Ancient Knowledge of the Chaco Canyon Anasazi

by Richard D. Fisher

The Sky Island Granary Row Site
The Paquimé Rosetta Stone
C.E. 1400

Chaco Canyon Granary Row
C.E. 1100-1150

© Sunracer Publications
All Rights Reserved August 2005
Review Copy

The Last Great Mysteries of the Chaco Canyon Anasazi
Full Circle - Paquimé to Chaco and Return

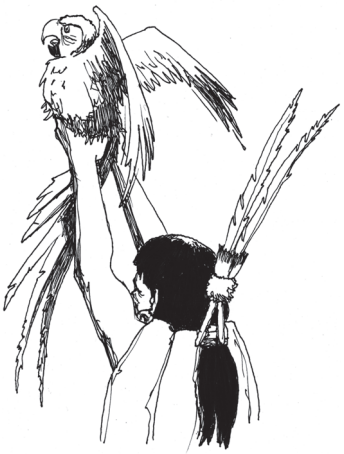
by Richard D. Fisher

"During the last decade, archaeologists have come to the realization that the complex society of the Chaco Canyon Anasazi designed their architecture according to their cosmology" (J. Malville).

The Chaco Canyon Anasazi had no visible means of support. How did they survive? These Anasazi developed a sophisticated, though previously unrecognized, knowledge of the earth, particularly in relation to extreme fluctuations in yearly rainfall and its effect upon agricultural yields. I propose, therefore, that much of the Chaco Canyon architecture was specifically designed and constructed in response to this knowledge. The Chacoans were able to identify a virtually unknown blue-green algae which was common in the soil throughout the region and produced soluble nitrates and as such, could be exploited to produce fertilizer on which the entire agricultural system was based. Astronomical architectural alignments were clearly important, but a dependable and ample food supply, through ingenious growing and storage methods, was the foundation of Chacoan civilization.

"We are always happy, unless we are a little hungry"
Felipe Torrez Cruz, Tarahumara Indian Runner, 1996.

The Chaco Canyon Anasazi identified and exploited a vast resource of cryptobiotic soil, which provided the fertilizer for their corn and required a vast storage capacity in systems of corn silos (kivas). It also supported the power to spread their Scarlet Macaw sun god religion and dominate the entire San Juan Basin with their unique culture for over two hundred years. The indigenous tribal groups and clans had known how to grow corn for over 1,800 years (Lyons). There is no evidence that they knew how to intensify production by using naturally occurring soluble nitrates (fertilizers) until the construction of Pueblo Bonito beginning in C.E. 800-850. It was not until the arrival of the Scarlet Macaw clan, however, that evidence for architecture which produces fertilizer emerges. It was this "green revolution" or more accurately defined "corn's golden era" of pre-Colombian Oasis America that has so captivated the imagination of scholars and the public with the enduring mystery of Chaco Canyon.



When I first started this project with the discovery of the Sky Island Granary Row site in the remote canyonlands of Mexico's Sierra Madre, I told the famous story of the conversation between Cortez and Montezuma. Cortez bragged, "My king eats from golden platters with golden utensils and drinks from golden chalices." Unimpressed, Montezuma observed, "I eat gold with my every bite." To the indigenous people of the new world, corn was gold and the most important thing in life. Just like everywhere else in the world, during that period, life was all about food. Fresh and nutritious food was very difficult to obtain, and without refrigeration, to store.

While archaeology worldwide has progressed dramatically with new scientific methods and techniques available during the last twenty years, Chaco Canyon archaeology has remained in a time warp during this innovative time period. Initially, I had no concern for archaeology and no reason to question Chaco's intractability. After analyzing the Sky Island Granary site, I began to search for the Hohokam and Anasazi long term grain storage facilities, and found none in the archaeological record. After five years of research, and based on the unpublished paper by Robert M. Adams, I came to believe that the numerous round structures identified as religious kivas were in fact, at least initially, exactly what one might expect them to be, corn silos.

As I interviewed hundreds of archaeologists from student researchers to retired ancient elders, I came to wonder why something that was scientifically so obviously a silo was still commonly identified as a religious room. These scholarly men and women were incredibly well educated and passionately dedicated to their science. It was just not logical that such dedicated professionals would be so deeply committed to the idea that ninety or more percent of Anasazi architecture was "religious." Slowly, as I received the enthusiastic help from so many of the most well known archaeologists of today, I came to realize that the kiva, or round religious room, was the foundation established for Anasazi culture and archaeology over one hundred years ago. Quite simply, an enormous pyramid of empirical scientific work had been based on a very reasonable, logical, yet incorrect premise at the birth of this science. The religious kiva concept was such a good initial choice, that it has been able to withstand the weight of a hundred years of very careful scientific research.

In Anasazi archaeology today, however, all structures have become poorly explained "religious" construction. Based on an initial definition of the religious kiva, the basis and most important aspect of Anasazi construction the only way the field can progress is to declare virtually everything else as having ceremonial religious meanings. This, in and of itself, is not incorrect. In my view, however, ninety or more percent of everything the Anasazi did had a practical agricultural application first.

Anasazi scholar Ian Thompson observes, "There is no Pueblo word for religion, no word distinguishing religion from every moment of life from conception to death. Life and religion are the same." In my view, herein lies the fundamental conundrum. The large banks of Anasazi silos stored tons of corn. This is not inconsistent with religion. In fact, as the most important thing in life, these silos were the center of religious life for the Chaco Canyon Anasazi. To confound the issue, there are two types of round rooms, small and large, at Chaco Canyon. My research has found that the small round rooms are for long term storage of grain and the large round rooms are essentially community ceremonial kitchens. The Chacoan religious structures were the platform mounds, which was what might be expected across North America during that time period.

I do not believe that Kachinas ever danced in the Chacoan kivas during the pre-Columbian era. I do believe that expansive ceremonies were conducted on platform mounds and "pyramids," much as in other major cultures of that era. I believe that these ceremonies focused on "sun god" beliefs as symbolized by the Scarlet Macaw. The kiva or earth goddess ceremonies occurred at a much later time period (C.E. 1275) when the matrilineal indigenous clan established dominance over the male dominated Sun/Scarlet Macaw clan(s).

It was not until after about C.E. 1275 that Kachinas began to hold ceremonies in what were formerly great kitchens or large corn silos outside of Chaco proper. As noted by Ian Thompson, there is no religious inconsistency in definition. In archaeology, however, this divergence in usage makes it impossible to resolve the intractable mystery of Chaco Canyon.

As the Tarahumara runner Felipe Torres Cruz points out and history confirms, happiness and the meaning of life for agriculturalists is fundamentally linked to every aspect of producing, storing, and consuming the food which is provided by God.

What I am striving to explain is how a fundamentally practical system of managing the food supply in Chaco Canyon and elsewhere translates into a sacred life-style and cultural legacy that endures to this day.

A chance interview with retired archaeologist Vorsila Bohrer helped me to understand that the cryptobiotic blue-green algae could be grown in the artificial aquatic environments such as Mummy Lake Mesa Verde. My perception of the so-called Hohokam "ballcourts" and the many other architectural constructions that I have identified, shifted, and the Anasazi puzzle that I have been working on for half a decade was completed. Vorsila Bohrer reported to me she had found a strange black material like "curls of old paint" in a natural depression in New Mexico. She had the material analyzed and it turned out to be dried blue-green algae. Instantly, with the realization that the fertilizer made in what I had been calling "sweetwater mulching swamps" could be dried, pulverized and transported, in a basket for instance, the entire Chaco system became clear. As a result I have now named these architectural structures "fertilizer dehydration basins."

This naturally occurring resource allowed the Chaco Canyon Anasazi to fill their massive system of granaries, increase population densities and create monumental architecture that had a practical and spiritual use such as Pueblo Bonito, the hundreds of other Great Houses and the extensive "road system." With the surplus corn that they were able to produce, however, came increasing anemia and depletion of regional wildlife populations which provided the essential dietary iron, leading in turn to increased warfare and even cannibalism. As harmonious natural life styles were the religious priority of the indigenous non-Mesoamerican clans, the majority of the population rejected the sophisticated agricultural strategies, along with the complex and perhaps authoritarian social systems. The archeological and oral record indicates that the allied indigenous clans drove the Parrot Clan farther and farther south until they were finally eliminated at Paquimé in about C.E. 1450.

While it has been very exhilarating to me personally, to make a strong, persuasive and comprehensive argument that the vast system of Chacoan "kivas" are actually a system of granaries and communal kitchens, it was even more deeply satisfying to have identified, with the help of Vorsila Bohrer, the basic mechanism with which fertilizer was produced from Mesa Verde to Guatemala in the pre-Columbian era. This "discovery" provides for the foundation for the development of all of North America's complex "high" civilizations.

Any culture that could manage an environmental resource like cryptobiotic soil to make the San Juan basin blossom, producing a huge surplus of golden corn, could rightfully claim that their knowledge came from God. With this ancient knowledge, the founders of Chacoan culture could persuade the in-situ indigenous clans to join them to develop what became one of the most mysterious and legendary cultures on the planet.

Religion-Kivas -vs- Mounds - The architecture of the mysterious and long-debated Anasazi people is marked by the round buildings called kivas. In general, "kiva" is the name given to round rooms of any shape and size. For the last one hundred years, archaeologists have insisted that the purpose of the kivas was religious. Not withstanding I am prepared to argue just the opposite: that small kivas are 100% for grain storage and that large kivas are communal kitchens.

I believe religious ceremonies took place on platform mounds that have been identified as trash middens which are prominently displayed in front of many Great Houses. At Chaco Canyon and elsewhere C.E. 850-1275, approximately 40-60% of the space is in round rooms, causing Chaco Canyon to be interpreted as a major religious center. My counter argument is that the Tarahumaras report that 90% of the meaning of life surrounds food and is totally integrated into their religious belief system. I say that with 40-60% of the architectural space in Pueblo Bonito and other Chacoan Great Houses dedicated to food storage and preparation, this control of the food supply would have given tremendous political power and a major draw for religious ceremonies. This proposal is completely consistent with all of the accepted archaeological evidence.

Where did they come from and where did they go? Following the Scarlet Macaws shows promise as a way to find the resolution of Chaco Canyon's origins. For the past seventy years many archaeologists have argued for "macaw" trade. This proposal, after years of intense investigation however, cannot be demonstrated. In fact, very little "trade" has been substantiated anywhere in the Anasazi/Hohokam/Paquimé with the possible exception of ceramics and shell trade. The Scarlet Macaws were arguably the personal property of Mesoamerican headmen or priests. "Among the initial clans to settle the Chaco landscape were the Parrot and Katsina clans" (Kuwanwisiwma). While the translation for the "Parrot" clan might be more correct as "Scarlet Macaw" clan, I believe, this Hopi report is absolutely correct. I propose that the Parrot (or Scarlet Macaw) clan represented the Mesoamerican patrilineal line and the Katsina clans represent the matrilineal indigenous lineages. The Chaco Canyon Anasazi were, according to archaeological evidence available today, a mix of a few Mesoamericans who intermarried with the local indigenous population. DNA testing of the "two high status" burials contrasted with the dozen or so accompanying dismembered burials found in Pueblo Bonito will aid in confirming or refuting this proposal. In fact, DNA testing of these two dignified Pueblo Bonito burials may very well resolve many mysteries concerning Chaco Canyon.

"The Hopi of today came from many directions including migrations from central Mexico. There were groups that were more like predators and who were not admitted to become Hopi. Hopi traditions are full of stories of movement due to crop failure, food shortfalls, and other kinds of threats to survival" (Emory Sekaquaptewa).

"The Chaco great houses projected a different sensibility. The finished product was very important. Skill and specialization were needed to do the fine stonework and lay the sharp-edged walls. I concluded that the structures had been built by men in the prime of life with a vision of something beyond daily life and the present moment. These were men who embraced a social-political-religious hierarchy and envisioned control and power over place, resources, and people... For me, they represented a desire to control human and natural resources. They were not about the Pueblo belief in the capability of everyone" (Swentzell).

Evidence indicated on departing Chaco Canyon they moved first to Aztec, then I suggest follow the Scarlet Macaws south to Wapatki, Point of Pines, Grasshopper and Kinishba ending up at Paquimé. There is also compelling evidence that they intermarried with the Great Sage Plain Anasazi. Matrilineal clans and their descendents remained to become modern Puebloan tribes.

What distinguished the Chaco Canyon Anasazi from prior and post Indigenous groups? The Chaco Canyon Anasazi brought with them the ancient knowledge of the Mesoamericans on how to find and exploit natural sources of soluble nitrates (fertilizer) which caused a "green revolution" or more accurately, a "golden revolution" in food production, primarily corn production. Although there is no directly evidence yet found, I propose it was the Scarlet Macaw clan that brought this ancient knowledge into the San Juan Basin for the first time. These agricultural innovations were the essential foundation for the Chaco Canyon Anasazi to culturally dominate the entire San Juan region. They were "farming" their entire environment including

plants which produced fertilizer that ultimately created a golden agricultural system which resulted in the Anasazi golden era.

They built distinctively large impressive buildings whose primary purpose was for the long term storage of vast quantities of corn. They had platform mounds for religious ceremonies. They had very distinctive agricultural strategies which allowed for increased population densities and surplus energy for labor. They built large numbers of round rooms for grain storage and food preparation. They utilized ingenious techniques to produce fertilizer. I suggest that with their surplus corn growing capacity, they developed large religious ceremonies atop the platform mounds in which tesquino/corn beer was consumed as a stimulant. These ceremonies attracted the clans from across the Chaco great house system. Some individual families had homes or quarters in Chaco central and dominated one or more great houses where most of the agricultural activities took place nearer the mountains, particularly the Chuska Mountains. Most, if not all, of the population participated in transhumance during the growing season often living far from Chaco.

What is Transhumance? From the original Greek and Latin, transhumance means quite literally "across ground." Some American archaeologists argue that this term is applied exclusively to the herding cultures of central Eurasia that follow their flocks seasonally from lowlands to highlands and back each year. I maintain that transhumance is the appropriate term for describing the widespread Native American practice of following a diversity of crops from lowlands where there are longer growing seasons, to highlands, where cold winter frost and heavy snows help control the ubiquitous corn pest, root cutworm. By having homes in both lowlands and highlands, the Anasazi were, for the most part, able to avoid a possible complete crop loss in any one year. Transhumance also provides that agriculture was done by virtually everyone, regardless of social status, and massive building projects such as Pueblo Bonito were constructed during the winter off season. This proposal helps resolve the major question of how large, complex buildings like Pueblo Bonito were constructed by the Chaco Canyon Anasazi. This proposal also explains within the context of known archaeology, how surplus food crops were grown and provided to the large seasonal work force needed for the massive construction projects as seen at the Chaco Canyon and its outliers.

"Food importation and a migratory segment of the population in the canyon seems the most reasonable, especially in view of the fact that early workers in the southwest such as Bandelier found many Pueblos were nearly abandoned in the summer and early fall months: 'Last night Juan Jose told me that the pueblos were almost depopulated in summer, nearly everybody going out to the ranchos, where they live till September or October. But few remain in the pueblo. Even the cacique leaves also for this huerta.' (From Banadelier's journal, April 17, 1882 as recorded by Lange and Riley 1966, p. 245)" (Loose, Lyons).

The Zuni people who perhaps numbered 3,000 inhabitants in C.E. 1700, most of whom lived in the central village of Halona:wa raised extensive corn crops spread over an area from present day St. Johns, Arizona, to the Zuni Mountains (50-70 miles) in what is now western New Mexico. Crops grew all over the territory of the Zuni's, and the people lived in the summers in widely separated villages (Hart).

Associated with transhumance is a new proposal for the load carrying capacity of "110 pound loads over a one-way distance ranging from 30-150 miles" (N. Malville). "Maize excavated from the oldest section of Pueblo Bonito was grown in fields fifty miles to the west, along Captain Tom Wash on the Chuska Mountain slopes. Six cobs dated between C.E. 850 and the mid-900s, and one dated between 1088 and 1150. Although we had a small sample of cobs, none matched the soil water chemistry of Chaco Canyon" (Cordell). This Tarahumara, Zuni, and Pueblo ethnographic information, indicates that corn was brought from throughout the San Juan Basin (approximately 100 mile radius of Chaco Canyon) to be stored in the Great Houses in the center of the Chaco system.

Why did the Chaco Canyon Anasazi abandon the San Juan River Basin? While drought and resource depletion were certainly contributing factors, the "straw that broke the camel's back" was anemia caused by a chronic lack of dietary iron. This became an unresolvable crisis when the increasingly rare and difficult-to-obtain wildlife populations were pushed back more than a three-days run from the Great Houses, making fresh meat too difficult to obtain.

The History Channel asked, "Were the Chaco Canyon Anasazi peaceful Hopi ancestors or terrorist cannibals?" (Arts & Entertainment). Cannibalism during the Chaco Canyon Anasazi time periods is a well documented yet controversial fact. As "wild meat," the best source of dietary iron, became increasingly rare, some of the Chaco Canyon Anasazi, who were directly descended by family lineage from the Mesoamerican male founders, may well have resorted to cannibalism to provide the absolutely required dietary iron. In turn, the descendents of the female indigenous clans may have rejected cannibalism and ultimately expelled those choosing high density Mesoamerican life-styles further and further south. This process began in approximately C.E. 1200 with widespread warfare, which is marked by a hiatus in the parrot importation and the burning of many villages, and continued with the introduction of Katsina religious concepts C.E. 1275-1300. This system wide event of warfare, I suggest, was a revolt by indigenous clans to push out the Mesoamerican descended clans. I propose to call this event the "Anasazi Reformation" in religion, social values, and lifestyles. The Anasazi completely disappeared with the complete destruction of Paquimé in C.E. 1425-1475.

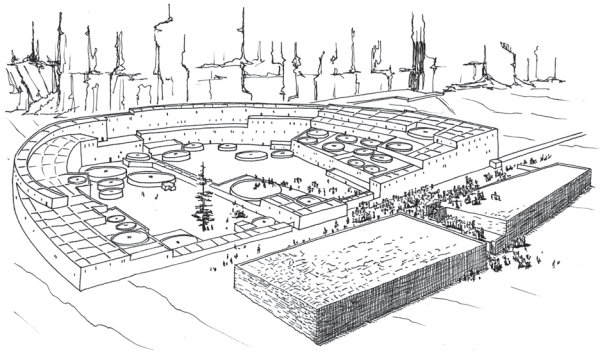
Hopi scholars relate concerning the cannibalism issue "There were also people who had traditions of human sacrifice, who were also not admitted into Hopi society" (Emory Sekaquaptewa).

Chaco Anasazi - Political Organization - Several models of political organization have been suggested. One model is a decentralized matrilineal society resembling the Hopi of today. The other is an extremely aggressive military style dictatorship that sponsored "terrorist cannibals." My research indicates that the Chacoans had a cooperative agricultural enterprise in the tonnage of corn stored in their extensive silo systems. The Chacoans dedicated themselves to the building of the massive great houses in exchange for the benefits of a secure food supply and perhaps even access to "vision quest" tesquino corn beer.

Tesquino-Corn Beer Production. How could the Chaco Canyon Anasazi pay a willing work force to do all of the building? The Chaco Canyon Anasazi demonstrated advanced knowledge in many fields, yet no evidence has emerged for brewing a very simple corn beer. Cultures throughout North America made corn beer with regularity during the Chaco time period. I do not know of any grain producing society on earth that did not at one time or another produce some type of alcoholic beverage. As far as I can discover, no study has been undertaken to investigate whether corn beer might have been made by the sophisticated Anasazi. Certainly, corn beer is very easy to make and in moderate quantities can be very beneficial for general health due to its high caloric and mineral content. Tesquino would have been much more potent for these people as the alcohol and sugars would have been enough in and of themselves to produce a mild or even advanced state of euphoria considering their normal low calorie, low sugar diet. The making of corn beer on a large scale for religious ceremonies would have given the Chaco "elites" tremendous power over distribution of this "sacrament" to surrounding populations. The making of

corn beer could very well be the overriding reason that Pueblo Bonito contains such a great number of small round rooms that could have been used as granaries. The making of corn beer may very well provide the avenue for research into the use of the large round rooms or what have been previously identified as "giant kivas." This is another point for investigation which will provide the ultimate answer for the Pueblo Bonito Great House as well as the entire Chaco Culture. (Disclaimer: To date, there has been no conclusive evidence for corn beer production.)

Fertilizer Production-Challenge to Hohokam Ballcourt Theory - David Wilcox, the authority on ballcourts and senior curator of anthropology at the Museum of Northern Arizona, stated in the June 2005 issue of Arizona Highways, "Well, the short answer is we don't know (what ballcourts are)". After seventy years, why is there no proof or even any strong and convincing evidence for ballcourts? The Hohokam oval might be called "useful monumental religious art" representing the female earth inviting the deposit of male fertile rain which is associated with lightning storms. From Tarahumara ethnographic reports, the earth is a human female or human females are the earth, not just representatives of these concepts. Equally, the sky is a human male or the human male is the same as the sky. The earth and the sky, being human, act like humans relating to sexual and reproductive activities, and equally, humans act like the "mother earth" and "father sky." This religious belief gives us the key to unlocking the mystery of the Hohokam ballcourts. In 1967, Edwin N. Ferdon, Jr. challenged the ballcourt theory noting that the original proposal by Emil Haury in 1935 was essentially that the "elongated depression" looked like a ballcourt, but that in the interim years to 1967 this theory was not supported by further evidence. Ferdon proposed that the elongated depression looked like a Papago "dance court." Since 1967 Ferdon's proposal has not been demonstrated. To date, these are essentially the only two proposals put forward. Yet it can be argued that if the Hohokam and others built elongated depressions that are essentially oval in shape and collect rainwater, that is exactly what the Hohokams intended to build. My proposal is based on Tarahumara ethnographic religious beliefs and scientific evidence concerning soluble nitrates contained in monsoonal rain along with intense lightning storms. I have built and tested scale models that reflect the shape of Hohokam "ballcourts" that have successfully demonstrated this proposal. I now believe that these oval topographical depressions are fertilizer dehydration basins. These are the Hohokam design for concentrating lightning rainfall, waste material and blue-green algae to produce soluble nitrates which could be delivered in either a liquid or dried form to the most desirable crops. I believe it is very likely that they used this fertilizer to enhance the sugar content in corn meant for brewing Tesquino (corn beer). This concept is worthy of further archaeological testing and debate. Simple stratigraphy test cores on unexcavated ballcourts should be sufficient to ascertain the potential for the proposal that the Hohokam used this shape to produce fertilizer.



Mound Builders -Chaco Canyon Anasazi - From Pueblo and Hopi ethnographic information the Chaco Canyon Anasazi have previously been assumed to be a culture whose religion was centered in the Kiva. My observation is that the Chaco Canyon Anasazi and others were a mound building culture like the rest of the highly complex cultures across North America during that same era.

Small "Kivas" or round rooms are granaries and large "Kivas" are corn processing rooms and perhaps are large communal kitchens used to prepare food and I believe corn beer "tesquino" for religious festivals. After C.E. 1275 Katsina religious beliefs transformed these round rooms into religious chambers in areas outside Chaco Central.

Noted archaeologist Thomas C. Windes records extensive mounds at the McPhee Pueblo (C.E. 860) which had an abnormally large outside midden, reaching more than three feet in depth. At *Casa del Rio*, located along the Chaco River, the multiple "midden" (platform mound) is more impressive: it reaches 16 feet above the surrounding terrain, and makes up an estimated 2230 cubic yards of material and is visible for miles around... in the mid-late 1000s, a highly visible and appealing type of agriculture came into vogue. Chacoan characteristics included core-and-veneer masonry, up to four stories, kivas built within the house construction, a giant kiva in a plaza or nearby, and a large mound or midden.

The map published of the Casa del Rio (In Search of Chaco, Noble/Windes, p19) shows an almost Paquimé layout of mounds, ponding areas, and potholes. The association of mounds and ponding areas is quite unique in the Anasazi area as far as I have been able to discover.

Other known Chaco era sites with high and extensive mounds are H-Spear (C.E. 1050-1150) (Mahoney) and Edge of the Cedars (C.E. 900-1150) (Hurst) where, Hurst observes, "Rubble mound rose more than 10 feet high with intact masonry rising into a second story." Still others are Guadalupe Ruin (Durand, Durand), Lake Valley, Willow Canyon, Great Bend (Winds), and Andrews (Van Dyke).

Archaeologist Dennis Gilpin (SWCA Environmental Consultants, personal interview 4/22/05) states at least four great houses have large middens which may have been mounds. These include the Chambers Great House, Navajo Springs, Tse Chi Zzi (Black Mesa) and the Bluff Great House, all dating to the same time period (C.E. 1050-1150).

I note that most archaeologists that I have interviewed agree that great houses from this time period were built to be seen from a distance. Many, if not most, of these great houses have what has been identified as a large "trash midden" in front. I question the Anasazi would build a great house that was meant "to be seen from a distance" and then put a trash mound right outside the front door. I suggest that these are platform mounds.

Since the predominant material in this region is sand, the platform mounds have eroded into rounded hillocks. There are some pottery shards scattered throughout the mound material as might be expected. I further observe that burials are commonly found in mounds and are very infrequently, if ever, found in kivas.

I was asked the question recently, why did they bury their people in trash heaps? My answer is, they buried their people in their religious structures which were ceremonial platform mounds, and as round rooms are granaries and food preparation chambers, there are few if any burials in these areas.

I would highlight that worldwide, humans bury their dead in religious buildings and not in areas where food is stored. Burials are a primary factor in analyzing the use of constructed space.

Recently, two pyramids have been discovered by archaeologists in central Chaco Canyon (Friedman, Stein, Blackhorse). This team has also identified five other pyramid sites that they believe to be Chacoan. I would suggest that these may more accurately be called "platform mounds."

The Chacoan System: Ritual Landscape and Agricultural Enterprise?

Were the Chacoan Great Houses let down on golden threads from heaven or were they built by the hands of people who wanted to know where their next meal was coming from? Evidence from a 1967 study by Loose, Lyons, and a recent interview with Stein, has led me to what may be one of the most important discoveries made about the Chacoans. Based on this evidence I now propose that the Chetro Ketl "grid garden" is rather a field of fertilizer dehydration basins. While I have covered the findings of Loose and Lyons in the Fertilizer Harvesting and Production section of this paper, the comments of John Stein are pertinent to this debate. "The Chetro Ketl grid garden was not an agricultural field in the traditional sense of the word. It was plastered, as was much of the Chacoan landscape in the central canyon" (Stein). In an interesting side note, Stein relates that the Navajos, who have been excavating the area for decades, feel that it is some kind of paved ballcourt or sports venue.

When all possible agricultural sites in Chaco Canyon proper are analyzed, "the 72.9 acres taken from the combined mapping of Vivian, Potter, and Kelli would have supported only 82 people within the entire canyon" (Loose, Lyons). I would strongly point out that there is no provision whatsoever for fertilizer during the 200 year usage of the central canyon. This is the basis for my initial observation that "the Chaco Canyon Anasazi had no visible means of support."

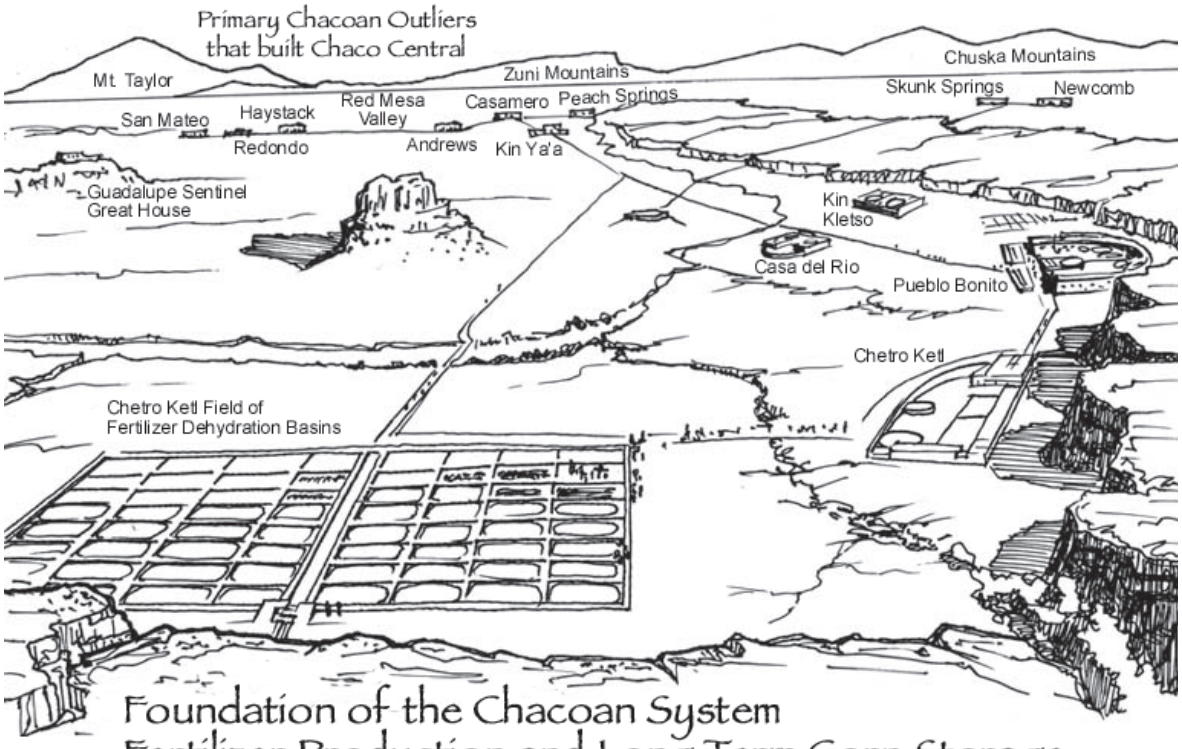
With the evidence now recorded in this thesis in context, I propose that the making of fertilizer from the blue/green algae, in addition to exploiting the vast agricultural resource of cryptobiotic soils that are dominant throughout the region, were harnessed by a highly organized system of transhumance labor between the canyon and the major outliers. This seasonal lifestyle allowed for the population to be dispersed and engaged in productive agricultural activities during the summer months and apply themselves during the winter months to building the monumental architecture that has made Chaco a focus of world attention. This transhumance system is the basis of every other important accomplishment of the Chacoans.

The vast system of agricultural great house grain silos and their attendant populations also provides the human resource for a successfully integrated cultural system. I have seen numerous proposals made for political structure, but none that are consistently convincing. I propose from the evidence available now that the Chacoan hierarchy was able to establish voluntary political control over the entire region through a system of intermarriage or multiple familiar alliances through marriage.

This completely new model for Chacoan culture fits the Chaco Canyon archaeology and is very common in agricultural systems worldwide. The builders of Pueblo Bonito or other central great houses like Chetro Ketl could have been married to the daughters of the headmen at outliers such as Kin Ya-a and Peach Springs as well as Newcomb at the same time. This would have provided cooperative benefits to all concerned in terms of resource availability, provision of fertilizer, as well as long term corn storage. This common human system also provides for a stable political platform from which to concentrate on the necessities of agriculture and aids in recruiting labor for seasonal monumental building projects. This is a model that works in harmony, I believe, with all the current accepted archaeological evidence.

I do not believe that the Chacoans held their rituals in hundreds upon hundreds of small, dark, smokey, and dangerous pits. Rather, evidence is continuing to emerge that they held their ceremonies on platform mounds and perhaps even pyramids, as did all highly organized Native American cultures during that time period.

The Chacoans were rightfully proud of their ingenious knowledge of their grand desert landscape and their mastery of its difficult and challenging elements. Like other great peoples worldwide, they would have felt that their powers were godgiven. Based on their ability to feed a large work force that built some of the most elemental and elegant architecture ever created, I am sure that, while there is very little actual evidence, they had a ritual tradition that lasted into the current era and matched their breathtaking landscape as well as their ingenious creativity.



© Sunracer Publications/Richard D. Fisher

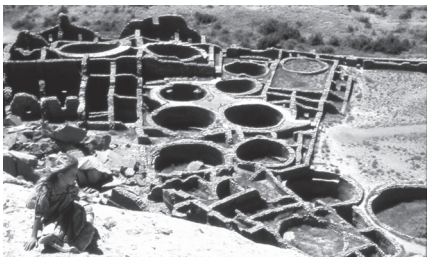
Kivas as Anasazi Granaries?
Ancient Anasazi Knowledge

In my research, I have found the following sixteen reasons to question the currently accepted view that kivas are strictly religious structures with specific ceremonial uses.

1. The discovery and analysis of the new Sky Island Site with its extensive granary system in the Northern Sierra Madre of Mexico ultimately made it possible to resolve the Anasazi kiva or granary controversy.
2. The large number of "kivas" in Pueblo Bonito have always been suspect.
3. Yellow Jacket has almost two hundred kivas (Lekson, in In Search of Chaco, Ch 4, p25)
4. There are virtually no burials found in round rooms. Burials are never found in food storage areas. Burials are often found in religious structures.
5. There are virtually no artifacts found in round rooms. If round rooms are used for food storage, beer or food preparation, it would be expected that the food remains would have been consumed by humans or rodents so no artifacts would be found.
6. Hopi kivas are square and below grade.
7. Most Anasazi kivas are round and above grade.
8. The fact that some kivas have been found painted with the stepfret design and covered with soot might be expected from the usage that we are proposing.
9. After C.E. 1275 kivas have been found to be painted with religious murals. This indicates the change to Katsina religious practices.
10. Large kivas have rectangular raised masonry boxes. One of the primary explanations for these boxes is "sprouting vaults." I believe these vaults were used to sprout corn which is one of the primary steps in making corn beer (the other proposal for the vaults is "foot drums"). While this is certainly possible, the sprouting vaults would be more consistent with the food and beer preparation use, for the large kivas. Due to the sprouting vaults "post wells" and firebox in large kivas, there is actually very little space for ceremonies.
11. Chaco Canyon "over engineering" is demonstrated by the many small kivas that have numerous exterior supporting walls. Archaeologists have described this as over engineering. If the kivas are actually granaries with tons of stored grain then these exterior walls are the proper support for the loose corn exerting outward pressure on the interior walls. This is also evident in virtually all sites where small kivas occur, such as Mesa Verde and the Great Sage Plain/Cayons of the ancients.
12. While all round rooms are being defined as kivas or religious chambers, there are at least three different types and many shapes and sizes in evidence. As far as I can find, there is no "religious" reason given by archaeologists as to the usage of the different types of round rooms. I suggest that each type has a specific use and that the variances within the types have specific practical applications. In fact, I can find no evidence of religious use prior to C.E.1275.
13. Many "small" granaries/kivas and "Great Houses" were built to coincide with the high rainfall period C.E. 1100-1130. There is a significant cluster of construction dates for small kivas during periods of high rainfall or just at the end of high rainfall periods. It is likely that during periods of high rainfall, more grain storage space was needed and this led to a construction boom of Great Houses with "blocked in kivas" which I propose are the supporting structures for the huge silos across the San Juan basin.
14. Yellow Jacket had 192 small kivas. Sand Canyon had over 100 kivas and 14 drying towers. At Sand Canyon the ratio is almost 4:1 rectangular to round rooms.
15. Great Sage Plain (in southwestern Colorado near present day Dove Creek/Cortez) archaeologists strongly feel that kivas were used as living rooms "because of what we find in them" (Varien). I have no doubt that this is true for the time period of the abandonment C.E. 1280 (Kuckelman). Evidence indicates that at the abandonment, the stored corn surplus was long gone and as the most strongly constructed, most secure rooms in the pueblos, round rooms certainly were used as habitations and safe houses. The period of the abandonment demonstrates increased warfare as resources became critically depleted. Families that normally lived in fringe communities moved into the central and strongest pueblos of their relatives for protection, making living space a premium resource. With the silos empty and large population numbers living in centralized pueblos, without adequate food, the people left their most valued, non transportable household items sitting on the floor of the round rooms when they left. This proposal is consistent with accepted archaeological facts and equally it is good common sense, which is often missing when evaluating the vast number of round rooms as "religious kivas."
16. Without "ethnographic reports" there is no evidence at all to support the religious use of kivas prior to C.E. 1275, rather, I believe, there is extensive circumstantial evidence that these round rooms are corn silos, as might be expected to be found in a culture whose entire purpose and focus was on growing corn.

Granary Row Paquimé Culture

Granary Row Mesa Verde



Granary Row Pueblo Bonito Chaco. This bank of small granaries was built during the high rainfall years of C.E. 1100-1150 (Windes, Pueblo Bonito, p27).

Detail of Granary - Exterior 4" bench inset and ventilation shaft

Chaco Precipitation Levels Compared to Estimated Kiva Construction Dates

Chaco Precipitation Highs and Lows		Kivas Built at Pueblo Bonito
High	930-950	6
High	1050-1080	5
High	1100-1120	27
Dry	980-990	—
Drought	1130-1180	—
Drought	1276-1299	Anasazi Abandonment

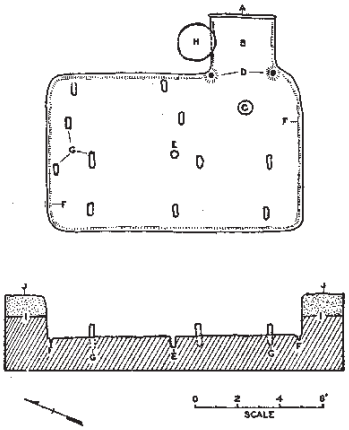
The bench width in many Chaco Canyon, Mesa Verde, and Great Sage Plain "kivas" as well as Paquimé granaries indicates a variety of uses which are consistent with dehydration towers and structures.

Mesa Verde Multiple Granary Benches 3-6" wide

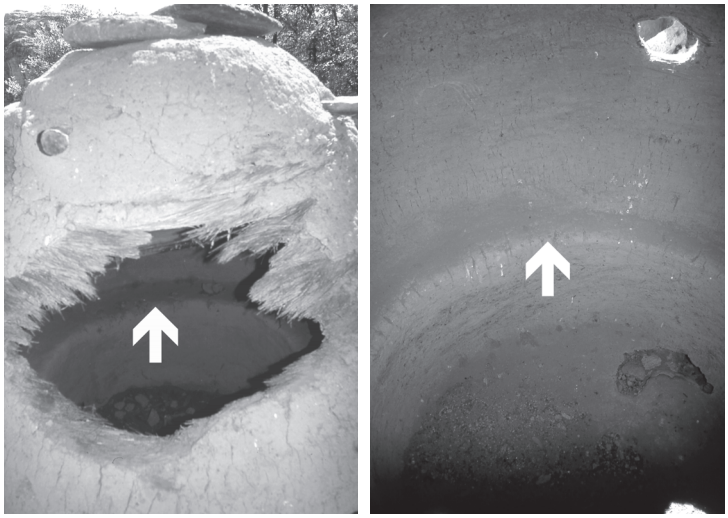
Kin Ya Chaco Outlier Multiple Granary Benches 3-4" wide

Everything at Chaco especially Pueblo Bonito was done on a grand scale. Even the granary benches average 4-6" wider than other granary benches.

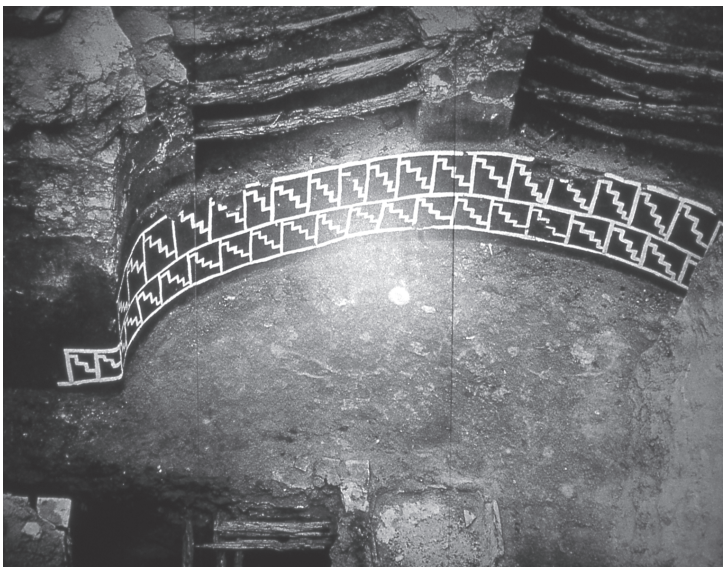
Hohokam Granary? (below)



The Hohokam had a less well understood structure that had a raised floor, fire pit, and schist stone risers; it is possible that this functioned in the same way as Chaco kiva/silos and Paquimé olla/granaries (Haury 1932).



The bench width of 3-6 inches in the Sky Island Paquimé site granaries is consistent with the bench width in many Mesa Verde "kivas" or round rooms (left two columns).



The Lowry "painted kiva" is the "smoking gun" for a grain or meat smoke house. There were 25 levels of plaster excavated, and many of the layers had soot between them. The plaster and the floor should have been tested for corn pollen and residue. The drying racks are built into the pillars and are evident in some Mesa Verde sites as well (Lowry smoker granary) (above three photos).

Kin Kletso

From the available archaeological evidence, it appears that Kin Kletso, New Alto, and Casa Chiquita were essentially grain elevators. Very few artifacts were found in these buildings, and the supporting rectangular rooms were for support of the main grain silos. Other uses such as raw cob sorting, habitation, and ceremonial uses may be indicated for the rectangular rooms. "Massive storage units, not residences, were presumably used for feasts and/or redistribution of goods" (Lekson).

These two "silos" with their support walls were used for centralized long term corn storage. I suggest that each one of the Chaco Canyon Great Houses is the centralized storage structure for one clan who brought their corn to the central Chaco Canyon from throughout the San Juan Basin. According to the dates of construction, Pueblo Bonito, along with perhaps Una Vida, was most likely founded by the Scarlet Macaw family/clan. The subsequent eleven buildings were founded by direct descendants or relatives of the original Scarlet Macaw clan.

The primary use of all thirteen Chaco Canyon buildings was for long term corn storage and for festivals, based on this storage capacity. Again, according to the dates of construction, the subsequent buildings suggest that sons, grandsons, and great grandsons were perhaps the builders of the other named Great Houses.

As highlighted by my transhumance proposal, each one of the central Great Houses had one or more "outliers" associated with it.

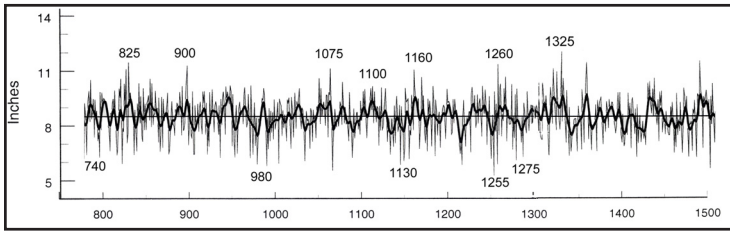
"When the farms are small they build small silos and as the farm size increases they build progressively larger silos but continue using the small ones.

There is a problem with 'smut' which is a soil born mold that comes in on the grain. The silos are fumigated once per year to protect it from confused flower beetle"(Tanner).

This is consistent with the building phases of Pueblo Bonito and many of the Great Houses or, possibly, Anasazi grain storage silos across the San Juan Basin.

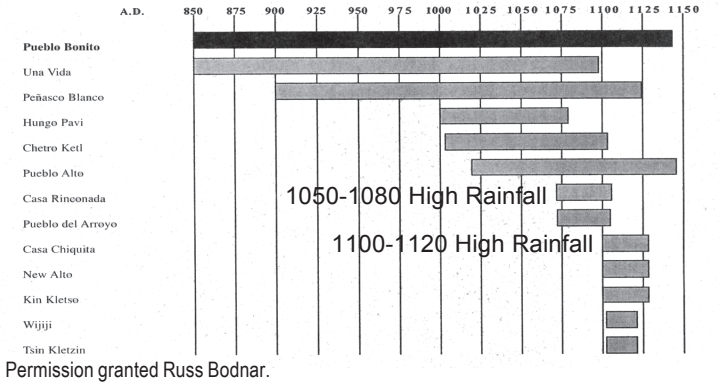
Examples of Chaco "over-engineering."

This support wall building was absolutely necessary to contain the tonnage of grain that was stored in these "kivas." This engineering support is absolutely consistent with outward pressure being exerted by liquid or loose grain (above). Original kiva room ratio of 1:6 or 1:5 and in later times 1:15 to 1:25 (Van Dyke).



This rainfall graph (left) demonstrates the extreme variability of yearly precipitation (Van West). The Anasazi of the San Juan Basin had to have long term corn storage for social stability. Any group with such storage capacity would have had a significant competitive edge over neighboring groups.

Construction Dates for Central Chaco Great Houses



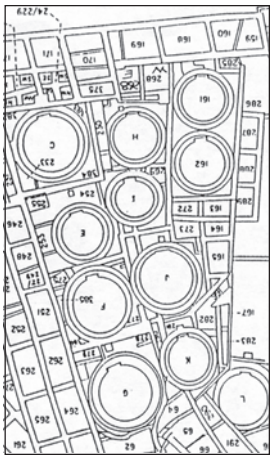
Permission granted Russ Bodnar.

Additional Dates

Newcomb 900-1140?
Skunk Springs 900-1140?
Guadalupe 918-971
Andrews 927-1109
Fort Wingate 948-1036
San Mateo 991-1107
Casamero 1033-1123
Wallace 1045-1108
Haystack 1050-1110
Aztec 1051-1135
Salmon 1068-1116
Chimney Rock 1078
Lowry Pueblo 1086-1170
Kin Ya-a 1087-1106
Wupatki 1106-1215
Edge of the Cedars 1109-1215
Bluff 1111
Dominguez 1123
Ida Jean 1124
Escalante 1124-1138
Sand Canyon 1200-1277
Point of Pines 1207-1297
Kinishiba 1241-1366
Gila Cliff 1264-1287
Paquimé 1250-1425/50

Granary Row
Styles of Paquimé/Chaco-Pueblo Bonito Kiva Silos

Granaries with unique design features have been known to exist in the Northern Sierra Madre Mountains associated with the Trincheras and Paquimé cultural system for over a hundred years. In the past decade granary systems have also been found at several Salado sites, including School House Point Mound and Pumpkin Center, which is known as Granary Row Locus 2. Evidence of other granaries is found at Canyon Creek and in the San Pedro Valley, in central and southern Arizona, and in the Mimbres area of southwestern New Mexico. All of these appear to be late date post-Chaco sites.

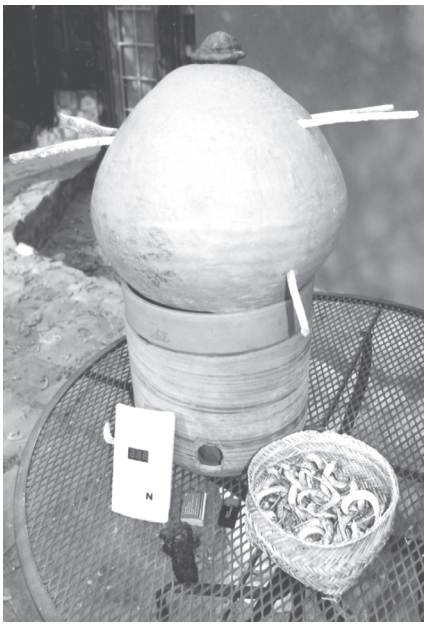


Pueblo Bonito (above and below)

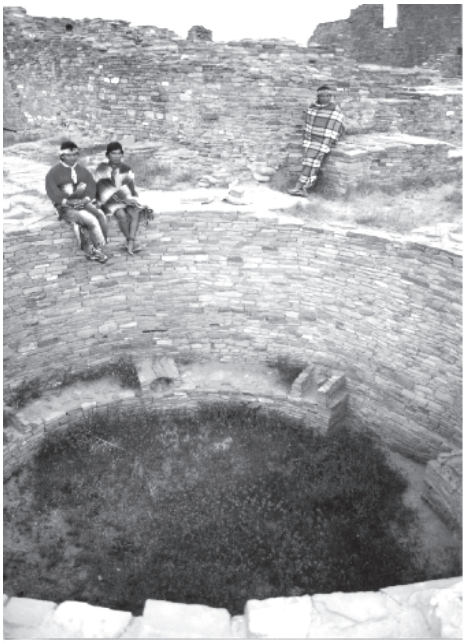
The archaeological debate whether the smaller "kivas" at Chaco (AD 850-1130) were actually corn storage silos continues. In the Paquimé (AD 1250-1425) culture region, however, the silos or granaries are self-evident. Corn must be stored at 12% or less moisture content or it will mold. Silo (kiva) "benches" and horizontal wood beam pilasters, like those found in Chaco Canyon, NM, "kivas," may have supported a latticework floor with an air space beneath to keep the corn dry (bottom right). The space for the horizontal wood beam pilasters are clearly visible on the exterior of the Paquimé granary (top right). In both cases, these extensive and large granaries indicate corn was widely grown throughout the region and then centralized for storage. In the Paquimé culture region the corn was dried, stored, and then transported to Paquimé itself, approximately 75 miles from the Sky Island site. At Chaco, the corn was grown up to 75-100 miles away, transported to the central outliers, and then transported again for storage in Chaco Canyon villages such as Pueblo Bonito. Transhumance agriculture is strongly supported by the evidence in this unique architecture.

The collection of fertile water and the corn storage strategy gave the Anasazi and Paquimé peoples the ability to survive many short term and a number of severe long term droughts (below).

Paquimé Sky Island



Recent archaeological hypotheses have led to scientific experiments on scale models (left). Using an advanced alarm system, these tests demonstrated that the carbon monoxide produced by one live charcoal briquette exceeded the deadly level by 10 times in less than sixty seconds. This strongly suggests that the ancients had knowledge of this naturally occurring long-term corn storage strategy when they designed their public architecture.



Technology of Paquimé/Chaco Smoker Granaries-Kiva Silos

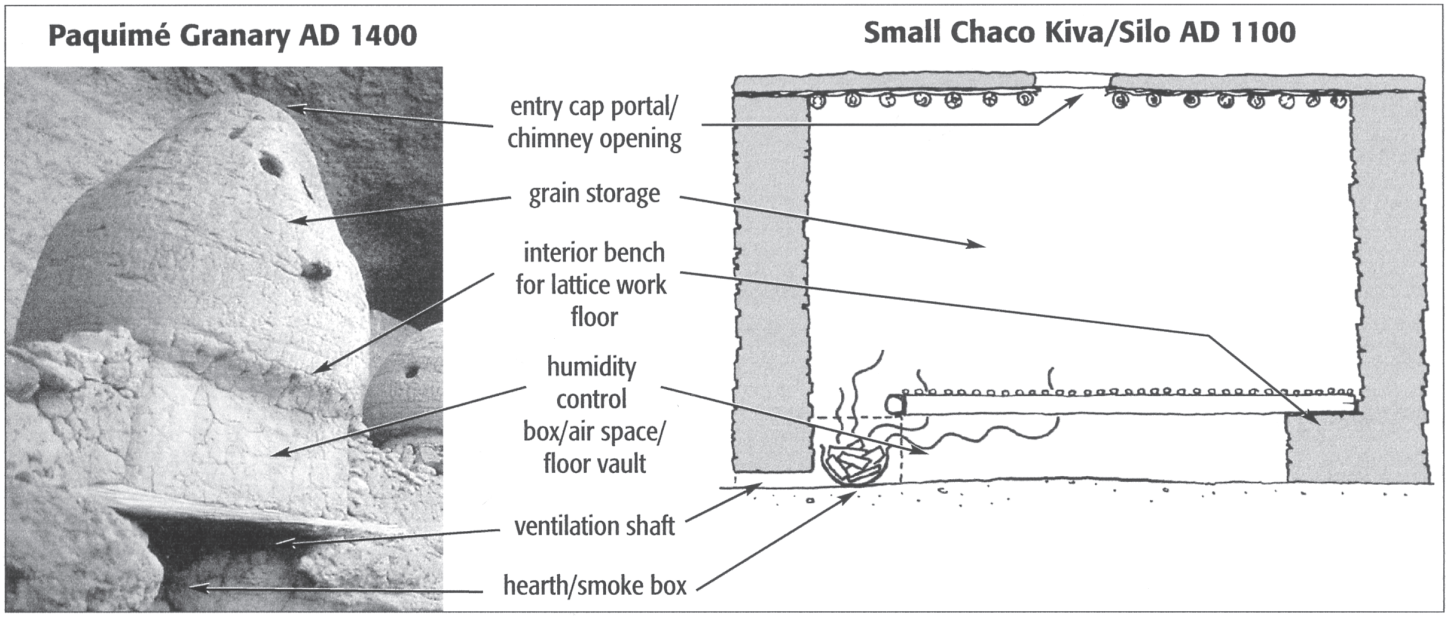
The Chaco kiva/silo debate among archaeologists continues to be a widely ignored concept. The basic question is whether all of the kiva-type rooms were just that, i.e. religious kivas, or were primarily long-term corn storage granaries. At Chaco Canyon, in Pueblo Bonito, there are at least four basic circular room designs. This would indicate that there were at least four different uses.

Based on our research of Paquimé granaries, we believe that the smaller Chaco kivas should be re-evaluated as multipurpose facilities that were primarily used as silos and, when empty were also used as living quarters previous to abandomnet and for religious blessing ceremonies after C.E. 1275. Many archaeologists agree with the living quarters theory, but fail to explain the hearth and ventilation system that produces carbon monoxide built into the smaller "kivas." Our research indicates a completely new theory that explains the hearth and ventilation features. What I propose is that these Chaco silos were such high tech grain storage facilities that most archaeologists have not as yet accepted any theory as to their practical useas long term grain silos.

The Hohokam had a less well understood structure that had a raised floor, fire pit and schist stone risers, and may have functioned in the same way as kiva silos and olla granaries. Although burials are common in Hohokam pit houses, there is no burial documented in this room excavated by Emil Haury.

My original proposal, based on a study of the Paquimé granaries, is that the Anasazi used live coals in the hearth below the humidity control box to manage environmental conditions in the storage chamber above. The smoke and tannins released from the charcoal helped flavor, preserve, and protect the stored grain from mold, insect and rodent pests. Robert M. Adams, the archaeologist who proposed this very ingenious theory, also observes that carbon monoxide from a sealed chamber is a very effective pesticide that has no harmful effect on grain as a food product. Kivas, however, are very dangerous to humans who might be using these small, dark, and smokey chambers as emergency living quarters. This storage strategy helped the Anasazi and Paquimé people survive many droughts and contra-indicates living quarters and religious chambers.

It is important that there are no burials in the round rooms of Pueblo Bonito, said Roger Moore, an archaeologist at Chaco Culture Park. It is also significant that there are no burials in Granary Row at Pumpkin Center or School House Point. It is clear that these peoples avoided burials in food storage facilities. Burials are not associated with Granary Row at Pueblo Bonito or Salado granaries, further supporting our hypothesis for long-term food storage.

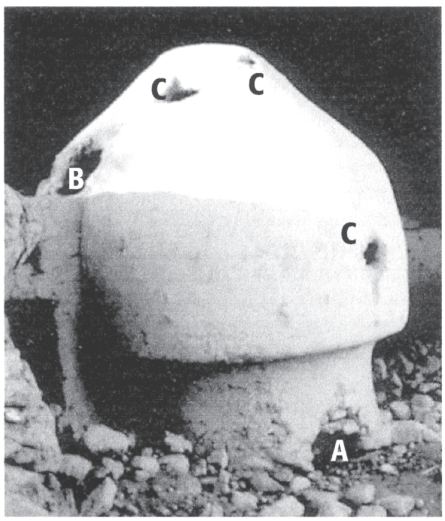


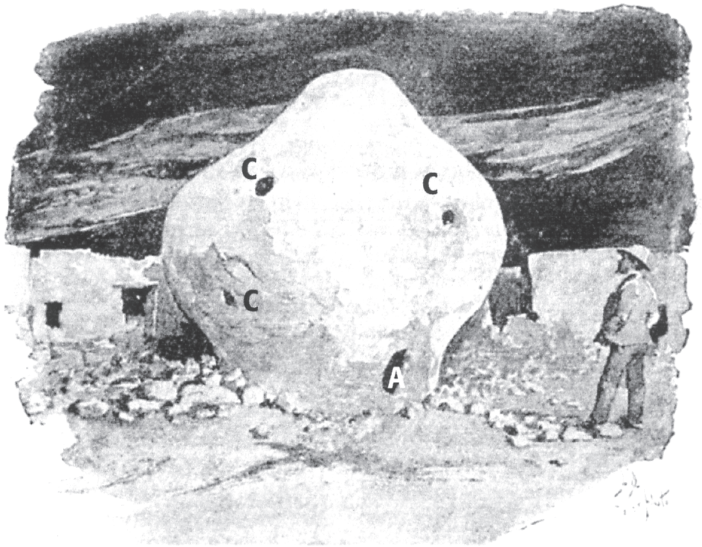
Paquimé Granary Openings:

A Access to humidity control/smoker coals.

B Walk-in access portal (left only).

C Latilla Ladder openings.





Human Load Transport Analysis Worldwide

"John Harris, the young Indian who packed 220 pounds up the summit at 40 cents a pound last fall, is now packing wood in Dyea at six bits per sled load." Dyea Trail Newspaper, 2/11/98, p. 4.

The two tons of Persicula Bandera shell at Paquimé originated more than 500 miles south near Banderas Bay and the great half ton logs at Chaco that came from the Chuska Mountains demonstrate the upper limit of the Anasazi and Paquimé transport performance.

The Sherpa are portaging "in the roadless hills of modern-day eastern Nepal"... "50 kg (110 lb) loads over one-way distances ranging from 50 to 250 km (30 to 150 miles). The Nepali evidence refutes Lightfoot's 50 km (30 miles) operational limit for an 'effective redistribution network, based on foot transportation.'"... The Native Americans transported food staples and durable goods "on a regular basis over distances of at least 100 to 150 km (60 to 90 miles) and on an occasional basis over much longer distances." Nancy J. Malville, Ph.D.

In the archaeological record, most adults (both male and female) had arthritis and spinal degeneration from carrying heavy loads. Black Mesa Anasazi Health. Reconstructing Life from Patterns of Death and Disease, 1991, p 110.

In the late 1990s long distance Tarahumara transport ranged from 50 to 150 lbs and from 30 to 100 miles. Ethnographic evidence gathered by Richard D. Fisher.

"An unbroken line of men, stretching into the cold skies, provides the stampede with its most memorable spectacle on the slopes of the Chilkoot Pass." This spectacle "at one glance mirrors all the terror, all the hardships, and all the yearning" of the Klondike gold rush of 1898. The Klondike Fever by Pierre Berton.

The Canadian Mounties placed a scale at the top of Chilkoot Pass and weighed every single burden for the 22,000 men who made the crossing that year. Every man entering Canada had to have at least one ton of supplies moved into Canada before they were allowed to continue down the river into the Yukon Territory. In 1898, every single load was carried by the prospectors themselves or their hired porters, a majority of whom were the local Native American Tlingits, Chilkoot, Chilkats, and Stikines tribes. "Over the mountains they stolidly trudged... a tumpline taut around their flat foreheads, a stout stick in one hand." This is as good a scientific and historical record as can be found for the human load carrying capacity.

The following are some of the more interesting abbreviated stories. Even seasoned military men and explorers, such as Frederick Schwatka (1883:13, 23-24), who at first shuddered at hiring Chilkoot packers, who would "take no less than $9-12 per 100 lbs" and yielded no bulk discount for his large party and load of roughly 2 tons, quickly came to admire their packing prowess.

"The amount some of these packers carry seems marvelous and makes estimates for pack mules or trains therefore seem superfluous. Their only packing gear is a couple of bands, one passing over the forehead, where it is flattened out into a broad strip, and the other over the arms and across the breast, the two meet behind on a level with the shoulder, and are there attached to lashings more or less intricate, according to the nature of the material to be transported."

"If a box or stiff bag, the breast band is so arranged in regard to length that when the elbow is placed against it (the box) the strip fits tightly over the extended forearm across the palm of the hand bent backwards. The head-band is then the width of the hand beyond this. At least I saw a few Indians arranging their packs and their harness according to this mode. The harness proper will not weigh over a pound, and the lashing according to its length. The strip across the head and breast is of untanned deer skin about 2 inches wide, with holes or slits in the ends protected from tearing out by spindles or bone or ivory."

Tlingits were trained from an early age to engage in the rugged physical tasks involved in packing. Parties often consisted not only of men, but also women, children, slaves (at least through the 1870s) and dogs (increasingly after the demise of slavery). Frederick Funston (1896:2-3) reported that his expedition "divided our goods into seven packs and engaged five men and two women to carry these loads to the summit of the pass... The Indians supported the loads on their backs by the aid of deerskin bands, passing across the forehead. Several children carried on their backs light loads, consisting of food and cooking utensils for the use of the Indians, while two of the dogs also wore packs." Pack loads varied from 36 to 137 pounds in weight, with boys carrying the lighter loads and men the heavier, according to Schwatka.

J. B. Moore (in Greer 1995:50) recorded that "native women and their young daughters and sons from ten years of age were also packing from fifty to seventy five and one hundred pounds on their backs for miners, earning from ten to twenty dollars per day." Oglivie (1913:132-134), the Canadian surveyor who made the crossing with the legendary Tagish-Tlingit packer Jim Mason (Keish, "Lone Wolf"), dubbed him "Skookum (the Chinook term for strong) Jim" for his feat of carrying 156 pounds of bacon over

the pass in a single trip. He noted, "This might be considered a load anywhere on any roads, but over the stony moraine of a glacier, as the first half of the distance is, and then up a steep pass, climbing more than 3000 feet in six or seven miles, some of it so steep that the hands have to be used to assist one up, certainly is a stiff test of strength and endurance."

Perhaps the highest claim for a Native packload was made by a very experienced witness, John Healy, the co-founder of the Healy and Wilson trading post at Dyea, who credits men with carrying up to 225 pounds and "whip[ping] the whole business over in two camps, camping the day at Sheep Camp" (Healy 1929:115; Greer 1995:50).

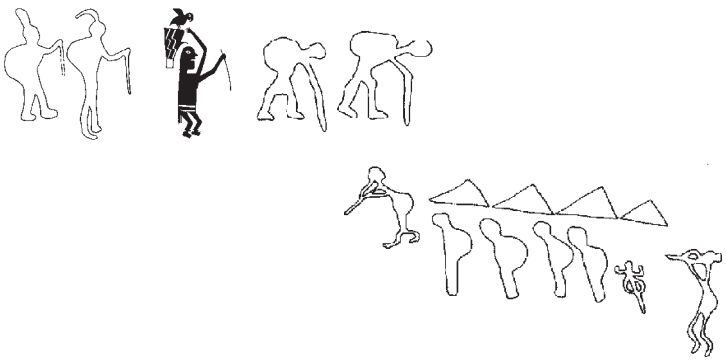
Although Berton (1985:244-245) doesn't cite where he got the information, he mentions that "an Indian packer managed to reach the summit with a three-hundred-and-fifty-pound barrel on his back." Also that "a Swede named Anderson and a Siwash Indian called Jumbo each made one trip from the Scales to the summit on a bet with a staggering three hundred pounds. They returned in a dead heat."

From The Archaeological Record of Paquimé and Chaco - At Paquimé itself more than two tons of sea shell were excavated. This reflects only the amount of shell stored when Paquimé was abandoned. The specific species of shell found is only what was on hand at the moment, or perhaps just a particular load. Ronna Bradley, Ph.D., reports that much of the Paquimé shell, especially *Persicula bandera*, originated from Banderas Bay at the juncture of Nayarit and Jalisco, more than 500 direct-line miles. She further observes that triangular pendants made of *Melongena patula*, similar to those found at Paquimé, were recovered from the site of Amapa in western Mexico, which is also near Banderas Bay. This evidence is the "smoking gun" for an extensive trade system and the transfer of perhaps dozens of tons of shell that had to be carried over great distances to Paquimé.

In another example, archaeologists at Chaco Canyon estimate that over 200,000 logs were moved between 40 and 90 miles to build the great houses. Some of the larger logs weighed up to 1,000 pounds and were estimated to be as much as 14 feet in length. Tom Windes further detailed that the average log weighed 300 pounds and was carried at waist level by eight porters using cross members for support. Some of the larger logs may have required as many as 16 porters carrying this load over an eight-to-ten day period.

In historical times, there are also many records of Tarahumaras moving huge loads through some of the most rugged terrain on earth. Grant Shepherd, in about 1890, accompanied a piano that was packed in a wooden crate, weighed between 750 and 975 pounds, and was carried by Tarahumaras from Carichic to Batopilas. They covered a distance of 185 miles through some of the most treacherous canyons to be found anywhere.

The scientific, historical and archaeological records suggest that Lightfoot underestimates human capacity by approximately 65%.



Kent Lightfoot's long distance estimate of 50 lbs and 30 miles is considered to be a casual work load by Canyon Tarahumara.

Significantly, the 30 km "political" zone surrounding Paquimé as defined by Michael E. Whalen and Paul E. Minnis corresponds very reasonably to the normal work distances of the modern Canyon Tarahumara. The transhumance Tarahumara have as many as four homes scattered over a 30 mile radius. They use these homes for agricultural purposes throughout the year.

Experienced Anglo-American and European mountain climbers often transport upwards of 90 lbs. over 30 to 60 miles. This was college student Richard D. Fisher's foot transport load when approaching a solo climb of Aconcagua Peak, January 1982.

Grand Canyon backpacking trips frequently entail loads of 40 to 70 lbs over distances of 30 to 100 miles. High school students and Boy Scouts often carry loads of 50 lbs for 50 miles over a 5 day time period. This example is approximately what Kent Lightfoot is estimating for the maximum range of efficient pre-historic Native American foot transportation.

Fertilizer Anasazi ~ Hohokam ~ Paquimé

One of the greatest secrets of Chaco Canyon archaeology is that these people have no visible means of support. Grid gardens have been proposed but I intend to propose that even these limited agricultural enhancements are now in question. Even if grid gardens mapped by Vivian, Potter and Kelly were accepted they would only cover an area of 72.9 acres within the National Park. This would have supported only 82 people, while the population of Chaco is estimated up to 6,000 people (Loose). Further Vivian and others make no allowance that the "grid gardens" would have been in use for up to 200 years and there has never been any formal proposal for fertilizer accepted by archaeologists.

I began to research the fertilizer production of the Anasazi when the Tarahumara Indians reported that fertilizer was absolutely required for agriculture. I reasoned that if the Tarahumaras required fertilizer then the Anasazi, Hohokam, and Paquimé cultures would also require high quality fertilizer. Beginning with ethnographic evidence of the Chinapas (floating gardens) used by the Aztecs, I began to investigate the potential use of water, reservoirs, wells, and ponds for creating fertilizer.

Diane Rushford of the Tuzigoot National Monument indicated the first opening concept for producing fertile water when she told me "agriculturalists can hear corn grow when ionized rain comes from thunder and lightning storms." She made the point so strongly that the concept followed my thinking for years and initiated this idea of "natural sources of fertilizer" for the Anasazi/Hohokam/Paquimé cultures.

What I discovered was a major breakthrough in the archaeological analysis of virtually all of the pre-Columbian cultures associated with Mesoamerica, including the Anasazi, Hohokam, and Paquimé.

The first key was the explanation of Mummy Lake where Ken Wright of the Paleohydrological Institute provided the basic archaeological data to support a soluble nitrate collection pond and surrounding walled garden.

The second breakthrough was for reinterpreting the usage of Hohokam ballcourts which I interpret as the architecture in which the Hohokam gathered fertile summer rainfall and mixed in other components to make liquid fertilizer.

The third, and for me the most important triangulation, was the mysterious pools on the agricultural construction of Lefthand Canyon provided by James A. Neely. I interpret these pools as being the mixing ponds for making the liquid fertilizer.

I also consider the Chaco Canyon well which is much too small to be a religious "kiva" and is not the standard shape and design for a corn storage silo/round room.

The Chaco Canyon "motes" have been an archaeological enigma. I suggest that the one along the south wall of Chetro Ketl has human waste collection compartments, and that this fertilizer was collected and then mixed in the "multiple headgate" to feed the system of fertilizer dehydration basins in the Chetro Ketl field.

R. G. Vivian has proposed that the Chaco Canyon "multiple headgate" with its three progressive boxes was constructed during three successive time periods. I counter with the proposal that the multiple headgate boxes were built as one unit and used to create a mixing or stirring motion as the water poured from one box to the next before entering the fertilizer dehydration basins. The water would have been inoculated with waste material and cyanobacteria to create liquid fertilizer.

The Paquimé well contained two whole bison and many sacrificial birds. Such a very rich mix of water and decaying meat would have produced a very valuable liquid fertilizer.

The Paquimé cistern closely matches several features of the Mummy Lake, Mesa Verde early intake system. This "intake box" was probably used to mix waste material and cyanobacteria to create liquid fertilizer in the cistern.

And finally the entire Paquimé site has many "water features" that would clearly have been for ponding gray or waste water. As a ceremonial site, many people would have arrived for festivals bringing with them valuable human fertilizer. Some of the activities on the mounds would also have produced waste material that when mixed with water would have produced liquid fertilizer.

Most or all of these fertilizer enhancements were likely used for hand watering special corn that was used to make tesquino corn beer, as fertilized corn has a high sugar content.

Pre-Classic Mayan foundations for fertilizer production - I have found substantial support that some of these ideas were in circulation since the Mayan pre-Classic period of 600BC-AD150 in the Mirador Basin of northern Guatemala. Professor Richard D. Hansen ,under the sponsorship of National Geographic and as documented on PBS, states "the Mirador Basin of the pre-Classic Mayan period had an economic agricultural engine where marsh muck from local swamps was deposited into terraces to produce fertile soil for the growing of corn and other crops. These deposits equaled thousands of tons of transported organic soil material. Some of these terraces were more than 3½ meters (10 feet) deep." Professor Hansen further stated that these agricultural methods are evident throughout the Mayan era into the time of the Aztec Chinampa swamp dredging agricultural system.

This ancient knowledge would be the basis for our Paquimé/Anasazi/Hohokam "natural systems" agricultural methods for producing fertilizer.

Marvin Harris, from his book *Cannibals and Kings*, points out a fascinating method in which the Peten Maya C.E. 300-800 had a way of produced fertilizer in a structure that looks something like a Chaco "road." Although Harris and his colleagues, including C.L. Lundell, never actually realized that the Maya were producing nitrate rich water for fertilizer, their basic analysis for the use of the linear depressed swale where leaves from dry season deciduous trees decayed was, I believe, correct.

Kin Ya Chacoan Great House and Road may provide the break through link between fertilizer, corn growing field design, and long term storage. Note the very distinctive Chacoan "road" that intersects the rim around the Kin Ya "island." I propose this site be tested as one great corn field which used substrate "irrigation" and infusion of soluble nitrates produced by the surrounding cryptobiotic soils (left). Permission granted Adriel Heisey.

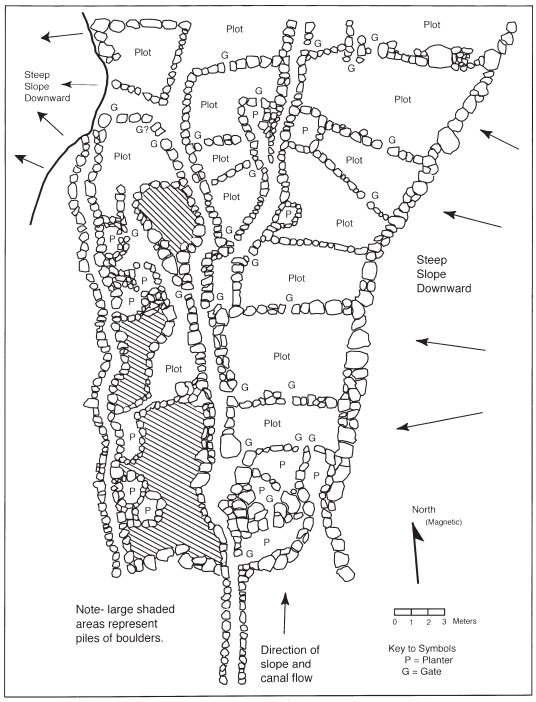
Fertilizer Production
Six Fertilizer Dehydration Basins

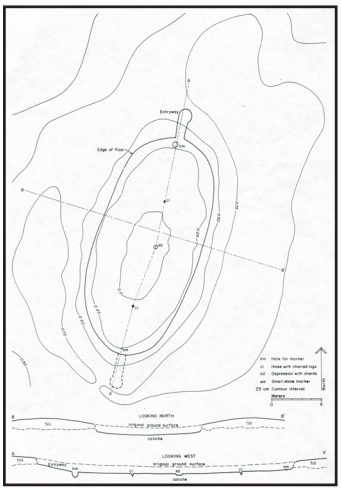
In the late 1990s, Professor James A. Neely published on his excavations at Lefhand Canyon a unique new system of gates and pools that was clearly an agricultural enhancement. This site is located on the northern flanks of the Pinaleno Mountains just south of the Gila River near Safford, Arizona. He has investigated a unique irrigation and garden system. He believes that this site dates to C.E. 1275-1315,and that these were migrant Western Anasazi, based on the pottery styles.

His schematic drawing illustrates small turnouts, or gates, in the canal that controlled amounts of water to be diverted into fields and into stone-bordered "pools." .... The pools vary in shape and size. In all, about 100 of these pools were recorded in Canal System 1. They were likely designed to impound small amounts of water, where farmers could dip water onto wilting plans, as needed, but their precise function is not known with certainty. He did not know the purpose of the intake gate and pool system.

This was my third specific archaeological find that supports my argument and is now one of six or more specific examples of my proposed use (Neely & Homburg) (right).

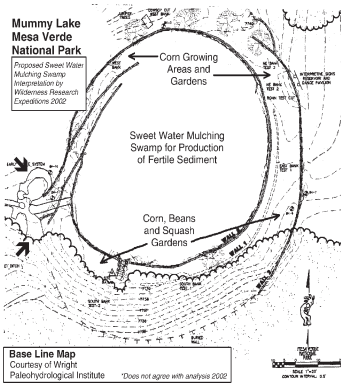
Courtesy Professor James A. Neely

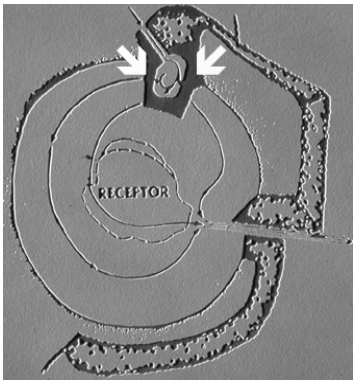


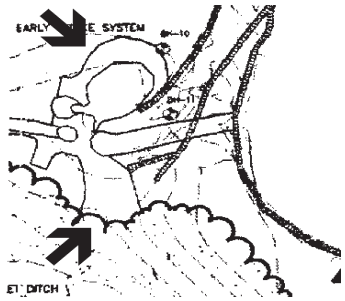


Small court at Snaketown

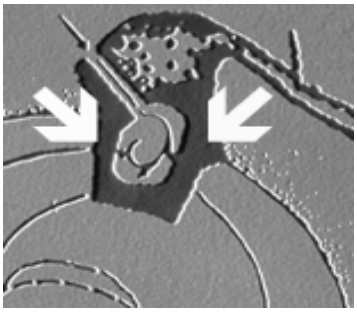
The use of Hohokom fertilizer dehydration basins (ballcourt) was contemporary with the Chacoan era C.E. 800-1150. Although designs varied, architectural constructions and methods of producing fertilizer was an integral part of Anasazi, Hohokam, and Paquimé culture during this entire era regardless of geographical location (above).





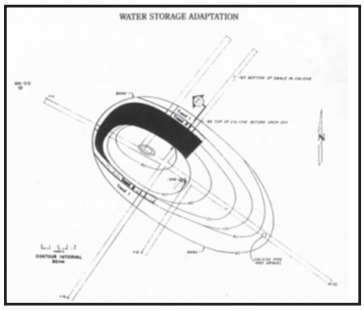


"Water/fertilizer intake system." Mummy Lake, Mesa Verde C.E. 1200



Water/fertilizer mixing intake system. Paquimé C.E. 1400

The Mesa Verde intake system virtually matches the Paquimé system which was perhaps 200 years later and more than 1,000 miles to the south.
This intake basin is probably used to automatically mix and inoculate the incoming water with cynobacteria and/or waste material such as manure to produce a mixture of nitrogen rich water with which high volume, high sugar content crops were hand watered or the sludge could be dehydrated, stored, or transported as needed (above).



Hot Wells Storage Basin with test trenches (Vernon L. Scarborough, 1988) (above). I propose this is an example of a Jornada Mogollon C.E. 1150-1340 fertilizer dehydration basin.

All kivas are not created equal. This Casa Rinconada "kiva" was clearly not a ceremonial chamber. Its designs indicate it could be a fertilizer creation chamber or perhaps even a storage unit. Clearly it does not fit the profile of a religious chamber (above).

Courtesy Kate Bauer

Ingenious Agricultural Strategies and Architectural Designs

Many Oasis America water features and basins have perplexed archaeologists for years. From Mummy Lake, Colorado to Wupatki and Casa Grande, Arizona, to the extensive lakes and wells of Paquimé, these water features have remained an enduring mystery as they collect very little water of questionable hygienic quality. Thousands of these artificially constructed water and organic debris catchment basins dot the landscape from the Hohokam and Anasazi in the north to the Aztec and Maya in the south. Our unique proposal is that these items represent a well-planned and constructed system of fertilizer dehydration basins for the production of fertile sediment to grow corn.

I also propose that these were specifically designed to catch monsoonal rainfall that was chemically altered by lightning, splitting nitrogen into nitrates that are usable by plants. Organic plant material, charcoal, human and animal waste, and blue/green algae were added to the nitrate rich water to produce, under the hot summer sun, an organic gray water solution that was used to fertilize the corn at the specific C4 genetic growth spurt characteristic inherent in the corn maturation cycle.

In most known cases, there are a large number of pot shards reportedly associated with water transport ceramics near these features. These specific utensils were items of high religious significance and were used to apply the fertile water to the dike fields associated with the water features (Scarborough, Wilcox, Wilshusen).

Hohokam and some Paquimé "ballcourts" have topographically depressed centers and raised oval sides. The floors were also sealed with caliche or other material so that they would hold water. Our proposition is, if the Hohokam and Paquimé people built them to collect and hold water, that was their intended use. There is one known confirmed example of a ballcourt at Paquimé.

As the concept of rainwater to fertilizer dehydration basins has never been proposed, anything that remotely resembles an elongated or oval shape, is today, being, I believe incorrectly, identified as a "ballcourt."

The fact that the Chetro Ketl field is layered with clay, or even plastered, indicates from context of sealed shallow basins across Oasis America that this is the most efficient, ingenious and grand scale fertilizer dehydration basin field yet found in the region. As one might expect from other Chacoan examples , the engineering and design of this fertilizer production technology would be the most advanced north of Paquimé.

One might ask how I, as a research and, in this case, forensic journalist, came upon the story that resolved the Chaco mystery. It is really quite simple. A decade ago, while delivering over 150 tons of famine relief corn to the Tarahumara Indians of Copper Canyon Mexico, one of the tribal elders told me, "Most important thing fertilizer, then rain, and finally control of root cut worm. With those things provided by god, we don't need food aid." Today, the Tarahumaras are the only aboriginal people left in this region who have to raise their own food to survive. Other indigenous as well as migrants into this region are at least three generations removed from any type of serious productive agriculture. The ancient knowledge of Anasazi, Hohokam, and Paquimé sophisticated agricultural technologies have been lost to the body of human knowledge, until now. When that ancient Tarahumara elder spoke, I listened and remembered.

I realized following the Tarahumara life-style that the Chacoans used transhumance to gain access to the highlands surrounding the San Juan basin to exploit higher rainfall, more fertile soils, and be near the hard freeze line to control root cut worm and other pests. My very last "discovery" in solving the fertilizer riddle came after this paper was officially finished. I must confess that the Chacoans were so sophisticated that I was completely stumped in finding how they made the most important thing, fertilizer.

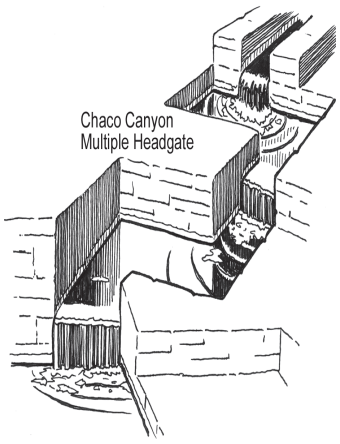
As I completed hundreds of interviews in bringing the agricultural foundation for these ancient cultures to light, archaeologists often reminded me "remember they were agriculturalists first. No food, no culture." I listened and remembered. Where this basic rule of survival lead me, I am sure will be as big a surprise to archaeologists as it was to me. For example, I had no intention of approaching "grid gardens" of Chaco as they seemed a very plausible and even likely agricultural strategy. I scanned that report at the very last moment before publication to make sure all of my "T's" were crossed and "I's" dotted. It shocked me when I found that in the very best case scenario that those gardens would only feed an estimated 82 people and were plastered over, of all things.

Perhaps a few romantics may be disappointed in the loss of Hohokam ballcourts, Chacoan grid gardens, and Paquimé ceremonial reservoirs. For me, the analogy that seems appropriate is the experience putting together a complex machine engineered in Japan from an instruction booklet. While one is working at construction, the impulse to smash the entire thing must be carefully resisted because when the project is finished, one can stand back and be awed by the genius of the Japanese.

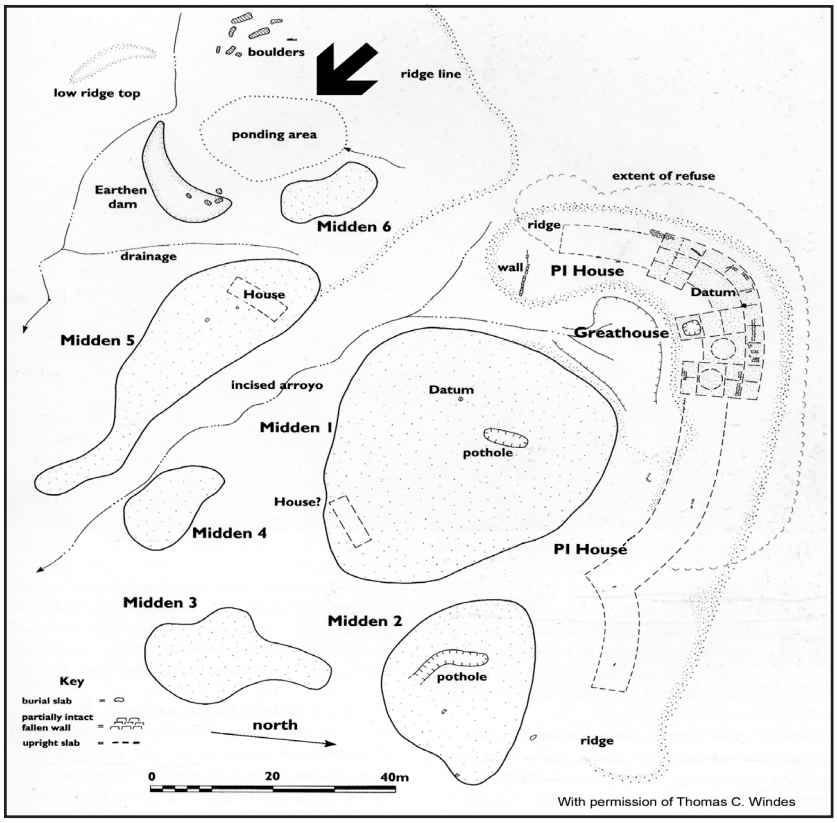
I now have this same experience with the Chaco Canyon Anasazi. Simply put, how did they understand their natural world so well that they applied technologies and practiced lifestyles that has defied modern science for over a century?

As the archaeologists frequently reminded me, "remember they were agriculturalists first" and fertilizer, according to the Tarahumara, is the "most important thing" in agriculture.

Often called the Chetro Ketl "mote," I propose that this structure along the south wall was a channel for the collection of human waste materials. Waste being used for fertilizer is one of the foundations of agriculture worldwide including "motes" found at European castles as well as in Mayan and Chinese cities during this era. No provision for this necessary deposit has been made at Chaco.

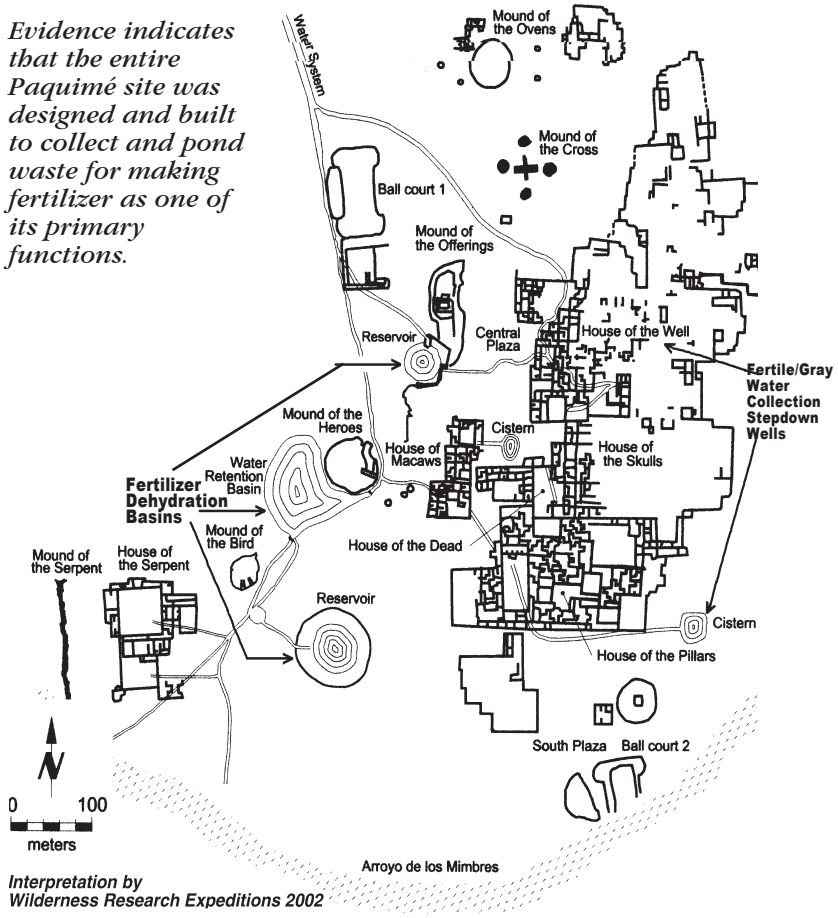


The three tiered Chaco Canyon multiple headgate design can be used for adding waste material to irrigation water to produce soluble nitrates for the field of fertilizer dehydration basins. This closely resembles the "gate and pool" system found at Lefthand Canyon by Prof. Neely. Contrasting this observation, R. Gwenn Vivian proposed that the three boxes were built at different time periods as canyon terrace levels changed.



The Casa del Rio and the Andrews Great House sites should be evaluated as a possible multiple platform mound and fertilizer production sites similar to Paquimé --- (Late C.E. 800's - Windes).

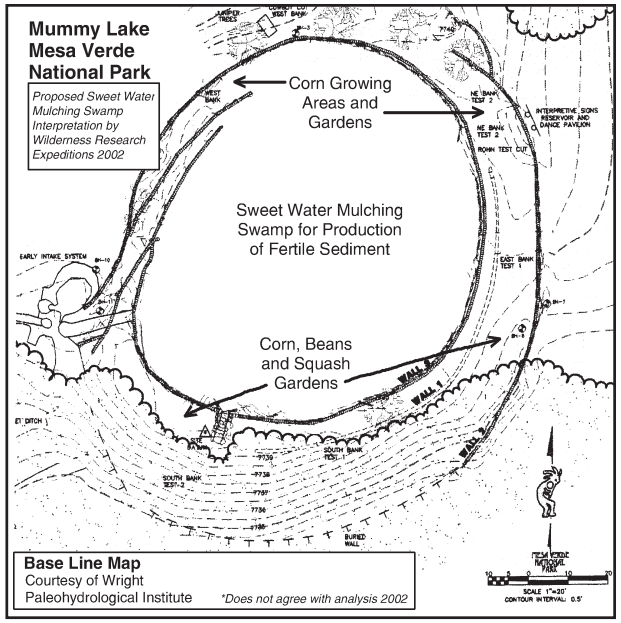
Evidence indicates that the entire Paquimé site was designed and built to collect and pond waste for making fertilizer as one of its primary functions.

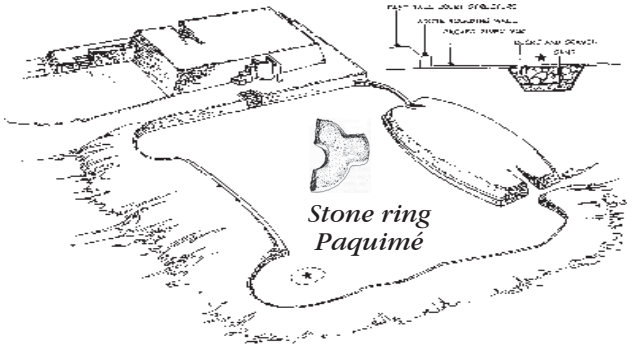


Interpretation by Wilderness Research Expeditions 2002

The "wall" system at Wupatki (above) is very similar to the one at Mummy Lake, Mesa Verde (below). Although tests apparently were not performed at Wupatki, it is very possible that it was originally filled with corn pollen as was the fill between the Mummy Lake walls. If the proper tests are not done, as in this case, the archaeological evidence will be lost forever. I recommend that all sites be carefully tested for pollen strata even in seemingly unlikely areas such as raised dikes as well as depressed swales like Chacoan "roads."

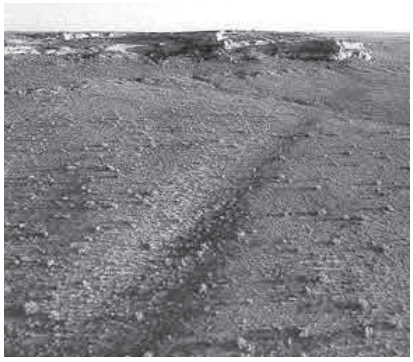
The very fine archaeology, including palynology, (study of pollen) done at Mummy Lake by Kenneth Wright in 1998/1999 provided the baseline data for discovering fertilizer dehydration basins in the Mesoamerica corridor from Guatemala to Colorado.





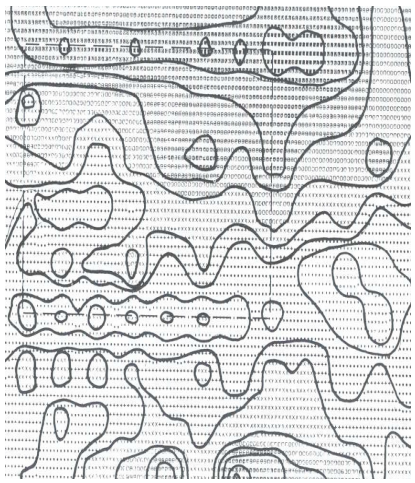
The only known pre-Columbian ballcourt in the Southwest was found at Paquimé by Charles DiPeso and featured a drain and a goal ring, C.E. 1250-1425 (above).

Natural Fertilizer Harvesting and Production
Chaco Anasazi



Chacoan Swale.
Permission granted Adriel Heisey

Bluff Great House Road
Permission granted Gene Stevenson, geologist, Bluff, Utah.



Topographic Analysis, Chetro Ketl field. Permission granted Richard W. Loose

Chaco Canyon Roads, Monumental Art or Agricultural Swales? As the photo on the left indicates, in many cases the constructed structures which have been identified as roads are, in fact, depressed swales. Investigation could determine if they were created to collect runoff from cryptobiotic soil which would naturally fertilize corn and other crops with soluble nitrates. I observe that if the Anasazi and others built structures that actually collect water, that is probably what they were built for. Stratigraphy and Palynology for the road swales has not been done so it is not known if corn was grown in these swales (Kincaid). A good example of a similar swale that may have been originally interpreted as a road and was later found to be a linear water collection basin is at the Mayan site of Peten. A thorough study of this proposal is certainly warranted.

Cyanobacteria, previously called blue-green algae, are one of the oldest known life forms (Belnap). Summer monsoon storm events produce soluble nitrates when the rainfall passes through cryptobiotic soils and pours over canyon rims into Zuni gardens (Pawluk). Tom Huntsberger reports that during a field study, he did a pre and post thunderstorm nitrate analysis of an area in the Colorado Plateau where cryptobiotic soils are common, and found that subsequent to the rainstorm, the nitrate levels were dramatically higher.

"Cryptobiotic soil crusts, consisting of soil cyanobacteria, lichens and mosses, play an important ecological role in the arid Southwest. In the cold deserts of the Colorado Plateau region (parts of Utah, Arizona, Colorado, and New Mexico), these crusts are extraordinarily well-developed, often representing over 70 percent of the living ground cover. Cryptobiotic crusts increase the stability of otherwise easily eroded soils, increase water infiltration in regions that receive little precipitation, and increase fertility in soils often limited in essential nutrients such as nitrogen and carbon" (Harper and Marble, 1988; Johansen, 1993; Metting, 1991; Belnap and Gardner, 1993; Belnap, 1994; Williams et all., 1995).

I propose that in most cases "roads" are raised above the surrounding landscape to prevent ponding of water and protect the roadway from erosion during heavy rainstorms. Clearly Chacoan roads do not follow this worldwide norm.

John Rooney, who supervised the phase two Chaco Road project, said he did not think the swales were built for transportation and communication. Rather, he felt it was some type of monumental art. He did indicate, however, that when he lost the "road" he was able to follow the plant litter as it created a dark line of organic material which collected at the bottom of the swale. He indicated that he had never heard of the cryptobiotic soil proposal but he did not see why they would grow crops so far from home. I suggest that nothing within a one hundred mile radius of any modern or ancient pueblo would be considered "far away" by the Tarahumara Indians and, I propose, by the Chacoans as well.

Making fertilizer in Chaco Canyon - Slot Canyons, such as this one above Pueblo Bonito, collect soluble nitrates from rainfall on the surrounding cryptobiotic soils. One can easily observe the obvious female shape of what I believe are natural mixing basins (left).

"After thinking about the Chetro Ketl field for thirty years, I am not at all convinced that it was an agricultural garden. The entire field was a series of basins approximately 4x5 meters each, comprising eleven acres in all. The soil is horrible, choked with calcium carbonate and sodium sulphate which created an impermeable water barrier" (preventing any root systems from developing). "These basins were sculpted or excavated out of the basement strata between the levies. The basins were coated with a clay layer that may have been from a flood event or the clay may have been hauled in and layered. Chaco Canyon was singled out as very poor farmland by the US Soil Conservation Service in 1936" (Loose).

"I believe as the clay plastering was so finely bedded and evenly applied that this would not have been a natural overbank or flood event. The entire central section of Chaco appears to have been plastered and this field does not seem to be an exception" (Stein).

I propose from this data that the Chetro Ketl field was not a "grid garden." It was rather an ingenious design of fertilizer dehydration basins. I now question whether any significant agriculture was practiced in Chaco Canyon proper. I believe that the Chacoan elite controlled agriculture throughout much of the San Juan Basin by harnessing the unique topographical characteristics of dehydration basins that allowed for the exploitation of the fertilizer produced by the cryptobiotic soil. The Chacoans harvested and dehydrated the blue-green algae in the uniquely efficient basins in evidence at the Chetro Ketl field. I believe this dried fertilizer could be efficiently transported throughout the 60-100 mile Transhumance radius. While great logs and tons of corn were transported into the central canyon proper, I propose that fertilizer was being exported on the return trip.

Combined with my Transhumance proposal, this fertilizer producing method would have given the Chacoans a visible means of support in this otherwise extremely harsh and inhospitable environment. In fact, evidence suggests this is why the Great Houses of Chaco Canyon were founded in this location.

Where Did The Chaco Canyon Anasazi Come From and Where Did They Go?

"Follow the Scarlet Macaws." I would agree with the Hopi writer Leigh J. Kuwanwisiwma that Chaco Canyon was founded by the "Parrot Clan." Evidence indicates that these followers of Mesoamerican religious practices intermarried with local indigenous Puebloan people and founded a unique dynasty in southwestern prehistory.

As the Chaco Canyon Anasazi move evidence indicates that it is possible to follow the believers in the Sun God/Scarlet Macaw belief system progressively south to Wupatki, Point of Pines, Grasshopper and Kinishba ending up at Paquimé.

Charmion McKusick reports that the Scarlet Macaws were sacrificed C.E. 900-1200 and that later the macaw feathers were harvested, but the birds were not sacrificed after C.E. 1275. McKusick further states "While macaws can be handled without injury by their keepers, they are vicious birds which could not be traded hand to hand. It would be necessary for an experienced courier to transport marketable macaws."

The Scarlet Macaws are the signature element of Mesoamericans in Anasazi culture.

Leading archaeologist, Steve Lekson, states there is a "tendency to minimize rare things. Only a few macaws, therefore, macaws are not important. That logic escapes me. Rare stuff is supposed to be rare. If we found a jade mask at Pueblo Bonito, would we belittle it because there was only one? Macaws are the moral equivalent of jade masks. Highly specialized knowledge needed to transport and maintain macaws makes the 1,000 km (621 mile) trip (one way) to obtain those cantankerous birds a *very* big deal, fully comparable to jade-working. This was no "down-the-line" exchange; the idea of a macaw being passed up and over the Sierra Madres, from hill tribe to hill tribe, is absurd. Instead of minimizing the 30 macaws and two dozen copper bells recovered at Chaco, wishing them away, we should dance jigs of joy that the archaeology gods have given us these astonishing data" (Lekson).

I would strongly agree with Lekson accept that I believe in context, that the Scarlet Macaws are not that rare. While material items such as ceramics and shells may be more common, these assemblages do not carry nearly the value of biological remains of a macaw.

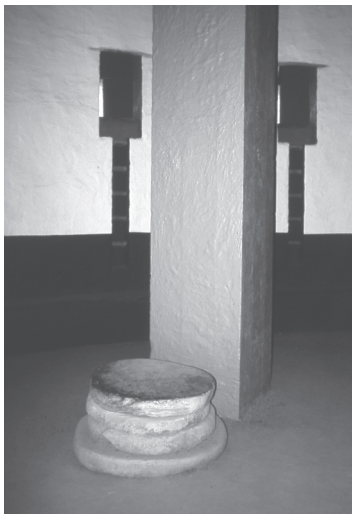
Selected Anemia(●) & Scarlet Macaw(✸) Archaeological Sites

Mesoamerica-Anasazi Macaws

Site	Dates	Macaws
Rio Grande	Post C.E. 1400	9
Paquimé	C.E. 1250-1425	504
Point of Pines	C.E. 1250-1400	28
Grasshopper	C.E. 1280-1375	13
Turkey Creek	C.E. 1275-1300	15
Salado	C.E. 1225-1400	5
Gila Cliff	C.E. 1275-1300	1
Kiet Siel	C.E. 1250-1300	1
Hiatus	C.E. 1200-1275	0
Sinagua-Wupatki	C.E. 1150-1250	53
Chaco	C.E. 850-1130	34
Mimbres	C.E. 1080-1150	3
Pueblo Grande	C.E. 700-900	2
Snaketown	C.E. 600's	3

Round Stones and Grain Growing Cultures - The theory that round stones were used as foundations is a very risky one for a grain growing culture like the Chaco Canyon Anasazi. It is more likely that these round stones were used for some type of grain processing. The fact that they also appear at Paquimé at a much later date and are not associated with "kivas" indicates that their use needs to be investigated in much more detail (below).

Worn Anasazi Round Stone, Aztec



Anasazi Round Stone, Aztec Great Kiva

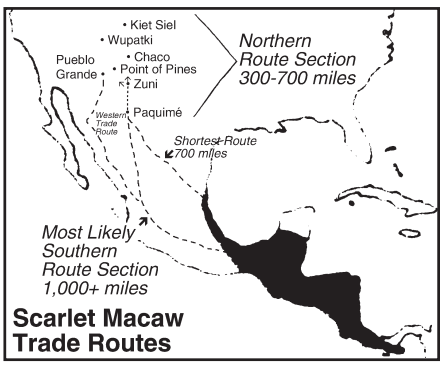
Chaco New Round Stone

Paquimé Round Stone

Long Distance Macaw/Shell Transport Routes

Scarlet Macaws occur in the humid tropical lowlands of southern Mexico. The macaws were moved in two distinct trips of 300-700 miles each. The first leg was from deep in Mesoamerica to Paquimé, Mimbres Valley or perhaps even Chaco and took less than eight weeks. The second leg of the journey was from the Mimbres/Paquimé trade center to Kiet Siel and Wupatki in northern Arizona. Young macaws, which hatch in March, must be removed from the nest at seven weeks old, carried in baskets, protected from chilling, and fed chewed hominy, often directly from the keeper's mouth, every few hours, day and night, Once fledged, they can eat about anything a human can eat and have a moderate tolerance for cold. This early feeding relationship results in human-imprinted birds that are attached to their keeper, but often vicious to strangers. It is easier to capture new young birds than to breed adult macaws, because human-imprinted birds seldom recognize other parrots as potential mates.

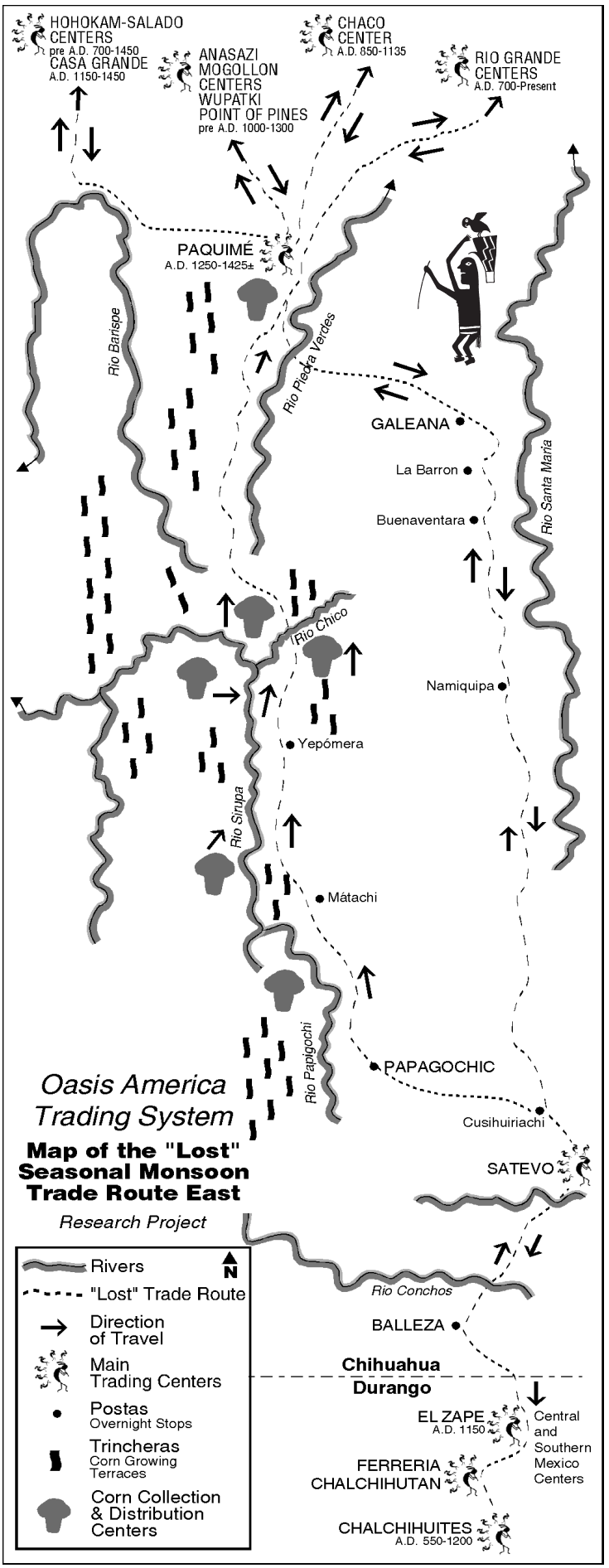
By the late 900s, Scarlet Macaws were being imported along a different trade route, running through the Mimbres River Valley to Chaco's sphere of influence (34 macaws). Mimbres pottery motifs and the age of skeletal remains suggest that juvenile macaws were carried to the Mimbres sites, raised there for almost a year, and then traded north just in time for religious ceremonies at the spring equinox, which is March 21-22.

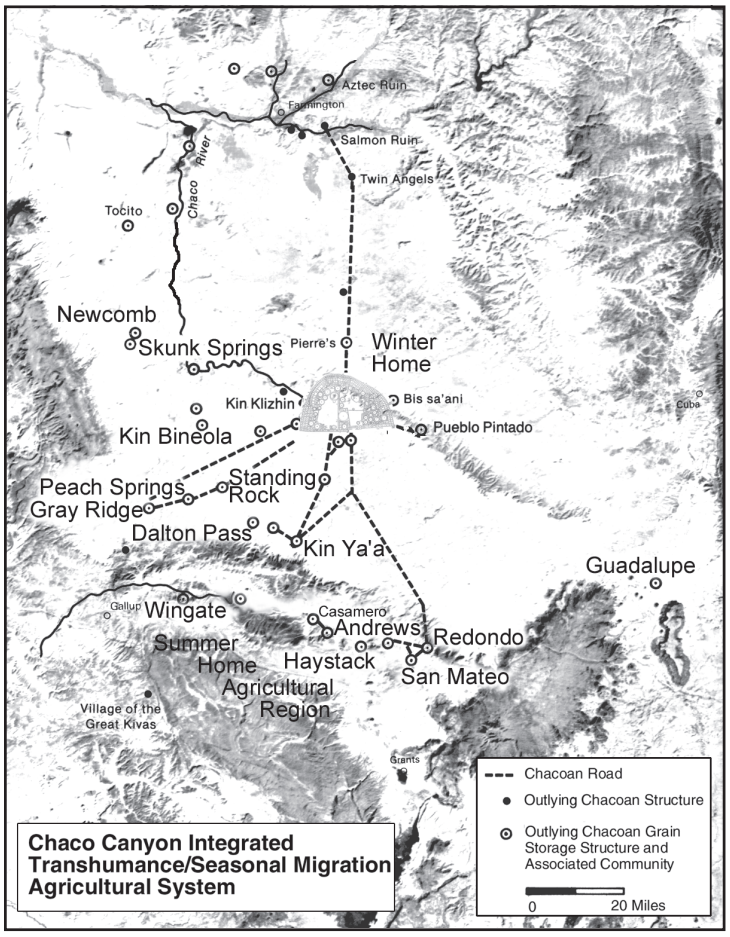


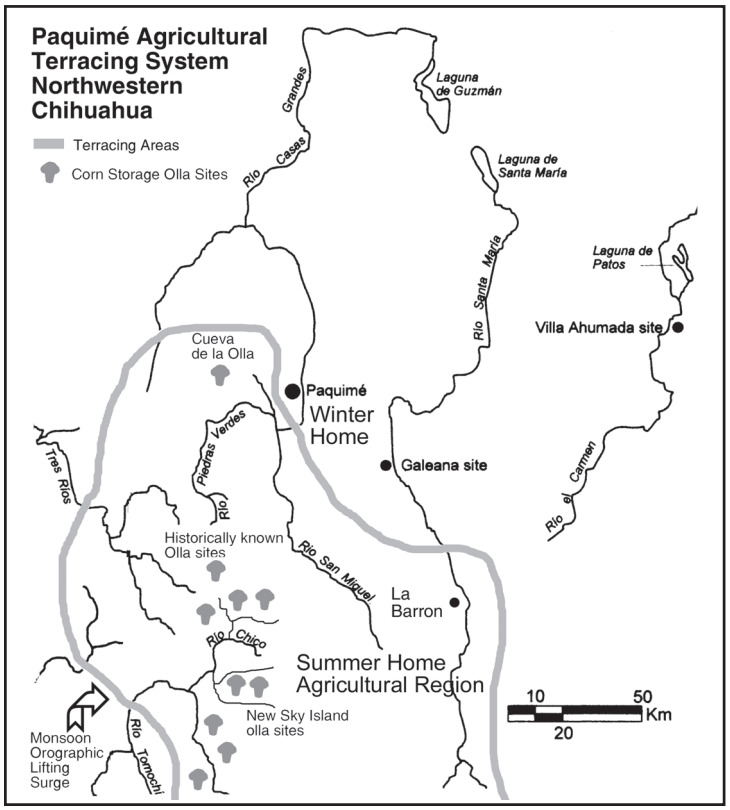
From 1150 to about 1200 the trade in Scarlet Macaws branched west, probably at Zuni, to the Sinagua area (53 macaws). More Scarlet Macaws were recovered at Wupatki than at any other site north of Mexico. This sudden shift of ceremonial activity probably was precipitated by the repeated eruptions of Sunset Crater.

The Scarlet Macaw trade became inactive in 1200 and did not resume until the Pueblo Katsina Cult arose around 1275. By this time, the Mimbres Villages were vacated and Paquimé had been built taking advantage of an already existing trade route. Paquimé specialized in raising juvenile Scarlet Macaws to a marketable size for trade to the later Rio Grande (9), Salado (5) and Mogollon (76). At least one Scarlet Macaw was hatched at Paquimé, but there is no evidence of a commercially successful breeding program at any site.

Of the 504 macaws recovered from Paquimé, only 96 were the locally available Military Macaws. The only Military Macaw sacrifice found north of Paquimé was buried wrapped in turquoise beads under a green stone by the fire pit of a kiva in the Mimbres Valley Gatlin Ranch Site. The Scarlet Macaw produces feathers of vivid red, yellow, and blue, all of which were and are used in religious paraphernalia. Osteology indicates that the residents of Point of Pines (28 macaws) in east central Arizona traded large Indian domestic turkeys to Paquimé in return for Scarlet Macaws in the early 1300s. Charmion R. McKusick







Transhumance/Seasonal Migration-Long Distance Travel

Transhumance/Seasonal Migration - What we are proposing here is to combine the established archaeological evidence relating to Paquimé and the new Sky Island site with current Tarahumara lifestyles. Today, the gentile Tarahumara grow most of their corn in dispersed fields at higher elevations and transport the dried corn back to their canyon winter homes after harvest. When people move from one established seasonal home to another, it is referred to as *transhumance or seasonal migration.* This is not a nomadic lifestyle; it is, rather, moving between two specific home sites.

Having personally seen and participated in moving the entire family from the canyons to the mountains in the late spring and then returning to the canyons in the late fall, I can see in a very practical way how this is done. Today, due to limited space available in the Sierra Tarahumara, the distances range from 10 to about 40 very rugged miles. It is easy to see that such a system could have worked as well over a distance of 50 to 75 miles. There are advantages to living in the canyons during the winter and in the mountains during the summer. Specifically, rainfall totals go up significantly from an elevation of 3,000 feet to 7,000 feet, and a much larger area can be utilized.

In a critical new discovery, Tarahumara ethnographic evidence shows that elevations provide the only practical control of root cutworm. The Tarahumaras report that their fields must experience numerous episodes of hard freezing each winter for abundant corn production year after year. It is clear that both the Paquimé and Chaco cultures had a system of outliers to take advantage of the higher elevations for both control of root cutworm as well as increased rainfall.

There are also some additional factors that Anglo-Americans understand well: The mountain climate is much more pleasant and attractive in the summer and there are fewer bothersome insects, especially those that carry disease, at lower elevations.

During the dry, winter months when the temperatures in the highlands are so bitterly cold, living conditions are much more attractive in the canyons or valleys. For the canyon Tarahumara, most of the religious ceremonies and large gatherings take place during the winter months when they are living closer to one another.

My personal experience has allowed me to see in a very practical way that the Paquimé people were most likely using this same system of transhumance as both an agricultural and social strategy. This led me to pursue an extensive review of the published archaeological literature, as well as to interview many of the most currently active archaeologists, to see what could be found on this topic.

For most archaeologists, the primary problem with transhumance is the distance. There are certainly many valid archaeological reasons for this social and agricultural strategy at Mesa Verde/Crow Canyon/Yellow Jacket, Chaco Canyon, Paquimé and many other areas as well. The Tarahumaras have no problem at all with a 40 to 75 mile distance for foot travel with heavy loads.

Oasis America Timeline and Mesoamerican Dietary Practices

Anasazi/Mesoamerican Timelines

Site	Dates	Site	Dates
Paquimé	± AD 1250-1425	Tarascan	± AD 1300-1521
Point of Pines	± AD 1250-1400	Aztec	± AD 1250-1521
Gila Cliff	± AD 1275-1300	Toltec	± AD 900-1250
Sinagua-Wupatki	± AD 1150-1250	Chalchihuites	± AD 550-1200
Salado	± AD 1225-1400	Alta Vista	± AD 450-1000
Chaco	± AD 850-1130	La Quemada	± AD 650-800
Snaketown	± AD 600's	Teotihuacán	± AD 150-750

Paquimé/Anasazi/Hohokam Timeline

AD 500
- Bow and Arrow appears AD 500
- ìHohokamî religion synthesized Mesoamerica with local ideas AD 700

600
- Early phase Pueblo period on Black Mesa AD 800-1030
- Initial construction of Great Houses at Chaco AD 900
- Sunset Crater erputs AD 1064
- Late phase Pueblo period Black Mesa AD 1070-1150
- Hohokam radical settlement changes. Snaketown abandoned AD 1100

700
- Chaco system reaches its peak AD 1100
- Aztec Great House constructed AD 1111-1121
- Walnut Canyon AD 1125
- Fifty-year drought begins AD 1130
- Winona Village AD 1130
- Chaco abandoned AD 1140-1175

800
- Mesa Verde Great Pueblos constructed AD 1150
- Sinagua peak population AD 1150-1220
- Wupatki AD 1182
- Joice Well site AD 1200-1400

900
- ìBallcourtsî abandoned AD 1200
- Macaw trade interrupted AD 1200-1275
- PaquimÈ founded AD 1250
- Hohokam residences relocated atop mounds, rectangular compound walls placed around them AD 1250

1000
- Old Caves Pueblo (Flagstaff) AD 1250-1300
- Mesa Verde Great Pueblos abandoned AD 1270
- Kiet Siel AD 1270
- Aztec Great House abandoned AD 1270-1290

1100
- Kayenta Anasazi migration AD 1270-1300
- Antelope House AD 1275-1286
- Katsina religious concepts AD 1275-1300
- Twenty-year drought begins AD 1276-1299
- Anasazi moved to Mogollon - Point of Pines AD 1280

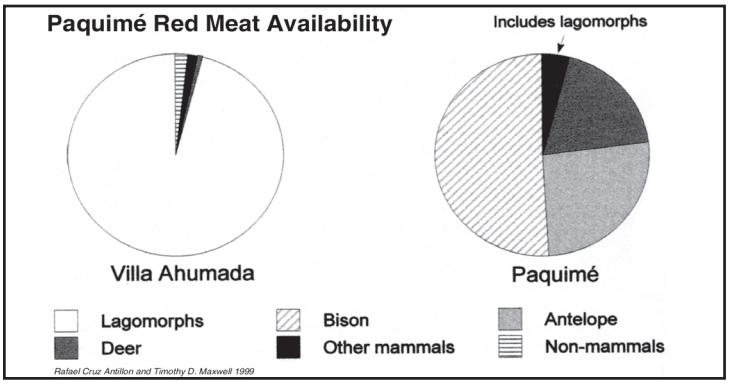
1200
- Chodistaas (Mogollon) Pueblo AD 1280
- Aztec and Chaco completely abandoned AD 1300
- Multi story towers Casa Grande AD 1300
- Pajaritan Plateau classic phase AD 1300-1325

1300
- Tuzigoot AD 1300-1400
- Chavez Pass AD 1300-1450
- Grasshopper (Mogollon) Canyon Creek Cliff Dwellings AD 1320
- Grasshopper peak population AD 1350

1400
- Gila Pueblo (Salado) AD 1350
- Hohokam damaging floods on Salt and Gila rivers platform mound ìelitesî destroyed AD 1356-1382
- Pajaritan population peak AD 1400

1500
- Central Mogollon abandoned AD 1400
- PaquimÈ attacked and destroyed AD 1425-1475
- Pueblo Grande-Casa Grande abandoned AD 1425-1475

Paquimé was unique in that a high percentage of the bone recovered is from bison. Some archaeologists theorize that bison were found in the ambient environment. However, none of the other sites excavated throughout the region, as far as is known, has any substantial bison bone in evidence. Other sites predating Paquimé also do not show any substantial assortment of bison bone. In fact, the large percentage of deer and antelope, while perhaps originating in a more localized environment, shows the ability of Paquimé to obtain large quantities of the most efficient and desirable sources of protein. This graph by Antillon and Maxwell (The Casas Grandes World, 1999) dramatically demonstrates that even other substantial Paquimé sites did not have access to bison.



The House of the Well in central Paquimé shows evidence of two full bison and many birds that were sacrificed in this very unusual location where a substantial amount of "high status" copper artifacts imported from western Mexico have been found on the steps leading to the well (Charles DiPeso, Victoria Vargas and Christine S. VanPool).

It is our hypothesis that, along with the very expensive Scarlet Macaws from southern Mexico, a large supply of corn from the Sierra Madre, the 2+ tons of shell from western Mexico, and the protein supply provided by Plains bison were imported to Paquimé for ceremonial reasons. This extensive trade network substantiates Paquimé's wealth and power very dramatically.

Anemia was the major debilitating disease found in the archaeological record throughout the Oasis America world. The archaeological record demonstrates that during the founding phases of any of the Oasis America city-states, the inhabitants were dining on deer, antelope, big horn sheep and, in the case of Paquimé, bison. In the final stages just prior to abandonment, the people were eating mice, rats, and rabbits to fulfill their red meat needs. Any population that was suffering from severe anemia would be at a severe competitive disadvantage with neighbors or invaders who were healthy. The Oasis America cultures had the option of adapting Mesoamerican dietary practices, and this phase of increased strife and warfare is now well documented in the archaeological record. At the beginning of the historic period, with Coronado's expedition, all tribes north of Durango and Sinaloa had rejected this option. The Hopi and Zuni, though descendants of the Anasazi, were no longer the same cultural group.

At Pueblo Grande, a major Hohokam site, a high carbohydrate and low protein diet caused a spike in female mortality during childbirth due to anemia, which produced a decline in fertility just before abandonment. Todd Boswick, Archaeologist-Pueblo Grande.

Chaco Canyon Anasazi
End of the Anasazi: Iron Deficient Diet-Anemia

by Richard D. Fisher

Abstract

Since the 1970's, a debate has raged concerning the abandonment of the Anasazi, Hohokam, and Paquimé regions of the American Southwest and northern Mexico (a region which I call Oasis America, which is characterized by oasis and rivers in a desert environment). Drought, famine, erosion, deforestation, salinity, soil infertility, warfare, cannibalism, and general resource depletion have all been proposed as causes for the desertion. For the most part, these reasons have been found not to be a primary cause of abandonment. I concur, after thoroughly researching each of these issues, that all of these "causes," taken together, very likely contributed to the severe dietary stress of the Anasazi/Hohokam/Paquimé cultures but were not the primary causes.

In a related debate, Marvin Harris proposed that a lack of "red meat" might have been a causation. He argued that a simple diet of corn and beans was not adequate to support complex, high-density cultures. Later, Louis E. Grivetti demonstrated that corn and beans did provide the adequate essential amino acids necessary for basic nutrition in pre-Columbian North America but does not address the general health of the population required for large building projects such as Pueblo Bonito at Chaco Canyon utilizing these very limited dietary resources.

Porotic hyperostosis in the orbital region.

I observe that a very specific lack of dietary iron was the ultimate root cause of the abandonment. I further propose that this might also be interpreted as the cause of the scientifically validated cannibalism in the Anasazi areas (Turner and others). It is widely accepted by archaeologists and anthropologists that pre-Columbian North Americans, in fact, had very few domestic animals. Harris correctly points out that these domestic animals competed with humans for the basic foods: corn, beans, and wild red meat. The lack of red meat and animal fats, due to the severe depletion of locally available wildlife, was a significant challenge to complex, high-density cultures such as that at Chaco Canyon. I agree, as well, with Grivetti that corn and beans would have provided the essential amino acids but the evidence demonstrates they could not provide the absolutely necessary dietary iron.

I propose that it was the essential lack of dietary iron that presented the Anasazi with a final and insurmountable obstacle to high-density, complex culture without resorting to cannibalism. I further observe that some groups of the Anasazi and others resorted to cannibalism (as did the Aztecs), but this practice was rejected by the majority of the population. It is noted from the following paper that Chaco Canyon has the highest rate of anemia when compared to the other Anasazi sites. Considering the bone evidence for the very poor nutritional status at Chaco Canyon, it is surprising that the Chacoans were able to accomplish any vigorous tasks at all. This contradiction highlights the very poor understanding of Chaco Canyon agriculture and lifestyles currently. My proposals provide the key for pursuing the resolution of this mystery.

Health and Disease in the Prehistoric Southwest a summary of key writings on Anemia - "Mesa Verde has yielded an abundant amount of skeletal remains (500 or so) from numerous excavated sites dating from 600 B.C. to A.D. 1300. Most of the remains are from the later time periods (A.D. 1000-1300) ... a low life expectancy as indications of a stressed population.

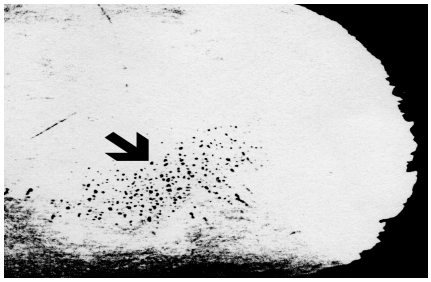
According to Akins, Chaco Canyon Anasazi suffered from what she terms "subsistence stress" as indicated by growth disruption, high rates of nutritional anemia, and degenerative diseases (1986:135). ... "authority-holding elites had greater access to nutritional resources and enjoyed better health (1986:137-140).

Bone density in adult males and females is the lowest during the abandonment phase, which probably reflects poor overall nutritional quality at that time. ... In addition to studies on the Mesa Verde and Chaco burials, human skeletal remains from the Kayenta region have also been analyzed. .. Similar to previous studies, Wade suggests that health was poor, with a slight trend toward increased stress in the later time period.

Ryan (1977) used Wade's Puerco Valley sample but combined it with burials from several other Kayenta Anasazi sites (A.D. 750-1300) and one historic Hopi site (Old Walpi, A.D. 1300-1700). His sample consisted of 353 burials representing Pueblo II through Pueblo IV occupation. ... Ryan suggests that health status dramatically decreased during the final stages of occupation. ... the study by Palkovich (1980) of 120 burials from Arroyo Hondo, located in central New Mexico in the Rio Grande area. This enormous site was occupied during two separate periods referred to as Component I (A.D. 1300-1330) and Component II (A.D. 1370-1420). Each occupation shows growth, prosperity, and sudden decline. ... Palkovich paints a harsh picture of the Arroyo Hondo Anasazi. Most individuals were afflicted with some pathology, and infant mortality was very high. Of the 54 subadults aged to 10 years, she further documents a very high rate of active infections and anemia in infants under the age of one (Palkovich 1987). ... Palkovich speculates that Arroyo Hondo infants have immediately acquired infections from their mothers, implying that maternal health was greatly compromised during pregnancy.

the study of Arroyo Hondo ethnobotanical reconstruction of food and diet, suggests strongly the presence of endemic malnutrition. ...

One common finding almost all the paleopathological studies reviewed here is the presence of nutritional anemia. El-Najjar and colleagues (1976) compared numerous Southwest skeletal populations based on dependency on maize (which is assumed to be a poor source of iron, protein, and other nutrients). Their sample was drawn primarily from Chaco and Kayenta sites, and they divide them into two ecological types: canyon bottom sites (maize-dependent subsistence) and sage plains sites (mixed maize subsistence). The study documents much higher frequencies of nutritional anemia in the canyon bottom sites and concludes that maize dependence in marginal areas such as those found in the Southwest predisposes individuals, particularly children, to health problems. ... Walker expanded this finding with an exhaustive review and synthesis of the published literature on anemia from all major Southwestern sites. ...



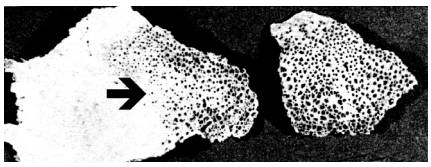
Porotic hyperostosis of an infant parietal that is slight in expression.

"The remarkable prevalence of osseous lesions indicative of anemia among prehistoric Southwest Indians apparently resulted from the interaction of a complex set of biological and cultural variables relating to nutrition and infectious disease. Lack of iron in the diet, prolonged breast feeding, diarrheal and helminth infections, and living conditions conducive to the spread of disease all appear to have contributed to the prevalence of [anemia] [1985-153]."

characterize health in the following manner: major nutritional deficiencies resulted from a corn diet ... major concern; most adults had arthritis and spinal degeneration from carrying heavy loads; parasites such as lice and helminths were common; and infant and childhood mortality was high.

Of these indicators of nutritional stress, porotic hyperostosis (resulting from anemia) is among the best-studied indicators for archaeological populations. Anemias can potentially affect any bone of the skeleton that is involved in the production of red blood cells. The extent of the involvement of postcranial as well as cranial bones usually indicates how severe an anemia is and whether it is associated with genetic abnormalities of hemoglobin or with nutritionally induced anemia (Stuart-Macadam 1987). ... nutritional anemia has been suggested to be the primary factor in the etiology of porotic hyperostosis for the vast majority of the documented cases in prehistory (Carlson et al. 1974; El-Najjar et al. 1975; Hengen 1971; Mensforth et al. 1978; Palkovich 1987; Stuart-Macadam 1987; Walker 1985).

Porotic hyperostosis is a descriptive term for lesions on the cranium, the roof of the eye orbits, and the ends of long bones. These lesions are produced by bone marrow proliferation that is diagnostic of anemia. The lesion, as the name implies, has a very porous (coral-like) appearance that develops when diploe (the trabecular portion of the cranial bone that separates the inner and outer surfaces) expands.



Porotic hyperostosis of an infant parietal that is severe in expression

Population-Level Analysis of Porotic Hyperostosis - A total of 119 individuals (approximately 69%) of the Black Mesa skeletal collection could be analyzed for the presence of porotic hyperostosis of the cranial vault, and 92 individuals (approximately 53%) of the collection could be scored for porotic hyperostosis on the orbits....

Iron-deficiency anemia is present on 87.7% of the Black Mesa individuals (showing either or both cranial and orbital expressions, either active or healed).

... early (A.D. 800-1030) and late (A.D. 1070-1150 Pueblo periods on Black Mesa ... For frequencies by severity, the only major difference is that there are no sever cases in the early period and five cases (20.0%) in the late period.

...data suggests that at least half of the Black Mesa adults were experiencing iron-deficiency anemia at the time of death, and that the rates are comparable with rates of anemia for several other Southwest sites. ...

Iron deficiency anemia was clearly a health problem for prehistoric Anasazi children.

Adult males and females are both at risk for anemia which suggests an underlying dietary deficiency because reproductive-aged females are prone to anemia owing to blood loss associated with menstruation and pregnancy. The equivalent frequencies imply a shared diet was low in iron.

"There is a strong case for persistent iron-deficiency anemia on Black Mesa throughout the entire Pueblo occupation. Eighty-seven percent of the population had some form (either active or remodeled) of the disease, and there appears to be slight increases in frequency over time. On Black Mesa, no subgroup appears to be particularly buffered from anemia, although it is clear that infants and the youngest children are the most profoundly affected "(Martin, Goodman, Armelagos, Magennis, p 162)

"El Najjar and Robertson (1976) document a severe case of porotic hyperostosis for a mummy child from Canyon de Chelly, and they point out that the Anasazi diet of maize is an important feature in the interpretation of the disease. An analysis of the maize species (which is a nonhybrid) used throughout the Southwest shows that it is very low in usable iron. ... The nutritive value of the Mexican tortilla has been described extensively (Cravioto et al. 1945) and shows quite clearly that iron content is very low (less than 3.2 mg/tortilla). ...

In an extensive study of the diet of a typical modern Latin American peasant farming village, (Acosta et al. 1984) the data show conclusively that iron content varies considerably according to what proportion of the diet is from red meat (which enhances absorption of iron) and vegetables and maize bread (which inhibit iron absorption). ...

Worthington-Roberts and coworkers (1988) conducted a similar study in the United States looking at the relative importance of red meat in the diet. Iron status was measured for individuals who regularly ate a variety of meat products and individuals who were vegetarians. Iron status of the vegetarians was quite poor, with many of the individuals of that group having evidence of iron-deficiency anemia. Thus, the importance of meat in the diet in sufficient amounts seems critical for meeting dietary requirements of iron" (Martin, Goodman, Armelagos, Magennis).

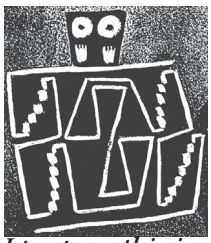
Porotic hyperostosis that is active and un-remodeled.

The Taloc, which is a fearsome goggle-eyed toothy petroglyph, I propose, was the symbol for the disease of severe anemia. This disease which was well known to the Anasazi and perhaps manifest itself in hollow-eyed faces which also featured diseased and receding gums in some cases.

Conclusion - Collected evidence suggests that when the large mammals were eliminated within a three days run (the time it takes meat to rot), the "elite" in the major centers had an unresolvable problem obtaining dietary iron from animal sources. I do not think that the builders of Chaco Canyon were surviving on "rabbit drives." My research indicates that anemia was the driving force for cannibalism and that cannibalism was not acceptable to the matrilineal indigenous clans of the Anasazi. This was the fundamental driving factor that caused the Anasazi to abandon the San Juan Basin.

The Anasazi and Cannibalism?

Evidence indicating Anasazi cannibalism is so dramatic that I propose it be accepted and the underlying causes and effects put into a balanced cultural and environmental interpretation of that era. Further studies into the basic role of anemia in North America pre-Columbian cannibalism are warranted and indeed, absolutely necessary to achieve a basic understanding of the dietary challenges faced by the many diverse Native American cultures that participated in cannibalism.



I propose this is the taloc face of anemia and perhaps cannibalism.

"The Turners hypothesize that cannibalism was brought from Mexico into the Anasazi territory, perhaps by religious cultists. Cannibalism was common in Mesoamerica, dating back 2,500 years, and Turner believes the cultists used it to terrorize and control the Anasazi. Remains at the Puerco River site are very similar to remains of victims of ritual sacrifice in Mexico, Turner says. 'We choose to see it as a group of people coming in and taking over in a very gang-like behavior,' he said. '(Cannibalism) was their gimmick. This was their weapon'" (Gehrke).

"Food for thought. *Man Corn*–named after the Aztec word for a sacred meal of human meat–provoked a fire storm. Critics have charged him (Turner) with everything from shoddy science to racism. He countered with a widely distributed manuscript–rejected by *American Antiquity*–denouncing them as "professionally reckless," "politically correct," and "rude."

Turner's proposal that ancient Mexicans invaded from the south has aroused the most derision. "The idea of a [Mexican] goon squad is ridiculous," says Kurt Dongoske, an archaeologist for the Hopi tribe. While remnants of trade with Mexico exist–pottery, copper bells, and macaw skeletons–there's little evidence of Mexicans' living in the area at the time. Turner's theory hangs on one skull found with notched teeth, a practice common in Mexico but rare in the Southwest. "Turner stepped beyond his level of expertise," sniffs Steven LeBlanc, director of collections at Harvard's Peabody Museum of Archaeology and Ethnology

Turner has his allies. Tim White, professor of human evolutionary studies at the University of California-Berkeley, compared broken, scarred, and scattered Anasazi and animal bones from Mancos Canyon in Colorado and discovered striking similarities. He dismisses the reburial theory, saying no other society uses the same method to prepare food and bury its dead. Even so, he refuses to speculate about who was behind the cannibalism. 'It's too early,' he says" (Hartigan).

"Regardless of whether one accepts Christie Turner's theories of rampant cannibalism, he makes a convincing case that whatever led to these bone assemblages, it was violent and mutilative. Gastronomic customs aside, something terrible happened to these people and cannibalism is only one tentative detail in something far more complex. While people rush off to rewrite cannibalism into the history of the Anasazi or Ancestral Pueblo, it is important to note that it is as of yet uncertain who were the victims and their attackers" (Burn).

The tribes north of Durango and Sinaloa, Mexico eliminated cannibalism before the arrival of the Spanish (Lascano).

"I believe there were times in the Southwest when cannibalism was necessary. As a child, I heard stories of historic Pueblo people's resorting to eating other people during times of extreme stress" (Swentzell).

"There were also people who had traditions of human sacrifice, who were also not admitted (into the Hopi)" (Emory Sekaquaptewa).

Chaco time period decline in the level of warfare. Significant increase in warfare after C.E. 1200 (LeBlanc) - My research indicates that the Chaco Canyon Anasazi developed strategies for producing large surpluses of corn which led to an extended period of relative peace, but eventually led to increased population, depletion of available dietary iron (local wildlife populations) and eventually increased warfare. The Chaco Canyon people likely intermarried with the peoples of the Great Sage Plain (Cortez-Dove Creek) in southeastern Colorado (Breternitz). As violence increased, people began to move permanently into the large centers such as Yellow Jacket, Lowry, Sand Canyon, and Escalante. As the Great Drought of C.E. 1276-1299 pushed the environment to the limit, the granaries were emptied of corn and people moved into these structures until the abandonment in approximately C.E. 1280 (Kunkleman).

Chaco Canyon colonizers came into the established Great Sage Plain communities, intermarried and built their special style of great houses such as Lowry, Ida Jean, Goodman Point, Escalante, Sand Canyon, and Wallace. There were two distinct periods of colonization in the C.E. 1090's and the C.E. 1120's . Most, if not all, of the great houses were abandoned at about C.E. 1150 which marks the end of the Chaco era throughout the region. The entire region was abandoned by C.E. 1300 (Breternitz).

I propose that the Chaco Canyon Anasazi brought with them their design of great corn silos. It is my proposal that centralized storage facilities (grain silos) was one of the unique Chaco Canyon architectural innovations. The Great Sage Plain Anasazi adapted these as they proved to be an ideal way for long term storage of corn as well as a great social center where corn beer was perhaps one of the important motivators for the life style during this time period C.E. 1090-1275.

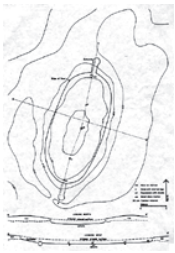
Abandonment and Reuse - "Twenty-five to thirty percent of the Anasazi could have survived with the resources available during the great drought" (C.E. 1276-1299) (Gummerman). I observe that archaeologists are not currently looking at the specific impacts of severe anemia, but rather are addressing a general decline in food resources throughout the region during the great drought.

It has been demonstrated that the Anasazi survived numerous droughts, and I believe their long term storage capacity in the system of silo/kivas may also have cushioned them in such a way as they could have survived the great drought as well. They certainly could have returned after the great drought, which they did not. I propose that it was a near extinction of large game animals throughout the region and the rarity of smaller game that made it virtually impossible for the Anasazi to reestablish their culture in the San Juan Basin. The large game animals may take hundreds of years to repopulate their former ranges preventing the Anasazi from returning after the drought. I further point out that there were previous abandonments in the San Juan Basin and that brief periods of re-population were possible for a short period of time. Chaco Canyon was abandoned in approximately C.E. 1150 and re-inhabited for a short period in C.E. 1250 by Aztec and Mesa Verde peoples (Bodnar).

Reported Anemia Percentages at Selected Anasazi Sites

Site	Timeline	Children	Adults
Black Mesa	(A.D. 800-1150)	85.40%	89.30%
Canyon de Chelly	(A.D. 700-1300)	88.00%	45.90%
Kayenta area	(A.D. 1000-1150)	42.90%	9.50%
Chaco Canyon	(A.D.900-1150)	88.30%	65.00%
Navajo Reservoir	(A.D.700-1100)	15.90%	10.40%
Kayenta-Puerco	(A.D.1150-1250)	46.70%	10.00%
Inscription Housse	(A.D.1250-1300)	63.60%	46.20%
Arroyo Hondo	(A.D. 1300-1350)	20.80%	0%

Hohokam Agricultural Strategies



Small court at Snaketown (Gladwin and others 1937)

It is very easy to see how Emil H. Haury in 1935 saw a "ballcourt" at the newly half-excavated Snaketown topographical depression. It certainly "looks like" a ballcourt. After 68 years, however, there is no definitive evidence for the ballcourt hypothesis. With over 200 "courts" identified, it would be expected that some distinctive evidence would have emerged. From 1935 to the present, the only other hypothesis suggested was a dance floor. With our new proposal for fertilizer dehydration basin, we argue that if the ancients constructed topographical depressions that collect water, this was their intended purpose.

Test Formula for Sweetwater Fertilizer

1 gallon distilled water
3 cups native mesquite/ palo verde detritus
1 cup interior of dove nest
1 tablespoon night soil
2 cups material from below wild bird feeder
2 tablespoons dead insects (drowned bees, ants, wasps)
1/2 cup charcoal
2 tablespoons bird and rodent droppings

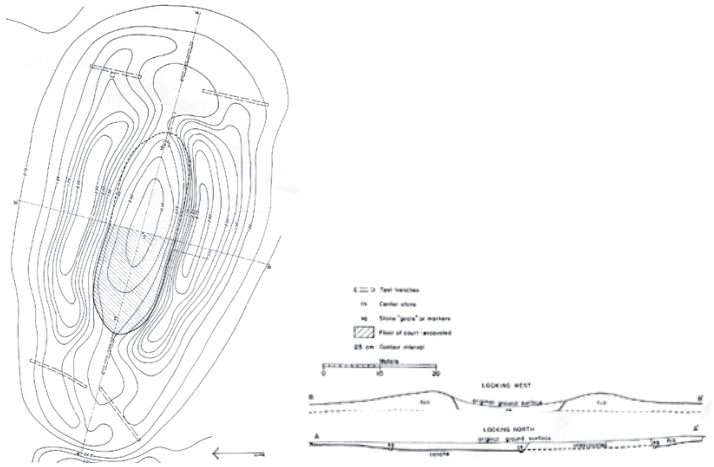
Let mixture stand in the sun for five days at 75-105 degrees Fahrenheit and average 50% humidity.

Ionization test for nitrogen and phosphorus

1. Sweetwater Phosphate=369mg/L Ammonia=215mg/L
2. Sweetwater/Organic Mulch mix Phosphate=401mg/L Ammonia= 227mg/L

(testing by Tom Huntsberger, Analytical Services Lab. Northern Arizona University August 4,2003)

Dr. Dean Blinn: this is a very high quality organic liquid fertilizer.



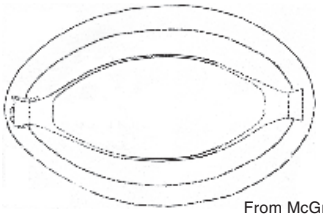
Large court at Snaketown (Gladwin and others 1937)

Characteristics of Fertilizer dehydration basin-*Paquimé Slot Catchment, Hohokam Oval Dish Catchment, Anasazi Masonry Mulching Ponds*

1. Topographically centralized depressions behind one or two oval or circular dams of masonry or earth.
2. Designed and function to collect rainwater from a relatively limited area or catchment.
3. Hold water for a short period of time, especially associated with monsoonal weather patterns.
4. Stratigraphy demonstrates a distinct layer of organic material above a floor sealed with plaster, adobe mud, or caliche.
5. Often associated with shards of water transport vessels of high quality and design features.
6. Located near towns or habitations which have a more proximate water supply of higher quality and/or quantity.
7. Also found in predominantly agricultural resource areas not closely/directly associated with known towns or habitations.
8. Two Sinagua sites, Wupatki and Winona Village, share characteristics with the Anasazi site of Mummy Lake, Mesa Verde, in that they have two masonry walls on the perimeter of the "ballcourt" which are filled, at least in part, with sediment taken from the "dish shaped" plastered floor.

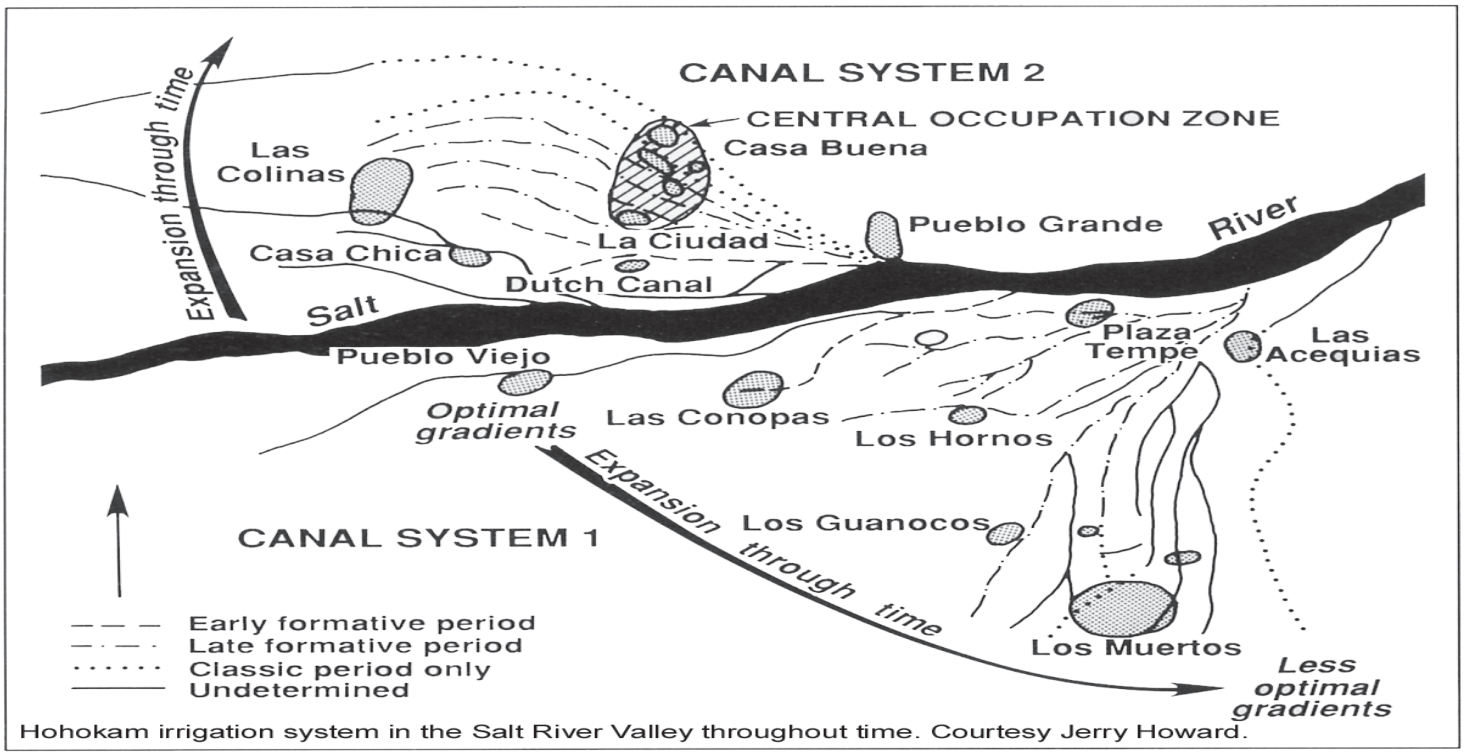
At Woods Canyon Reservoir, Richard A Wilshusen notes there was extensive "clearing of this sediment and placement on top of the dam ... must represent an ongoing process, otherwise the catchment basin would have filled only with sediment ... the soil in the immediate area is of sufficient quality to germinate corn or beans .... vessel forms combined with the high percentage of white ware are quite appropriate for dipping water, transporting water a short distance, or excavating muddy sediments from the basin ... it is of course possible that the basin was used for agricultural purposes ... over 77% of all the sherds are white wares, and the predominant form is jars ... this is a very different assemblage than any other site in our experience ... finally, the extremely high percentage of white ware jars and relative paucity of gray ware suggests a special-use site rather than a habitation site ... [at] Mummy Lake excavations, 86% are jar forms and 87% are white wares ... [Ponding] features such as Woods Canyon Reservoir, Little Cajon Lake, Goodman Lake, and Moqui Lake are not physically a part of a large site, although large potential Chaco-era communities are usually within 2 km...." Wilshusen, Churchill, Potter

Identified as "possible Hohokam ballgame handstones." From Wilcox/Sternberg. Our perhaps more probable explanation is hoe or shovel implements for these stone age agriculturalists with their extensive canal systems. Hoe blade widths range from 3-10 inches (below).



From McGregor

Wupatki, AZ topographical schematic "Ballcourts" -vs- Fertilizer Dehydration Basin. Both were designed to gather and contain water. Note the conspicuous absence of drains as designed into the Paquimé ballcourt (above).



Hohokam irrigation system in the Salt River Valley throughout time. Courtesy Jerry Howard.

The Hohokam Canal System and Mesquite - The Hohokam canal system was probably built primarily for the cultivation of a Mesquite Bosque. It has been long questioned why the Hohokam built such an extensive system on one of the saltiest rivers in North American. Bean and especially corn cultivation is moderately to severely impacted by saline water and salinity. Mesquite is not impacted by levels of salinity found in the Salt River basin. My observation is that the Hohokam's primary reason was to grow mesquite in the "delta" shaped canal system and mesquite conditioned the soil for corn and beans with nitrogen, and shade temperature reduction, and moderated freeze sensitivity in the winter.

Prosopis L. Mesquite, as described by Franklin T. Bonner, scientist emeritus USDA Forest Service, is a tree which is "a hardy nitrogen-fixer. Mesquite legumes make high-quality forage for livestock and wildlife, and the seeds were widely used by Native American peoples in the Southwest (Davis and others 1975; Marting and Alexander 1974; Vines 1960). The crude protein contents of honey and velvet mesquite seeds are 31 and 24%, respectively (Becker and Grosjean 1980), and the legumes of honey mesquite are high in carbohydrates (Harden and Zolfaghari 1988)."

Professor Todd Bostwick said "the Hohokam would have always faced the challenge of soil salinity, yet they farmed the same region for more than a thousand years, indicating that they understood how to deal with soil salinity — through the flushing of soils, leaving certain tracts fallow, alternating crop types planted, and other soil management techniques. Mesquite comprises approximately 50% of the archaeological record as compared to corn and beans."

While I agree with Professor Bostwick, my observation indicates that, from the archaeological record, the canal system was built primarily to "grow mesquite" for food, fire wood, and building materials. Worldwide, especially in very arid climates, trees are grown as an agricultural crop, and the Hohokam were doing the same.

Mesquite is a legume and as such it provides probably the "other" soil management technique used to add fertilizing soluble nitrates the soils.



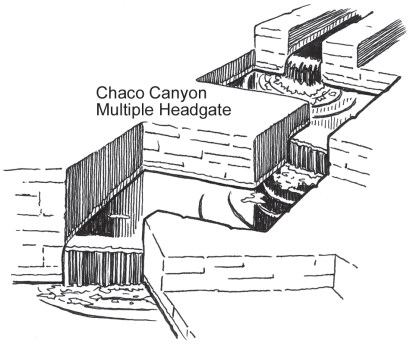
When provided with adequate water, native mesquite produces a prolific supply of food, building material, and firewood. Mesquite is approximately 50% of the food product recovered from Hohokam sites.

In interviews, neither professors Bostwick nor Howard, indicated that the Hohokam used "grid gardens" which have been proposed as the primary agricultural design during that time period elsewhere in Oasis America. I suggest that the Salt River mesquite delta across the Phoenix Valley also functioned in such a way as the salty water was used very little for corn and beans or perhaps not used at all. The primary parasite for corn is root cutworm and with very few hours below freezing each year, gardens in the Phoenix Valley could perhaps have only been used for a year or two maximum due to root cutworm infestations. I propose that the strategy used by the Hohokam was to maintain an extensive mesquite forest watered by the canal system and that the gardens for corn and beans were moved throughout the "delta" continuously.

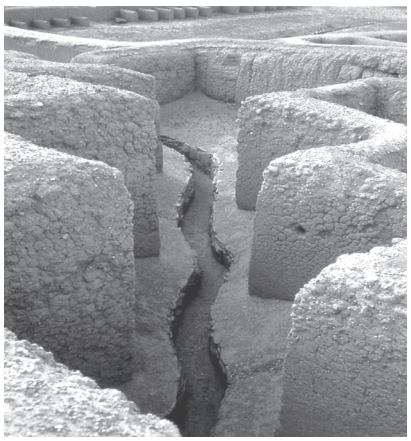
Another factor to consider is that some of the canals are very deeply incised. This would have put the irrigation water well below any usable level for corn and beans, but would have been ideal to water the deep tap roots of the mesquite.

Religious Ceramic/Rock Art/Architectural Design

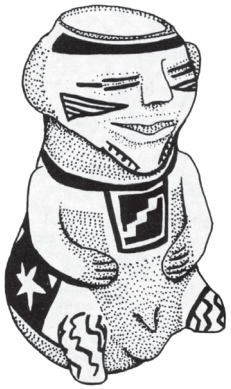
The Fertilizer Design Pattern
Chaco-Paquimé



Chaco Canyon accentuated "stepfret" design - At Chaco Canyon the "stepfret" ceramic design is very dramatic and sharply pointed. I believe the black and white relief symbolizes a dualistic universe, male and female. I also suggest that the very sharply angular stepfret design used at Chaco is indicative of male lightning which they associated with fertile rainfall. At Chaco the stepfret was primarily lightning male and at other Anasazi locations represented the more female 90 degree angle step (above).



Paquimé stepfret design was built directly into the architecture of the site. The fact that it is surrounding an underground sewer line, I propose, is evidence that it is the design associated with naturally occurring, as well as human produced, fertilizer (above).



Salado Effigy
AD 1350

Villa Ahumada Male
AD 1350

Villa Ahumada Female
AD 1350

Paquimé Effigy
AD 1425

Photo images courtesy of Logan Museum of Anthropology

"Sky, clouds, lightning, precipitation, and the wind - strong evidence that the associated beliefs concerned fertility and weather control. The icons thus provide evidence for the existence of an earth/fertility cult ... beliefs involving the well-being of the collective and the earth rather than the well-being of the individual and ancestors.... This uniformity in design styles on a virtually pansouthwestern basis suggest that the design transcend whatever regional economic systems existed in the 1300s. It further indicates that designs masked rather than emphasized any economic or political boundaries extant at this time." Ceramics and Ideology by Patricia L. Crown, Ph.D.

Zuni symbolism indicates that "every design is significant ... the tendency at Zuni to invariably associate decorative designs with ideas of a religious character. This is not a personal peculiarity of one woman, but is a general pattern of Zuni thought.... An overwhelming number of designs suggest clouds of different kinds, - rain, snow, wind, lightning, flowers 'because they come out after the rain.'" The Pueblo Potter by Ruth L. Bunzel, Ph.D.

Step-fret and spiral designs throughout the Anasazi world and well beyond demonstrate similar religious belief systems. The designs can be seen as similar to the yin/yang concept of Oriental religions; the Tarahumara culture explains them as a male/female relationship. The Tarahumara religious and cultural concept of step-fret and spiral design patterns is in fact so simple as to be almost painful. Their belief system is that the universe and the earth are made up of two essential components-male and female-which fit together in an exactly matching cosmic unity.

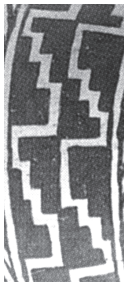
These designs demonstrate the weight of their significance throughout the Oasis America culture by the fact they were reproduced perhaps many millions of times on ceramics as well as in massive architecture as seen at Paquimé and perhaps Zuni.

Along with Scarlet Macaws and many other common features, these designs can be seen to indicate a shared religious belief system throughout the region and throughout the 250+ year time frame from Mesa Verde in the north to Paquimé in the south. Other theories proposed include: this design has no specific meaning; it is a simple cloud pattern; it originates from the basket weave designs of 400 years earlier.

Salado Jar
AD 1300

Chaco Jar
AD 1100

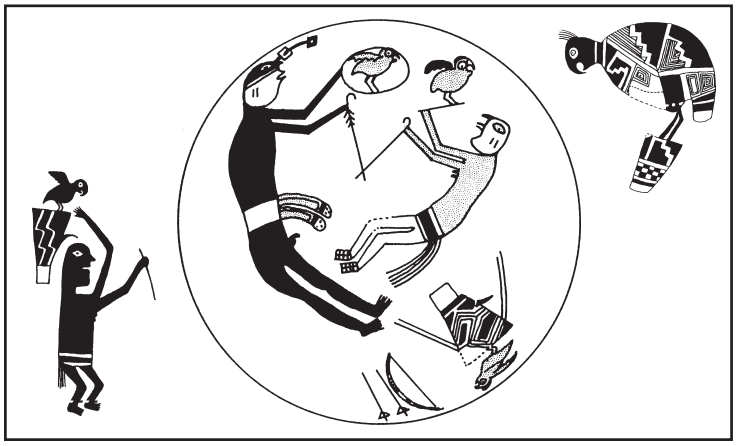
Mimbres Bowl
AD 1100



Anasazi Mug
AD 1200

"One yin, one yang, that is the Tao." This quotation is the first known reference to Yin and Yang, the pair of polar energies whose cyclic fluctuations and interactions cause and govern Creation. Yin is the moon, water, and earth. Yang is the sun, fire, and heavens. Yin corresponds to the dark, the receptive, the passive, the feminine. Yang corresponds to the bright, the creative, the active, the masculine.

This is a dynamic symbol showing the continual interaction and balance of the two energies, and as such it is a very harmonizing symbol. As each of these energies reaches its apogee, it begins to transform into its opposite, and this is shown by the dots in the symbol. At its height, yang contains the seed of yin, just as yin contains the seed of yang. "Everything has yin and yang in it and from their rise and fall coupling comes new life." Tao-te Ching *by Lao-tzu*



The Mimbres polychrome representation (above) shows the "vision quest" sky deity delivering the macaw in an enclosed seed casing through the "staff(s) of authority" to the earth female deity, as the macaw enters the natural sphere of existence. Notice the strong step-fret design pattern associated with the separate macaw on carrying basket and with the kokopelli macaw trader.

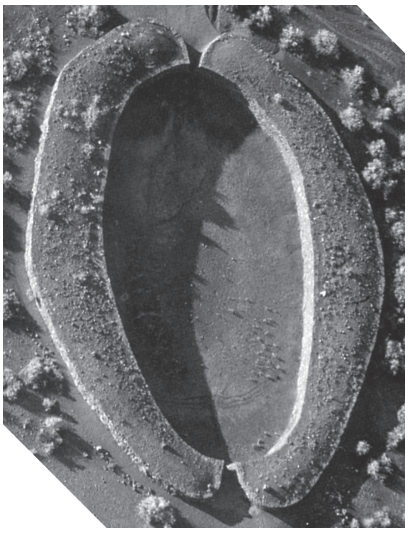
Paquimé archaeologist (Charles DiPeso) is shown (right) with anthropomorphic male "plug" from the stone birth canal of the ceremonial macaw birthing chambers. These enclosures have been previously interpreted as macaw nesting boxes. It is noted, however, that macaws are very unlikely to breed and nest under the conditions illustrated in the lower right photographs. The original interpretation given here is that the macaws exit mother earth during major religious ceremonies, most likely at the spring equinox. As they walk into the light they are lifted by the priest to greet the father sky.

The "macaw stones" or doors to parrot pens show an isomorphic patterning with ballcourt distribution (Whalen and Minnis 1996). Our interpretation is that many of the architectural structures identified as "ballcourts" are actually fertilizer dehydration basin. The macaw stones were used as water control devices in this context and also have the religious connotation of releasing the fertile water, thereby completing the rainwater/fertility cycle for the corn crop. This is a completely new concept, and as far as is known, the actual layout and design of the fertilizer dehydration basin relating to the macaw stone cannot be understood without further study.

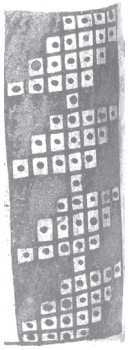
Jornada Mogollon Tlaloc (above and right) AD 750-1000

Fertilizer Rosetta Stone Illustration Interpreted by Tarahumara Ethnographic Evidence

Male Sky God with "stepfret" lightening legs. Three Rivers Petroglyph. Permission granted Joe Ben Sanders. Monumental art-female fertile rain attractor. Practical application is the making of fertilizer from a mix of rain associated with lightning and detritus/waste materials in what I now call a fertilizer dehydration basin (right) Wupatki Basin. Permission granted Adriel Heisey.



Charles DiPeso examines the obvious male/femaile relationship with the Macaw enclosure doorways. I propose this again, is the basic symbolism used for the dualistic nature that was revered by the Pre-Columbian Oasis America cultures.



Chacoan Solid Step-Fret Background with Male/Female Box Dot AD 1100

References

Adams, Robert M. 2003. A New Paradigm for the Comprehensive Reinterpretation of Southwestern Archaeology: The Kiva as Corn Bin. Privately distributed draft: Natchez, MS.

Allen, Craig D. 2004. U.S. Geological Survey, Jemez Mountains Field Station. Pajarito Plateau classic pueblo period (A.D. 1400) reservoirs and water retention structures, lightning strike density, production of rainfall in the Jemez and other mountain ranges in northwestern New Mexico. Personal interview with Richard D. Fisher. April 1, 2004.

Allen, Paul L. 2002. The Mystery Rekindled: An archaeologist's controversial new theory speculates they were just corn silos. *The Tucson Citizen*. November 16, 2002. Tucson, AZ.

Andrews, John P. and Todd W. Bostwick 1997. Desert Farmers at the River's Edge: The Hohokam and Pueblo Grande. City of Phoenix, Parks, Recreation and Library Department, Pueblo Grande Museum and Cultural Park: Phoenix, AZ.

Arts & Entertainment 2005. Cannibals. Program #44289 (Broadcasted on the History Channel, Spring 2005), A&E Television Network, New York, NY.

Atkins, Nancy J. 2001. Chaco Canyon Mortuary Practices Archaeological Correlates of Complexity. In A*ncient Burial Practices in the American Southwest*, edited by Douglas R. Mitchell and Judy L. Brunson-Hadley. Arizona State Museum Library: Tucson, AZ.

Bach, Dan 2004. Types and Applications of Naturally Occurring Fertilizers. M.A. Plant Physiology and Owner, Bach's Cactus Nursery, Tucson, Arizona. Personal Interview with Richard D. Fisher, June 4, 2004.

Barey, Patricia 1990. *Bandelier National Monument*. Southwest Parks and Monuments Association: Tucson, AZ.

Bauer, Kate 2005. *Archaeoagricultural Considerations at Chetro Ketl and Casa Rinconada; Chaco Canyon, New Mexico.* Personal communication: Richard D. Fisher.

Bayman, James M. and Suzanne K. Fish *1992.* Reservoirs and Locational Shifts in Sonoran Desert Subsistence. In *Research in Economic Anthropology*, Supplement 6, pp. 267-306. JAI Press, Inc.: Greenwich, CT.

Belnap, Jayne 2004. Impacts of Climate Change on Life and Ecosystems Cryptobiotic Soils: Holding the Place. U.S. Department of the Interior, U.S. Geological Survey http://geochange.er.usgs.gov/sw/impacts/biology/crypto/

Cryptobiotic Soil http://www.canyoneering.com/environment/crypto.html

Benson, Larry and Linda Cordell 2003. Ancient Maize from Chacoan Great Houses: Where was it grown? US Geologic Survey, PNAS, October 28, 2003, vol. 100, no. 22, 13111-13115 http://www.pnas.org/cgi/content/abstract/100/22/13111

Berdan, Frances F. 1982. *The Aztecs of Central Mexico: An Imperial Society*. Case Studies in Cultural Anthropology, pp. 19-23. CBS College Publishing: New York, NY.

Berton, Pierre 1965. The Klondike Fever: The Life and Death of the Last Great Gold Rush. Alfred A. Knopf: New York, NY. 1966. Klondike: The Last Great Gold Rush 1896-1899. (revised edition) McClelland and Stewart Ltd.: Toronto.

Bodnar, Russ 2005. Chief of Interpretation, Chaco Culture National Historic Park, New Mexico. Dates for Chacoan Sites. Personal interview with Richard D. Fisher, July 13, 2005

Bohrer, Vorsila L. 2005. Retired, Department of Anthropology, Eastern new Mexico University and Owner, Southwestern Ethno-Botanical Enterprises. Cryptobiotic Soils. Personal interview with Richard D. Fisher, July 20, 2005.

Bonner Franklin T. Scientist Emeritus – USDA Forest Service, Southern Research Station, Mississippi State, MS. http://wpsm.net/Prosopis.pdf.

Bostwick, Todd W. 2003. City Archaeologist, City of Phoenix, AZ. Pueblo Grande Museum. High mortality of Hohokam women during childbearing years and anemia. Personal Interview with Richard D. Fisher. August 2003. 1993. The Northwestern Ballcourt. In *Archaeology of the Pueblo Grande Platform Mound and Surrounding Features Vol. 2; Features in the Central Precinct of the Pueblo Grande Community,* edited by Todd W. Bostwick and Christian E. Downum, pp. 131-143. Pueblo Grande Museum Anthropological Papers No. 1. Pueblo Grande Museum, Parks, Recreation and Library Department: Phoenix, AZ.

Breternitz, David 2005. Professor Emeritus, Department Southwest Archaeology, Colorado University at Boulder. Great Sage Plain Great Houses CE1090-1150. Personal interview with Richard D. Fisher, June 31, 2005.

Britt, Robert Roy 1999. Lightning Interacts with Space, Electrons Rain Down. December 16, 1999. Space.com http://www.space.com/scienceastronomy/planetearth/space_lightning_991216.html

Bullock, Peter Y. 1991. *Macaws at Casas Grandes and in the American Southwest*. Manuscript on file, Office of Archaeological Studies, Museum of New Mexico: Santa Fe, NM.

Bullock, Peter Y. and Alan Cooper 2002. Ancient DNA and Macaw Identification in the American Southwest: A Progress Report. The Artifact, Volume 40, pp. 1-10. The Society: El Paso, TX.

Bunzel, Ruth L. 1972. *The Pueblo Potter: A Study of Creative Imagination in Primitive Art*. Dover Press: New York, NY.

Burn, Infinite 2004. Cannibalism in the American Southwest. http://www.everything2.com/index.pl?node_id=1689904

Byzant Symbols 2003. www.byzant.com

California Foundation for Agriculture in the Classroom 2003. Plant Nutrients - Nitrogen. Natural Resource Fact Sheet. Composed by the California Foundation for Agriculture in the Classroom (CFAITC). Sacramento, CA. http://www.cfaitc.org/Commodity/pdf/nitrogen.pdf

Chandler, Vicky, Ph.D. 2004. Regents' Professor, Dept. of Plant Science, University of Arizona. Maize Sensitivity to Salinity. Personal interview with Richard D. Fisher. March 29, 2004.

Cheek, Lawrence W. 1994. *A.D. 1250 Ancient Peoples of the Southwest*. Arizona Highways Book Division, Arizona Department of Transportation: Phoenix, AZ.

Chhabra, Ranbir 1996. Soil Salinity and Water Quality. A.A. Balkema: Brookfield, VT.

Clark, Jeffery J. and Jeames M. Vint, Editors 2000. Tonto Creek Archaeological Project Archaeological Investigations Along Tonto Creek, Volume 2: Site *Descriptions for the Punkin Center Section.* Anthropological Papers No. 22. Center for Desert Archaeology: Tucson, AZ.

Cordell, Linda S. 2004. "Chaco's Corn: Where was it Grown", in In Search of Chaco: New Approaches to an Archaeological Enigma edited by David Grant Noble. School of American Research Press, Santa Fe, NM.

Cordy, Gail E. 2004. USGS, Tucson Office, Tucson, AZ. Comparative Salinity of Eight Southwestern Rivers. Personal interview/email exchange with Richard D. Fisher. March 30, 2004.

Crown, Patricia L. 1994. *Ceramics & Ideology: Salado Polychrome Pottery*. University of New Mexico Press: Albuquerque, NM.

Damp, Jonathon, Ph.D. 2004. Principal Investigator, Zuni Cultural Resource Enterprise , Zuni, New Mexico . Abundant Summer Rainfall AD1050-1150 Chaco Period. Personal Interview with Richard D. Fisher, May 27, 2004.

Dean, Jeff 2005. Professor of Dendocronology-Laboratory of Tree Ring Research, University of Arizona, Tucson, AZ. Chaco High and Low Precipitation. Personal interview with Richard D. Fisher, June 30, 2005.

Di Peso, Charles C. 1974. *Casas Grandes, A Fallen Trading Center of the Gran Chichimeca*, Volume 2. The Amerind Foundation, Inc.: Dragoon, AZ.

DiPeso, Charles C., John B. Rinaldo and Gloria J. Fenner 1973. *Casas Grandes, A Fallen Trading Center of the Gran Chichimeca,* Volumes 4, 8. The Amerind Foundation, Inc.: Dragoon, AZ.

Durand, Stephen R. and Kathy Roler Durand 2000. Notes from the Edge: Settlement Pattern Changes at the Guadalupe Community in *Great House Communities Across the Chacoan Landscape,* edited by John Kantner and Nancy M. Mahoney. University of Arizona Press: Tucson, AZ.

Ergle, Mary Ellen 2001. Tlingit Packers Over the Chilkoot Trail: Rates and Pounds Carried. National Park Service. Government Printing Office: Washington, DC.

Ferdon, Edwin N., Jr. 1967. The Hohokam "Ball Court:" An Alternate View of its Function. In *The Kiva* 33(1): 1-12. Arizona Archaeological and Historical Society, Arizona State Museum: Tucson, AZ.

Fish, Paul R., Peter J. Pilles, Jr. and Suzanne K. Fish 1980. Colonies, Traders and Traits: The Hohokam in the North. In *Current Issues in Hohokam Prehistory, Proceedings of a Symposium,* edited

by David Doyel and Fred Plog, pp. 151-175. Anthropological Research Papers No. 23. Arizona State University: Tempe, AZ.

Foster, Michael S. and Shirley Gorenstein, Editors 2000. Greater Mesoamerica: The Archaeology of West and Northwest Mexico. The University of Utah Press: Salt Lake City, UT.

Friedman, Richard 2005. GIS Supervisor, City of Farmington, Farmington, New Mexico. Roads. Personal interview with Richard D. Fisher July 12-13, 2005.

Friedman, Richard, John Stein, and Taft Blackhorse 2005. Pyramids. Personal interview between Richard Freedman and Richard D. Fisher July 12-13, 2005.

Frisbie, Theodore R. 1985. The Chaco Phenomenon and Spanish Colonial Missions Commonality through Paucity. *In Prehistory and History in the Southwest,* edited by Nancy L. Fox. Papers of the Archaeological Society of New Mexico 11:73-90. Archaeological Society of New Mexico: Albuquerque, NM.

Funston, Frederick 1896. *Over the Chilkoot Pass to the Yukon*. Scribners: New York, NY.

Gehrke, Robert Associated Press Writer. Anasazi Practiced Cannibalism? One Scientist Thinks So. Deseret Morning News publication, Salt Lake City, UT. http://www.newnation.org/NCR/reference/NCR-Anasazi.html

Greer, Sheila C. 1994. *Skookum Stories on the Chilkoot/Dyea Trail.* Carcross-Tagish First Nations: Carcross, Yukon Territory.

Gilpin, Dennis 2005. SWCA Environmental Consultant, Flagstaff, AZ. Great Houses with Possible Mounds. Personal interview with Richard D. Fisher, April 22, 2005.

Grivetti, Louis E. 2005. Nutritionist in Agricultural Experiment Station, Department of Nutrition, University of California at Davis. Personal interview with Richard D. Fisher, April 28, 2005.

Gummerman, George 2005. Anasazi Numerical Survival in the San Juan Basin. Personal interview with Richard D. Fisher July 13, 2005.

Gummerman, George, Timothy A. Kohler, and Robert G. Reynolds 2005. *Simulating Ancient Societies* in Scientific American, July 2005.

Hansen, Richard D. *2003. The Architectural Development of an Early Maya Structure at Nakbe, Peten, Guatemala*. Report submitted to FAMSI (Foundation for the Advancement of Mesoamerican Studies, Inc.). Personal Interview with Richard D. Fisher, May 18, 2004.

Harris, Marvin 1977. Cannibals and Kings: The Origins of Cultures. Vintage Books-Random House, New York, NY.

Hart, E. Richard 2003. Pedro Pino; Governor of Zuni Pueblo, 1830-1878. Utah State University Press, Logan, UT.

Hartigan, Rachel 2000. Dying for Dinner: A Debate Rages Over Desert Cannibalism. U.S. News and World Report, July 24, 2000 edition. www.usnews.com/usnews/doubleissue/mysteries/anasazi.htm

Haury, Emil W. 1965. Ball Courts. In Excavations in Snaketowns Material Culture, University of Arizona Press, Tucson, AZ. *1932. Roosevelt:9:6 A Hohokam Site of the Colonial Period*. Medallion Papers No. XI. The Medallion: Gila Pueblo; Globe, AZ.

Healy, J. 1929. Papers in Ms. Stefansson Collection. Dartmouth College Library: Hanover, NH. Photocopy on file, Yukon National Historical Sites; Whitehorse, Yukon Territory.

Heisey, Adriel 2005. Ultra light aerial photography. 2004. Aerial Photographer, Tucson , Arizona . Aerial Photography and Observable Aerial Phenomena of the Chacoan Road System. Personal Interview with Richard D. Fisher, June 3, 2004 .

Howard, Jerry 1991. Permission to use Hohokam Irrigation system in the Salt River Valley through time diagram 5/6/05. from page 8 of Article by David E. Doyel, The Hohokam; Ancient Dwellers of the Arizona Desert in the book The Hohokam Ancient People of the Desert. Ed. David Grant Noble. School of American Research Press, Santa Fe, NM.

Huntsberger, Tom 2003. Director, Analytical Services Lab, Northern Arizona University, Flagstaff, AZ. Cryptobiotic Soil Soluble Nitrates Testing After Monsoon Storm. Personal interview with Richard D. Fisher, August 4, 2003

Imster, Eleanor 2001. Earth & Sky Radio Series Interview, Nitrogen Fertilizer. January 29, 2001. Byrd & Block Communications Inc. http://www.earthsky.com/shows/shows.php?t=20010129

Johnson, George 1995. Social Strife May Have Exiled Ancient Indians. *The New York Times.* August, 20, 1996. New York, NY.

Kantner, John and Nancy M. Mahoney (ed.) 2000. *Great House Communities Across the Chacoan Landscape*. Anthropological Papers of the University of Arizona No. 64. The University of Arizona Press: Tucson, AZ.

Keys, David 1998. *Catastrophe: An Investigation into the Origins of the Modern World.* Ballentine Books: New York, NY.

KIDDE Safety 1998. *Nightthawk Carbon Monoxide Alarm User's Guide*. KIDDE Safety. Mebane, NC.

Kimball, John W. 2004. Professor Emeritus Biology/Immunology, Harvard University, "Fixed" Nitrogen from Thunderstorms. Personal Interview and email exchange with Richard D. Fisher, March 25, 2004

2004. Nitrogen Cycle. Kimball's Biology Pages. http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html

Hurst, Winston B. 2000. Chaco Outlier or Backwoods Pretender? A Provincial Great House at Edge of the Cedars Ruin, Utah in *Great House Communities Across the Chacoan Landscape,* edited by John Kantner and Nancy M. Mahoney. University of Arizona Press: Tucson, AZ.

Kincaid, Chris 2005. Branch Chief for Cultural Resources, Glen Canyon National Recreation Area, AZ, Project Director - Chaco Roads Project Phase I, 1983. Stratigrophy and Palynology. Personal Interview with Richard D. Fisher May 13, 2005.

2004. Bureau of Land Management Coordinator, Glen Canyon National Recreation Area, Page, Arizona. Chaco Road Systems. Personal Interview with Richard D. Fisher, June 3, 2004

Kohler, Timothy A. 2005. Professor & Interim Chair, Department Anthropology, Washington State University, Pullman, WA. and Research Associate, Crow Canyon Archaeological Center, Cortez, NM. Climate on the Great Sage Plain. Personal interview with Richard D. Fisher June 29, 2005

Kuckelman, Kristin 2005. Senior Research Archaeologist, Crow Canyon Archaeology Center, Cortez, CO. Discussion of Lowry Kiva and related issues. Personal interview with Richard D. Fisher, June 29, 2005

Kuwanwisiwma, Leigh J. 2004. Chapter 6 – Yupkoyvi: The Hopi Story of Chaco Canyon. In In Search of Chaco: New Approaches to an Archaeological Enigma, edited by David Grant Noble. School of American Research: Santa Fe, NM.

Lazcano, Carlos 2001. Ecotourism Director/Archaeological Researcher, Chihuahua State Government, Chihuahua, Mexico. Cannibalism. Personal interview with Richard D. Fisher, April 2001.

1999. *Exploring a Forgotten World: Lost Sites of the Paquimé Culture*. Grupo Cementos de Chihuahua Editorial México Desconocido, S.A. de C.V.

Leblanc, Stephen A. 2005. Chaco time period decline in the level of warfare. Significant increase in warfare after CE1200. Personal interview with Richard D. Fisher June 28, 2005.

Lekson, Stephen H. 2004. Architecture: The Central Matter of Chaco Canyon. In *In Search of Chaco: New Approaches to an Archaeological Enigma,* edited by David Grant Noble. School of American Research: Santa Fe, NM.

2000. Great! Chapter 12 in *Great House Communities Across the Chacoan Landscape,* edited by John Kantner and Nancy M. Mahoney. University of Arizona Press: Tucson, AZ.

Lindauer, Owen 1978. The Place of the Storehouses Roosevelt Platform Mound Study Report on the Schoolhouse Point *Mound, Pinto Creek Complex, Part 1*. Roosevelt Monograph Series 6, Anthropological Field Studies 35. Arizona State University: Tempe, AZ.

1978. The Place of the Storehouses Roosevelt Platform Mound Study Report on the Schoolhouse Point Mound, Pinto Creek Complex, Part 2. Roosevelt Monograph Series 6, Anthropological Field Studies 35. Arizona State University: Tempe, AZ.

Lindsay, Alexander J., Jr. 1965. *Preliminary Report on Excavations at the Wupatki Ball Court.* Wupatki National Monument, National Park Service. Flagstaff Area National Monuments: Flagstaff, AZ.

Long, Paul V., Jr. 1966. Archaeological Excavations in Lower Glen Canyon, Utah, 1959-1960. *Glen Canyon Series No. 7, Museum of Northern Arizona Bulletin 42:63-68.* Museum of Northern Arizona: Flagstaff, AZ.

Loose, Richard W. 2005. Senior Laser Systems Engineer, BAE Systems, High Energy Laser Systems Test Facility (HELSTF), White Sands Missile Range, NM. Chetro Ketl Fields. Personal interview with Richard D. Fisher July 26, 2005.

Loose, Richard W. and Thomas R. Lyons 1976. The Chetro Ketl Field: A Planned Water Control System in Chaco Canyon. In Remote Sensing Experiments in Cultural Resource Studies: Non-destructive Methods of Archaeological Exploration, Survey, and Analysis, assembled by Thomas R. Lyons. Reports of the Chaco Center, Number One. National Park Service U.S. Department of the Interior and University of New Mexico, Albuquerque, NM.

Lumholtz, Carl 1902. Unknown Mexico, Chapters 4-22. In *History of Copper Canyon and the Tarahumara Indians,* Anthology 2000; edited by Richard D. Fisher. Sunracer Publications: Tucson, AZ.

Lyons, Patrick 2005. Preservation Archaeologists, The Center for Desert Archaeology, Tucson, AZ. Origin Dates for Corn Cultivation in the Southwest. Personal interview with Richard D. Fisher, July 25, 2005.

Mabry, Jonathon 2005. Sr. Project Director, Desert Archaeology, Tucson, AZ. Hohokam Ballcourt Dates C.E. 800-1100. Personal interview with Richard D. Fisher July 27, 2005.

Mahoney, Nancy M. 2000. Redefining the Scale of Chacoan Communities in *Great House Communities Across the Chacoan Landscape,* edited by John Kantner and Nancy M. Mahoney. University of Arizona Press: Tucson, AZ.

Malville, J. McKim 2004. Sacred Time in Chaco Canyon and Beyond. Chapter 12 in *In Search of Chaco: New Approaches to an Archaeological Enigma,* edited by David Grant Noble. School of American Research: Santa Fe, NM.

2005. Retired Archaeologist, University of Colorado at Boulder. Chaco Canyon. Personal interview with Richard D. Fisher July 13, 2005.

Malville, Nancy J. 2001. Long-distance Transport of Bulk Goods in the Pre-Hispanic American Southwest. In *Journal of Anthropological Archaeology 20:230-243.* Academic Press: Orlando, FL.

Martin, Debra L., Alan H. Goodman, George J. Armelagos and Ann L. Magennis 1991. *Black Mesa Anasazi Health: Reconstructing Life from Patterns of Death and Disease*. Southern Illinois University at Carbondale Center for Archaeological Investigations. Occasional Paper 14. Carbondale, IL.

Maxwell, Timothy D. and Rafael Cruz Antillón 2003. Loma de Moctezuma: At the Edge of the Casas Grandes World. In *Archaeology Southwest*; edited by Paul E. Minnis and Michael E. Whalen. Center for Desert Archaeology: Tucson, AZ.

McClurg, Kathy 1995. Kernels of Truth: A common world food supply fuels CU-Boulder research. *Summit* Magazine. http://www.colorado.edu/CUMUSEUM/Personnel/kernel.html

McGregor, John C. 1936. Ball Courts in Northern Arizona? *Museum of Northern Arizona, Museum Notes 8(11):55-58*. Northern Arizona Society of Science and Art: Flagstaff, AZ.

1937. *Winona Village: A XIIth Century Settlement with a Ball Court near Flagstaff, Arizona.* Museum of Northern Arizona Bulletin 12:10-19. Northern Arizona Society of Science and Art: Flagstaff, AZ.

1941. Winona and Ridge Ruin Part I, Architecture and Material Culture. *Museum of Northern Arizona Bulletin 18:83-89.* Northern Arizona Society of Science and Art: Flagstaff, AZ.

McKusick, Charmion R. 2001. Southwest Birds of Sacrifice. *The Arizona Archaeologist 31*. Arizona Archaeological Society: Phoenix, AZ.

2005. Scarlet Macaws Trade Issues and Time Line Chaco Canyon. Personal interview with Richard D. Fisher, July 14, 2005.

Mills, Barbara J. 2001. Recent Research on Chaco: Changing Views on Economy, Ritual and Society. In *Journal of Archaeological Research 10(1):65-67.* Kluwer Academic/Plenum Publishers: New York, NY.

Minnis, Paul E., Michael E. Whalen, Jane H. Kelley and Joe D. Stewart 1992. Prehistoric Macaw Breeding in the North American Southwest. *American Antiquity 58(2):270-276.* Society for American Archaeology: Menasha, WI.

Moore, Roger 2004. V. T. Park Archaeologist, Chaco Cultural National Historic Park, Nageezi , New Mexico. Interpretation of Chacoan Architecture/Kivas/Reservoirs/Agricultural Systems. Personal Interview with Richard D. Fisher, May 27, 2004 and June 3, 2004 .

Morales, Michael, Jr. 1993. *Prehistoric Ballcourts in Northern Arizona.* Unpublished M.A. thesis, Department of Anthropology, Northern Arizona University: Flagstaff, AZ.

NASA Astrobiology Institute 2001. Starved for Nitrogen. Astrobiology News staff writer. NASA Astrobiology Institute. July 27, 2001. http://www.nai.arc.nasa.gov/news_stories/news_detail.cfm?ID=130

Neely, James A. and Jeffrey A. Homburg 2004. Ancient Agricultural Systems and Settlements in Lefthand Canyon, Safford Basin http://pubs.usgs.gov/of/2004/1062/5_neely.pdf.

2004. *Prehistoric Agriculture and Settlement in Lefthand Canyon, Safford Valley, Southeastern Arizona.* Draft. University of Texas at Austin: Austin, TX.

Neitzel, Jill E. (ed.) 2003. *Pueblo Bonito: Center of the Chacoan World.* Smithsonian Institute: Washington and London.

New Mexico Bureau of Mines and Mineral Resources 1977. *Satellite Photomap of New Mexico.* New Mexico Bureau of Mines and Mineral Resources: Socorro, NM.

Noble, David Grant (ed.) 1982. *New Light on Chaco Canyon*. School of American Research Press: Santa Fe, NM.

1991. *The Hohokam: Ancient People of the Desert.* School of American Research Press: Santa Fe, NM.

2004. *In Search of Chaco: New Approaches to an Archaeological Enigma.* School of American Research Press: Santa Fe, NM.

Ogilvie, William 1897. Extracts from The Report of an Exploration Made in 1896-97. In *The Yukon Territory* by W.H. Dall, G.M. Dawson and W. Ogilvie. Downey and Co: London

1974. *Early Days on the Yukon*. Arno Press: New York, NY.

Olson, Gerald W. 1981. Soils and the Environment: A Guide to Soil Surveys and their Applications. Chapman and Hall: New York, NY.

1981. Archaeology: Lessons on Future Soil Use. *Journal of Soil and Water Conservation* 36(5):261-264. Soil Conservation Society of America: Ankeny, IA.

Pawluk, Roman 2004. Program Director, Zuni Conservation Project, Pueblo of Zuni, Zuni, New Mexico, Natural Sources of Fixed Nitrogen, Cryptobiotic Soil and Others. Personal Interviews with Richard D. Fisher, May 27, 2004 and December 27, 2004.

Pillsbury, Arthur F. 1981. The Salinity of Rivers. Scientific American. 245(1):54-65. http://www.sci.sdsu.edu/salton/ThesalinityofRivers.html

Reid, Jefferson and Stephanie Whittlesey 1997. *The Archaeology of Ancient Arizona*. The University of Arizona Press: Tucson, AZ.

Robinson, William J., and Catherine Cameron 1991. A Directory of Tree-Ring Dated Prehistoric Sites in the American Southwest. Laboratory of Tree-Ring Research, University of Arizona, Tucson, AZ.

Rooney, John 2004. Bureau of Land Management, Albuquerque , New Mexico , Chacoan Road System. Personal Interview with Richard D. Fisher, May 27, 2004.

2005. Resource Program Manager, Bureau of Land Management, Albuquerque, NM. Chaco Road System. Personal interview with Richard D. Fisher, May 13, 2005.

Rushford, Diane 2005. Park Guide, Montezuma Castle National Monument, Verde Valley, AZ. Ionized or water soluble nitrate rainfall impact on corn growing. Personal interview with Richard D. Fisher, May 13, 2005

Scarborough, Vernon L. 1988. A Water Storage Adaptation in the American Southwest. *Journal of Anthropological Research* 44(1):21-40. University of New Mexico, Albuquerque, NM.

1994. Maya Water Management. *National Geographic Research & Exploration 10(2):184-199.* National Geographic Society: Washington, D.C.

Schaafsma, Curtis F. and Carroll L. Riley (ed.) 1999. *The Casas Grandes World*. The University of Utah Press: Salt Lake City, UT.

Schmidt, Robert H., Jr., and Rex E. Gerald 1988. The Distribution of Conservation-type Water Control Systems in the Northern Sierra Madre Occidental. In *The Kiva* 53:2:165-178. Arizona Archaeological and Historical Society, Arizona State Museum: Tucson, AZ.

Schwartz, Douglas W., Jane Kepp and Richard C. Chapman 1969. The Walhalla Plateau. In *Archaeology of the Grand Canyon*, pp. 6-7 and 121-133. School of American Research: Santa Fe, NM.

Schwatka, Lt. Frederick 1885. *Along Alaska's Great River*. W.L. Mershon & Co.: Rahway, NJ. Reprinted 1983; Alaska Northwest Publishing Co.: Anchorage, AK.

1888. *A Military Reconnaissance in Alaska*. Senate Document 1023. Government Printing Office: Washington, D.C. (1883?)

Sekaquaptewa, Emory 2005. A Hopi Scholar's View of Some Anasazi Issues. Personal interview with Richard D. Fisher, June 28, 2005.

Shepherd, Grant 2001. Silver Magnet, Chapters 1-30. In *History of Copper Canyon and the Tarahumara Indians*, Anthology, edited by Richard D. Fisher. Sunracer Publications, Tucson, AZ.

Slifer, Dennis, and James Duffield 1992. Kokopelli: Fluteplayer Images in Rock Art. *Ancient City Press: Santa Fe, NM.*

Sparks, Heather 2001. Nitrates, Lightning, Key to Life at Early Earth. July 16, 2001. Space.com http://www.space.com/scienceastronomy/planetearth/earth_archaean_010716.html

Stein, John 2005. Historic Preservation Department, Navajo Nation, Window Rock, AZ. Plastered Chetro Ketl Field. Personal interview with Richard D. Fisher, August 2, 2005.

Strutin, Michele 1994. Chaco: A Cultural Legacy. Chaco Culture National Historical Park. Southwest Parks and Monuments *Association: Tucson, AZ.*

Sutherland, Kay 1995. *Spirits from the South.* The Artifact *34(1&2). El Paso Archaeological Society, Inc.: El Paso, TX.*

2001. Ethnographic Assessment of Indigenous Mexican and Mayan Cultural Affiliation to Hueco Tanks State Historical Park. Texas Parks and Wildlife. Rain House Publications: Austin, TX.

Swentzell, Rina 2004. A Pueblo Woman's Perspective on Chaco Canyon, in In Search of Chaco: New Approaches to an Archaeological Enigma edited by David Grant Noble. School of American Research Press, Santa Fe, NM.

Tanner, Ron 2005. Owner, Midland Bean Company, Dove Creek, CO. Modern Granary Maintenance and Concerns/Issues. Personal interview with Richard D. Fisher, June 29, 2005

Thompson, Ian 1994?(no date given on publication) The Escalante Community. Southwest Natural and Cultural Heritage Association, Albuquerque, NM

Threlkeld, Kay 1988. *Tonto National Monument*. Southwest Parks and Monuments Association: Tucson, AZ.

Thybony, Scott 1996. Walnut Canyon National Monument. Second edition, edited by T. J. Priehs and Laura Symms-Wallace. *Southwest Parks and Monuments Association: Tucson, AZ.*

Till, Jonathon 2005. Lab Analysis Manager, Crow Canyon Archaeology Center, Cortez, CO. Utah Chacoan Roads. Personal interview with Richard D. Fisher, July 19, 2005.

Toll, Wolky, Ph.D. 2004. Office of Archaeological Studies, Museum of New Mexico , Santa Fe , New Mexico. Personal Interview with Richard D. Fisher, May 27, 2004.

Towle, Linda 2004. Chief of Research, Mesa Verde National Park , Mesa Verde , Colorado . Kiva Styles and Reservoirs. Personal Interview with Richard D. Fisher, June 2, 2004

U.S. Bureau of Reclamation 2003. Central Arizona Salinity Study, Phase 1 Report. U.S. Bureau of Reclamation, Phoenix Area Office, Phoenix, AZ, Program Development Division. http://www.usbr.gov/lc/phoenix/user/7000/cassreprt2004.html

Van Dyke, Ruth M. 2000. Chacoan Ritual Landscapes: The View from Red Mesa Valley in *Great House Communities Across the Chacoan Landscape,* edited by John Kantner and Nancy M. Mahoney. University of Arizona Press: Tucson, AZ.

VanPool, Todd L., Christine S. VanPool, and David A. Phillips, Jr. 2002. The Salado and the Casas Grandes Phenomena: Evidence for a Religious Schism in the Greater *Southwest*. Manuscript on file, University of New Mexico: Albuquerque, NM.

Van West, Carla R. 2005 Director of Preservation Research, SRI Foundation, Rio Rancho, New Mexico. Agriculture. Personal interview with Richard D. Fisher July 6, 2005.

Varien, Mark 2005. Director of Research, Crow Canyon Archaeology Center, Cortez, CO. Excavated Contents of Kivas in Great Sage Plain. Personal interview with Richard D. Fisher, June 29, 2005.

Walker, Phillip 1985. Anemia Among Prehistoric Indians of the American Southwest. Chapter 13, In Health and Disease in the Prehistoric Southwest, Editors Charles F. Merbs and Robert J. Miller, Anthropological Research Papers No. 34, Arizona State University, Phoenix, Arizona 1985

Whalen, Michael E., and Paul E. Minnis 1996. Ball Courts and Political Centralization in the Casas Grandes Region. *American Antiquity* 61(4):732-746. Society for American Archaeology: Menasha, WI.

2002. Casas Grandes and its Hinterland: Prehistoric Regional Organization in Northwest Mexico. The University of Arizona Press: Tucson, AZ.

Wheeler, Gerald, Ph.D. 2004. Plant Pathologist and Agronomist, Acre Lab, Tucson, Arizona. Basic Fertilizer Available in Natural Systems. Personal Interview with Richard D. Fisher, June 3, 2004 .

Wilcox, David 1997. *Organizational Parameters of Southwest/Mesoamerican Connectivity*. Manuscript, Museum of Northern Arizona University Press: Tucson, AZ.

2002. The Wupatki Nexus: Chaco-Hohokam-Chumash Connectivity, A.D. 1150-1225. In *The Archaeology of Contact: Processes and Consequences*. Proceedings of the 25th Annual Conference of the Archaeological Association of the University of Calgary, edited by Kurtis Lesick, Barbara Kulle, Christine Cluney and Meaghan Peuramaki-Brown, pp. 218-234. The Archaeological Association of the University of Calgary: Calgary, AB.

2005. Senior Curator of anthropology at the Museum of Northern Arizona, Flagstaff, AZ. AZ Highways article June 2005 titled Ballcourt Mysteries Linger: Did Celebrants at Arizona's 200 sites Use Severed Heads as Balls? By Anne Montgomery

Wilcox, David R., and Charles Sternberg 1994. Hohokam Ballcourts and Their Interpretation. *Arizona State Museum Archaeological Series No.160 U*niversity of Arizona: Tucson, AZ.

Wilshusen, Richard H., Melissa J. Churchill, and James M. Potter 1998. Prehistoric Reservoirs and Water Basins in the Mesa Verde Region: Intensification of Water Collection Strategies During the Great Pueblo Period. *American Antiquity* 62(4):664-681. Society for American Archaeology: Menasha, WI.

Windes, Thomas C. 2003. The Rise of Early Chacoan Great Houses In *In Search of Chaco: New Approaches to an Archaeological Enigma,* edited by David Grant Noble. School of American Research: Santa Fe, NM.

2004. Archaeologist, United States National Park Service, Albuquerque , New Mexico . Chaco Circular Structures and Rainwater Catchments. Personal Interview with Richard D. Fisher, June 1-2, 2004.

Wright, Kenneth R. 2000. *Paleohydrology Study of Mummy Lake 1998-99 Site 5MV833*. Wright Paleohydrological Institute. Mesa Verde National Park, National Park Service and Colorado Historical Society. Public Works Historic Society, American Public Works Association: Kansas City, MO.