned. No pathologies or anomalies are noted on this specimen.

Feature 20 Burial Description

Provenience: 492E, 522N, Level 8, inside a pithouse (Structure 6)

Minimum Number of Individuals: One

Sex: Female

Age: Late adult

Cranial Pathologies/Anomalies: None noted.

Postcranial Pathologies/Anomalies: There is marked osteophytic lipping on the vertebral bodies. The lower thoracic and lumbar vertebrae show reactive lesions on the articular processes. There is an accessory articulation at the L5-S1 junction. The left shoulder and elbow joints show marginal lipping that is characteristic of arthritic changes.

The remains are poorly preserved and eroded. Most of the bones present are fragmentary and only one cranial vault fragment was recovered. The postcranial skeleton is incomplete and the bones recovered are fragmentary. The left shoulder, left upper arm, both hands, right ischium, right pubis, right tibia, left fibula and both feet are missing. Some of these must be represented in the bag of approximately 250 miscellaneous fragments of unidentifiable bone that were excavated from the area.

Feature 20 was found beneath the floor of a jacal surface structure (Structure 7) within the fill of a pithouse (Structure 6). Part of this burial was exposed by and fell into the expanding arroyo on the Kite ranch. As a result of this, it is not known if this individual was interred before or after the construction of the jacal surface structure. The cranium was noted to be protruding from the arroyo wall during the summer of 1985. In 1986, fragments of the occipital were noticed on the floor of the arroyo, suggesting that the rest of the cranium had been washed away sometime during the preceding year. Some rodent disturbance was noted, accounting for further under-representation of skeletal elements (Thiel 1987).

Visual examination of the hip bones showed that this individual is a female. The rarefaction of the available pubic bone and evidence of degenerative changes (probably arthritis) indicate that this individual is a late adult.

Feature 23 Burial Description

Provenience: 492E, 522N, Level 10, inside a pithouse (Structure 6)

Minimum Number of Individuals: Two

Sex: Female

Age: Late adult

Cranial Pathologies/Anomalies: Severe mandibular alveolar resorption is noted on this specimen. Contradicting Thiel's (1987) findings, no occipital flattening is noted on this specimen.

Postcranial Pathologies/Anomalies: Some marginal lipping is noted on the right talus.

Feature 23 was excavated beneath and to the east of Feature 20. The cranium protruded from the fill in which Feature 20 had been placed. Some of the bones were articulated, but most were disturbed sometime after deposition. Preparation for the deposition of the overlying body of Feature 20 is the most likely cause of this disturbance. Rodent activity and erosion of the burial into the arroyo account for further fragmentation observed (Thiel 1987). Generally, the bones appear to have been displaced towards the east with the cranium deliberately placed in the region of the thorax.

Most of the skeleton is represented, but the bones are extremely fragmentary and eroded. Most of the cranium, the left wrist, both hands, the right fibula and both ankles and feet are missing. Numerous small bone fragments were excavated with this burial. They are in labelled bags, so it is assumed that they were identifiable in the field as being from certain areas of the skeleton (Thiel 1987).

Visual examination of the cranium indicates that this individual is a female. This determination contradicts Thiel's findings. Based upon the state of complete epiphyseal union, the edentulous mandible and slight degenerative changes noted, it is estimated that this individual is a late adult.

Feature 24 Burial Description

Provenience: 492E, 520N, Level 10, beneath a pithouse (Structure 7)

Minimum Number of Individuals: One

Sex: Male

Age: Middle adult

Cranial Pathologies/Anomalies: Severe alveolar resorption and dental attrition are noted in both the maxilla and mandible. There is a large carious lesion on the occlusal surface of the right mandibular second molar.

Postcranial Pathologies/Anomalies: None recorded

Feature 24 was unearthed from beneath the floor of Structure 7. Most of the cranium is represented by the remains. No postcranial remains were delivered to the M.S.U. Anthropology Department even though there are postcranial bones described in the 1987 inventory and analysis.

Visual examination of the cranium indicates that this individual is male. The dental attrition noted, reflecting a Scott score of 32, indicates that this individual was a middle adult. This estimation is older than that made by Thiel. This burial is distinguished by treatment. The individual was buried with shaped rocks lying across the head and along the back of the body.

Feature 25 Burial Description

Provenience: 492-493E, 519.50-520.20N, Level 11, above a pithouse (Structure 6)

Minimum Number of Individuals: One

Sex: Female

Age: Middle adult

Cranial Pathologies/Anomalies: Severe attrition is noted on the dentition of this specimen. The left mandibular second molar shows a large carious lesion in the middle of the occlusal surface.

Postcranial Pathologies/Anomalies: Preauricular sulci are noted on both ilia of this specimen.

Feature 25 was recovered from above the ventilator shaft of a pithouse (Structure 6), below Feature 24. The skeleton was supine with the legs drawn up to the chest, indicating that the body was placed into a restricted space. The remains are almost complete. The cranium is fragmented, probably due to the weight of the overlying metate. The right clavicle, scapula, ulna, radius and hand bones as well as the hip bones, left fibula and right foot are not present. Again, Thiel (1987) attributes these omissions to rodent disturbance.

Visual examination of the cranium and mandible indicates that this individual was a female. The completed epiphyseal union and dental attrition (Scott score of 30) indicate that the specimen was a middle adult. The absence of degenerative changes on the skeleton supports this estimation.

Pueblo de la Mesa

The site information for Pueblo de la Mesa (LA-2091) derives from site reports (Rautman 1992, 1993), personal communication, and my own field observations. Pueblo de la Mesa is located in the Cibola National Forest in Torrance County. The site is located on top of a mesa approximately 100 meters above the surrounding plain. The remains of the pueblo itself are on the north side of the mesa, overlooking a large prehistoric pueblo site called Pueblo Colorado. This larger pueblo is about 2 kilometers north of Pueblo de la Mesa and is located on the plain.

There are approximately 100 rooms in Pueblo de la Mesa. An elongate roomblock (Roomblock II) divides two interior plazas (Rautman 1992; Rautman 1993). The height of the rubble suggests that this portion of the pueblo could have been two stories. This roomblock is three rooms wide. A small plaza (the North Plaza) is located to the north of Roomblock II. The southeastern end of the plaza contains a kiva and also a smaller subsurface structure. Roomblock I, a single line of rooms, forms the northern boundary of this plaza. Two more roomblocks (III and IV) are situated to the south of the North Plaza. They form the western boundaries of the South Plaza. The rubble remains of a masonry wall define the eastern and southern portion of this plaza. Several features interpreted as water reservoirs are found on the top of the mesa south of the pueblo. In addition, some of the bedrock outcrops on the mesa north of the pueblo show evidence of use as groundstones.

In 1989, Dr. Kate Spielman of the University of Arizona tested the site to determine its age and the nature of the deposits. According the Laboratory of Anthropology site files, the site can be dated from 1250 to 1450 A.D. based upon pottery types present (Rautman 1992a). The ceramic assemblage collected at LA-2091 contains primarily Glaze A and also some Glaze B sherds, indicating that it was occupied at the same time as nearby Pueblo Colorado. The larger pueblo continued to be occupied after Pueblo de la Mesa was abandoned. It has been suggested that Pueblo de la Mesa could have functioned as a fortified refuge for the earliest Pueblo Colorado populations (anonymous, cited in Rautman 1992a).

Pueblo de la Mesa Burial Descriptions

Table 2.2 summarizes the burial population recovered from Pueblo de la Mesa.

Table 2.2 - Pueblo de la Mesa Burial Summary

Burial	Sex	Age
1A	Female	Young adult
1B	Undetermined	5-7
2	Probable female	3-5
3	Probable male	4-6
4	Undetermined	12-24 months
5	Probable female	12-18

Burials 1A and 1B

Provenience: Roomblock I, Room 5, 520-521E, 536-537N, Level 3-4

Minimum Number of Individuals: Two (the description of pathologies and anomalies represents those found in the adult, none were found on the subadult)

Sex: Individual A: Female

Individual B: Undetermined

Age: Individual A: Young adult

Individual B: 5-7

Cranial Pathologies/Anomalies: Some occlusal attrition and several carious lesions are noted in the specimen. Alveolar resorption is present on both the labial and lingual borders of the maxillary molars. Mandibular resorption is not evident, but there is a small area of lipping along the buccal side of the mandibular molars. Resorption led to the exposure of the lingual roots of the right first and second maxillary molars and is secondary to a large apical abscess in the third molar. Occlusal caries are noted on the right and left maxillary third molars. No caries are noted in the mandibular dentition and minimal attrition is apparent.

The left mandibular condyle and fossa are flat and exhibit lipping that is characteristic of temporomandibular joint disease.

There is a flattening on the left posterior half of the cranium. This involves the left parietal, left temporal and left half of the occipital. The left occipital condyle is compressed antero-posteriorly. No fracture lines or other evidence of trauma are noted in this region. It is therefore concluded that this condition represents cultural flattening of the posterior left half of the cranium.

Postcranial Pathologies/Anomalies: Both humeri show septal apertures. The left fifth metacarpal exhibits a healed fracture. Pre-auricular sulci are evident on both ilia. Slight dorsal pubic pitting is also identifiable.

Burial 1 was the first of four burials excavated from a masonry room (Room 5). It was found in the west half of the room, situated on a well-preserved floor beside a hearth and with a rock cairn on top of the bones. The remains are well-preserved and complete. The only missing elements are: the first cervical vertebra, hyoid, some of the right carpals and metacarpals, some of the left tarsals, and several phalanges. Some postmortem breakage occurred during excavation and where possible, these breaks were refitted. Extensive damage to the right hip bone obscures the morphology of the pubis, but the complete left specimen allows for sex determination. The presence of several subadult bones with this specimen raises the minimum number of individuals for this feature to two.

Nine potsherds were found in association with this burial. All of them are glazed ceramics of a late date (post-dating Glaze A and B) which were not used until after the abandonment of the site. It is postulated that Burial 1 represents a later interment, placed after site abandonment possibly by groups who were still living at nearby Pueblo Colorado (Rautman 1993).

Visual examination of the cranium and hip bones indicates that this individual is a female. The skeleton shows complete epiphyseal union, a minimal degree of dental attrition (Scott score of 21) and no degenerative changes, indicating that she is a young adult.

Burial 2

Provenience: Roomblock II, Room 4, 516E, 506N, Level 9-10

Minimum Number of Individuals: One

Sex: Probable female

Age: Four years (plus or minus one year)

Cranial Pathologies/Anomalies: None noted

Postcranial Pathologies/Anomalies: None noted

Burial 2 was the only discrete burial excavated in Roomblock II (Room 4). The remains are well-preserved and complete. The only missing elements are: the hyoid, some vertebral body fragments, the sternum and some phalanges. No erosion is noted for this specimen. The cranium is mostly disarticulated, but two articulated fragments were recovered.

The age of this individual is determined by examination of dental development and eruption. The long bones of this individual are comparable in length to those of Burial 3. It is assumed, then, that since this specimen is aged at a year younger by dental eruption sequence, it is female (See Table 2.3) (Johnston 1962; Ubelaker 1978).

Table 2.3--Age Estimation of Burials 2 and 3

Burial	Dental Age Estimate	Left Tibia Length	Long Bone Age
2	4±1 years	138 mm	2.5-3.5 years
3	5±1 years	141 mm	2.5-3.5 years

Burial 3

Provenience: Roomblock I, Room 5, 521E, 536N, Level 12

Minimum Number of Individuals: One

Sex: Probable male

Age: Five years (plus or minus one year)

Cranial Pathologies/Anomalies: None noted

Postcranial Pathologies/Anomalies: None noted

This burial was the second found in Room 5. It was found in the southeast quadrant below a floor (Surface 3). The remains are well-preserved and complete. The cranium is present, but badly fragmented. The only elements missing are: the hyoid, some vertebral arch and neural arch fragments, some ribs, the left scapula, the left pubis, both tali, the left calcaneus and some of the phalanges. Some erosion is noted on the ends of long bones.

Age of this individual is determined by dental development and eruption. Since this individual's long bones are similar in length to those of Burial 2 yet the dental eruption indicates that it is a year older, it is assumed that this individual was male (See Table 2.3) (Johnston 1962; Ubelaker 1978).

Burial 4

Provenience: Roomblock I, Room 521E, 536N, Level 10-11

Minimum Number of Individuals: One

Sex: Undetermined

Age: Eighteen months (plus or minus six months)

Cranial Pathologies/Anomalies: None noted

Postcranial Pathologies/Anomalies: None noted

This, the third burial found in Room 5, was found on top of an adobe floor in the southwest quadrant. It appeared to be placed under the west wall of the room. The remains are well-preserved and mostly complete. The cranium is present, but unfused and disarticulated. The only elements missing are: the hyoid, vertebral and neural arch fragments, sternum, manubrium, several ribs, the left ischium, the left tibia, the left fibula and several phalanges. Some breakage and erosion is present on the ends of long bones.

Age of this specimen is determined by examination of dental development and eruption. Sex is undeterminable due to the young age of the specimen.

Burial 5

Provenience: Roomblock I, Room 521E, 536N, Level 12-13

Minimum Number of Individuals: One

Sex: Probably female

Age: Fifteen years (plus or minus three years)

Cranial Pathologies/Anomalies: None noted.

Postcranial Pathologies/Anomalies: None noted.

This burial was the last to be excavated from Room 5. The remains are well-preserved and complete. The cranium is complete, but unfused and disarticulated. The only skeletal element that is missing is the hyoid bone. The bony surfaces are slightly eroded.

The sex of this specimen is determined by visual examination of the hip bones. Since it is a subadult, the features are not fully developed, but they are obviously developing distinct ventral arcs and subpubic concavities. Age is estimated by dental development and eruption. Pubic symphysis morphology and epiphyseal union evidence support this estimation.

Chapter 3

STABLE ISOTOPE ANALYSIS

Sampling

Initial stable isotope analysis for the Kite Site material was carried out at the University of Calgary by Dr. M. Anne Katzenberg. The results are presented in Appendix B. The stable isotope analysis for Pueblo de la Mesa and retrials of the Kite Site specimens were carried out at the Michigan State University Stable Isotope Laboratory under the supervision of Dr. P.H. Ostrom. These data are also presented in Appendix B.

Ribs from each of the Kite Site and Pueblo de la Mesa burials were analyzed at M.S.U.. The earlier analysis of the Kite Site materials was performed on ribs, therefore ribs were chosen to maintain consistency of samples for this study. It is optimal to use thick cortical bone, such as that found in long bone shafts, to perform stable isotope analysis (Ostrom, personal communication). However, due to the specifications stated in a letter from the U.S.D.A. Forest Service, only small, non-diagnostic bones may be used in chemical studies (Rautman 1990, personal communication).

Sample Preparation

The laboratory procedures followed are found in Ostrom et al. (1990). A portion (approximately four grams) of one rib from each of the burials was analyzed. The specimens were scrubbed with a brush and abraded with an electric hand drill (Dremel) to remove surface contaminants such as dirt, sediments and plant material. They were then immersed in a 1.0% solution of hydrochloric acid for five to ten seconds and rinsed in double distilled water. The specimens were then covered and left to dry.

After two hours the specimens were split open with the Dremel and examined under a dissecting microscope for internal contamination. Some dirt was found in the Pueblo de la Mesa samples and roots were found in the Kite Site sample. These samples were all re-immersed in hydrochloric acid, rinsed, and checked for contamination. When no visible contaminants were found the samples underwent demineralization. Several small beakers were purified by ashing: heating them in a 500°C oven for an hour. The samples were placed in these beakers and covered with ashed aluminum foil and placed in a freezer prior to isolation of organic matter.

The next step was to prepare the samples for isolation of high molecular weight organic material by dialysis. The dialysis process removes the low molecular weight organic material and mineral components of the bone. This is accomplished by first grinding the specimens into a fine powder which is then dissolved in 0°C 6N HCl and dialyzed at a low temperature in distilled water for two weeks. The water was changed twice a day for the first week, then once a day for the second week. The remaining material was then freeze-dried.

A Dumas combustion in a sealed quartz tube was performed on the material in order to convert it to suitably pure gases prior to analysis on a VG Prism stable isotope ratio mass spectrometer. Two of the samples gave uncharacteristically high isotope signatures upon initial analysis and underwent sample preparation a second time. More consistent results were obtained from these re-trials samples, therefore it is concluded the first trials of the two samples were contaminated.

Carbon Isotope Results

Of the fourteen samples run, six originated from the Kite Site Pithouse Village: five from the burials (Features 9, 14, 20, 23, and 25) and one from a piece of dried, unfertilized cactus collected from the mesa site in 1994. The remaining eight samples originated from Pueblo de la Mesa: one from each of the five burials and also from three faunal bones found at the site (antelope, bison and rabbit). The complete data set is found in Appendix B.

The Kite Site skeletal sample's δC^{13} values range from

-4.9‰ to -3.8‰ with a mean δC^{13} value of -4.1‰, and a standard deviation of 0.5. The Pueblo de la Mesa population shows a range between -12.6‰ and -3.0‰ with mean of -5.4‰, standard deviation of 4.1. One outlier (Burial 4) exists that does not fit the general pattern indicated by the δC^{13} values of the other specimens (see Appendix B). The fact that Burial 4 represents an eighteen month old child may explain this variance in the data. Children that young may either still be breastfeeding or being fed a specialized diet, thus artificially increasing the δC^{13} values for that individual (Katzenberg 1992).

A T-test was performed on these data with S-Plus software. A comparison of the Kite Site and Pueblo de la Mesa δC^{13} data gave a p-value of 0.4785. This is well above the 0.05 confidence level and indicates that there are no statistically significant differences between the two populations' δC^{13} values. In fact these data demonstrate that, for these two sites, pithouse and pueblo populations exploited very similar dietary resources. Therefore, the first null hypothesis cannot be rejected based upon the results of this analysis.

Nitrogen Isotope Results

Reproducibility of δN^{15} determinations was evaluated by triplicate analysis of Pueblo de la Mesa Burial 3. The low standard deviation (13.6 ±0.0577‰) of these data (13.6‰, 13.6‰, 13.7‰) is consistent with that of similar analyses performed in the stable isotope lab at M.S.U.. The complete data are presented in Appendix B.

The range of δN^{15} values for the pithouse site is 11.9‰ to 13.3‰ with a mean of 12.6‰, standard deviation of 0.5. For the pueblo site, the δN^{15} values range from 10.9‰ to 17.0‰ with a mean of 13.2‰, standard deviation of 2.4.

Here again, the T-test p-value of 0.6305 shows that there are no significant differences in the δN^{15} values for these two sites. Assuming that the δN^{15} food source at the base of the food web was similar for both populations, this indicates that they exploited a similar resource base. The second null hypothesis cannot be rejected based upon the results of this analysis.

The values obtain for the Burials 2 and 3 from the pueblo site show an interesting trend. Both these burials show δN^{15} values that are much higher than the other three burials found at the site. Burial 2, the four year old child, shows a significantly higher δN^{15} value, compared to that of Burial 3, the five year old child. It has been suggested that results like these may indicate decreased trophic levels associated with weaning (Ostrom, personal communication). The younger individual, possibly still breastfeeding, shows an elevated δN^{15} value. Once weaned, this level falls, as shown in the isotopic signature of the five year old.

Possible Sources of Error

Stable isotope analysis of these two populations provided some interesting information. The data did not, however, disprove the null hypothesis. Comparison of the sites' isotope values did not show significant differences. There are several possible explanations for this phenomenon.

Studies have suggested that living in an arid environment may influence an animal's nitrogen isotope values (Heaton et al. 1986; Ambrose and DeNiro 1987; Sealy et al. 1987). However, the δN^{15} values are less critical to considering our question of maize dependence than the δC^{13} values since the $\delta^{13}C/\delta C^{12}$ ratio is the best indicator of C_3/C_4 plant exploitation.

Taphonomical changes may also affect stable isotope analysis. The two sites, however, are undisturbed and no artificial chemical fertilization of the soil has occurred at either locality, as far as we know, so this factor does not appear to have affected the data. The narrow range of variation of the data suggests that taphonomy was not a factor. Sample preparation techniques could alter the values, but great care was taken in order to prevent contamination of the samples at all stages of the preparation. Sample yield may affect accuracy also, but the samples showed a high yield of organic material (between ten and seventeen percent).

Instrumental problems are another possible source of error in stable isotope analysis. However, when the samples were analyzed, several test runs were performed on one sample (Burial 3 from Pueblo de la Mesa), showing a great degree of replicability of the δN^{15} figures.

Some consideration of the populations themselves is also necessary in analyzing the trends shown by the data. The Pueblo de la Mesa sample consists almost entirely of subadults, the only fully mature individual being a female who appears to be a late interment at the site. There is some suggestion that breast feeding may affect δN values of the infants and juveniles, artificially elevating their nitrogen isotope signatures by 3‰ (Katzenberg 1992: 113). One last problem is that both populations are rather small, thus making statistical comparisons inappropriate. Certainly larger samples would be optimal, but budget constraints and the small sizes of the burial populations available do not allow for more extensive sampling.

Given the assumption that none of these factors influenced the data, alternative hypotheses are needed to explain the lack of difference in δC^{13} and δN^{15} values between the two sites. The most reasonable of these is that people at the sites were in fact eating generally similar diets. This does not fit the common notion that the pithouse to pueblo transition involved a shift to a more sedentary, maize-based settlement system. However, some aspects of the two populations may explain why they do not support this hypothesis.

It seems more likely that there was in fact little or no differentiation in the diet of the two populations, even though they inhabited dissimilar dwellings. It is the conclusion of this study, then, that these two groups were exploiting similar resource bases and had comparable diets.

Chapter 4

ANTHROPOLOGICAL IMPLICATIONS

Implications for Diet Reconstruction

Stable isotope analysis can be useful in reconstructing the diet of past populations. With proper sampling, laboratory procedures and analysis, much information about subsistence strategies of a given population can be gleaned. In the past, this type of analysis has answered questions about trophic levels of food sources, marine versus terrestrial subsistence, and maize dependence (van der Merwe and Vogel 1978; DeNiro and Epstein 1981; Schoeninger et al. 1983; Schoeninger et al. 1990).

For the two skeletal populations in this study, stable isotope analysis was used to evaluate the traditional view of dietary change at the pithouse to pueblo transition. Comparisons of the mean δC^{13} values for the sites have been demonstrated to elicit information about the relative maize dependence of the populations. The mean δN^{15} values for the sites shed light onto the trophic levels of foods consumed.

Evidence for Dietary Continuity

If long term consumption habits did indeed change during the pithouse to pueblo transition in the Sierra

Blanca region of central New Mexico, then pithouse skeletal samples should vary from pueblo samples in a predicted manner. The isotope analysis of the Kite Site and Pueblo de la Mesa populations contradicts this long-established view. The lack of significant differences in δC^{13} values indicates that these populations did not eat differing levels of maize, relative to one another. The similar δN^{15} values indicate that these two populations were exploiting similar plant and animal food sources.

Comparison with Gilman's Hypothesis

Gilman (1987) attempts to show that the physical features of both pithouses and pueblos can be used to predict the subsistence patterns of the populations which inhabited them. She supports this theory with ethnographic evidence from pithouse and pueblo dwellers. By citing certain climatological and cultural factors that make pueblo dwellings more efficient that pithouse dwellings, she hypothesizes that these were the reasons that prehistoric peoples made the transition. She further supports the commonly-held notion that a relatively stable food source (maize) would have been necessary to sustain these populations.

The results of the stable isotope analysis of the Kite Site Pithouse Village and Pueblo de la Mesa burial populations contradict her findings. Here, no statistically significant differences in the stable isotope values could be found between the pre- and post-transition populations studied here. This indicates that prehistoric pithouse-using populations in this area may have been more dependent on agriculture than the ethnographic populations that Gilman cited.

Comparison with Rocek's Hypothesis

Rocek's (1995) study of maize ubiquity from flotation samples from a pithouse and pueblo site concluded that no statistically significant differences in diet can be found, during the season of site occupation. This suggests that sampling and preservation factors have contributed to the view that pueblo-dwellers are more dependent on agricultural products.

This study supports Rocek's suggestion that pithouse and pueblo populations may not differ so greatly in their subsistence. Stable isotope analysis, however, is a measure of total diet, not just that consumed at the time of site occupation. In this way, this study and Rocek's differ. The fact, however, that these two studies support the notion of dietary continuity over the pithouse to pueblo transition is salient. More and more evidence is coming to light to challenge the long-held view of subsistence shift during this period (Powell 1983; Rocek 1995). This study suggests that economic change such as agricultural intensification varies independently from patterns of seasonal mobility and sedentism.

Suggestions for Future Research

Most evidence from prehistoric excavations in the United States southwest indicates that sedentism and maize dependence both increased after Native American peoples made the transition from inhabiting pithouses to building and living in pueblos (Cordell 1984; Gilman 1987; Rocek 1995). The artifacts excavated from the Kite Site Pithouse Village and Pueblo de la Mesa provide evidence for maize cultivation. Groundstone manos and metates and even charred maize cobs and fragments indicate that both populations did exploit the tropical grass. However, the stable isotope analysis of skeletal material failed to show statistically significant results in the food sources of these populations. Whatever the reason for this discrepancy, it cannot be ignored that this study fails to support the long-held view.

Very little stable isotope data is available for central New Mexico. More analyses of human bone from the region, with much larger sample sizes, are necessary before any major revisions of theory are attempted. However, if such studies show similar results to those of this project, it will be necessary to re-evaluate current notions of sedentism and maize dependence in the region.

APPENDICES

APPENDIX A

Kite Site Pithouse Village Burial Inventories

Feature 9

Element	Comments
frontal	
R&L parietals	fragmentary
R&L temporals	fragmentary
R&L nasals	with partial frontal
35 unidentifiable cranial fragments	
vertebrae	1 thoracic, 3 lumbar, 11 neural arch frags., 12 body frags.
sacrum	bodies unfused
coccyx	
ribs	10 frags.
scapula	7 unsidable fragments
L humerus	fragmentary
R radius	fragmentary
R metacarpal 2	
R metacarpal 3	
all L metacarpals	
R capitate	
R greater multangular	
R&L pisiform	
L lunate	
L lesser multangular	
L hamate	
L scaphoid	
phalanges	1 proximal, 2 middle, 4 distal
R&L ilium	preauricular sulci
R&L ischium	eroded, iliac crests and rami fusing
R&L pubis	eroded
R&L femur	broken distally
R&L patella	
R&L tibia	
R&L fibula	R proximal and L distal ends broken
R&L talus	
R&L calcaneus	
R&L cuboid	
R&L navicular	
R&L cuneiform 1	
R&L cuneiform 2	
R&L cuneiform 3	
all R metatarsals	
phalanges	2 proximal, 3 middle, 2 distal
200 unidentified fragments in several small bags	

Feature 14

frontal	fragmentary
L temporal	refit with partial L parietal and occipital

14 large cranial vault fragments
R&L nasals
maxilla
R&L I1
R&L I2
R&L C

L P1	one of the RPs found in "isolated bone" bag
L P2	
L M1	

mandibular dentition: 2 molars, one premolar found in "isolated bone" bags

vertebrae	6 thoracic frags., 12 lumbar frags., 17 unidentified frags.
sacrum	fragmentary
ribs	36 frags.
R&L clavicle	broken
L scapula	fragmentary, rodent gnawing noted
R&L humerus	fragmentary, rodent gnawing on left bone
L ulna	proximal half
R&L hip bones	very fragmentary and broken
R&L femur	fragmented, rodent gnawing on left bone

several bags with approximately 300 total unidentified cranial and postcranial fragments

Feature 19

frontal	L half
R&L parietals	whole R, partial L
occipital	partial
mandible	body w/ partial dentition
L I2	
R&L C	R loose
R&L P1	R loose
R&L P2	R loose, L unerupted
R&L M1	R loose
L M2	erupting, alveolus open
L M3	erupting, alveolus mostly closed

one loose molar cap
several bags containing approximately 150 cranial fragments

Feature 20

R temporal	frag. found in East wall
vertebrae	7 thoracic, T12, 5 lumbar
sacrum	8 frags.
ribs	37 frags.
sternum	1 frag.
R clavicle	large exostosis on medial edge
R scapula	fragment
R humerus	2 frags.
R&L radius	in 3 and 2 frags., respectively
R&L ulna	each in 2 frags.
R metacarpal 1	

1 proximal phalanx	
R&L ilium	fragmentary
L ischium	fragmentary
L pubis	fragmentary, possible dorsal pubic pitting and pre-auricular sulcus noted
R&L femur	fragmented without condyles
R patella	
L tibia	2 frags.
R fibula	shaft with 25 frags.

several bags with approximately 250 fragments of unidentified bone

Feature 23

R&L parietal	small frags.
R&L temporal	small mastoids
occipital	5 frags. of occipital and nuchal planum
mandible	L body and partial ascending ramus with a closed area of long-term resorption at the site of the molars and closing in progress by the premolars, mand. condyle fragment
L M1 (mandibular)	
one SA molar cap	
2 bags with approximately 25 cranial frags. in each	
ribs	75 frags.
clavicle	12 frags.
R&L humerus	R (whole) in frags., L one frag. of it
R&L radius	both whole; R in 6 frags., L in 3 frags.
R&L ulna	both whole; R in 4 frags., L in 12 frags.
all R carpals except scaphoid	
fragments of all R metacarpals	
2 proximal phalanges	
R&L femur	R whole, fragmented, L frags.
R&L tibia	R whole, fragmented, L frags.
R fibula	shaft frag.
R&L talus	arthritic lesions

approximately 500 unidentified bone chips placed in several bags, some labelled as pelvis, vertebrae, scapulae, etc. It is assumed that these pieces were excavated from the general area of the skeleton indicated on the bag. None of these remains are inconsistent with the bag labels.

Feature 24

frontal	
R&L parietals	broken
R&L temporals	broken
occipital	broken
sphenoid	broken
L zygomatic	broken
maxilla	partial dentition
R I	

L P1	
R&L P2	
R&L M1	
R&L M2	
R M3	
mandible	partial dentition
L I	marked shoveling
R&L P1	
R&L P2	
R M1	
R&L M2	R has large cavity on occlusal surface
R&L M3	
isolated teeth	2 max. Is, 1 mand. I, one molar (no crown)
bag	45 cranial frags., 2 occipital frags, 1 palatine frag., 7 sphenoid frags.

Feature 25

frontal	fragmentary
parietals	fragmentary
temporals	fragmentary
occipital	fragmentary
zygomatics	
maxillae	
L I1	shovelled
R&L I2	shovelled
R&L C	
R&L P1	
R&L P2	
R&L M1	
R M2	
mandible	R&L M1 both absent and resorbed
L I1	
R&L I2	
R&L C	
R&L P1	
L P2	
R&L M2	
cranial frags.	one bag with approximately 300 cranial frags.
partial vert.	T10-T12, L1-L5, 2 thoracic neural arches, 1 body frag.
sacrum	
ribs	15 frags.
L clavicle	fragmented
L scapula	
R&L humerus	broken, refit
L ulna	olecranon process only
phalanges	3 proximal
R&L ilium	preauricular sulci noted
L ischium	wide sciatic notch
R&L femur	R fragmented

R&L tibia both broken
R fibula
L talus
L calcaneus
L cuneiform 1
L cuneiform 2
R prox. phalanx 1
unidentified frags.--approximately 60

Pueblo de la Mesa Burial Inventories

Burial 1

complete cranium	basilar suture fused, cradleboard flattening
mandible	TMJ disease
dentition--max.	marked attrition, several caries
RM3 LM3	
RM2 LM2	
RM1 LM1	
RP2 LP2	
RP1 LP1	
RC	
RI1 and LI2 refit	
dentition--mand.	
RM2 LM2	
RM1 LM1	
RP1 LP1	
cervical vert.	C2, C3, C6, C7, 1 body, 2 sp. proc., 2 frags.
thoracic vert.	T1, T4-T12 (lesion between T4-5 bodies)
lumbar vert.	L1-L5 (lipping on lumbars)
sacrum	
ribs	R rib 1, 4R whole ribs, 10R rib frags. L rib 1 (used for isotope analysis), 4L whole ribs, 9L rib frags., 7 unsidable rib frags.
sternum	
manubrium	
R&L clavicle	
R&L scapula	L broken postmortem
R&L humerus	
R&L radius	both broken postmortem (refit)
R&L ulna	
R lesser multangular	
R lunate	
R triquetral	
all 8 L carpals	
R&L metacarpal 1	
L metacarpal 2	
L metacarpal 3	
L metacarpal 4	
R&L metacarpal 5	healed fracture, L metacarpal 5

R&L ilium	R broken postmortem, preauricular sulcus present, slight dorsal pubic pitting
R&L ischium	R broken postmortem
R&L pubis	R broken postmortem
R&L femur	R head broken postmortem
R&L patella	
R&L tibia	
R&L fibula	R head missing
R talus	
R calcaneus	
R&L navicular	
R lunate	
R second cuneiform	
R third cuneiform	
R&L metatarsal 1	
R&L metatarsal 2	
R&L metatarsal 3	
R&L metatarsal 4	
R&L metatarsal 5	
hand phalanges	6 proximal, 3 middle
foot phalanges	4 proximal, 3 middle, 2 distal

Associated subadult remains:
2 rib fragments, 1 cervical vertebra
cranial, thorax and abdomen soil samples are present

Burial 2

frontal	art. w/ partial ethmoid and sphenoid
R parietal	art. w/ occipital (basilar part fused, lateral masses unfused)
L parietal	
R&L temporals	1 malleus, 1 stapes
R&L zygomatics	
R&L maxillae	
R&L nasal	
17 cranial frags.	
mandible	
dentition--max.	
R&L i2	
R i1	
R&L c	
R&L m1	
R&L m2	
R&L M1 (unerupted)	
dentition--mand.	
R&L i1	
R&L i2	
L c	
R&L m1	
R&L m2	
R&L M1 (unerupted)	
vert: all neural arches	

19 vert. body frags.	
13 unid. vert. frags	
ribs	R rib 1, 10R ribs, L rib 1 frag., 10 L ribs, 2 unsidable rib frags.
R&L clavicle	
R&L scapula	
R&L humerus	
R&L radius	
R&L ulna	
R arm epiphysis	
4 L arm epiphyses	
5 R hand phalanges	
19 L hand phalanges	
R&L ilium	
R&L ischium	
R&L pubis	
R&L femur	
R&L tibia	
R&L fibula	
R&L calcaneus	
6 R leg epiphyses	
5 L leg epiphyses	
20 R foot phalanges	
8 L foot phalanges	
cranial, thorax and abdomen soil samples	

Burial 3

R&L parietal frags.	
R&L temporal frags.	
R zygomatic	
3 occipital frags.	
70+ cranial frags.	
maxillae	partial dentition
R&L m1	
R&L m2	
L M1	
mandible	partial dentition
L i2	
R m1	
isolated teeth	4 i, 4 c, 1 I crown, 3 m, 1 M crown
18 vert. body frags.	
50 neural arch frags.	
4 sacrum frags.	
ribs	2R, 5L, 62 unsidable frags.
sternum	
R&L clavicle	
L scapula	
R&L humerus	
R&L radius	
R&L ulna	
13 R hand bones	
13 L hand bones	

R&L ilium
R&L ischium
R pubis
R&L femur
R&L tibia
R&L fibula
R calcaneus
2 R leg epiphyses
2 L leg epiphyses
21 foot bones
70+ unidentified bone frags.
cranial and thoracic soil samples

Burial 4

R&L parietal	
R&L temporal	
sphenoid	4 frags.
occipital	3 frags.
R&L nasals	
maxilla	3 frags. w/ 2 unerupted molars
R mandible	w/ i, m1, unerupted m2
isolated teeth:	8 i, 3 c, 3 m w/ partial roots, 4 m crowns
4 vert. body frags.	
16 neural arch frags.	
ribs	11

R&L humerus frags.
R&L radius frags.
R&L ulna frags.
R&L ilium
R ischium
R&L femur
R tibia
R fibula frag.
16 hand and foot bones
57 unidentified frags.
cranial soil sample

Burial 5

R frontal frag.	
R parietal frag.	
R temporal	
R occipital frag.	
R zygomatic frag.	
R&L nasals	
R&L maxilla	w/ RP1, RM1, RM2, LP2, LM1
mandible	w/ RP2, RM1, LI2, LC
isolated teeth	7 incisors, 3 canines, 4 premolars, 4 molars
50+ cranial frags.	
vertebrae	complete
sacrum	complete

ribs	9R ribs, L rib 1, 10L ribs, 23 rib frags.
sternum	
manubrium	
R&L clavicle	
R&L scapula	
R&L humerus	2R and 1L epiphyses
R&L radius	2R and 1L epiphyses
R&L ulna	
R&L hands	
R&L ilium	
R&L ischium	
R&L pubis	
R&L femur	3R and 3L epiphyses
R&L patella	
R&L tibia	2R and 2L epiphyses
R&L fibula	2R and 2L epiphyses
R&L feet	complete except for partial phalanges

cranial, thorax and abdomen soil samples

APPENDIX B

Sample	Powder	Dried	% Yield
Feature 9	1.63 g	0.11 g	6.8%
Feature 14	1.17 g	0.18 g	15%
Feature 20	1.61 g	0.14 g	8.7%
Feature 23	0.47 g	0.02 g	4.2%
Feature 25	2.50 g	0.25 g	10%
Burial 1	1.51 g	0.26 g	17%
Burial 2	2.92 g	0.40 g	14%
Burial 3	1.65 g	0.26 g	16%
Burial 4	1.34 g	0.19 g	14%
Burial 5	1.55 g	0.27 g	17%
Antelope	2.22 g	0.27 g	12%
Bison	2.42 g	0.35 g	14%
Rabbit	2.00 g	0.30 g	15%
Cactus	N/A	N/A	N/A

Sample	δC^{13} collagen	δC^{13} diet	δN^{15} collagen	δN^{15} diet
Kite Site				
Feature 9	-8.9‰	-13.9‰	10.3‰	7.3‰
Feature 14	-8.8‰	-13.8‰	9.4‰	6.4‰
Feature 20	-8.9‰	-13.8‰	9.7‰	6.7‰
Feature 23	-9.9‰	-14.9‰	9.9‰	6.9‰
Feature 25	-8.9‰	-13.9‰	8.9‰	5.9‰
Pueblo de la Mesa				
Burial 1	-8.0‰	-13.0‰	9.6‰	6.6‰
Burial 2	-8.9‰	-13.9‰	14.0‰	11.0‰
Burial 3	-9.7‰	-14.7‰	10.6‰	7.6‰
Burial 4	-17.6‰	-22.6‰	7.9‰	4.9‰
Burial 5	-8.0‰	-13.0‰	8.8‰	5.8‰
Antelope	-19.1‰		6.7‰	
Bison	-8.7‰		5.8‰	
Rabbit	-8.5‰		9.7‰	
Cactus	-12.0‰		8.1‰	

APPENDIX C

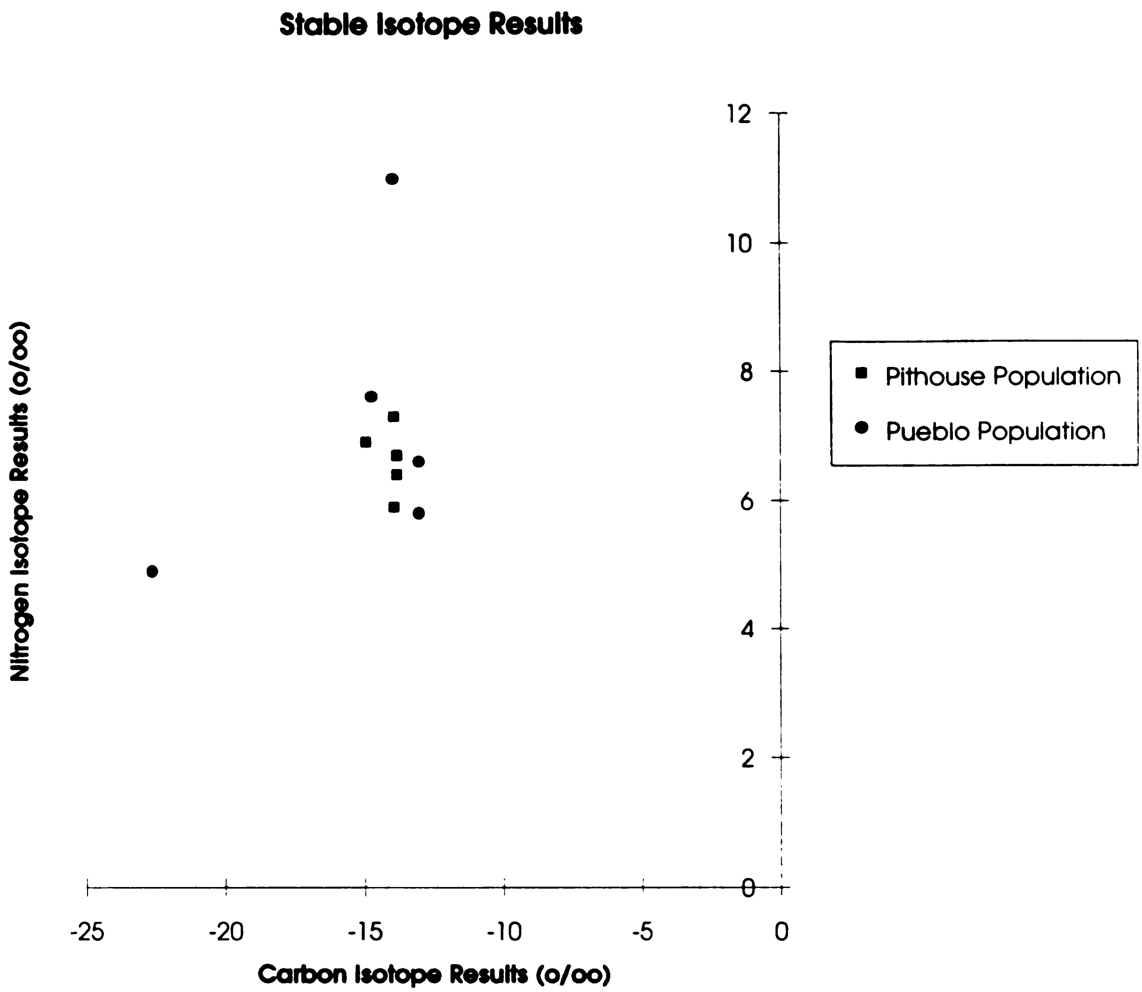

Figure 1 - Graph of Stable Isotope Analysis Results

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