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Spatial analysis of prehistoric Hohokam ballcourts with respect to core and periphery hierarchy

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Spatial Analysis of Prehistoric Hohokam Ballcourts with Respect to Core and Periphery Hierarchy

by

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The objective of my thesis is to demonstrate spatial clustering of ballcourts at Hohokam sites using the Poisson statistical method. Different numbers of ballcourts in a specific region indicates social, ceremonial, and political function because Hohokam interaction networks are structured through the ballcourt system.

Core areas are defined as a concentration of ballcourt sites. Each described regional system has at least one site with multiple ballcourts. The core region population has a greater social function, is more responsible for cultural innovation, and has a higher local productivity due to the use of irrigation systems or other productive agricultural systems. Both large and small courts exist, and each may have its own social function.

Peripheral zone populations are those that may depend on the core area populations. There are three such zones: the inner, the intermediate, and the far peripheries. Each region has ballcourts. Usually, only one court sites exist, and no ballcourt sites may exist in the far periphery. The far periphery population also has contact with people in the Phoenix Basin which is seen through similarities in the distribution of Hohokam ritual paraphernalia. However, the areas also contrast with the core Hohokam.

The statistical measure used to distinguish the core area from the peripheral zones is the degree of conformity of observed occurrences with the theoretical Poisson distribution. The observed frequencies of ballcourts in the sample units are compared to the expected frequency distributions under the assumption of a Poisson series. The Poisson series is associated with events which occur <u>randomly</u> in a continuum of space. Therefore, tests for agreement with a Poisson series are used as tests for randomness of distribution. Using this method, Hohokam core areas have a cluster pattern, whereas peripheral zones are randomly scattered over the landscape.

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CHAPTER 1

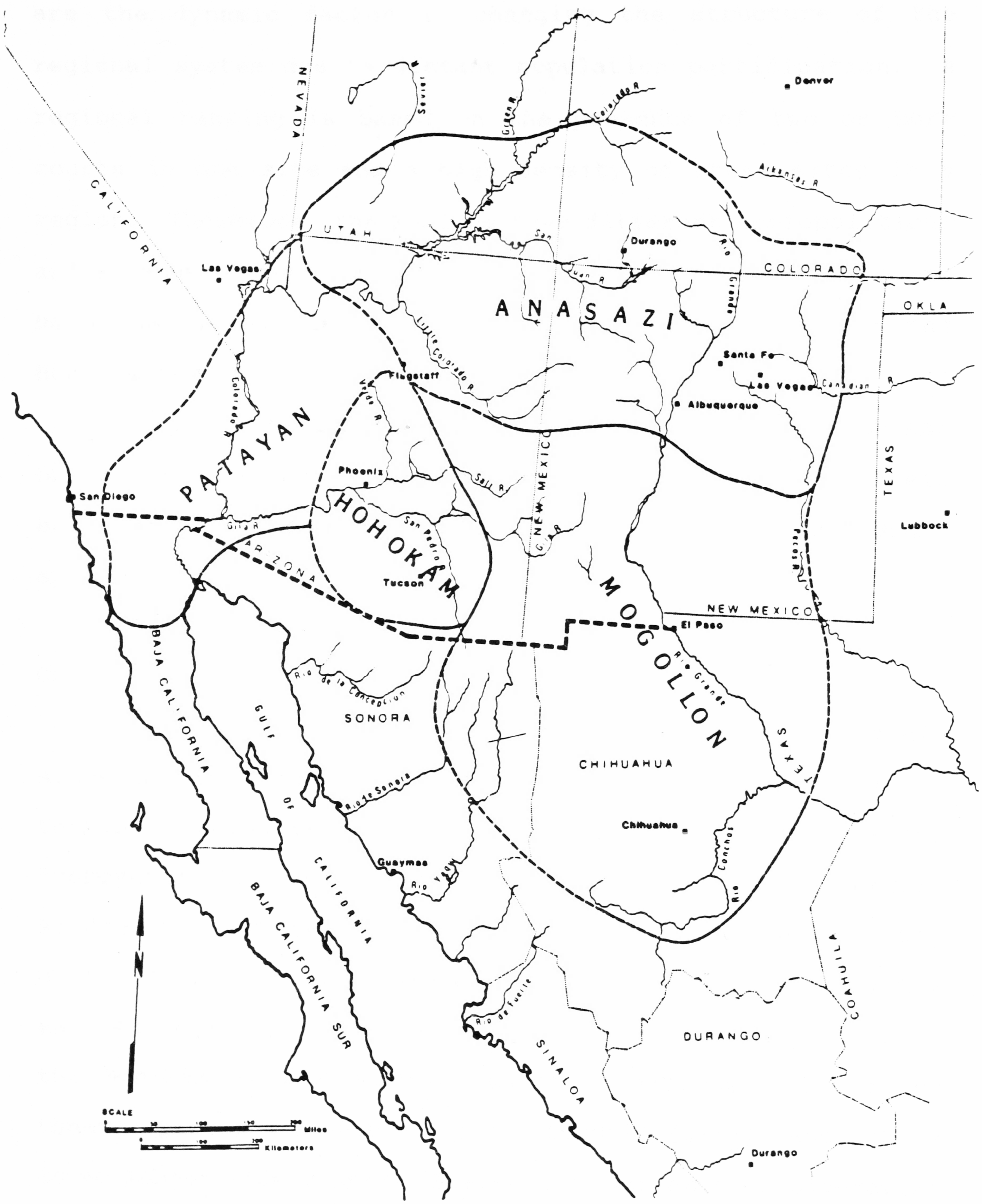
INTRODUCTION

The objective of this thesis is to demonstrate spatial clustering of ballcourts at Hohokam sites using the Poisson statistical method. Different numbers of ballcourts in a specific region may indicate social, ceremonial, and political function because networks of social connections in the Hohokam region are structured through the ballcourt system.

The Hohokam were prehistoric farmers who occupied the lower Sonoran Desert in central and southern Arizona (see Figure 1). A typical village contains house clusters. In larger settlements, the house clusters are formed around plazas, ballcourts, and platform mounds. The Hohokam practiced cremation of the dead and had extensive canal irrigation networks, the largest occupying more than 30 km^2 (Fish 1989). Widespread trade of exotic and shell goods were also common among the Hohokam.

Many Hohokam sites contain one or more ballcourts. Although the ballcourts are not identical to those of Mesoamerica, the ballgame is part of the Hohokam tradition. It is the ballgame not the court that diffused into the Sonoran Desert (Wilcox and Sternberg 1983). The ballcourts

Figure 1-- General Hohokam Reference Map



Source: Cordell (1984: 15)

are the dynamic factor in changing the structure of the regional system due to distant population participation. A regional ranking is based on the presence of two or more courts in one site and a high density of these sites in a region. Therefore, the regions have different sociopolitical and ceremonial functions. Areas with a high density of courts have the highest level of agricultural productivity in the Hohokam region.

Although the topic of the thesis is limited to Hohokam ballcourts, a brief history of the Hohokam and their environment is necessary to better understand the ballcourt system.

Origins

Previous to the Hohokam, there are few Late Archaic sites in the Sonoran Desert that represent earlier small farming communities. However, the few that exist demonstrate "nonsynchronous adoption of farming and ceramics in southern Arizona" (Fish 1989:25). As a result, there was an empty niche for desert agriculturalists, which was filled by the earliest Hohokam. Two major theories suggest the origins of the Hohokam in the Sonoran Desert of Arizona. The first theory, proposed by Haury (1976), Gladwin (1948), and others is no longer widely held. However, it warrants consideration because it was once popular. This theory proposes that the

Hohokam came from Mexico and are characterized by pottery, sedentism, and irrigation. Haury (1976:351) states:

> My reconstruction proposes that a group of people came from Mexico probably as early as 300 B.C. and that after having 'settled-in' the society enjoyed a long local development, though nudged to greater cultural heights from time to time by infusions from Mesoamerica.

Proponents of this view suggest Mexican origins because of the advanced characteristics that appear in Hohokam sites compared with other Southwestern cultures. The Hohokam "developed a water-managing capability, coupled with a tillage technology, and a roster of domesticated plants probably including one or more races of maize new to the Southwest, cotton and the old stand-bys, beans and squash" (Haury 1976:351).

In addition to irrigation technology, the Hohokam had an established village life, care of the dead, and decorated pottery. Ballcourts provide additional support for a migration expansion of Hohokam origins which is seen in northern Arizona. Although the courts did not look exactly like those of higher Mesoamerican cultures, the ideology and actual ballgame are most likely products of Mesoamerican influence (Wilcox and Sternberg 1983).

The other theory, more widely held at present, was first proposed by Di Peso (1956) and Hayden (1970). It states that the Sonoran Desert has been occupied continuously since the end of the Altithermal by the Ootam (Papago speakers). At the southern end of the Sonoran Desert, the Ootam are in contact with Mesoamerican cultures acquiring pottery, irrigation, and other specialized traits.

> Given the corridor of Piman speakers from South to North a group of these southern people is thought to have brought the Vahki phase of the Hohokam, en bloc, to Snaketown on the Gila River... (Hayden 1970:87).

Support of this view consists of archaeological evidence suggesting continuity between Late Archaic and early Hohokam sites as well as a Papago legend. Di Peso states that these people (the Ootam) are the original inhabitants of the land, and during the Pioneer Period, (see Table 1) the local inhabitants were absorbed into the Hohokam population. Linguistic evidence shows that from the Middle Gila River to the Rio Santiago (the range of the Ootam) a mutually intelligible form of Pima was spoken in historic times. Sauer takes this interpretation further by stating that throughout the region, "... there was a well-travelled Indian route all the way from Mexico City along the eastern edge of the Pima country and up to the Hopi" (quoted in Underhill 1939:21). The above hypothesis attempts to explain how the Hohokam were connected both to local traditions as well as the Mesoamerican characteristics which is shown in some aspects of their culture.

Table 1-- Hohokam Chronology

Haury (1976)		F Plog (1980)		Schiffer (1982)	
Classic		Classic		Classic	
Civano	1300–1450	Civano	1350–?	Civano	1300–1450
Soho	1100–1300	Soho	1100–1300	Soho	1175–1300
Sedentary		Colonial		Sedentary	
Sacaton	900–1100	Sacaton	950–1150	Sacaton	1000–1175
		Santa Cruz	750–950		
Colonial		Pioneer	(Vahki)	Colonial	
Santa Cruz	700–900	Snaketown	550–750	Santa Cruz	875–1000
Gila Butte	550–700	Estrella	A.D. 350–550	Gila Butte	800–875
Pioneer				Pioneer	
Snaketown	350–550		?	Snaketown	750–800
Sweetwater	200–350			Sweetwater	700–750
Estrella	1–200			Estrella	650–700
Vahki	300 B.C.–A.D. 1			Vahki	A.D. 500–650

Source: Cordell (1984: 11)

Environment

Hohokam culture was located in an environment that posed difficulties for desert farmers. However they overcame the constraints and occupied the Sonoran Desert for approximately 1000 years. Environment is an essential component of any study of human behavior and civilization. McGuire and Schiffer (1982:9) state that "human societies and their changes must be understood as resulting from the interaction of the material condition of existence: demography, subsistence, environment, and other human groups."

Geography

The Hohokam settled in the Sonoran Desert section of the Basin and Range Province. In this region, there are numerous parallel mountain ranges that rise several thousand meters above the desert floor. The mountain ranges trend northeast-southwest with bordering basins which cover approximately 75% of the province and up to 80% of the area in southwestern Arizona (Stone 1986:7). In the region, important mountain ranges include (from west to east) Gila Bend, Bradshaw, Ajo, Sand, Estrella, Mazatzal, Santa Catalina, Santa Rita, White, Galliuro, Pinaleno, and Chiricahua Mountains. Basins are bowl-shaped and have widths that range from 10 to 32 km and average about 19 km (Fish and Nabhan 1991:31).

Hohokam subsistence is greatly effected by the structure

(Fish and Nabhan 1991:31).

Hohokam subsistence is greatly effected by the structure of the local geography. The basin system produces localized environmental zones which follow the transect from mountain peaks to floodplains and valleys to slopes. "Only in a few cases of higher ranges do mountains on one side of a basin afford substantial resources unavailable on the other side or on the upper reaches of bajadas" (Fish and Nabhan 1991:31). As a result of this phenomenon, travel across valleys is not necessary and access to resources is not competitive.

Hydrology

In the Hohokam study area there are two main rivers: the Gila River and the Salt River. Fed by water sheds outside of the desert, these rivers along with several major perennial tributaries are the primary basis for subsistence (McGuire 1982). As a result of upland winter water sources, there is a heavier water volume during the late winter and early spring. The Gila has several tributaries, small streams, and washes that provide additional agricultural lands. "Along the Salt and Gila, gently sloping terrace and basin floor morphology allow canal networks to be extended laterally from the riverbeds, creating wide expanses of irrigable land" (Fish and Nabhan 1991:33). It is along major rivers such as the Gila, Salt, Verde, San Pedro, and Santa Cruz that canal irrigation has its best potential for increasing agricultural lands. The areas farther away from major rivers utilized dry land farming techniques and *akchin* farming when canal irrigation was not possible.

Other significant drainages debauch to the south into the Salt and Gila Rivers. Because of a lack of winter snowfall, their watershed results from rainfall and run off which collects water from local bajadas and mountains. Typically, the volume of water occurs in the spring which is not conducive to agriculture. As a result, alternate farming methods, such as floodwater farming and *akchin* farming are practiced (Bernard-Shaw 1988).

In the Sonoran Desert, periodic overbank flooding occurs. The floods are irregular, leaving the surrounding area either depleted of water or flooded. As a result of floods and high ground water table conditions, large amounts of salts are deposited on the surface of the soil.

In order to conserve drinking water, various types of water storage, such as charcos, and rock tanks, are frequently used. According to Bryan (1923), the largest of these are found along downcut areas and channel falls. "Tanks and charcos can hold water for a few hours or up to several weeks depending on reservoir size, local evaporation rates and the amount of initial rainfall" (Berry and Marmaduke 1982:19).

Another source of water in the Basin and Range Province is ground water. "Water can be obtained by digging shallow holes in the beds of many intermittent streams" (Berry and

Marmaduke 1982:19). The Hohokam dug shallow wells at high water levels along the Gila River. At Snaketown, Haury (1976) reports a well that was approximately three meters deep. This well is fed by a reservoir along Queen Creek. According to Berry and Marmaduke (1982:20):

> Haury has cited this particular characteristic of the environment at Snaketown (i.e., the high water table) as one that may have been especially significant in the use of this location by prehistoric farmers over such a long period of time.

Attaining water by a variety of means was essential for the Hohokam because water limits the possibilities for agriculture.

Due to physiography and hydrology diversity, there is also considerable variations in the of the flora and fauna in the Sonoran Desert. The Hohokam area has four vegetation zones which correspond to the altitude: the Lower Sonoran, the Upper Sonoran, the Transition, and the Canadian zones.

The Lower Sonoran life zone appears in the Sonoran Desert where the elevation is 914 meters or under. For the Hohokam, the Lower Sonoran Desert contains a large variety of plants. "There are over 375 species which are suitable for human food or other economic uses, with various plants ripening in different seasons" (Doelle 1976:52). Within the Sonoran Desert, there are four biotic communities: paloverde-sahuaro, creosotebush, saltbush, and riparian. The paleoverde-sahuaro group is found in the upper bajadas and hills. Although there is variation within the community, macrofossil remains indicate that sahuaro, cholla, prickly pear cacti, organ-pipe cacti, foothill paleoverde, ironwood, and ocotillo are present in the past as well. The zone houses medium and small mammals such as deer, jackrabbit, cottontail, squirrel, rat, and mouse.

Lower in elevation, the creosotebush-bursage community flourishes. Creosotebush and white bursage appear concurrently. Because of the creosotebush's aggressive growth, many other plant varieties cannot compete. As a result, the area did not contain a diversity of plant species.

The third community is the desert saltbush, which occurs in valley bottoms. Saltbush, chamiso, and mesquite are the dominant plants. Mesquite, an important prehistoric resource, is heavily exploited and "this zone may have been an important factor in the reduction of seasonal movements by incipient agriculturalists" (Berry and Marmaduke 1982:25).

Riparian communities appear along stream and river channels. Ash, cottonwood, willow, and walnut are the most abundant flora species in this zone. However, when natural water supplies are abundant, mesquite and blue paloverde also appear in the riparian community. Beaver, muskrat, otter, skunk, raccoon, gophers, squirrels, mice, and rats are the most important species to be found in the area.

The Upper Sonoran life zone supports a variety of flora and fauna at an elevation between 914 and 2130 meters. This zone occurs above the desert and below the evergreen woodland (Bronitsky and Merritt 1986).

> Dense stands of tough evergreen shrubs such as manzanita and scrub oak, only occasionally broken by isolated trees characterize the chaparral plant community of the Upper Sonoran life zone and occurs most frequently in the northeast part of the study area, although small isolated stands occur throughout... (Bronitsky and Merritt 1986:25).

Throughout the Basin and Range Province, black-tailed or mule deer, white tailed deer, bighorn sheep, and antelope live. However, they also inhabit the more mountainous regions. Fox and wolf also commonly inhabit the Upper Sonoran life zone.

The transitional life zone (from 2130 to 2400 meters) is predominantly a pine forest. The Hohokam exploit this zone from spring to fall for Ponderosa pine nuts and other types of flora and fauna.

Above the transitional zone is a fir forest, or the Canadian life zone at an elevation of 2400 to 2750 meters. This zone occurs in the various mountain ranges of the Basin and Range Province. Douglas and white fir predominate the zone; however, the area is not extremely important for the Hohokam.

Subsistence

The Hohokam environment contained a variety of different zones in which many different plants and animals thrived. The Hohokam region provided enough diversity so that they could flourish with the available resources. As a result, large communities were established in the Sonoran Desert.

One of the important factors for establishing control over the environment was the building of irrigation canal systems (Plog 1980). As a result, the Hohokam could have planted two crops of maize per year.

> The first crop was planted in February when runoff filled the Gila River and provided water for the irrigation canals feeding the terrace fields. This crop was harvested in June when the saguaro fruit also ripened; so if the crop failed, a larger percentage of the diet would be derived from the wild saguaro. The second maize crop was planted in July when the Gila River was swollen from the summer storms. As this crop ripened in the fall, so did the mesquite seeds; so the amount of mesquite harvested was dependent on how successful the maize harvest was (Rafferty and Rice 1979:74).

Because some of the Hohokam environment was in the mountain and valley area, the land slope did not allow for abundant irrigable land. In these areas, natural resources were more relied upon. However, where there was a shortage of land and an abundance of resources, large sites did appear. One such example is Gila Butte (U:13:8 ASM). This area had four available resource zones plus the added riverine environment (Sellers and Hill 1974).

Further studies by geoarchaeologists show that the changes in floodplains also lead to changes in settlement patterns, and that there were cultural influences on site locations. In the southern Tucson Basin stretch of the Santa

Cruz River, "all late Rincon and Tanque Verde floodplain settlements are on topography where elevation differentials (on the dunes) or containment of flow (by head-stream channels on the proximal portion of the fan and by the arroyo channel that created the cienega) would isolate them from floods" (Ellis and Waters 1991:129). Therefore, if the inhabitants of a site practiced intense agriculture, the site would appear closer to an unentrenched floodplain which would assure successful agriculture practices.

However, there were also cultural influences on settlement patterns. Ellis and Waters stated that residence rules and other such social conditions influenced settlement patterns as much as environmental constraints. Because of the Hohokam's agricultural tendencies, there was a natural attraction to riverine environments.

> To ignore landscape as a systematic variable is to assume, perhaps falsely, that it was a constant. Even if it is obvious, it is nontrivial to assert that human adaptation occurs on landscapes, and that changes in the nature of the landscape affect the adaptation and our understanding of it (Ellis and Waters 1991:136).

Settlement Pattern

Environmental constraints and subsistence patterns limit site location. Throughout the Sonoran Desert there are some generalities in Hohokam sites. A typical large Hohokam site consists of many pithouses and mounds, one or more ballcourts, cremation areas, and where possible, a canal system. These features are clearly seen at the best-known Hohokam site, Snaketown, excavated in the 1920s by Gladwin (1948) and in the 1960s by Haury (1976). The population of many of the Hohokam sites were arranged in clusters of pithouses within the site. Although there are many obvious clusters, some houses occur outside of these house clusters. Haury (1976) and others believe that the house arrangement and overall site location may be a result of available water. However, this type of arrangement within sites is unlikely unless canal irrigation is the driving force behind such an arrangement. Between the house clusters are open spaces which are probably due to a desire to define house clusters from other house groups.

Even though the availability of water may affect the placement of houses, ballcourt placement could have played a role in house cluster arrangements. The ceremonial significance of the ballgame and other activities that occurred at ballcourts are important factors in most of the Hohokam site orientations.

An explanation of site components-- houses, mounds, irrigation, and ballcourts-- follows, which will give some insight into the settlement structure in the Hohokam region.

Houses

As previously stated, Hohokam houses are not connected or closely spaced, but they are open to the village. The hearth is always midway from the point of the entrance and the long axis of the house. The floor is often adobe covered into which postholes are placed for roof support. Therefore, roof construction is determined by floor shape. "A four-main-post plan was usual for square houses, and a two-main-post support for a ridge type roof, employing auxiliary supports near the edges was normal for long-axis houses" (Haury 1976:72).

Mounds

Artificial platforms appear at Hohokam sites beginning in the Sedentary Period. Spatially, the mounds appear different, but they have the same function.

> The platform mound in use at any given stage was flat-topped and slope-sided with round corners and an irregular squarish or subrectangular outline. The platforms were faced with a plaster of mixed caliche and adobe, placed directly over the earth core (Wasley 1960:244).

There are three types of mounds. The first type is constructed from pure trash with a heavy pottery fill and general refuse. These mounds are the most numerous and are traditionally thought to be a result of a custom of tidiness (piling and concentrating trash). Trash mounds require the most time for growth. A white ash layer of five meters found at a mound at Snaketown suggests that these mounds are occasionally burned and may be part of the site arrangement (Haury 1976:82). The second type is composed of mixed trash and desert soil. They contain mainly soil and are not capped.

Platform mounds are the third type of mound, which are "either trash accumulation capped with a caliche-clay mixture or mounds especially built... to a preconceived plan in fulfillment of presumed ritual requirements" (Haury 1976:80-81). As seen from the Gatlin Site (Wasley 1960), construction is staged and uses artificial elevated platforms. These mounds are designed for ritual use and additions are periodically constructed. Adjacent to some mounds, such as the Gatlin Site (Wasely 1960) and Mound 39 at Snaketown (Haury 1976), are cremation areas, which further emphasize their ceremonial function.

The largest number of mounds occur near house clusters. As a result, the size of a mound depends upon the length of use. Although there is a proliferation of all three types of mounds, the practice of mound building does not appear to span the entire history of the Hohokam culture.

Irrigation Systems

Due to a general lack of run off for agriculture, irrigation canals were utilized by the Hohokam. Irrigation canals and their branches are rounded and "a U-shaped cross section, with quite steep sides and the main canal, shows repeated filling and clearing" (Woodbury 1961:551). The irrigation systems are quite impressive. At Park of Four

Waters a 60 meter trench was dug across two large canals showing their size (Woodbury 1961). These canals were dug three meters into the soil and lined with brown clay. For the most part, historic canals follow those of the prehistoric.

As Woodbury (1961:553) states "the total extent of canal systems can serve as a basis for more realistic estimates of possible cultivated acreage and population...." On the average, canal systems irrigate land 16 to 48 km from the main water source. Therefore, populations could survive and farm away from major rivers with appropriate seasonal flow and floodplain characteristics. The additional waterworks also allow for a higher population because of a more intensive subsistence strategy.

The implications of this system for social structure are problematic. According to Wittfogel (1957) this type of system can be classified as a hydraulic society. He believed that the maintenance and organization needed to control, plan, and engineer such a large hydraulic system would need to be bureaucratic. Although the theory seems plausible,

> it is perhaps only our own ethnocentric bias that makes us suppose that any undertaking beyond the scope of a single family or small group of relatives must have highly organized direction on a permanent basis for this success (as quoted in Woodbury 1961:557).

Whatever the social system of the Hohokam, the development of an extensive irrigation system allowed for survival and population growth (Upham and Rice 1980).

Cremations

One social aspect of the Hohokam is cremation of the dead. After A.D. 1200, cremations decreased and the Hohokam interred their dead. According to Haury (1976:164), there are three types of deposits in the remains:

> 1) pit depositories, round or oval in shape, holding both bones and offerings, if present; sometimes with ancillary pits containing bones and artifacts in a manner reminiscent of Yuma customs, that is, the ashes of a single person divided four ways and separately buried; 2) trenches of variable length with bones and smashed artifacts well mixed; and 3) urn disposal.

Trench and pit deposits occur early in Hohokam prehistory.

Grave goods are common. The earliest burials contain smashed pottery. There are four categories into which the funeral objects can be placed. Shell beads, bracelets, and hair ornaments comprise the first category of objects probably worn at the time of cremation. Tools, such as scrapers, manos, metates, and pottery suggest the belief that the dead would need these objects after death. The third category is comprised of objects that may indicate the dead person's occupation. The fourth group consists of "esoterica, namely, stone palettes, clay figurines and incense burners" (Haury 1976:166). Although the grave goods occur in burials, their meaning remains unclear except that they had some meaning in the cremation customs.

The dead are cremated in long pits which are part of a funeral pyre, and are easily detected by the baked clay edges and ashy contents. The Hohokam employ "in the flesh" cremations. This conclusion is based on the completely incinerated condition of the burnt bone (Merbs 1967).

> The condition further indicated either that the dead had been dismembered before cremation or that the fire had been extremely intense (with the latter explanation being more likely), as all parts of the skeleton were thoroughly incinerated. This, taken along with the extremely fragmentary nature of the remains, also suggests that they may have been stirred at some time late in the cremation process. (Merbs 1967:501)

The ashes of the dead are placed in mounds. These mounds show no trace of fire and contain a large amount of grave goods. The cremated bones are placed in the bottom of a pit that is 91 to 152 cm deep and cylindrical (Wasley 1960).

Pottery

Another social indication of the Hohokam that aids in the distinguishability of core and periphery zones is Hohokam pottery. Early types of pottery are plain, brown, and red undecorated vessels that are created by molding. These squash-shaped ceramics are made from unground clay that has a coarse sand temper (Cordell 1984). The first changes in form are a smooth surface and an outer slip. Early decoration covers the outside of the bowl and is a repeated subject matter, such as a cross or a star.

The size and shape of pottery varies. "Some are deep and semi-spherical with straight rims and rounded edges, while others are more shallow and shaped like round platters" (Cummings 1953:193). The decoration, typically spirals and geometric forms, covers the entire vessel.

There are two basic color patterns with some regional variation seen in Hohokam pottery: red-on-buff and Gila Polychrome. The typical Hohokam vessel shows red-on-buff decoration. Red is applied to the clay surface and is darker than the surface to which it is applied due to the amount of oxide from the iron (Waters 1982:537). Simple patterns are employed early with more complex and zoomorphic forms such as frogs, cranes, and fish in the later phases such as the Sacaton phase.

Shape and finish become more refined with the complexity of decoration. Ollas (storage vessels) and bowls are most prevalent: however, ladles, canteens, and cups are also present. Overall, bowls are shallow with straight rims. The most shallow bowls appear to be trays or platters. Another type of bowl is "deep with slightly flattened bottoms and widely out-curving rims" (Cummings 1953:197). These types of vessels typify Hohokam red-on-buff pottery.

The other common pottery type, Gila Polychrome, begins about A. D. 1300. The clay is not as well prepared nor as well finished as the red-on-buff, however, the decoration is more elaborate (Haury 1976:203). Exterior rims of the bowl are covered in a red slip with an interior of clear white.

The elaborate designs are located in the interior of the vessel and are black.

> The exterior design is a black on the white band, often four to five inches wide; sometimes it is painted in black outlined with white on a red background of the bowl or on a darker band or red. Or, red may be combined with black on a white background (Cummings 1953:199).

Although the art work is elaborate, the clay manufacture is comparatively inferior.

Ballcourts

The final aspect of public architecture that is used to establish core and periphery areas is the ballcourt. Some Hohokam sites contain one or more ballcourts. Although these ballcourts do not appear identical to those of Mesoamerica, the ballgame appears to have been a typical element of Hohokam communities. It is the ballgame not the court that diffused into southern Arizona (Wilcox and Sternberg 1983). A Hohokam ballcourt is a large oval basin-shaped hollow. The floor and walls are covered with caliche, and rock is sometimes incorporated into the walls and then plastered. The floor (which typically contains small pits and a center stone) curves at a 37 degree angle. The ends are specially constructed features that are similar to the pithouse entryways. The sides are embankments of piled earth.

Sites with more than one court are hypothesized to be centers within the core area. Wilcox and Sternberg (1983) believe that the regional centers within the core area, such as Casa Grande and Snaketown which have multiple ballcourts, are centers of activity, and many communities would come together for ceremonial activities at the ballcourts. Sites found in the peripheral zones typically have one ballcourt at their largest sites. However, the farthest rural populations, small hamlets, may not have a ballcourt.

Ballcourts are located near the central plaza or near mound complexes. The courts are an important factor in changing the structure of the regional system due to distant population participation. A settlement hierarchy may be indicated with the presence of multiple court sites and a cluster of ballcourts in a region. Therefore, a different sociopolitical function of the region may exist. Sites with large courts, those with a length of approximately 83 m and a width of 32 m, have communities with the highest level of productivity and have more influence over small court communities, those with a length of 18 m and a width of 10 m. A more complete discussion of ballcourts appears in Chapter 3.

Conclusion

The Hohokam settled in the Sonoran Desert which restricted their agricultural potential due to a lack of water. However, through canal irrigation, they were able to overcome environmental constrains. Settlement pattern reflects their success.

Ballcourts, a reflection of the Hohokam ceremonial system, are a component of the settlement pattern. Different regions in the Hohokam area contain denser concentrations of ballcourts. It is in the areas of highest density in which the core area exists.

CHAPTER 2

CORE AND PERIPHERY OF THE HOHOKAM

The Phoenix Basin is typically considered the core area for the Hohokam, and the surrounding area the periphery. For the most part, the periphery zone corresponds to major basins and river valleys. According to McGuire (1991), these areas include the Tucson Basin, the lower Verde River, the Gila Bend, the San Pedro River, and the Upper Santa Cruz River. The Phoenix Basin is considered the core of the Hohokam culture because it is here that the most elaborate items are found. The area contains the largest sites, the biggest and largest variety of ballcourt types, the most extensive irrigation systems, and the highest percentage of red-on-buff pottery. In the periphery areas, these items do occur, however, they are less elaborate and appear chronologically later than in the core area (McGuire 1991). The Phoenix Basin is the accepted core area of the Hohokam; but, it is possible that the core and periphery areas shifted. In the transition from the Archaic to settled agricultural communities, the Phoenix Basin did not appear as a core area. "The earliest evidence of settlements comes from the Tucson Basin and southeast Arizona" (McGuire 1991:366). A basic small settlement agricultural pattern is adopted over a very large area, which is larger than the Hohokam regional system at its peak. In the Colonial period, there is expansion of a group of traits including ballcourts, red-on-buff pottery, stone bowls, and shells manufactured in the Phoenix Basin. Some of the "periphery" area communities adopted much of the Hohokam tradition; however, most of the material culture continues to be of the local tradition (Gasser 1980). Peripheral area populations had already begun to diverge from the core area populations in the Colonial period.

The appearance of ballcourts during the Colonial period may indicate a change in Hohokam ceremonial life. The ballcourts serve as a center for community and/or intercommunity ceremonial elaboration. The Phoenix Basin gained control and dominated the Hohokam area because the ideological and the ceremonial exchange that linked the system had their origins in the Phoenix Basin. There was an increasing importance placed on calendrically scheduled events that involved intra- and intercommunity participation. This new focus is demonstrated by public structures such as the ballcourts. Because of the large distribution of ballcourts in the Hohokam area, it may be that ritual held the Hohokam system together.

Another shift in the core and periphery areas may have occurred at the end of the Sedentary period and the beginning of the Classic. The Hohokam regional system collapsed and was reorganized. As a result, major alteration and different adaptations are present in the material culture. Ballcourts are abandoned and the resulting cultural material resembles that of the Salado to the northeast. The loss of ballcourts suggests that there is a change in ceremonial life and intercommunity communication. Cordell (1984) states that the presence of Salado pottery suggests that a new religious influence may have entered the Hohokam area. If she is correct, the ceremonial use of ballcourts may have ended, resulting in a very limited distribution of ballcourts. There are Classic period ballcourts (for example at Casa Grande) that do not appear to create a ceremonial system. This idea further emphasizes the possible ceremonial significance of the Preclassic Hohokam ballcourts.

By examining ballcourt distribution, a core area, an inner periphery, an intermediate periphery, and a far periphery can be identified. An ethnoarchaeological example from outside of the Hohokam area comes from the Quiche Maya of Mesoamerica. The Quiche used the ballcourt to mark land boundaries in the peripheral zones (Fox 1987). This type of ballcourt placement may have some importance to the core and periphery concept that is employed in the Hohokam area.

The core area of the Hohokam occurs in the riverine areas of the Gila and Salt Rivers within the Phoenix Basin. It is defined by a concentration of sites with two or more ballcourts. The Salt-Gila core region communities have more social functions, are more responsible for cultural innovation and cultural stimulation, are a center for trade, are more socially complex, and have a higher local productivity due to extensive irrigation systems. In the core area, both large and small courts exist. The number and size of Hohokam ballcourts display a ranking system within the Hohokam region and its regional, political, social, and economical impact.

As previously stated, the periphery area is the region outside of the Phoenix Basin. The nonriverine areas within the Phoenix Basin are the inner periphery which are probably tied through kinship with earlier centers. Principle river valleys surrounding the Phoenix Basin are classified as the intermediate periphery which includes the Tucson Basin, the lower Verde, the Gila Bend, and the San Pedro Valley. The far periphery includes the Tonto Basin, the Papagueria, the Flagstaff area, the northern Sonora, southeastern Arizona (the San Simon and Sulphur Springs valleys) and Point of Pines. Each region may have ballcourts. Usually, only single ballcourt sites exist in the peripheral areas.

Core and periphery relations are suggested by the distribution of ballcourts throughout the Sonoran Desert. Within the Hohokam area there are currently 193 known ballcourts (Wilcox and Sternberg 1983; personal communication with Wilcox 1991). The Phoenix Basin is indicated as a core region because 50% of the ballcourt sites in the area are multiple court sites (Wilcox and Sternberg 1983). Straight line distances to adjacent sites fall within the range of 10 km or less in the core area, suggesting a possible regional system that is structured through activities that occurred at ballcourts. The ballcourt network stretches farthest to the east and southeast along river systems. This pattern results in apparent site clustering in a series of alluvial basins and other areas of arable land. The farther a region is from the center of a core area, the more likely the region may be a distinguishable local system. However, the core maintains contact with the far periphery.

> Interaction on a community level was integrated into a variety of fairly complex local systems that were in turn articulated into a larger regional system (Wilcox and Sternberg 1983:194).

The periphery zones are also concentrated along principle drainages, which may be due to environmental restrictions of the Sonoran Desert. Although they do not have the quantity of ballcourts that the Phoenix Basin has, their ballcourts served local intercommunity purposes. For larger ceremonies, inhabitants from these regions may have traveled to major centers.

Within each intermediate periphery it is possible that there is a leading center. Many times these sites have more than one ballcourt. For example, the Hodges site (AA:12:18 [ASM]) in the Tucson Basin and the Gatlin site (Z:2:1 [ASM]) in the Gila Bend may be such centers. The Tucson Basin could be a competing center albeit on a smaller scale. This is suggested by in a close cultural relationship that links the periphery to the Phoenix Basin, which is seen by 27% of the known Hohokam courts being located in the Tucson Basin (Wilcox and Sternberg 1983).

The far periphery also had contact with the Phoenix Basin which is seen through Hohokam ritual paraphernalia. However, there is also contrast with the core Hohokam. The far periphery, although influenced by the core, is also articulated with other non-Hohokam systems to develop a pan-regional system. Mimbres pottery and limited Mesoamerican contact support the pan-regional theory (Haury 1976). However, by incorporating the far peripheries with the core, an introduction of exotic goods from far regions occurs in the core, inner, intermediate, and far peripheries.

CHAPTER 3

NUMBER AND TYPE OF BALLCOURTS FOUND IN THE HOHOKAM REGION

Much of this thesis builds on a seminal work on Hohokam Ballcourts and Their Interpretation by Wilcox and Sternberg (1983). Wilcox's data on location, dimensions, and types of ballcourts are drawn on in this chapter to discuss the basic parameters of the system. This forms the background to statistical tests of regional clustering that are presented in Chapters 4 and 5.

Functional Parameters

The structural characteristics of the Hohokam ballcourts are discussed in Chapter 1. Size and shape of the ballcourt varies throughout southern Arizona. There are large and small varieties and five types of ballcourts. Length and width from crest to crest and the ratio of length to width give the functional parameters of the elliptical shaped ballcourts (Wilcox and Sternberg 1983:177).

Length ranges from 18 m to 83 m and width from 10 m to 32 m (Wilcox and Sternberg 1983). These measurements and the measurements of area can be used to construct the five different categories of courts found in the area. The variability of ballcourts shows some clustering into the above "types."

Many of the ballcourts are arranged dyadically according to the equinox. It is because of this arrangement that Wilcox and others infer that courts are used at different times each year to symbolize different mythological events that revolved around the cosmological concept of the sun crossing the heavens.

According to Wilcox, the difference in size may suggest varying team size. As Wilcox and Sternberg (1983:80) note:

> The smallest courts may have involved a game between teams of only one or two each; there is hardly room for more to play. The three intermediate types could each have accommodated competitions between teams of four....Team size in the largest Hohokam courts, however, probably involved two to four times as many players. Because the large courts are also the most variable in their length and width characteristics, team size also may have varied among them.

Wilcox (1983) further suggests that because variation in the length and width measurements of the different court types is not random that it strongly suggests a version of the Mesoamerican ballgame. Finally, because of the internal consistency of size measurements, there are possibly three versions of the ballgame played.

Audience participation

Another consideration for ballcourts and their function to the Hohokam is audience participation. Court-centered activities differ from the core area to the peripheral areas. These activities are "apparently found to complement a wide variety of other ceremonial activities, contributing something similar to many different ceremonial systems" (Wilcox and Sternberg 1983:188). Architecture of the court system is similar in core and periphery ballcourt distribution. However, no central plaza exists in the far periphery sites and courts may be part of a functionally different ceremonial system.

The audience may have watched the ballgames from the embankment of the courts which was over one meter in height. Because of the embankments, a view of the ballgame would have been impossible from a far distance, thus the audience stood on top of the embankments. "Calculations of the standing-room statistics made... suggest that audiences may have varied from about 150-350 on the smaller courts ... to 250-800 on the larger ones..." (Wilcox and Sternberg 1983:184).

Assuming various community size estimates, it is possible that entire community populations could gather to watch ballgames. On larger ballcourts, several communities could gather, where as on smaller ones, several households could gather to view an event.

The size and type of court has important implications on the function of the ballcourt in communities.

> If the magnitudes of settlement population and audience participation in court activities were indeed roughly equivalent, as we have inferred, then the prospect for <u>intercommunity</u> involvement is good (Wilcox and Sternberg 1983:185).

Conversely, if the population and audience participation is smaller, intracommunity participation is likely to be higher. One problem with this model is that if certain groups are excluded from participation in the ballgame, such as women or children, large courts are not necessary and may not appear in the various sites. However, it is likely that court size is influenced by inter- or intracommunity participation.

Site Context

The location of a Hohokam ballcourt is another important factor in its role for the community. According to Sayles (1945) and Tuthill (1947), sites do exist where the Hohokam courts appear on or near the edge of a settlement. However, this pattern occurs most frequently in the far periphery (Flagstaff and the San Pedro River Valley). In these sites, the artifact assemblage contrasts with the core. It therefore may be suggested that the ballcourts in the far periphery are incorporated differently than in the core area.

In the core area and the inner and intermediate peripheries, courts are generally located on the "edge of a central site precinct that often consists of a set of large mounds surrounding what probably was a large central plaza" (Wilcox and Sternberg 1983:187). Among the small and large courts, orientation and position vary. In the larger sites, there are mounds in the area of ballcourts. At Snaketown (U:13:1 [ASM]) (Haury 1976) and Gatlin (Z:2:1 [ASM]) there are caliche-capped mounds (Wasley 1960). However, these sites are not typical of the region. Ballcourts are more likely to be located near trash mounds or central plazas as with U:6:40 (ASM), U:11:1 (ASM), and U:15:55 (ASM).

CHAPTER 4

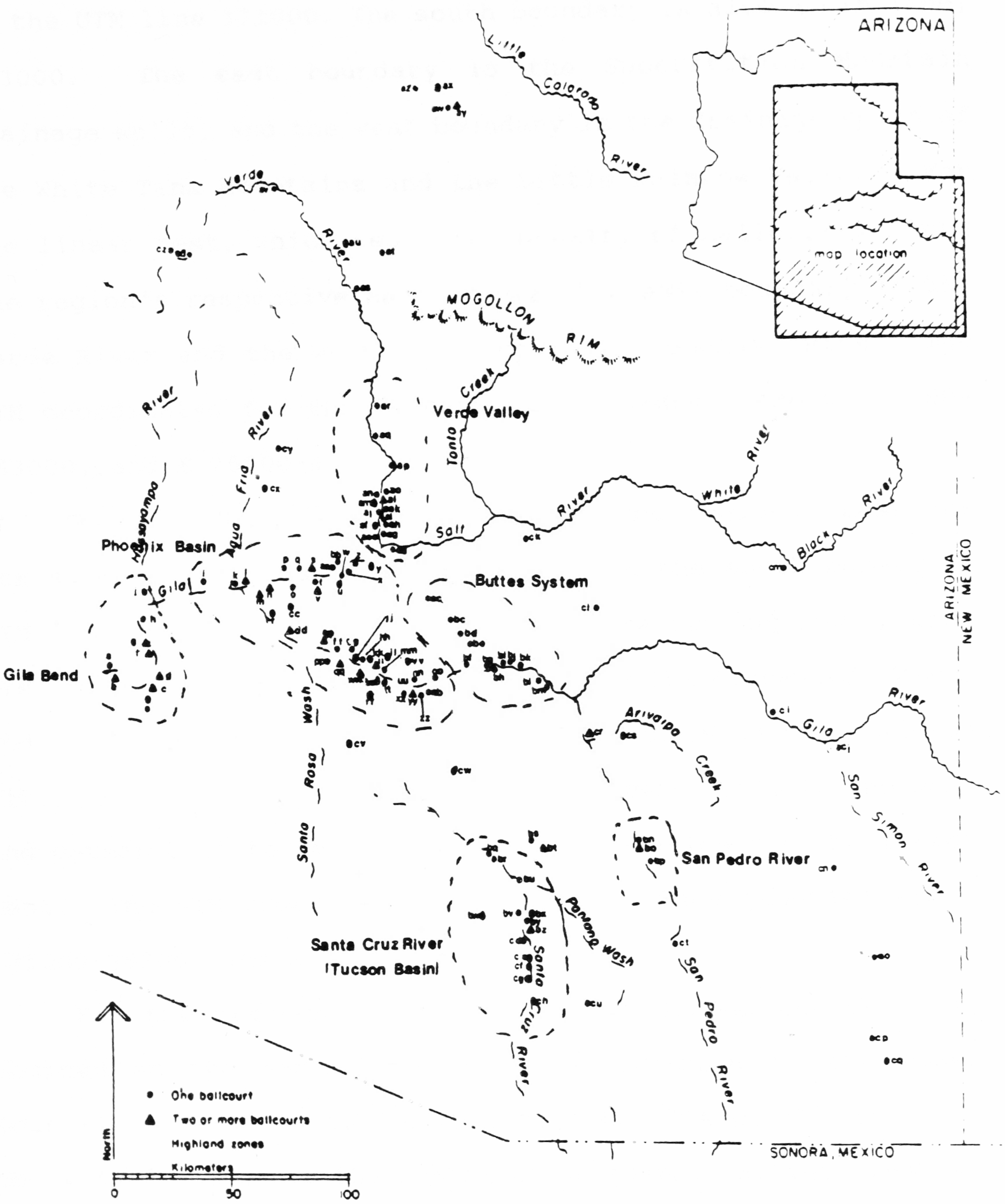
METHODS AND MATERIALS

The spatial patterning that is described is based upon information from Arizona site cards that are obtainable from the Arizona State Museum at the University of Arizona. Only sites with known ballcourts are used in the study. Additional information regarding site files was obtained through the Arizona State Museum computer database system AZSITE. In some cases, sites had UTM numbers assigned to them and a precise location is available. For the others, the site cards provide the township and range coordinates from which UTM numbers are assigned. This is accomplished through the use of United States Geological Service maps of Arizona at the scale of 1:250,000 and township and range grids. Once the site is plotted from township and range points, UTM numbers (North and East) are extrapolated (see Appendix 1).

Regional Boundaries

After plotting all of the ballcourt sites, core and periphery zones are established using physical boundaries where possible (see Figure 2). The core area contains the Phoenix Basin. This area is described as the Gila and Salt Rivers. It is the core area because there is a higher density of ballcourt sites and a higher density of multiple-court sites. For this study, the core area's north boundary

Figure 2-- Hohokam Core and Periphery Map



Adapted from: Wilcox and Sternberg (1983: 104)
See Appendix 1 for key

is the UTM line 371000. The south boundary is also a UTM line, 353000. The east boundary is the Superstition Mountain drainage split, and the west boundary is the drainage split of the White Tank Mountains and the Little Rainbow Valley. For the linear test, which tests the density of ballcourts along the region's respective major river, the east boundary is the Verde River and the west boundary is the Buckeye River. The UTM coordinates for the Phoenix Basin quadrant are N 371000-353000, and E 35000-47000.

The Gila Bend periphery zone for the regional test has its north boarder as UTM line 371000 and the south border is UTM line 363000. Natural boundaries are not apparent, thus UTM lines are used. The east boundary is the Hassayampa River and the Maricopa Mountains. The west boundary is the drainage division in the Eagletail Mountains. Powers Butte to the west and Oatman Flat to the east are the boundaries for the linear test. The UTM coordinates for the Gila Bend quadrant are N 371000-363000 and E 28000-37000.

For the regional test, the Buttes System periphery is bounded on the north by a drainage division in the Pinal Mountains of the Tonto National Forest. The south border is the wash division of the Tortilla Mountains. Silver Creek is the east border and the west border is a drainage division of the Mineral and Dinosaur Mountains. The linear test boundaries are the core boundary to the west and Smith Wash to the east. The UTM grid coordinates are N 370000-364000 and E 46000-53000.

The Santa Cruz River (Tucson Basin) periphery has a north boundary in the Falcon Valley along the north UTM line. The south boundary is a series of mountain ranges along the UTM line. A drainage divide in the Roskruge Mountains gives the west boundary and the east boundary is another drainage division in the Santa Catalina Mountains. The linear test boundaries in the north and south are the respective UTM lines. The UTM coordinates for the periphery are N 361000-353000 and E 45000-55000.

Cooper Creek and Cottonwood Wash are the northern boundaries for the San Pedro River periphery. The south boundary is UTM line 357000. The drainage division of the Galiuro Mountains is the east boundary and the drainage split for the Santa Catalina Mountains is the western boundary. Cooper Creek and Teran Wash are the linear north and south boundaries respectively. The UTM coordinates for the periphery are N 363000-357000 and E 52000-57000.

The Verde Valley is bordered on the north by the Horseshoe Dam and on the south by the Salt River. The east border is the drainage division in the mountains ranges of the Tonto National Forest. It is also the Gila County and Maricopa County line. The west border is the drainage division of the McDowell Mountains. Horseshoe Dam and the Salt River are the north-south borders for the linear test.

The coordinates for the periphery are N 376000-371000, and E 42000-48000.

Poisson Distribution

The statistical measure that aids in distinguishing the core area from the peripheral zones is the Poisson distribution. The use of this statistic tests the distribution against the assumption that a "random location of points so that any quadrant has an equal and independent chance of receiving a point" (Clarke 1977:240). A comparison of the observed frequencies of Hohokam ballcourts in the study area to the expected distribution frequencies was used in this thesis under the assumption of a Poisson series using Chi squared as a measure of goodness-of-fit (Clarke 1977; Hage and Harary 1983; Hoder and Orton 1976). The Poisson series is associated with events which occur randomly in a continuum of space. Therefore, tests for agreement with a Poisson series are used as tests for randomness of distribution. This provided a measure of whether ballcourts were distributed randomly in space.

The study region was first divided by a uniform grid of squares. In this case, UTM segment lines are used as the grid with a grid size of 10 km^2. The number of occurrences of ballcourts in each quadrant is counted, and the observed frequency distribution is compared with the Poisson distribution corresponding to the same density of points.

This is accomplished through the use of a goodness-of-fit test of the Chi squared statistic. The significance level for the Chi squared statistic is set at P> .05 which states that there is a 95% confidence level that the Chi squared method produced an interval that covers the true parameter value. Here, the true parameter value is the null hypothesis of the Poisson distribution, which states that sites are not clustered.

The Poisson distribution method is used in two ways: macro-regional (two dimensional) and linear (one dimensional). A grid of UTM coordinate lines is used in the core area, inner, intermediate, and far peripheries. The quadrants containing 0, 1, 2, ... etc. ballcourts are counted. The observed frequency of the ballcourt occurrences are then compared with the Poisson function (for formulae see Appendix 2). A Chi squared statistic is then calculated and the null hypothesis of a random pattern is accepted or rejected.

Because many sites with ballcourts appear to be clustered along rivers due to desert environmental constraints and the need for canal irrigation to aid in agriculture, a linear (one dimensional) approach is also utilized. Each major river system is determined and marked as 5 km segments. The frequency of sites with ballcourts in these segments is then compared with the expected frequency obtained from the Poisson distribution. The Chi squared test of goodness-of-fit is also used to test cluster or random patterning.

Sources of Error

The most obvious source of error in this thesis is the fact that not all ballcourts in the Arizona region have been found or documented. Although many areas have been extensively surveyed, there are other areas that have not been as thoroughly surveyed. However, early large-scale survey conducted by the Gila Pueblo and others (McGuire and Schiffer 1982) coupled with more recent work are likely to have recorded most of the large habitation sites where ballcourts are found. Ballcourts can also be identified on the surface without an extensive survey. They appear as elliptical depressions.

Another possible source of error is that the data only reflect ballcourt sites and not non-ballcourt sites. The density of Hohokam sites in general is not adequately represented by this study. However, current survey work is not adequate to discuss Hohokam settlement on a regional scale.

Finally, the computation of UTM numbers for each site may be a source of error. Many of the site cards from ASM and ASU did not contain UTM numbers, although, they did provide township and range data. From this information, the UTM numbers are estimated as closely as possible. Unfortunately, many of the township and range numbers were not identified to the 1/4 of a 1/4 section. Therefore, some of the ballcourt sites may not be accurately placed on the general reference map. Although their location is an approximation, the statistical values for the Poisson distribution in the regional mode is probably not affected dramatically. The statistics for the linear mode may be affected because the range is smaller (5 km) which requires a more accurate placement of the ballcourt site. However, there is no reason to believe that the inaccuracies biased the results in any way.

CHAPTER 5

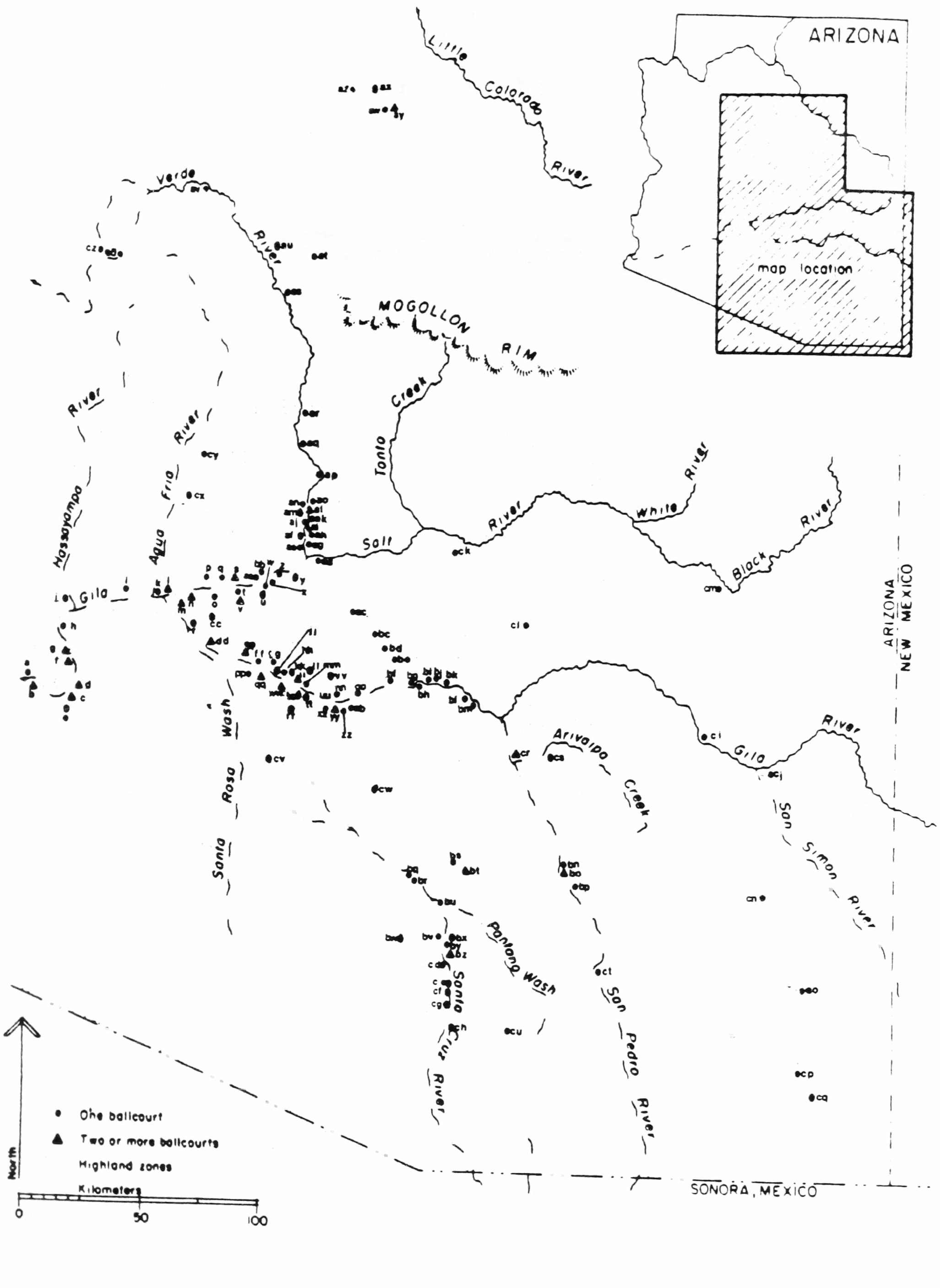
RESULTS

Using UTM numbers, a general reference map which is adapted from Wilcox and Sternberg (1983: 104) is created (see Figure 3). All of the known ballcourt sites that are available from site cards are plotted. From this arrangement of points, core and periphery is measured comparing observed frequencies to those expected under the assumptions of the Poisson series using the Chi squared goodness-of-fit test. Both regional (two dimensions) and linear (one dimension) zones are tested. The results are discussed below.

Regional Variation (Two dimensional)

From the available data (see Tables 2-7), it can be concluded that the core area and the Verde River Valley are clustered, and that the other regions show random distribution. The Verde Valley, although considered a periphery by Wilcox, may show a cluster pattern because it had interaction with areas to the north. Perhaps the Verde Valley may have been the core region for another regional system while still participating in the Hohokam system. Ballcourts that occur outside of the Hohokam zone, such as at Point of Pines, are explained as a ceremonial feature of the Hohokam that the Verde Valley may have introduced to

Figure 3-- Ballcourt Location Map



Adapted from: Wilcox and Sternberg (1983: 104)
See Appendix 1 for key

Table 2

Ballcourt Distribution of the Phoenix Basin (Core Area)

Number of ballcourts	Observed frequency	Expected frequency
0	73	57.633
1	13	28.183
2	1	6.891
3	4	2.246
4	0	.823
5	1	.322
6	1	.131
7	0	.055
8	1	.024

X^2=12.869

A hypothesis of agreement is rejected with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value exceeds the tabled valued of 5.99 for two degrees of freedom. Rows 4-9 are pooled because the values are less than 5. Therefore, the core area is clustered.

Table 3
Ballcourt Distribution of the Gila Bend Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	55	55.603
1	9	7.784

X^2=.197

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Therefore, the periphery is not clustered.

Table 4
Ballcourt Distribution of the Buttes System Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	36	32.526
1	3	9.075
2	3	1.266
3	1	.235

X^2=1.580

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 3 and 4 are pooled because the values are less that 5. Therefore, there is no clustering.

Table 5

Ballcourt Distribution in the San Pedro River Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	28	27.149
1	1	2.715
2	1	.136

X^2= .281

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 2 and 3 are pooled because the values are less than 5. Therefore, there is no clustering.

Table 6

Ballcourt Distribution in the Santa Cruz River Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	72	66.335
1	3	12.471
2	4	1.172
3	0	.15
4	1	.021

X^2= 2.93

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 2-5 are pooled because the values of rows 3-5 are less that 5. Therefore, there is no clustering.

Table 7

Ballcourt Distribution of the Verde River Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	29	22.800
1	2	9.800
2	1	2.110
3	1	.600
4	2	.200

$X^2 = 4.837$

A hypothesis of agreement is rejected with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value exceeds the tabled value of 3.84 for one degree of freedom. Rows 2-5 are pooled because the values of rows 3-5 are less than 5. Therefore, there is clustering.

northern groups (Merbs 1967). However, there may be internal differentiation between the Verde periphery and the core within the region. There appears to be different elements occurring with ballcourt placement in the core and the periphery areas on a regional scale. The core area has ballcourt sites with one or more ballcourts per site. In the periphery, especially the inner periphery, there are one or two ballcourts per site. The intermediate and far peripheries have only one ballcourt per site.

The following distribution suggests a hierarchy in the Hohokam area. One level of Hohokam hierarchy is the division of sites with ballcourts and those without ballcourts. Another level of hierarchy is seen with under 20% of the ballcourt sites having multiple courts. Within each local system, there is at least one site with multiple ballcourts. From this information, the Hohokam region can be divided into major centers (core area) and local systems (periphery).

Major Centers

Major centers have more than one court per site. Many of the sites have both large and small courts. Wilcox and Sternberg (1983) infer that populations at Hohokam ballcourt sites with multiple courts are responsible for a greater variety of social functions and thus are major centers. The different number and size of ballcourts suggests that functionally different activities took place in them. The courts may have been used at different times each year to symbolize different mythological events.

As stated before, intra- and intercommunity participation was held at public structures such as the ballcourts. Due to the increasing reliance on calendrically scheduled events, Hohokam core and periphery ballcourt systems were the focus of ceremonial activities (Neitzel 1991). The Phoenix Basin gained control and dominated as the Hohokam core area because ideological and ceremonial exchange linked the system and had its origins in the region.

During the Pioneer period, most of the population in the core area was concentrated along the middle Gila River. There are twice as many sites in the area than in any other area (Wilcox and Sternberg 1983). One example of a preeminent regional center in the core area is Snaketown. Because the site is not typical of most Hohokam settlements it is a good example of a major center. There is a large congregation of houses-in-pits that open onto a central plaza. The large ballcourt at Snaketown is the earliest, largest is volume, and the longest used court in the region (Haury 1976).

Although many of these same features, including large and small ballcourts, are seen at other sites such as Los Hornos (U:9:41 [ASM]), Villa Buena (T:12:9 [ASM]), and Pueblo Grande (U:9:1 [ASM]), the complexity of Snaketown is not seen elsewhere. Therefore, Snaketown is "a preeminent regional center, a continuing source of innovation, and cultural stimulation throughout southern Arizona from the early Pioneer period to the late Sedentary" (Wilcox and Sternberg 1983:203).

Local Systems

In contrast to major centers, local systems are a level above the community but are lower in rank than sites in the core area. Each of the described periphery areas may be considered a local system. Each system has a specific sphere of influence. There is a significant degree of variability in the larger local systems. Although populations did increase, there is never the sophisticated organization of the core due to the greater ecological diversity. As a result, local economic interdependence and weak regional integration exist (Wilcox and Sternberg 1983). Within each local system it is possible that there is a leading center. These centers have a repetition of structural patterning, within the site, that is similar to the core and they may also have more than one ballcourt, although it is not necessary in all areas. If leading centers do exist in the Hohokam system, the Hodges site (AA:12:18 [ASM]) in the Tucson Basin, the Gatlin site (Z:2:1 [ASM]) in the Gila Bend, and the Redington site (BB:11:1 [ASM]) in the San Pedro Valley are possible centers (Wilcox and Sternberg 1983).

Organization of the settlements and trade within and among them is also functionally different than that occurs in the major centers. "Exchange among affinal relatives was probably the basic framework on which the somewhat more complex exchange network indicated by the ballcourt data was built" (Wilcox and Sternberg 1983:206). Communities at sites with smaller courts may have owed political allegiance to a site with a larger ballcourt. A general hypothesis for the size of ballcourts states that larger courts occur in communities that have the highest local productivity. Thus, within each local system it is possible to see a site hierarchy in the number of ballcourts per site.

One example of a local system with a possible leading center occurs in the Tucson Basin. The Tucson Basin has comparable political units to the core area. There is greater productivity due to irrigation systems at AA:12:18 (ASM). Shell from the Gulf of California also appears at the Hohokam habitation sites. One can conclude that although it is unlikely that the leading center is equivalent to those of the core area, it is possible that its social structure is such that some type of political alliance with smaller settlements was present.

Linear Variation

Another type of comparison for the Hohokam core and periphery zones is to examine linear clustering. When one observes the apparent clustering of sites in the Hohokam area, it appears that the densest concentration of sites occurs along the rivers. Although the most dense concentration of courts is in the Phoenix Basin, the core area is located along the Gila and Salt Rivers. There appears to be a series of clusters along alluvial basins whose size and agricultural potential vary.

One of the main factors for the apparent clustering along alluvial basins is the restriction of life in the Sonoran Desert. Irrigation is of high importance to Hohokam survival. Therefore, if the inhabitants of a site intensely practiced agriculture, the site will appear closer to an unentrenched floodplain which will help assure successful agriculture practices.

The Poisson distribution statistic is also used to compare the frequencies of ballcourts in core and periphery areas. From the Chi squared statistic, only the core area is clustered in a linear test. Courts are randomly distributed in periphery zones. Tables 8 through 13 provide the basis for the above conclusion.

Table 8

Linear Ballcourt Distribution of the Phoenix Basin (Core Area)

Number of ballcourts	Observed frequency	Expected frequency
0	18	26.371
1	7	16.877
2	6	5.401
3	1	2.304
4	0	1.106
5	2	.566

$X^2 = 9.653$

A hypothesis of agreement is rejected with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value exceeds the table value of 5.99 for two degrees of freedom. Rows 3-6 are pooled because the values are less than 5. Therefore, there is clustering.

Table 9
Linear Ballcourt Distribution of the Gila Bend Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	10	9.404
1	3	4.392
2	2	1.025

$X^2 = .07$

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 2-3 are pooled because the values are less than 5. Therefore, there is no clustering.

Table 10
Linear Ballcourt Distribution of the Buttes System Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	6	5.820
1	3	3.701
2	2	1.177

$X^2 = .009$

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 2-3 are pooled because the values are less than 5. Therefore, there is no clustering.

Table 11
Linear Ballcourt Distribution of the San Pedro River Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	7	7.407
1	3	2.222

$X^2 = .294$

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Therefore, there is no clustering.

Table 12
Linear Ballcourt Distribution of the Santa Cruz River Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	14	11.541
1	3	6.347
2	1	1.746
3	2	.640

$X^2 = 1.379$

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 2-4 are pooled because the values of rows 3-4 are less than 5. Therefore, there is no clustering.

Table 13
Linear Ballcourt Distribution of the Verde River Periphery

Number of ballcourts	Observed frequency	Expected frequency
0	3	7.459
1	3	6.146
2	4	2.532
3	1	1.391

$X^2 = 3.091$

A hypothesis of agreement is retained with a Poisson series at the 95% probability level (P> .05) because the computed X^2 value does not exceed the tabled value of 3.84 for one degree of freedom. Rows 2-4 are pooled because the values of rows 3-4 are less than 5. Therefore, there is no clustering.

As can be seen from the previous tables, clustering of ballcourts is only found in the core area. These findings support the discussion of major centers and local systems. Although ballcourt distribution in a linear pattern is not statistically significant for the periphery, this pattern may exist due to environmental constraints. The data suggests a division between core and periphery which can also be seen in regional hierarchy. The social function of ballcourts in the core and periphery will be further examined in the next section.

CHAPTER 6

DISCUSSION

The Hohokam ballcourt system was probably one of the mechanisms by which local and long distance trade is regulated by the communities. It is also through the ballcourt system that social integration occurs in the core and periphery regions.

According to Barnes (1972), the core population is the center of political and economic power which aids in directing the resources from various periphery area populations. Some characteristics of core communities include "the development of interregional exchange networks, growth of settlement size, intensification of resource use and the concentration of surpluses" which are entailed in advanced social and technological processes (Lerner 1987:97). Because the ballcourt system may be one of the characteristics by which social and technological advances are measured, one expects to find a denser concentration of ballcourt sites in the core area (see Figure 4). It will follow that the core area will also have a higher density of multiple court sites.

The periphery zone population is less complex politically and economically, and may be subject to the core area population for agricultural products, raw materials, and ritual paraphernalia. The further from the core, the

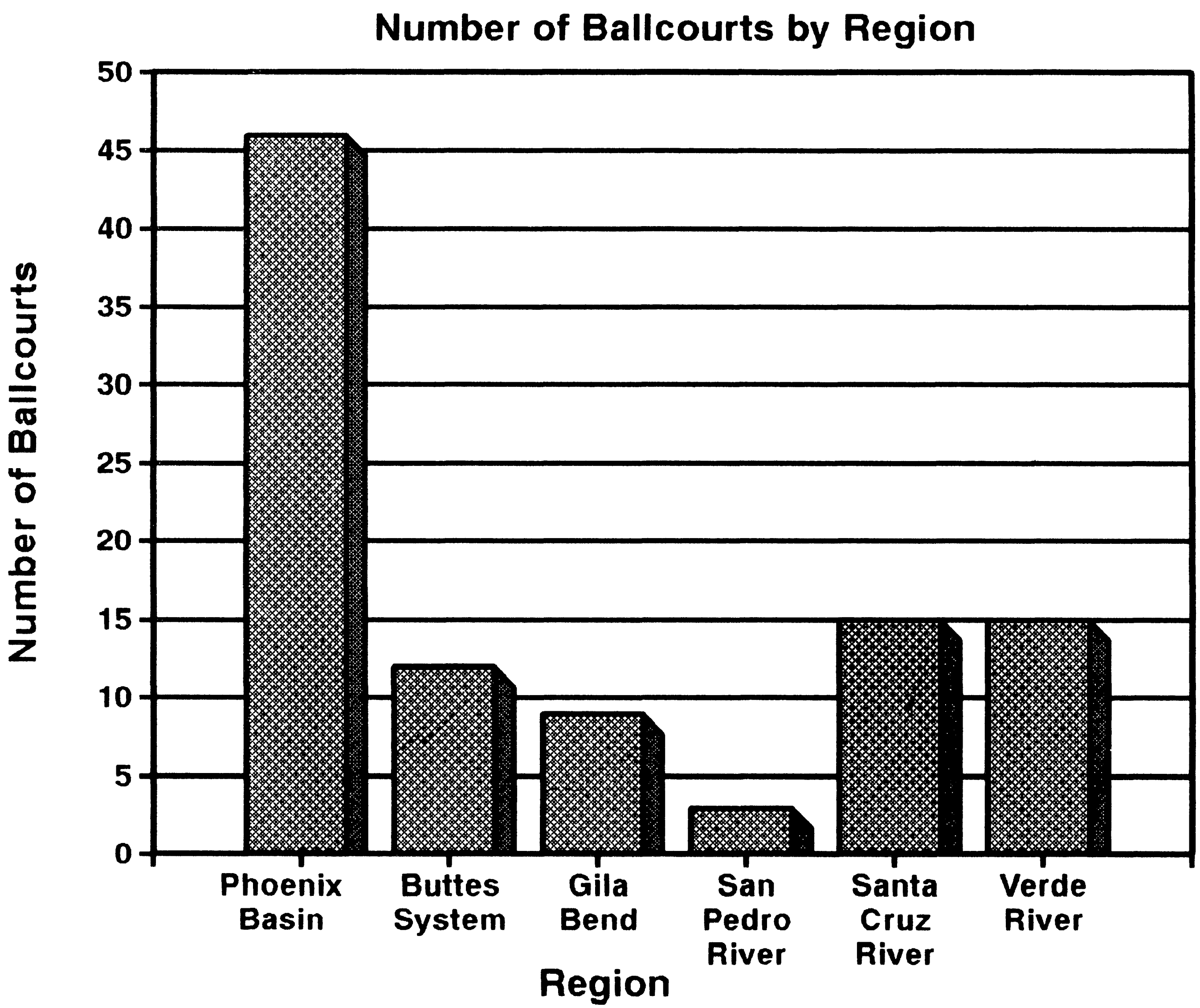


Figure 4--Ballcourt Number by Region

less likely the periphery will resemble the core area. Periphery populations may simply equate to a Maya system in which the periphery owes tribute to the core and has little control over the core's demands. For example, a peripheral zone community that specializes in a particular raw material, such as shell, may export the raw material in demand to the core.

Neither the core nor the periphery community is an autonomous system. "The linkage between these systems is part of a feedback relationship in which the core dominates the periphery, forming a pattern of dynamic interaction between the two systems" (Lerner 1987:98). This view makes the periphery dependent on the core under almost all circumstances. However, the relationship between core and periphery does not always remain static. As can be seen from the discussion of core and periphery in Chapter 3, the core has changed locations and strengths. This change may also be seen in the distribution of ballcourts. Not all periphery areas have multiple court sites. Those communities with multiple court sites may have been at one time more socially important than those peripheries without multiple courts. The interaction within the periphery population may become more complex to oversee exchange and other socio-political needs of an increased population.

Increased interaction can be seen in the Verde Valley periphery which may explain the regional clustering of ballcourts. Although other peripheries have similar densities, the Verde Valley shows clustering because of its different scope of interaction. Gladwin and Gladwin (1930) and others state that the area may have been a boundary for the north and south populations (Fish, Pilles, and Fish 1980). However, the area is more typically considered a inner periphery of the Hohokam core area. The Verde Valley does have a multiple court site, thus there is the possibility of a local leading center.

Assuming that the Verde Valley is closely tied to the core area, the number of items from the core area should exceed the number of objects from other regional systems. According to Hirth (1978), if the organizational complexity increases, the integration of a local economy into a regional system would be a vital part of such of a development. Interaction can be seen by the inclusion of several different artifacts that are not produced in the area. Nonlocal materials that are found in the Verde Valley and/or in other periphery zones include:

> mosaic mirrors, shell, and copper bells from Mesoamerica, obsidian, chert, quartz, and other stone for the production of stylized projectile points and blades, andesite and quartz-basalt for ground stone tools exotic pottery from all four directions, but especially from the north, and numerous exotic materials used for jewelry, pigment and ceremonial purposes. (Doyel 1991:252)

Many of these items are status goods, especially decorated ceramics and shell products.

Lerner (1987) calculates the amount of intrusive objects in the Verde Valley with three different time periods (Early, Middle and Late). From the data she concludes that there is an organizational shift and an increase in societal complexity.

> During the early periods of occupation, the population inhabiting the periphery participated in a sphere of interaction directed primarily to the south with a predominance of Hohokam artifacts. Later periods of occupation indicated a change in the directionality of interaction to other regions. This pattern suggests that, while ties with the Hohokam core still existed, there was an increase in the exchange relations with populations to the north. (Lerner 1987: 115)

From the above statement, it can be concluded that the periphery zone populations had a tendency to expand and become less dependent on the core. This is supported by the clustering statistics for the Verde Valley.

One example of the tendency to expand into other regions is seen in ballcourt distribution. As previously stated, the ballcourt system was probably extremely important in regulating local and long distance trade. Evidence of trade is seen in the presence of ballcourts in non-Hohokam sites from Point of Pines to Wupatki (Doyel 1991). This innovation suggests an attempt to introduce Hohokam ceremonialism into non-Hohokam societies. The introduction of ballcourts also may have helped the Hohokam acquire status goods for the emerging elite of the core area.

Another possible reason for a widespread distribution of ballcourts in southern Arizona is a ceremonial explanation. The first appearance of ballcourts during the Colonial period may indicate a change in the Hohokam ceremonial life. The ballcourts serve a community and/or intercommunity ceremonial elaboration. Neitzel (1991:213-214) believes that "the focus of ceremonial activities at these public structures suggests an increasing emphasis on calendrically scheduled events that involved community as well as inter community participants." It is the ritual that holds the Hohokam system together. From the density of ballcourts, it is apparent that the Phoenix Basin is the core area. It is in this area that ideological and ceremonial exchange linked the Hohokam regional system.

CHAPTER 7

CONCLUSION

As one can see from the Poisson distribution and the Chi squared statistic, there is a regional and linear cluster pattern in the core area. The various peripheries show a pattern of randomness and independent selection with regard to ballcourt placement except the Verde Valley. The lack of conformity to a random pattern in the Verde Valley may be due to a different type of interaction with the cultures to the north of the Hohokam while at the same time being a periphery to the Hohokam system.

This conclusion exemplifies the greater social complexity of the core area population. The ballcourt system is the ceremonial, social, and political center of the Hohokam area. Core areas are defined by a denser concentration of ballcourts. Sites in this area may have one or more courts per site. Each court may have had its own function. It is inferred by Wilcox and Sternberg (1983) and others that courts are used at different times each year to symbolize different mythological events that revolved around the cosmological concept of the sun crossing the heavens. As a result, the major center ballcourts are positioned dyadically at equinoctial points of descent and ascent. The largest courts are the earliest constructed, the largest in volume, and the longest used. This suggests that communities with these courts (usually in the core region populations) are part of a preeminent regional center that is a continuing source of innovation and cultural stimulation from A.D. 300 to 1100.

Peripheral zone populations are those that may depend on the core population. There are three zones: the inner, the intermediate, and the far peripheries. Each region has ballcourts. Usually one court per site exists, however, two court settlements may exist as with a local system. Each periphery has the possibility of being a local system with a leading center. The most obvious occurrence of these possible sites is a multiple court site within a periphery zone.

The concept of core and periphery assumes that the periphery population is dependent on the core population for resources. This may not always be the case. As seen in the Verde Valley, although it initially is connected to the Hohokam core, by the Late period the region has branched out to the north and has contact with other communities. This can be seen in the imported objects that occur at various Verde Valley sites. Although the periphery communities have a tendency to become dissimilar from the core, there is contact with the core because there are ballcourts in the periphery areas.

The concept of site hierarchy in the Hohokam area has other issues which should be examined. If there is a true hierarchy, this should be reflected by social differentiation of individuals, and the grave goods should show differences. Are ballcourt sites larger than nonballcourt sites, and if so, are the other components of the settlement pattern and population influence of equal proportion? What is the difference socially and politically between single ballcourt sites and multiple court sites? These questions would further justify the core and periphery model with respect to ballcourts in the Hohokam area. It would also aid in the development of differentiation between single ballcourt sites and multiple courts sites in the core area and the peripheries.

The approach taken in this thesis could potentially be used in the study of Mesoamerican ballcourts. Ballcourts in Mesoamerica are the center of the ceremonial system, and the ballcourt sites may also show a clustering pattern (MacNeish 1964; McGuire 1980; Schroeder 1955; Schroeder 1965). There are sites in Mesoamerica that have more that five courts (Fox 1987). Because it is believed that the ballgame and not the court came into the Southwest from Mesoamerica, the same ideological concepts may be in effect and a comparison in social and political influence over the periphery areas may be relevant.

Appendix 1

Ballcourt Site Numbers and UTM Numbers

Site Number		N	E	Number of ballcourts
a. T:13:9	ASM	3660000	319200	1
b. T:13:2	ASM	3654000	324600	2
c. Z:2:1	ASM	3650600	341200	2
d. T:14:14	ASM	3764700	314400	3
e. T:14:15	ASM	3654100	343300	3
f. T:14:16	ASM	3665800	340500	2
g. T:14:19	ASM	3661800	447100	3
h. T:9:1	ASM	3680600	335600	1
i. T:11:38	ASM	3696000	362550	1
j. T:10:46	ASM	3700040	343240	1
k. T:11:23	ASU	3697360	375560	1
l. T:11:39	ASU	3696860	381760	2
m. T:12:9	ASM	3691995	387080	3
n. T:12:19	ASM	3693640	387050	2
o. T:12:6	ASU	2695175	400325	1
p. T:12:10	ASM	3702900	396400	1
q. T:12:1	ASM	3702405	403370	1
r. U:9:1	ASM	4099900	370080	2
s. U:9:7	ASM	3700920	408680	1
t. Mesa 4:2		3697200	409300	1
u. U:9:48	ASM	3694500	411600	2
v. U:9:41	ASM	3699200	409400	2
w. U:9:25	ASM	3699300	421200	1
x. U:9:51	ASU	3701840	425820	1
y. U:9:81	ASU	3702700	427000	1
z. Mesa 3:2		3702700	427800	1
aa. U:9:28	PG	3703300	418000	1
bb. U:9:29	ASU	3703160	419130	1
cc. U:9:11	ASU	3703160	418540	2
dd. T:16:9	ASM	3675670	399340	2
ee. U:13:1	ASM	3672400	414990	2
ff. U:13:8	ASM	3669270	420185	1
gg. U:13:6	ASM	3668660	427480	1
hh. U:14:8	ASM	3664565	431275	1
ii. U:14:2	ASM	3662068	437103	3
jj. U:14:20	ASM	3661470	437040	3
kk. U:14:18	ASM	3662430	435355	*
ll. U:14:37	ASM	3662840	435470	3
mm. U:14:15	ASM	3663415	434268	1
nn. U:14:54	ASM	3677000	453300	1
oo. U:15:52	ASM	3657100	462800	1
pp. U:13:4	ASU	3664600	416600	1
qq. U:13:95	ASM	3663420	421893	1
rr. U:13:99	ASM	3663323	421210	1
ss. U:13:101	ASM	3662990	422000	1

tt.	U:13:103	ASM	366260	422310	1
uu.	Gila Butte 5:39		3662600	421400	1
vv.	Gila Butte 5:41		3662600	421400	1
ww.	U:13:27	ASM	3660540	429673	2
xx.	AA:2:17	ASM	3651065	450305	1
yy.	AA:2:2	ASM	3651065	450305	2
zz.	AA:2:63	ASM	3649552	444672	1
ab.	U:15:1	ASM	3652140	459780	1
ac.	U:11:1	ASU	3690700	458000	1
ad.	U:6:40	ASM	3712145	443345	1
ae.	U:6:150	ASM	3716120	436825	1
af.	U:6:11	ASM	3716860	436275	1
ag.	U:6:125	ASM	3716728	438615	1
ah.	U:6:110	ASM	3722890	439790	1
ai.	U:6:102	ASM	3724050	438485	1
aj.	U:6:81	ASM	3726528	438383	1
ak.	U:6:91	ASM	3728223	439170	1
al.	U:6:78	ASM	3731660	438835	4
am.	U:6:3	ASM	3730530	438780	1
an.	U:6:96	ASM	3734095	437948	1
ao.	U:2:19	ASM	3735260	439280	1
ap.	U:2:60	ASU	3748350	443250	1
aq.	U:2:36	ASU	5758825	435250	1
ar.	U:2:21	ASM	3759050	434100	1
as.	NA 3527		3822000	425100	1
at.	NA 4626		3770000	439200	1
au.	O:14:51	ASM	3772770	435180	1
av.	N:4:12	ASM	3862100	391900	1
aw.	I:15:1	ASM	3896660	466820	1
ax.	I:10:1	ASU	3903800	451950	1
ay.	NA 3669		3896660	476320	2
az.	NA 72		3903800	449900	1
bc.	U:11:2	ASU	3681800	466600	1
bd.	U:15:1	ASU	3677225	471650	1
be.	U:15:55	ASM	3672990	475400	1
bf.	Gila Butte 8:1		3662095	444400	1
bg.	U:16:14	ASM	3662095	484485	1
bh.	U:16:29	ASM	3663190	485600	1
bi.	U:16:78	ASM	3664450	491863	1
bj.	U:16:95	ASM	3663730	490970	1
bk.	U:16:119	ASM	3663635	497248	1
bl.	V:13:58	ASM	3657325	505900	1
bm.	V:13:8	ASM	3674800	508600	1
bn.	BB:11:11	ASM	3588777	547677	1
bo.	BB:11:1	ASM	3588202	548152	2
bp.	BB:11:18	ASM	3580801	553501	1
bq.	AA:12:73	ASM	3586450	485870	1
br.	AA:12:57	ASM	3582770	487328	1
bs.	BB:9:88	ASM	3589000	503000	1
bt.	BB:9:1	ASM	3587000	508100	2
bu.	AA:12:18	ASM	3576120	494980	2

bv.	AA:6:25	ASM	3558420	499340	1
bw.	AA:16:311	ASM	3563460	480100	1
bx.	AA:16:46	ASM	3858460	499500	1
by.	BB:13:15	ASM	3555650	500975	1
bz.	BB:13:7	ASM	3564100	501500	2
cd.	BB:13:16	ASM	3547620	500850	1
ce.	BB:13:16-G	ASM	3547820	500400	1
cf.	BB:13:41	ASM	3548100	500700	1
cg.	BB:13:50	ASM	3548100	500500	1
ch.	BB:13:221	ASM	3542000	502910	1
ci.	CC:1:4	ASM	3645300	604400	1
cj.	CC:2:3	ASM	3635024	634000	3
ck.	U:8:37	ASM	3717000	499400	1
cl.	V:10:4	ASM	3686460	529900	1
cm.	W:9:10	ASM	3720580	697669	1
cn.	CC:10:5	ASM	3581500	629550	1
co.	CC:15:1	ASM	3543462	648037	1
cp.	FF:7:2	ASM	3509450	646450	1
cq.	FF:4:2	ASM	3533805	646450	1
cr.	BB:2:2	ASM	3634673	526401	2
cs.	BB:2:10	BLM	3634041	534000	1
ct.	BB:15:1	ASM	3549000	564500	1
cu.	EE:2:105	ASM	3521300	526365	1
cv.	Gila Butte 9:5		3629910	485600	1
cw.	AA:8:21	ASM	3619350	499900	1
cx.	T:4:10	ASM	3753210	394460	1
cy.	T:8:19	ASM	3732600	385890	1
cz.	Prescott 6:7	GP	3770000	348300	1
de.	Prescott 6:8	GP	3770000	360400	1

<u>Key</u>

ASM= Arizona State Museum
ASU= Arizona State University
BLM= Bureau of Land Management
GP= Gila Pueblo
*= multiple court site, exact number unknown

Appendix 2

Poission Distribution Equations

$\bar{y} = \frac{\text{total number of ballcourts}}{\text{total number of grids}}$

$e^{\bar{y}}$= function key $e^{\bar{y}}$ of $\bar{y}$

n=number of ballcourts

$f_0 = \frac{n}{e^{\bar{y}}}$

$f_1 = \frac{n\bar{y}}{e^{\bar{y}}} (\bar{y})$

These equations are used to to obtain the expected frequency.

$f_2 = \frac{n\bar{y}}{e^{\bar{y}}} (\bar{y}/2)$

$f_3 = \frac{n\bar{y}_2}{e^{\bar{y}}} (\bar{y}/3)$

$f_4 = \frac{n\bar{y}^3}{e^{\bar{y}}} (\bar{y}/4)$

$f_5 = \frac{n\bar{y}^4}{e^{\bar{y}}} (\bar{y}/5)$

$f_6 = \frac{n\bar{y}_5}{e^{\bar{y}}} (\bar{y}/6)$

$f_7 = \frac{n\bar{y}^6}{e^{\bar{y}}} (\bar{y}/7)$

$f_8 = \frac{n\bar{y}^7}{e^{\bar{y}}} (\bar{y}/8)$

Chi squared statistic

$\frac{(\text{observed frequency-expected frequency})^2}{\text{expected frequency}}$

Use this equation for each degree of freedom.
Then add the numbers together to obtain Chi squared probability.

df= (r-1)(c-1)

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