Landscape alignments among 21 natural features and 61 Anasazi great kiva sites on the Southern Colorado Plateau: a comparison with random patterns

A large number of precise locations of Anasazi great kiva sites were obtained for a time period from about 500 A.D. to 1300 A.D. (Basketmaker III – Pueblo III). Using Geopatterns software, a test area encompassing all 61 existing sites was set up within the larger geography of 21 most unique natural features. Three-point alignments generated by sets of 61 random points (in the test area) are compared with those among existing built great kiva sites. Ten different accuracies are tested ranging from 0.015° to 0.15°. Existing patterns are compared with those of 100 random sets of 61 each at each range of accuracy. Built sites create more three-point alignments than 98% of random sets along a number of dimensions. Comparisons between BIII-PI and PII-PIII periods suggest greater contributions of alignments from earlier great kiva sites. The small number of alignments comprising more than three points (4-7) are also compared between existing and random sets with the highest overall number of three-point alignments at the accuracy range of 0.075°. Random probabilities of the “greatest” of alignments are tested.

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Earlier publications by the author, an architect/landscape architect with an academic background in social anthropology, suggested the design of specific large-scale layouts of ceremonial sites. In this paper, however, there is no assertion that any particular alignment or pattern, of whatever number of sites, is an artifact. The focus is entirely on numbers that comparison with random phenomena produce.

At present, no such numbers have been associated with larger scale geometrical site or landscape relationships in the Anasazi or Ancestral Pueblo world. Archaeologists (particularly Fritz 1978) and archaeoastronomers (Sofaer and Sinclair 1986) agree that the two 11th century great houses (ceremonial pueblo-like structures) located -> 3.754 km apart on the north (Pueblo Alto) and south (Tsin Kletzin) rims of Chaco Canyon form a designed North-South cardinal alignment, together with complementary cardinal orientations of the two buildings. Yet further mapping, more precise than the one or two degree accuracy margins of archaeoastronomers is needed. The precise cardinal or true north meridian from the center of the smaller great house to
the south, Tsin Kletzin misses the center of the much larger ceremonial focus, the great house of Pueblo Alto, by about 40 meters, an angular deviation from true north of about 0.611°. The western edges of the two very differently scaled structures, however, are quite accurately cardinal (0.039° or about 2.5 meters); the space formed by the small structure New Alto and the west wall of Pueblo Alto may have served as a kind of ritual gateway into the canyon.

When it comes to much larger alignments across portions of landscape not visible from each other, the idea that the Anasazi were actively and accurately surveying such artifacts needs an even more rigorous discourse. Any surveyed alignment of such prehistoric sites would of course be wholly symbolic, with an undoubtedly added dimension of socially significant, ritual practice (see Doxtater 1991). Why would the Anasazi create such artifacts? Were the present piece part of a larger volume, one could more thoroughly discuss all the reasons, including social and ideological, that Anasazi populations moved about and otherwise organized themselves across the plateau. As Nelson and Schachner (2002) detail in their overview, the movement from the San Juan area in the 13th century is just the largest and most apparent of a pervasive pattern. While it is suggested that people moving into other areas must have had social relationships with established occupants, and that connections might have been maintained with places of origin, still, specific related ritual practices are difficult to discern.

One possibility is a view of ceremonial pottery not so much as simple exchange among fixed populations, but as associated with larger scale residential movements (Zedeño 1998). It is Zedeño’s slightly earlier work on “territoriality” of the Hopi (1997) that set the stage for her focus on pottery. In spite of the ethnographic fact that the Hopi ritually maintain shrines in a relatively smaller territory (within the Navajo nation), their clan histories speak clearly about use of more distant natural features, and of maintaining linkage with distant places of clan origin. If it is found not improbable that large-scale, formal, surveyed alignments were designed between most significant natural features and ceremonial great kiva sites, then such might have been part of a ritual mechanism to mitigate immediate potentials of territorial conflict. Religious function may not have been unlike aspects of the smaller scaled ritual frameworks on the landscape such as in the Tewa (Ortiz 1969), or possibly Hopi (Doxtater 1979)--smaller and more territorial in essence after the breakup of Chacoan scale organization in the PIII period (Bernardi 2005).

Limited text space also precludes any full discussion or simulation of technical issues of surveying. Actual field testing and computer simulation of accuracies by the author (Doxtater
2002, 2007, 2009) describe very plausible ways that simple tripods with plumb lines could have been used to align interim points between distant features down to visual acuity at about 0.017°. Lekson’s volume on the Chaco Meridian (1999) provides an extensive discussion of possible surveying practices in the SW, including ways of determining the direction of true north by sun observation. Description of other ancient surveying techniques can be found in Gallo (2004) and Söderman (1999). Trial and error processes where points between two very distant points, not visible from each other, can eventually be aligned are diagramed by Lewis (2001:223), and Doxtater (2002). The author’s custom application, Geopatterns (Doxtater 2007), describes accurate great circle relationships among points on the earth’s ellipsoid surface. In the following analysis, 106 existing three-point alignments among built and natural points are compared with alignments created by random points. The average length of a three-point alignment in the set of existing 106 points is 258 km, with the longest at 791 km and the shortest at 57 km. The typical alignment length is long enough that surveying would involve diverse topography and most often multiple interim station points, i.e. that the two end points cannot be seen from a single point in between. In a related vein, the length of most of these alignments precludes any purely topographic cause.

**Existing literature on random comparisons**

The first critiques of assertions of designed landscape alignments were simple computer procedures testing claims about Ley Lines in England, usually under 10 km in length. As detailed thirty years ago by archaeologists Williamson and Bellemy (1983), random arrays of points at similar scales and accuracies produced many coincidental alignments. Other brief studies of random alignments--as much exercises in computer application--produced similar conclusions, e.g. O’Carroll (1979) and Papadopoulos (2001). For any given number of points (sites) of a given dimension, spread in a defined spatial area, numbers of three, four, five, etc. point random alignments can be predicted. Generally these facts are taken to mean that most if not all assertions that certain landscape features are intentionally aligned are probably wrong.

Two things have been missing in these peripheral forays into larger symbolic landscape structures. First is the most obvious, i.e. that just because some larger number of random alignments exists among a set of features doesn’t rule out intentional patterns among some subset. It just means that one cannot use comparisons with random phenomena to prove
intentional design. While prehistoric builders might have understood a few coincidental alignments, particularly with natural features, and might have intentionally designed additional layouts, they would have had no clue about some much larger number of random patterns. The second and more important ingredient missing in the limited literature on random geometries is application to a particular cultural landscape setting, where the selection and definition of “points” is clear, and the spatial scale of analysis is well reasoned. The first mainstream archaeological publication to test the alignment of built features against random patterns was Swanson’s GIS based analysis of signal fire alignments at relatively small scales of several kilometers on Cerro Moctezuma, the apparently sacred peak with a kiva-like feature (see figure 1) visible to the west of Paquime in Northern Mexico (2003). Using ten randomly generated sets of points on the mountain, and the Student’s $t$-test statistical process, he concluded that the existing pattern of signal locations had a high probability of intentional design. Note the limited number of random sets used and the reliance on statistical methodology to infer probability.

Also more recently, but in the Old World archaeology of Scandinavia, Stahlqvist enlisted statistical faculty at the University of Uppsala for his novel dissertation seeking to prove that Neolithic peoples used the locations of small burial mounds, at smaller scales, to create cardinal cross centers associated with territorial boundaries (2000). By randomly varying points away from existing intersections and along the axes of cardinally (north-south or east-west) related crosses, Stahlqvist and colleagues were able to state a good probability of design, in spite of controversy about whether the patterns were Neolithic or part of Early Medieval organization.

The following work compares alignments among existing sites and random ones. While two publications, Doxtater 2007 and 2009 include random comparisons, they focus primarily on specific sites and their patterned relationships. A piece of the 2007 paper does include a simple analysis of points in a specified area, the focus of the present paper. The number of sites, however, was quite restricted, only 22, and is subject to questions about an impartiality of site inclusion. The focus of that article, however, was on the use of the Geopatterns application for a computer oriented audience. The present work takes as blind an approach as possible, collecting as many great kiva site locations as are practicably available.

Because Geopatterns is a math-based application that calculates great circle relationships between points on the surface of the earth, unlike raster based GIS, a much larger number of random sets can be generated, eliminating the need for statistical “bridges” to probabilities. It
was specifically designed for this purpose, in addition to basic abilities to describe great circle geometries.

**Selection of natural features**

All historical ethnographies of traditional cultures living on the Southern Colorado Plateau, especially the Pueblo and Navajo, include explicit religious expression that focuses on most dramatic natural features. In Ortiz’s Tewa World (1969), these Anasazi descendants, structured three rings of successively more sacred ritual openings, thresholds or *sipapu*, in the landscape surrounding their mother pueblo. As diagrammed in Saile (1977), four mountains at the greatest distance from the center expressed the most powerful locus of contact with spirits. In the same religious vein, on the top of Mount Taylor, one of the highest mountains of the southeast portion of the Anasazi area, Snead and Preucel (1999:176), describe a six-foot deep hole, three feet in diameter, presumed to have been dug by indigenous people for *sipapu* related ritual. This is the “West” mountain for Laguna, but “North” mountain for Acoma. Short trails lead out to Keres pueblos; ritual practitioners use these shrines to pray for crops and good hunting. In a recent technical report of the US Forest Service, Anschuetz (2007:150) finds an early twentieth century description of a shrine located on the top of Cerro Chicoma. It consisted of six directionally oriented trails (*awu-mu-waya* or “rain-roads”) radiating from its center; these represented the spirit trails and pilgrimage routes of the Pueblos of Taos, San Juan, Santa Clara, San Ildefonso, Cochiti and Jemez. The sixth opening expressed the pathway used by the Navajo on their pilgrimages.

The Navajo are believed to have moved into the Anasazi sphere sometime around the 16th century adopting central aspects of Pueblo religion, particularly its cosmology or symbolic structure of space (Lamphere 1983). Witherspoon and Peterson associate important cognitive and cultural attributes, e.g. motifs on rugs, sand paintings, masks, clothing, staffs, hair buns, rock walls to the formal (spatial) structure of their large-scale horizontal and vertical directions anchored at four distant mountains (Humphrey’s Peak, Hesperus, Mount Taylor and Blanca Peak) together with mythology of the emergence through four underworlds or previous stages of existence (1995:34). They see this structure as a cognitive (center) core of Navajo thought and religion. Aldred (2000:23) makes the argument that Navajo land and religion are one. For a comprehensive list of major landscape features see McPherson (1992: 15).
Fig. 1 Selection of most prominent natural features in the Anasazi landscape.
Other unique natural features can also be ethnographically identified as pilgrimage foci for Pueblo groups in relation to elaborate emergence myths. At the Hopi pueblo Oraibi, for example, Geertz (1984) compares multiple versions, most of which contain clear spatial symbolism of an opposition between some “emergence” from below to above. Hieb (1994) dedicates his piece to the concept of “sipapu”, examining the active ritual use of these openings in the ground that are traditionally built in semi-subterranean Hopi ceremonial kivas. The Grand Canyon is one of the most dramatic of such openings. Ethnographic evidence in the case of the Hopi links emergence mythology to this natural sipapu. Mischa Titiev (1937) recorded the most detailed ethnographic account of the Hopi salt expedition to the canyon from the village of Oraibi. Both the Hopi and Zuni make pilgrimage to gather salt at their respective sacred sources, one to the Grand Canyon (Eiseman 1959, Vecsey 1983:88), the other to Koluwala:wa or the confluence of the Zuni and Little Colorado Rivers some distance southeast (Ferguson & Hart 1985:125).

For the Zuni, this is an important pilgrimage made every four years by religious leaders; all Zuni go to this threshold location after death. The trip the Hopi make down Salt Trail Canyon, as seen
in figure 2, takes them by a supposedly natural mound feature, about ten meters in diameter. Additional accounts of this pilgrimage experience come from two naturalist/writers, Eiseman (1959) and more recently Engelhard (2004). Eiseman photographed the mound feature shown in figure 2 and documented other shrines on the way to the actual junction of the two rivers where he located the salt source. Engelhard (2004) also describes multiple shrines along the trail. For both writers, the salt sources and the threshold confluence itself, not the mound shrine, is the ultimate destination of the pilgrimage, as is the case with the Zuni. For present purposes, the topographic point of the confluence, the central point of the triangular sandbar, is here called “Sipapu”. The great circle distance from the Sipapu to the middle mesa of the Hopi villages is over 125 kilometers. Pilgrimages of this length among the historical Pueblo people are common, and in the case of the Hopi a good example of large scale ritual involving powerful natural features beyond their territorial markers.

The relationship between historical Pueblo ceremonialism, mostly understood as having emerged in the fourteenth through sixteenth centuries, to earlier prehistoric periods recognizes significant overlap of the “kiva and sipapu complex” (Ware and Blinman 2000, 403), quite probably entailing landscape components. While it is generally difficult to archaeologically determine actual ceremonial use of natural features, Comb Ridge in Southeastern Utah is an exception in this regard. From the illustrations of figure 1, the uniqueness of this north-south thirty kilometer escarpment is clear. Hurst and Till (unpublished conference presentation 2010) speak of the unusual network of prehistoric roads and shrines associated with Comb Ridge, data from the first major comprehensive survey of the area. Their overall theme emphasizes the structure of meaning and ritual in the natural landscape, somewhat in distinction to large readily apparent architectural monuments like great houses and even great kivas. They mention that Native American sources still regard the intersection point of Comb Ridge and the San Juan River as a kind of “cosmic center” (see also McPherson 2010 for a Navajo perspective). At the actual rock point of Comb Ridge at the river, one can see in Google Earth, figure 1, a circular prehistoric feature the size and shape of great kivas of the times; it is called “Rincon”.

The feature Hurst and Till do not include, undoubtedly because its broad tourist exposure and image propagation has made it so well known, is the rock art site at Butler Wash, a series of “kachina” or priest looking figures carved into the rock faces of Comb Ridge as it meets the San Juan River (figure 3). “Kachinas” are visiting spirits impersonated during Pueblo rituals. While
Fig. 3 "Main Kachina Panel" (Basketmaker II, A.D. 500 and earlier) near intersection of Comb Ridge and the San Juan River; petroglyph figures are about human scale. Precise alignment of Main Kachina Panel with Sipapu and Lowry Great Kiva (photo by author, plan drawing below courtesy of Winston Hurst—alignment added).
the *kachina* cults practiced in the historical Pueblos may have begun after the breakup of the Chacoan phenomenon around A.D. 1250 (Adams 1991), the Butler Wash “*kachinas*” are felt to be considerably older, back to the Basketmaker II period ending about A.D. 500 (defined as the “San Juan Anthropomorphic Style” by Schaalma 1980:109-119). During the interim Basketmaker III period, just before people began to build true pueblos in the 800s (rather than pit houses) not unrelated rock art is a good indication of a rich ceremonial life before the exuberance of 11th century Chaco. These earlier practices may have included religious conceptions of *sipapus* and ritual in larger landscapes (Robins and Hays-Gilpin 2000:241-2).

For present purposes, the Butler Wash site is *not* included as a purely natural feature, even though it lies about 3.035 km to the east of the actual Comb Ridge point, and was most probably associated with the religiosity of the North-South Comb Ridge feature. Rather it is treated as a ceremonial site and included with the list of great kiva locations.

The second most recognized prehistoric sacred natural feature is Chimney Rock in Southwest Colorado, figure 1. Perhaps associated with astronomical sighting between Chimney Rock and its companion pillar (Malville 2004: chapter 10), is the ceremonial great kiva and small great house built right on the ridge, aligned perhaps to solstice phenomena (though the primary sighting coincidence is the lunar standstill). A second, and perhaps even more striking “twin” feature (Hurst and Till emphasize natural twin features), is Ship Rock, figure 1, even though only ethnographical evidence points to its sacredness (e.g. in the Zuni origin myth, Parsons 1923:147).

Not unrelated to astronomical phenomena, is the coincidental cardinal north-south relationship between the second highest mountain in the Anasazi sphere, Mount Wilson (detailed just below) and the most recent basalt flow in the Zuñi-Bandera volcanic field, called McCarty’s Flow. Based on collected legends, Nichols (1949) dated the flow to within collective memory of present day Pueblo Indians, particularly at Acoma. His date was about A.D. 700 A.D. More recent, and more technologically advanced analysis, pushes the geological date back farther to somewhere between 500 and 2,000 B.C. (http://geoinfo.nmt.edu) The inclusion of McCarty’s Flow for present purposes is based both its unique natural history, and the recognition of the symbolic power given north-south axes in Hopi ritual (see Doxtater 1979), and in Chacoan archaeology, e.g. Marshall (1997). At a distance of 336.564 km from McCarty’s Flow, Mount Wilson deviates coincidentally from a precise true north by 0.152°.
Another possibly prehistorically sacred natural feature, Cabezon, is “one of the most well-known landmarks in Northwest New Mexico” and the “highest volcanic neck in the area” (Bureau of Land Management posting). The Navajo believe the feature is the severed head of “Big Monster”, killed by Monster Slayer (Jett 1992). One indication of its religious meaning to the Anasazi might be the location of the easternmost Chacoan outlier, Guadalupe, about 9.446 km SSW of Cabezon (the photo of figure 1 is taken from the outlier ruins). It is one of the very few outliers this far east during the Chacoan period, and is curiously adjacent to Cabezon.

Fig. 4 Highest mountains in the Anasazi region (Southern Colorado Plateau), plus eleven other most prominent natural features (Sipapu, Rincon - Comb Ridge Point, Ship Rock, Chimney Rock, Hesperus, Mesa Verde High Point, Hosta Butte, Haystack, McCarty’s Flow, and Cabezon). Cerro Moctezuma off map to the south. Radii indicate distance to next higher peak. Blanca Peak (upper right hand corner) is the highest and therefore has no radius.

To the natural features described above are added a list of the highest in the Anasazi region of the Southern Colorado Plateau, as shown in figure 4. Virtually all have been described by historical native peoples as sacred. They are, however, included primarily as likely candidates for prehistoric usage because of their height and geographic relationship between each other.
One mountain, Hesperus, is added here because it forms one of the four Navajo sacred peaks, the other three being on the highest list: Humphrey’s Peak, Mount Taylor, and Blanca Peak. Direct visibilities between the highest peaks can be profiled in a Google Earth add-on, and can be part of simulating actual alignment surveys. These must eventually accompany attempts to determine intentional design of any specific existing pattern, but are beyond the scope of the present paper.

Finally, three last natural features are added somewhat in violation to the quest for pure randomness, i.e. avoiding particular patterns. The points in a Chaco cross, Hosta Butte (SW), the high point on Mesa Verde (NW) (present fire lookout), and Cerro Moctezuma (S), have been the focus of previous publication (Doxtater 2002). Looking south from the north rim of Chaco Canyon, the two most prominent natural features are Mount Taylor (SE) and Hosta Butte (SW). While Chimney Rock to the NE of Chaco cannot be seen from the rim, it was held to be Hosta Butte’s axial partner. Cerro Moctezuma, already mentioned in regard to its fire site alignment study, has a circular ceremonial feature on its summit, not actually the highest in this more modest range of peaks. According to Lekson, the urbanistic Paquime just below was the ultimate successor to Chacoan and Aztecan centers (Lekson 1999).

The reader should keep an eye on these three sites, recognizing in the end that they do not play a very large role in generating alignments. They were not included because of any attempt to “pad” the number of existing alignments to compare with the random.

**Locations of great kiva sites**

It is considerably more difficult to establish precise locations of a large number of built site ruins compared to most unique natural features. In this latter case, high points are clearly marked on USGS 7.5 quad maps or can be accurately determined from topographic form, such as at Ship Rock’s twin peaks where a mid-point must be chosen, or at the junction of the Colorado and Little Colorado Rivers in the Grand Canyon. The following analysis profiles accuracies down to around visual acuity (0.017°). Thus it is essential to locate existing sites as accurately as possible. In a 100 km alignment of an interim point and two end points, a 0.017° deviation of accuracy amounts to about 15 meters if the interim point is at the center of the line. Site locations are recorded down to tenths of an arc second, about 3 meters, and GPS and mapmaking errors can be expected in the range of two or three arc seconds. All work is done in a WGS 84 compatible map grid.
Prehistoric great kivas, which occur throughout the Basketmaker III (500 A.D.) through Pueblo III (1300 A.D.) periods, run from about 14 to 23 meters in diameter, are characteristically semi-subterranean ceremonial settings with four pillars, central roof openings and floor *sipapu*. At present, while most acknowledge that the great kivas of Chaco Canyon might well have been used by pilgrims traveling from some great distance, the conventional wisdom about outlier great kivas is that they were local, perhaps lineage affairs. The usual Chacoan pattern is for a great kiva to be accompanied by a pueblo-like great house also associated in function with larger social scale ritual (whether pilgrimage or local lineage). Kendrick and Judge (2000) speak of a more rhetorical, competitive role of the great houses at Lowry compared to a more integrative function of the great kivas within the community. The obvious ritual focus of the overall site is taken in the present work to be the great kiva.

While general site locations are available in archaeological data bases, often important features do not have clear map or GPS locations. In a small number of cases, using general UTM locations in Google Earth, one can find the clear outlines of great kivas, from which accurate positions can be recorded, see figure 5. Most of the time, however, one combs through hardcopy archives, and any library material on sites looking for an “x” marked on a quad map or equivalent. No good location information is available for nine known sites. Others undoubtedly exist. Given the large number of sites for which good locations were available, 61, however, it is not believed that the omission of an additional 9 or more seriously impacts the outcome of the study. This is not to say that the site information for all 61 is perfect. At several community foci, more than one great kiva and even great houses are known within a relatively close distance, say a couple hundred meters; Peñasco Blanco in Chaco Canyon is one such example. In this case the largest and earliest (PI), just north of the great house, figure 4, is used as the analysis point for the entire site. At Tse Bee Kintsoh, however, down in the Red River Valley, there are said to be four great kivas in close association to the great house. In cases such as these, where a map location exists primarily for the largest great house, the probable closest great kiva is used. More often, better site maps allow one to specifically locate the great kiva, particularly if it lies a hundred meters or more detached from the great house. Where great kivas and great houses are a greater distance apart, yet still considered part of the same community, e.g. Ackmen and Haystack, separate locations are included in the analysis.

In many respects the accurate locations of great kivas are more important from the larger
Fig. 5 Great kiva images from Google Earth
probability perspective than dating them in two periods, BMII-PI and PII-PIII. This junction is generally recognized as a distinction between earlier more mobile groups which aggregate at times into great kiva and other villages (in the Chuskas, early Chaco Canyon and particularly up in the San Juan area) and subsequent organization into Chaco related “phenomena” (Adler and Wilshusen 1990). A greater climatic variability occurs during the earlier period (see again Nelson and Schachner 2002).

The reader should consider the selection of sites in the two time periods as provisional. With 61 sites involved, the potential questions from archaeological readers about their dating will undoubtedly be numerous. The strategy, for present purposes only, is to record the most readily available site date given in archaeologically broad survey publications or state archives. More specifically, it is the date of the community (and probable focus), not the great kiva or great house architecture that is used. The logic here is twofold. In that alignments are contexts with other sites, it seems less likely that a great kiva would be built and aligned on an earlier established unaligned site, unless of course the alignment and the distant context originated at the site at a later time. Paramount, perhaps, is the site location, not the fact that an architectural great kiva was built. Secondly, some early shrine, kiva or sipapu-like feature might well have been erased in subsequent, more architecturalized ritual settings. The shrine/kiva feature at the Comb Ridge point might be an example here (figure 1), or the simple sipapu and shrine at the tops of most sacred mountains like Mount Taylor and Chicoma. A parallel example can be observed in the historical Hopi village Walpi, where architecturally defined kivas and their sipapus are essentially subordinate to the naturally formed village plaza with its most sacred sipapu, just a simple, small hole in the ground.

Given the above considerations, the 61 sites are divided into an early group of 34, and a later one of 27 as detailed below. While many more outlier sites exist that do not have associated great kivas, every attempt has been made to include the greatest number of those with great kivas for which site information is available. The great kivas associated with the Bonito Phase great houses of Chaco Canyon (Pueblo Bonito, Chetro Kettle, Pueblo Arroyo, Hungo Pavi, and Wijiji) are excluded from the analysis because of the possible fact that most of these locations were determined by small scale relationships within the canyon after the importance of Chaco itself had been created, perhaps through large-scale alignments. It is difficult to see how all of these sites could have been located in such proximity primarily through large scale determinants.
Included in Chaco Canyon are two Basketmaker great kivas (“villages”), two singular (without great houses) possibly also early great kivas, and three later sites associated with the first three early PII great houses: Peñasco Blanco, Casa Rincoñada (built later but spatially adjacent to Pueblo Bonito), and Kin Nahasbas (also built later but spatially adjacent to Una Vida). Interestingly enough, contrary to the free-standing character of those included, excluded great kivas are all confined within a great house plaza.

**Basket Maker III – Pueblo I**


2. **29 SJ – 1642** Unexcavated great kiva in Chaco Canyon, not related to a great house. Listed as early PII in Marshall, et.al. 1979, pg. 273, but more recently Dabney Ford at Chaco Canyon National Historical Park is inclined to earlier dating, even BMIII (personal communication). This location is marked as “ruins” on quad map, as explained by Park staff. See also photo in Van Dyke 2007:115.


4. & 5. **Ackmen (N) & Ackmen (S)** Situated about 200 meters from each other, these two great kivas are dated as PI, about 855-872 A.D. by Martin and Rinaldo 1939. Summarized in Marshall, et.al. 1979, pg. 311. Great kiva locations from topo map in Martin and Rinaldo, pg. 325.

5. **Andrews** Van Dyke (1999:62) lists two habitation sites with dates in late PI (about 882-889 A.D.); two great kivas are built around 924-941 in early PII. The great house-great kiva complex dates from about 919 A.D. (this is the great kiva location used in the analysis - location determined from map on page 58).

6. **Bad Dog Ridge** Listed as having a BMIII component in Gilpin and Benallie Jr. (2000), page 162. They list five great kivas (two in BMIII) on the large site extending well into PII. The location of the largest was determined from UTM’s by Gilpin and from map on page 167. Largest of the possible great kiva depressions (apparent focal point) is used as point.

7. **Bluff** Cameron (2009) states that this site had been used since BM III times, pg. 298. Great kiva location from GPS by author.

8. **Broken Flute Cave** Listed as dated A.D. 623-635 (Morris) by Gilpin and Benallie (2000), pg. 162. UTM’s supplied by Dennis Gilpin used as great kiva location.

9. **Chimney Rock Great Kiva** From Parker (2004) the Chimney Rock community was active throughout the PI period, as well as PII, pg. 54. Coordinates for great kiva were determined from quad map provided by Kane (2004) pg. 105.

10. **Coolidge** Kantner (1999) gives a 883 A.D. beginning date for the site (pg. 123). Site location clearly indicated on quad map copy from ARMS (Archaeological Records
Management Section NM). Both great kivas are quite close to the great house; point between two kivas used.

12. **Cottonwood Falls** Severance (2004) defines the beginning of the site in the mid 800’s A.D. Site location of great kiva from GPS by author.

13. **Dalton Pass** Kantner (1999) summarizes this site with starting dates in the mid 800’s A.D., pg. 116. Site location from map on same page; can be seen in Google Earth.

14. **Ganado** Listed as BIII-PI by Gilpin and Benallie (2000) pg. 162. Site location of approximate center point between the five possible great kivas from GPS by author.

15. **Grass Mesa** Clearly defined as beginning in BM III in Lipe, et.al. (1988). Great kiva location from maps on pages 2 and 14, among others.

16. **Haystack 3 (LA 12573-D)** This southern of a pair of great kivas about 280 m apart is given a date of late PI-early PII by Marshall, et. al. (1979), pg. 166. Site location from their quad map of the area on same page.

17. **Juniper Cove** Listed in Gilpin and Benallie Jr. as 650-675 A.D. Sketch map in Gilpin and Benalli Jr. 2000, pg. 163.


19. **Kin Bineola K1** (immediately adjacent to great house) Site occupation begins around 750 A.D. according to Powers et. al. pg. 243. Location from GPS by author.

20. **Kin Bineola K2** (3.023 km to the south of great kiva/great house complex) Assumed to be related to Kin Bineola K1 with its date of 750 A.D. Site location from quad map in Marshall, et. al. pg. 58.

21. **Kiva Mesa BM III** Basket Maker III site about 800 m. from PII great kiva/great house complex, as defined by Reed(2000). UTM center of BMIII village with its three great kivas provided by Paul Reed.

22. **Los Rayos** Dating stated as PI on ARMS data sheet. Associated UTM’s enabled recognition of great kiva on Google Earth.

23. **Lowry Ruin** Great kiva is tree-ring dated to PII at 1086 A.D. (Martin 1936, pg. 195) but a population of widely dispersed BMIII pit houses was found in Kendrick and Judge’s (2000) survey of the “Lowry Community”, pg. 116. Great kiva location from GPS by author.


25. **Morris Site 39** Powers, et. al. (1983) found ceramics from BM III in the site cluster, pg. 142. Site location from topo map on file with ARMS.

26. **Morris Site 41** Powers, et.al.(1983) describe a range of occupations from BMIII to PIII within the site cluster, pg. 147. Great kiva is located via a combination of three topo maps on file with ARMS (from Morris).

27. **Peach Springs** Earliest dating from BMIII period comes from Powers, et.al.’s survey of the outlier site (1983), pg. 72. Later great kiva can be located from quad maps provided in survey.

28. **Red Willow** From ARMS data sheets, this site begins in PI. Provided UTM’s enable location of great kiva in Google Earth.

29. **Rincon Great Kiva/Shrine** Feature at southern tip of Comb Ridge has not been excavated. Included in earlier period because of adjacent PI village. Site location from GPS by
author, and is visible in Google Earth. This point is also included in set of natural features as it defines the point of Comb Ridge at the San Juan River.

30. **Shabik'eshee Village** One of two BMIII villages with great kivas in early Chaco Canyon (Wills & Windes 1989). Site location indicated on USGS quad map.

31. **Skunk Springs** Has a PI component together with PII and PIII, Marshall, et.al. (1979), pg. 109. Site location of great house (with both PI and PII, PIII components and great kiva) can be determined from topography in map on pg. 110.

32. **Squaw Springs** Marshall, et.al. 1979, pg. 249 suggest an occupational span of the nuclear community beginning in late PI. Probable location determined from site description in Marshall & Stein (1978, pg. 1) together with UTM’s provided by ARMS.

33. **Tohatchi** Described as BMIII village in Marshall, et.al. 1979, pg. 285. Site location from GPS by author.

34. **Tse Bee Kintsoh** Kantner (1999) provides a 750 A.D. beginning date for the community (pg. 124). There are reportedly four great kivas at this site; the one closest to the great house is used in the present analysis (from map in Kantner 1995 pg. 16).

**Pueblo II – Pueblo III**

35. **Allentown** Marshall, et. al. 1979, pg. 289 cite Roberts (1939:252) to date the community locus as PII. Approximate site location determined from map in Roberts, Plate 1. Great House ruins visible in Google Earth; great kiva location derived from site plan in Powers, et. al. pg. 234.

36. **Axtec Complex Center** A PIII site as defined in Powers, et.al. 1983, pg. 151. Center of complex determined by author’s GPS and site map in Stein and McKenna (1988) pg. 69.

37. **Casa Rincoñada** Marshall, et. al.(1979) give tree ring date of 1027-1054 A.D., pg. 269. Location from GPS by author.

38. **Casamero** Marshall, et. al. (1979) give dates of 1000-1125 A.D., pg. 131. Great Kiva adjacent to great house is used for GPS position by author.

39. **Coyotes Sing Here** Marshall, et. al. (1979) give a late PII date for the outlier site, pg. 145. Site location from marked quad map in ARMS files.

40. **El Rito** Powers, et.al.(1983) give site dates as early PII, pg. 222. Great kiva location determined by Gauthier’s map reprinted in Powers on page 224, together with quad maps.

41. **Escalon** Dating comes from Van Dyke’s (2002) list of Classic Bonito Phase (1040-1120 A.D.) outliers with great kivas, pg. 236. Site is located on quad map on file with ARMS.

42. **Fort Wingate** Marshall, et.al. (1979) give an establishment date of late PI-early PII, running up to PIII pg. 155. The great kiva on the site was destroyed in the construction of I-40, but can be located by UTM’s from ARMS (general location), quad map topography, and site plan on pg. 156.

43. **Goesling Pueblo** ARMS lists the earliest date as PII on their record sheet. Accompanying UTM location allows visual recognition in Google Earth.

44. **Guadalupe** Durand and Durand (2000) begin their site dates right at 900 A.D., pg. 106. Good topo maps in the publication allow for great kiva location.

45. **Haystack 1** Marshall, et. al. (1979) give a late PII-early PIII date to this great kiva directly adjacent to its great house, pg. 159. Great kiva point from GPS by author.
46. **Haystack 2 (N)** (LA 12573-A) Located just 800m. north of LA 12573-D, Marshall, et.al. (1979) give dates of PII, pg. 163. Kiva location determined from quad map provided on page 166.

47. **Kin Hocho’i** Dating comes from Van Dyke’s (2002) list of Classic Bonito Phase (1040-1120 A.D.) outliers with great kivas, pg. 236. Site location from UTM’s in Fowler, et. al. (1987), maps on pages 33 and 41.

48. **Kin Nahasbas** Discussion about this great kiva site in Vivian and Reiter (1960) centers on PII dates, pg. 103. GPS located by author.

49. **Kin Ya’A** Marshall, et.al. (1979) give PII-PIII dates, pg. 201. GPS great kiva location by author.

50. **Kiva Mesa PII** Reed (2000) documents the PII components of this site, pg. 995. Great kiva can be located by photo on page 998.

51. **Las Ventanas** Marshall, et.al. (1979) place this site in PII-PIII, pg. 187. Site located on quad map on file with ARMS.

52. **Muddy Water** Marshall, et. al. (1979) give a temporal affinity of PII, pg. 207. Topo map on page 208 allows location of great kiva.

53. **Navajo Springs** Warburton and Graves (1992) place this outlier site at PII, pg. 51. Great kiva can be located from aerial photos and site drawings in article.

54. **Newcomb** Site dating from PII given in Marshall, et. al. (1979), pg. 101. GPS by author was taken at great kiva large midden at center of linear site.

55. **Peñasco Blanco** There are four great kivas directly associated with this great house in Chaco Canyon. The largest, just north of the great house is used (located via Google Earth). The kivas are undated according to Marshall, et. al. (1979), pg. 270; they give two dates, 900 A.D. and 1050-1088 A.D. for the great house.

56. **Pueblo Pintado** Marshall, et.al. (1979) give a date of 1060 A.D. for construction of the great house, and 900 A.D. to 1250 time range for the associated community, pg. 81 & 86. GPS location by author.

57. **Salmon** Excavated Chacoan component date for great house and great kiva is 1080, Marshall, et. al. (1979), pg. 304. GPS location by author.

58. **Sanostee** Temporal affinity given as PII by Marshall, et. al. (1979), pg. 105. Great kiva/great house location not marked on quad map segments on file with ARMS, but with these as starters, probable great kiva is just visible in Google Earth.

59. **Standing Rock** Marshall, et.al. (1979) give dates as late PII – early PIII, pg. 231. Great kiva can be located from map on pg. 214 in Powers, et.al. (1983).

60. **Toh La Kai** Temporal affinity of late PII-early PIII in Marshall, et.al. (1979), pg. 235. Site marked on quad map segment on file with ARMS.

61. **Village of the Great Kivas** Dating by Roberts (1932), pg. 156 gives a tree-ring date of the great house at 1015 A.D. GPS location by author.

[Great kiva sites not included for lack of maps or other information by which to position: Padilla Well, Cove, Whirlwind Lake, Ida Jean, Vidal Great Kiva, Jackson Lake, San Mateo Mesa, Nez Site, Heaton Canyon]
COMPARISON OF EXISTING NATURAL/ BUILT SITES WITH RANDOM PATTERNS

21 natural sites together with 61 built and 61 random locations at 10 accuracies

As shown in figure 6, one can first locate the existing 21 natural and 61 great kiva sites in Geopatterns, and then draw a test area around the maximum area of the 61 great kivas. In the test area one can delete all of the existing and replace them with 61 randomly located points. The 21 natural points are constant and included in the calculation of random alignments. One naturally coincident large-scale alignment occurs among the 21 natural points: Sipapu – Chicoma- Truchas (average deviation of 0.019°, overall length of the line is 555.009 km). Each random set takes about half a minute to set up and record the number of three-point alignments at a particular accuracy. Twenty such sets were initially examined to determine the number needed to establish an acceptable random average with minimal variation between groups of like numbered sets. The total was increased to 100 sets, which proved to be quite stable. Because the overall number of points involved, 21 + 61=82 is quite high, the 100 set group even seemed quite stable across increasing numbers of alignments at ten different accuracies. Since visual acuity is said by optical scientists to be around 0.017°, it seemed appropriate to start close to this level of alignment accuracy, in this case 0.015°, incrementally adding 0.015° up to a maximum deviation of 0.15. Thus 100 sets of 61 random points each were created for each of the ten levels of accuracy, for a total of 1,000 sets.

There is an overlap of natural and built points in one instance, the Rincon great kiva/shrine. This point is accurately both the natural tip of Comb Ridge, and a built ceremonial feature. Recognizing that random distributions of 61 points in the test area might also load up two points virtually on top of each other, a point is entered into the existing list for the natural and built features separately (the same location for both points). In the consideration of total number of alignments created by the existing 82 points, the coincidence of the Rincon point with Comb Ridge point essentially doubles the number of associated alignments with this location.

The range of randomly created 3-point alignments at the middle accuracy of 0.075° runs from a low of 64 to a high of 112, a 48 point difference, with an average of 82.6. How does one, then, think about the possibility that with the existing set of 82 (again 21 natural and 61 built), some number might be intentionally aligned, i.e. designed? In a case with a very small number of points in a given area, say three, with a given accuracy, accurate alignment would essentially
Fig. 6 Geopatterns screens showing 21 natural features and 61 great kiva sites (above), and random points replacing the 61 existing ceremonial sites in probability tests (below).
only happen if they lined up intentionally (some very large number of random sets would be necessary to equal the feat). With much larger numbers of points where large numbers of random alignments occur, one can imagine the opposite effect, i.e. where intentionally aligned points are largely masked by randomness. Is there a range of points in between where intentional alignments can be additive, i.e. independent of random patterns, actually influencing the total count?

Given 82 existing sites, if there are intentional alignments, there will also surely be random ones as well. The diagram of figure 7 attempts to get at a logical understanding of the situation. It assumes that in the range of the present number of sites, some independence exists between designed and random alignments. The diagram shows that below the lowest number of random points, 64 in the 0.075° case, any intentional alignments will be totally masked for all practical purposes. If the number of existing alignments falls within range from 64 to 112, however, an increasing probability exists that its total number contains some number of intentional alignments. Working with sets of 100 as a base, as existing numbers appear close to or above the highest random set, one finds the greatest probability that at least some number of alignments are intentional.

The results of the 100 set tests at 10 levels of accuracy are shown in the box and whisker plots of figure 8. The existing 61 great kiva sites, in the context with 21 natural features, exceed the highest random set at four levels of accuracy: 0.06°, 0.09°, 0.012° and 0.135°. Here the probabilities that the existing set is totally random are lower than 0.0099. While Geopatterns does have the capacity to run very large numbers of random sets for very unique geometric patterns with a small number of points, it cannot at present economically run (much more
Fig. 8 Box and whisker plots for tests of random alignments at ten accuracies: each plot expresses results of 100 sets where each set has 82 points (equivalent number to total great kiva sites plus natural features); number of alignments among great kiva and natural points is indicated on each plot.
automatically) multiple number tests on sets with many alignments and many points. Intuitively, if one ran 1,000 sets for each level of accuracy, one would most likely find at least one set that exceeds the existing, suggesting a range of probability somewhere between 0.0099 and 0.00099.

The highest alignment producing random set of the 100 at 0.105° creates a number identical with the existing landscape pattern, and five have one or more random sets better than the existing: 0.015° (two sets higher = 0.02), 0.030° (one set higher = 0.01), 0.045° (one set higher = 0.01), 0.075° (two sets higher = 0.02), and 0.15° (one set higher = 0.01). Since the behavior of these comparisons is quite similar in all ten ranges of accuracy, one cannot say at present that if some number of intentional alignments is present among kivas and landscape features that any particular degree of accuracy is more representative than another.

**Comparing BMIII/PI and PII/PIII**

As part of the larger data set showing the number of alignments each site is involved with, figure 9 also potentially reveals a distinction between the early and late sites (using the middle accuracy of 0.075). Again the purpose of the present exercise is to look only at numbers, and not attempt to archaeologically profile early sites that have later components (e.g. Ganado, Bad Dog, Bluff, Coolidge, Chimney Rock, etc.). If in fact some number of the existing alignments were designed, from the present perspective only, then one might expect the earlier sites to grow in alignment connections as later sites come on line. If integration is occurring early on, then new locations would not logically be independent of BMIII/PI landscape structure, unless of course all later sites are wholly of a Chacoan definition and operate, as it were, in their own world. This is what appears to happen. The average alignment number of early sites is 4.15, compared to the average for later sites of 3.26. Not only is there a larger number of sites in the early period, but each of these sites are ultimately more involved in alignments than the later ones.

Yet, this imbalance between a group of 34 and one of 27 can also happen by chance. One can divide each of ten random sets (61 each @ 0.075°) into two groups of 34 and 27 to represent early and late sites (random alignments of the ten sets ranges from 112 to 71). The greatest difference between any two groups in average number of alignment involvements per site is 0.96, where, reversed from the existing, the first 34 sites has the smaller average. The difference between the averages of the existing earlier and later groups is 0.89. Nevertheless existing/random comparisons of early and late site groups may be approached in other ways.
The alignment averages imbalance in the existing split could actually be real, yet indistinguishable from this form of random comparison. One can inquire about how the early group performs independent of the later sites with their lessor alignment averages. Fig. 10 shows...
how the 34 early sites (again in the context with 21 natural features) compare with 100 sets of 34 random points each at four lower accuracies of 0.03° – 0.075°. Does the greater number of alignment involvement per site somehow translate into a clearer distinction between the existing and the highest random sets at these accuracies? Not really. While no random set of the four

![Box and whisker plots for alignments created in 100 sets of 34 random points (plus 21 natural) each, at four accuracies, compared to the number of alignments among 34 early great kiva points.](image)

Fig. 10 Box and whisker plots for alignments created in 100 sets of 34 random points (plus 21 natural) each, at four accuracies, compared to the number of alignments among 34 early great kiva points.
accuracies is higher than the related existing one (two are lower, two are equal), overall the strength of early sites is quite similar to that of the combined group of 61. It is tempting to look at four plots for just the late group. This however cannot happen since the early sites were always there when later ones were located. In this regard, early/late comparison ideas might shift to some possible effect of the natural 21 points. In this case it makes some sense to consider both groups independently as they interacted with the natural features. Interestingly enough, the plots of figure 11, show a major difference between early and late sites.

As we knew from figure 10, the early 0.075 existing group is considerably above the highest of the 100 random sets of 35. The late group by itself, as if they were the first to be built, performs very poorly, actually at a level below the average for the 100 random sets.
Nevertheless, when one looks again at the list of sites and their alignment numbers (figure 9), the late group with its average of 3.26 doesn’t seem to be doing *that* poorly (they after all do quite well when part of the entire group of 61) suggesting that its sharp drop into the middle of the random spread could be due to the severing of alignments with earlier sites. Again this coincides with the greater numbers of early than later great kiva sites and the two averages themselves, i.e. earlier sites are around longer and will therefore have more involvement than the later.

Once again, one must ask whether this effect of independent subgroups could also occur randomly. Five higher individual random sets of 61 points were subdivided into two groups of 34 and 27 via four different strategies: first 34 second 27, first 27 second 34, middle 34 ends 27, and middle 27 ends 34. It was determined that the presence of the 21 natural sites made little difference in the kind of comparison seen in figure 11; thus in the exercise shown in figure 12 only the 61 points were used with no natural features.

In these twenty different 34/27 splits of high random 0.075° sets, the existing has the greatest difference between numbers of alignments in the two groups. Yet much random variation occurs. The next most dramatic difference occurs in the Middle 27/Ends 34 of the 110 alignment random set. Its numerical difference is 10 while the existing is 11. When the site averages for the two groups in this best random example are summed (lumping both groups
together with the 21 natural sites), the difference between the averages is 0.45, about half of the existing difference of 0.89.

These comparisons of early and late groups attempt to create more dimensions to the effort of raising possible existing designed alignments from the shadows of the random. There exists a certain consistency of ideas, perhaps, first of all that possible intentional alignments are happening just as frequently if not more so in the earlier group. Secondly, these early sites continue to attract new relationships when later sites are located and built.

**Actual patterns in early and late groups with testing of greater than 3-pt alignments**

Without creating any unwarranted focus on any particular pattern as being intentional, one can compare the Geopatterns maps of the early existing 34 and the highest individual random set of 34 (of 100), at the accuracy of 0.075°, figure 13. Of particular interest are alignments greater than three points. The existing set has one 5-point alignment and no 4-pointers, while the random has three 4-pointers. The numbers of 3-point alignments (most basic or initial Geopatterns data) associated with each of these greater alignments are also shown in the illustration.

Given the apparent uniqueness of the five point alignment between Sipapu and Lowry in the existing landscape, compared to the random, this pattern can be isolated and tested for probability. On closer examination of the five 3-point alignments, they all fall below an accuracy of 0.04°. Using this level of accuracy, then, one can set up Geopatterns to create large numbers of 34 point random sets, looking for the same “search string” that captures the existing 5-point pattern: A + A(2) + A(3) + A (3) + A(2), where each “A” is a 3-point alignment at or under 0.04°, and parentheses indicate the number of points of overlap with the previous points accumulated in the string. In 1,000 sets of 34 random points each (together with 21 natural features), the above search instructions and accuracy find seven such patterns. Three of these are similar to the 4-point random alignment between Sipapu, Chicoma, and Truchas shown in figure 13. Recalling that these three natural sites are the only coincidentally aligned natural features, one might logically eliminate the three in the 5-point test. Remaining are four 5-point alignments of 1,000. Three involve the pairs of Mount Baldy – Mount Wilson, Hosta Butte – Moctezuma, Chicoma – Wheeler Peak, and one is composed entirely of random points. No
39 EARLY EXISTING 3-PT ALIGNMENTS @ 0.075
(multiple alignment highlighted)

HIGHEST RANDOM SET OF 100:
35 3-PT ALIGNMENTS @ 0.075
(multiple alignments highlighted)

Fig. 13 Map comparison of early group alignments with highest random set of 100 (34 points each) at an accuracy of 0.075.
The Sipapu-Comb Ridge pattern occurs in this 1,000 set test. Thus the probability of the existing 5-point early alignment being random is at least as low as 0.004.

One can now consider the pattern maps for the existing total 82 sites and highest random set of 100, both at 0.075°. Again, particularly at these higher numbers of site/feature locations and 3-point alignments, there is likely to be considerable numbers of random patterns in the existing location of kiva sites. This being said, the array of alignments in the existing appears on the whole to be more focused or constrained in relation to the five multiple alignments indicated by heavier lines in figure 14. Part of this effect is because, compared to the random, the existing sites are somewhat more clustered toward the southeast center of the test box, where proximities to multiple alignments are most intense.

The random map shows six multiple alignments, including one 5-pointer, again loading up on the coincidental natural 3-point alignment Sipapu-Chicoma-Truchas. This line is about 2.25° off from being cardinal east-west. In the map of the existing, a more complex set of alignment and cardinal relationships occurs between Mount Wilson and Cerro Moctezuma, the natural feature McCarty’s Flow and four great kiva sites in between: Aztec, Penasco Blanco, 29SJ423, and Andrews. In total this complex includes five overlapping 3-point alignments and nine different north-south cardinal relationships between pairs of points (at the range of 0.075°).

In the present design of Geopatterns 2 search strings, the number of additive single patterns are limited to five, so any total test of the complex Mount Wilson/Cerro Moctezuma pattern is not possible. We are able, however, to see the probability of the four great kiva sites overlapping with Mount Wilson, A + A(2) + A(2) + A(3), made cardinal with a north-south relationship between Penasco Blanco and Andrews, + C(2). At the deviation range of 0.055° (within which all of the single patterns fall), this search string occurs 14 times among 10,000 sets of 61 random points each (along with the 21 natural features), for a probability of 0.0014. Because all of the 14 random north-south patterns found involve Mount Wilson and either McCarthy’s Flow or Cerro Moctezuma or both, the existing pattern involving the four great kiva sites and only Mount Wilson most likely has an even lower probability of being random.

With the next generation of Geopatterns it should be possible to expand the analysis prior to adding symbolic, ethnographic considerations of particular natural and built features and their patterns. How rare is it that a point (Kachina Panel) on one 5-point alignment, Sipapu – Lowry, connects with a multiple alignment pattern (via Kiva Mesa) to a point (McCarty’s Flow) on a
Fig. 14 Map comparison of total existing alignments with highest random set of 100 (61 points each) at an accuracy of 0.075.
cardinal multipoint alignment, Mount Wilson-Cerro Moctezuma? One ideally would then include the way the end-point at Lowry links to the Baldy Peak-Chimney Rock axis (though this alignment pattern has no intersection in Chaco Canyon with the Mount Wilson “Meridian”). Resolution of this apparent non-connection may involve patterns focused on Kin Bineola.

**Concluding remarks**

What then, does the reader believe at this point? Is it by simple random chance that the list of 61 great kiva sites and 21 natural ones exhibits its comparative characteristics? Or at the other extreme, is it likely that all of the existing alignments are intentionally designed? Certainly part of these and other, more modulated possible conclusions is the relationship of the different kinds of comparisons. Is there a logic to the whole:

1. The existing alignments between great kivas and landscape features are in a probability range of 0.02 to 0.0099 compared to 100 sets of 61 random points in each of ten levels of accuracy.
2. The greater number of great kiva sites in the early BMIII-PI period (34) is a first indication of possible early alignment importance.
3. The greater averages of alignment involvement per site in the early group contributes to the possibility of alignment importance in early sites, i.e. that later ones build upon early ones, always in the context of the 21 natural features.
4. A comparatively high difference in numbers of alignments among the two groups taken independently from each other, and without the natural features, follows the logic of the other two early-late indicators.
5. There exists a 0.004 random probability of 5-point early alignment.
6. There exists 0.0014 random probability of cardinal 5-point later alignment.

It would seem to be unscientific to conclude that the Anasazi, *in all probability*, did not survey any alignments, totally dismissing this kind of research as illegitimate, just as it would be even more illogical to believe that all alignments of a particular range of accuracies were designed. If one accepts the probability of some designed alignments, subsequent analysis is merited,
focusing more conventional ethnographic and archaeological inquiry on particular patterns. Yet much more can certainly be done in probability analysis itself.

This author is left with questions about how one conceptualizes relations between the real and the random. If one takes the smaller set of existing early sites, along with the 21 natural, it is possible to lay out 34 random points connected by alignments in a most efficient manner, i.e. that each site is located by only two alignment relationships to other sites (minimum necessary to precisely create an intersection and site location). In this exercise, using the present landscape context, the number of alignments is roughly identical to the number of sites. Consider first if the designed alignments are totally independent of the random, and each designed site has only two alignment relationships to other sites. Again, the existing built/natural mix creates 39 alignments. If one expects the random to contribute the average, in this case about 24 (24.29), then 39-24, or 15 is an approximate number of designed alignments. Since it would take about 34 designed alignments to connect most efficiently 34 sites, then clearly only about half of the existing sites (15 again) would be designed.

Then consider the larger group of 61 (always in the context of the 21 natural), and about 60 or so alignments that would be the most efficient designed means of linking all together. The existing total alignment number is 106, minus the 60, leaving room for a contribution of about 45 random alignments. But since the lowest of the 100 random sets (all at the 0.075 range) is 64, and the average is about 82, the most likely number of designed alignments would be much less than 60—more in the range of 106 – 82 or 24.

This of course is but a mental game where existing are independent from the random, and the random contribution is likely to be around the average. In actual situations one cannot be certain that the random contribution isn’t an unusually high or low number. It is also probably true that there is a range, perhaps even in the present analysis, where designed alignments exert some influence over the numbers of random. This probable continuum from very small numbers of points, where the random exert greatest influence, to the very large where any independence of the existing becomes invisible, needs much better understanding.

In the short run, the very low random probabilities of very unusual features, such as the Mount Wilson Meridian, should initiate more established ethnographic and archaeological analyses. It may well be that a thorough understanding of a small number of major alignments as artifacts will provide entry into discerning the real from the random in more subordinate patterns.
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