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An Archaeoastr<sup>o</sup>nomical Reconnaissance of  
the Dolores Archaeological Program Area

by

John A. Eddy and Allen E. Kane

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Under the supervision of  
David A. Breternitz, Senior Principal Investigator

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## ABSTRACT

As a portion of the nonintensive investigations proposed for the Dolores Project Cultural Resources Mitigation Program in 1978, Dr. J. Eddy of the Astrophysics Department, University of Colorado, and A. Kane, Program Co-Principal Investigator, carried out a reconnaissance relating to possible knowledge and use of astronomy in southwestern Colorado Anasazi communities. Investigations were conducted at eight prehistoric sites: McPhee Pueblo (Site 5MT4475), Little House (Site 5MT2191), Cline Crest Ruins (Site 5MT2663), Emerson Ruins (Site 5MT4447), Yucca House, Yellowjacket Spring Ruins, Goodman Point Ruins, and Mud Springs (Toltec) Ruin. The data obtained during the reconnaissance were ambiguous; some structures exhibited no obvious astronomical alignments, while others revealed potentially significant alignments that are probably coincidental. More positive results were obtained from the tri-wall structures at Emerson Ruin, Yucca House, Mud Springs, and the great kiva at Goodman Point Ruins; measurements recorded along wall lines indicated that these structures may have been oriented according to north-south cardinal directions and to the winter and summer solstices. Several hypotheses concerning the use of astronomical data by Anasazi communities in southwestern Colorado are presented; these formulations can be used as source material for further such studies in the area.

## INTRODUCTION

An archaeoastronomical reconnaissance was specified in the original work plan submitted by the University of Colorado (Breternitz and Kane [1]) detailing proposed operations for the Dolores Cultural Resources Mitigation Program 1978 field season. The intent of this study was to gather data relating to the possible use of astronomical knowledge by prehistoric groups in the project area. It was thought that such data could be used to answer questions posed in the Dolores Archaeological Program (D.A.P.) General Research Design (Kane [2]).

Astronomy can be viewed as a multifunctional tool with applications to economic, social, and ideological systems integral to human societies (Aveni [3:9-10]). Specifically, astronomical alignments can serve as a guide for scheduling agricultural activities (and may therefore provide input for reconstructions of prehistoric economics, D.A.P. Research Design Problem Domain 1) and as an adjunct to community ritualism (input to Problem Domain 3, Social Organization). Prehistoric astronomical knowledge and construction were probably managed by community specialists. Ethnographic evidence supporting the concept of religious/astronomical specialists in southwestern communities is provided by Fewkes [4, 5, 6], who studied ceremonies incorporating astronomical phenomena at Zuni and the Hopi pueblos. Such phenomena also have implications for social inference and integration (Problem Domain 3). There is a good possibility that local prehistoric cultures indirectly received this and other knowledge from Mesoamerica through the San Juan Basin area (Hedrick et al. [7]). Evidence for astronomical knowledge, therefore, might provide evidence of foreign interaction (Problem Domain 4).

## METHODS

The first step in implementing the reconnaissance was to select a group of sites from which to obtain astronomical measurements. Because project excavations were in a very early stage during the scheduled period of the reconnaissance, consideration was given to several sites outside the project's administrative area. The latter were included to provide a broader perspective for estimating the use of astronomy by local prehistoric peoples. Ultimately, four sites within the project area and four nearby locations were chosen (Figure 8.1). The selection process was based on a review of early archaeological reports that described possible astronomical alignments (Holmes [8], Prudden [9], Fewkes [10]) and on a field assessment of locations where measurements could be easily obtained (done by Kane during the week before the scheduled reconnaissance). Eight sites were chosen for investigation:

1. McPhee Pueblo (Site 5MT4475). The site is a large roomblock unit at McPhee Village, a population center located in the Dolores valley which dates to A.D. 800-950.

2. Little House (Site 5MT2191). Little House is a small seasonal pueblo, perhaps used by one household group as a base for tending agricultural plots. The site is located in the Sagehen Flats area and dates to A.D. 800-900.

3. Cline Crest Pueblo (Site 5MT2663). This site is the central architectural complex at Cline Crest Village, a large population center located on the uplands, west of the Dolores valley. The site is contemporaneous with the occupation at McPhee Village (A.D. 800-900).

4. Emerson Ruins (Site 5MT4447). This site is believed to be a

Figure 8.1 Location of archaeological sites included  
in the 1978 archaeoastronomy  
reconnaissance.

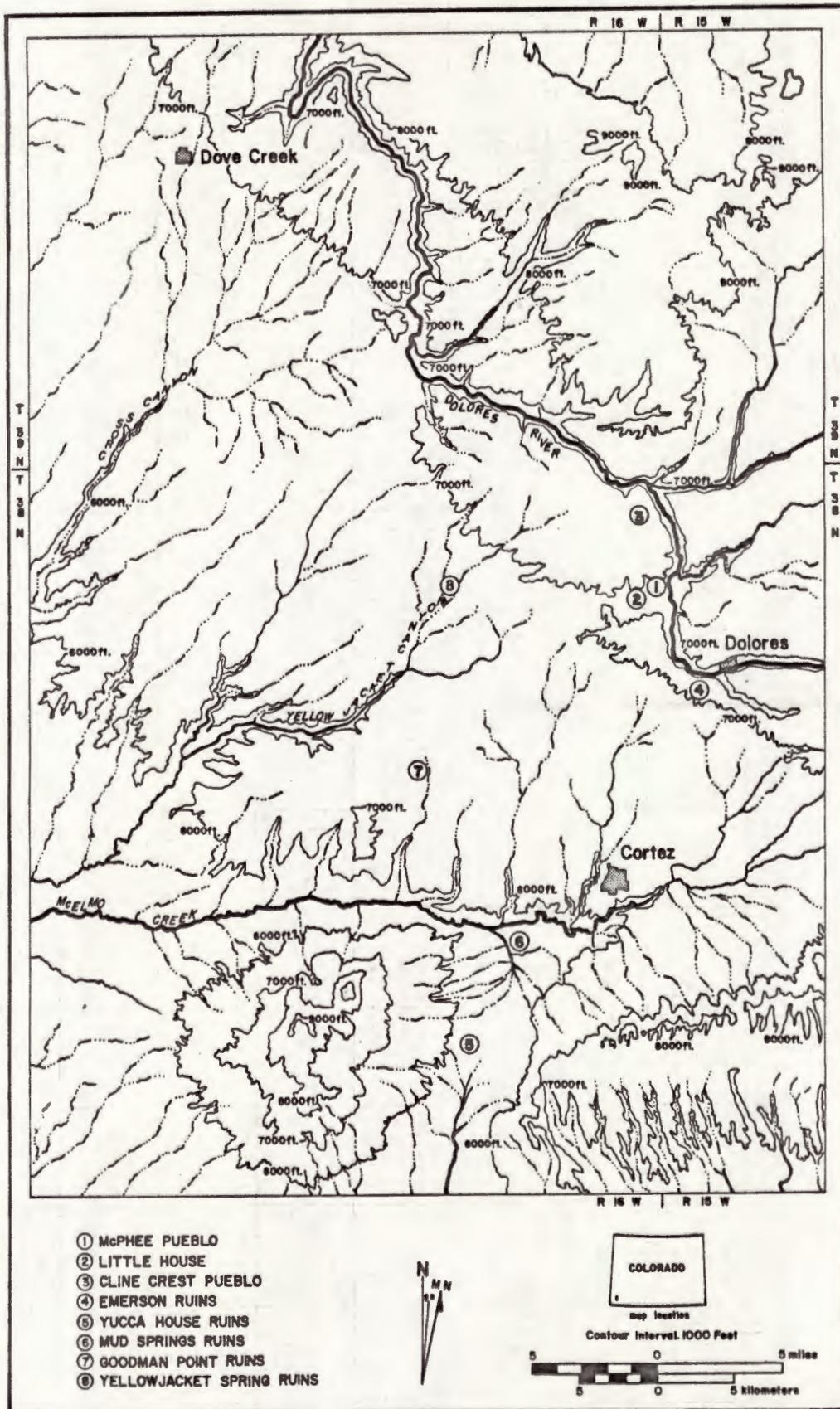


Figure 8.1 Location of archaeological sites included in the 1978 archaeoastronomy reconnaissance.

tri-wall structure; such edifices are rare in the Four Corners area and may reflect specialized social or ceremonial activities. Emerson Ruin is believed to date to the period A.D. 1100-1250.

5. Yucca House Ruins (no Smithsonian site designation). Yucca House (also known as Aztec Springs) is a large, late Anasazi village incorporating specialized architecture. Yucca House is located near the present alignment of the proposed Towaoc Canal, a project construction feature, and dates to the A.D. 1200s.

6. Mud Springs (Toltec) Ruin (no Smithsonian site designation). This site is a large village which includes a tri-wall structure; it is located approximately two miles east of the proposed alignment of the Towaoc Canal and probably dates to the A.D. 1200s.

7. Goodman Point Ruins (no Smithsonian site designation). The site is a large prehistoric community that includes a great kiva. It is located several miles west of the Towaoc Canal and probably dates to the period A.D. 1100-1300.

8. Yellowjacket Spring (Surouaro) Ruins (no Smithsonian site designation). This site is a large prehistoric village that includes a great kiva. It is located several miles west of the proposed Dove Creek canal and probably dates to the period A.D. 1000-1200.

The actual field reconnaissance took place on 23 and 24 August 1978.

Astronomers studying prehistoric cultures for evidence of knowledge and use of astronomy recognize two basic ancient astronomical systems. The first, horizon-based astronomy, is based on celestial events that take place at the horizon (rising and setting of the sun, etc.); the second, polar-ecliptic, or polar-equatorial, systems are based on the identification of a "north" star (Aveni [3:12]). New World astronomical systems

have been horizon-based types (see, for example, Aveni and Hartung [11], Thompson [12], Eddy [13], Hawkins [14]). Aveni describes five classes of horizon celestial events that may have been of importance to prehistoric astronomers [3:12, 24]: (a) rising and setting of stars; (b) rising and setting of the sun; (c) rising and setting of the moon; (d) rising and setting of the planets; and (e) heliacal rising and setting of stars and planets (that is, when they first appear in the morning or evening sky after previously being obscured by the sun).

The D.A.P. reconnaissance was designed to investigate horizon phenomena. At each of the selected sites, Eddy and Kane chose wall or other architectural alignments along which to measure azimuths (degrees of arc along the horizon from astronomical north to the orientation being measured). The field azimuths of the alignment and the sun's position were then recorded using a surveyor's transit (Figure 8.2); the exact times of the measurements were also recorded. Procedures used were similar to those described by Aveni [3:26-29]. All recorded field azimuths were later converted in the laboratory to true azimuths (hence the measurements presented in this report are given in degrees "T," or true). A second laboratory task was the determination of the positions of significant horizon events at the time the measured structure was in use (sunrise and sunsets at solstices and equinoxes, rise and set of prominent stars, etc.).

Figure 8.2 Field measurement technique. The observer obtains the field azimuth of the architectural alignment (A), the azimuth of the sun (S), and the altitudes of the sun (H) and of the horizon in the direction of the alignment (H'). These readings are then used in the laboratory to calculate a true azimuth (T). (Adapted from Aveni [3:28, Figure 1.7]).

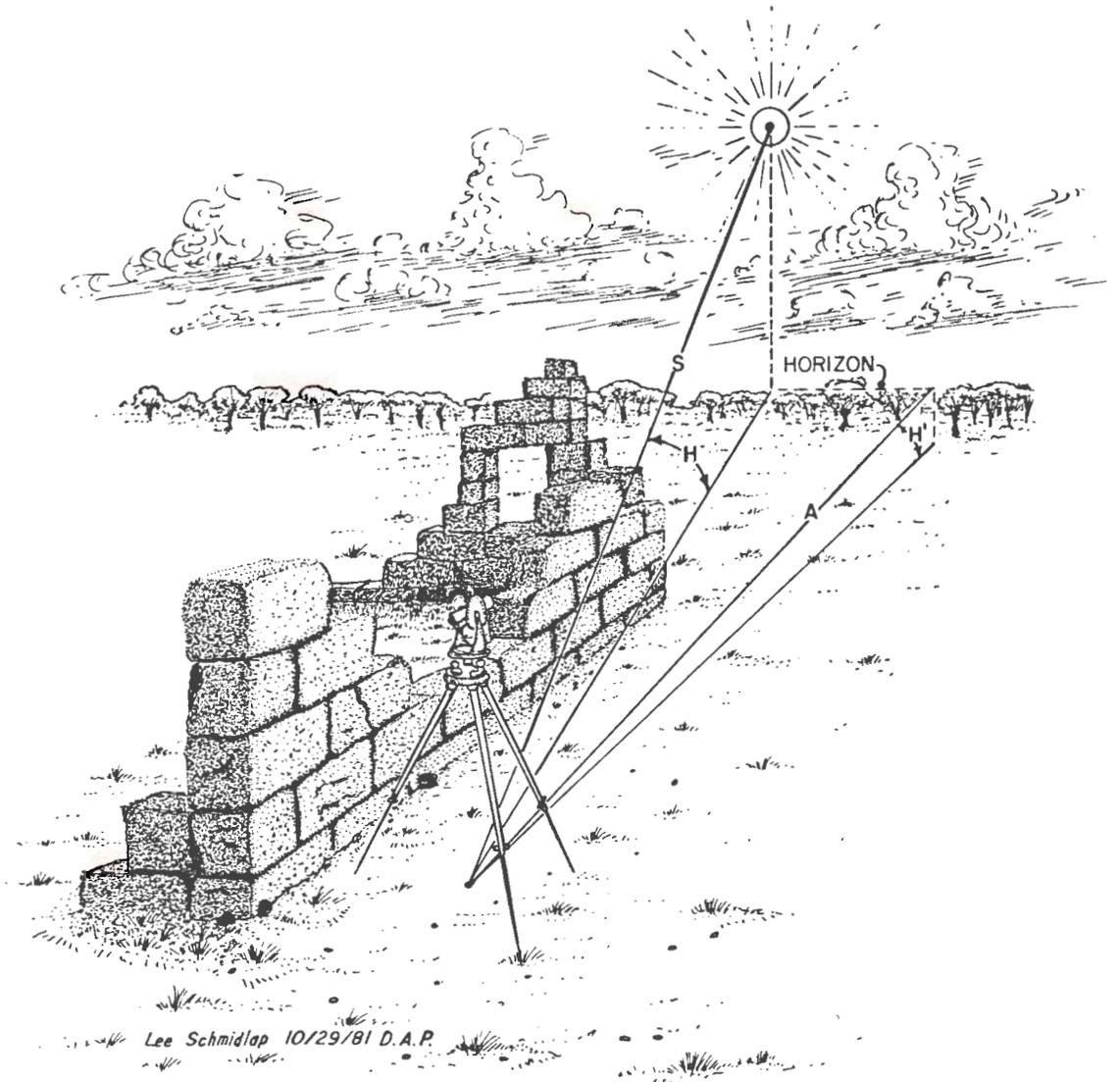


Figure 8.2 Operational considerations in obtaining field measurements.

## RESULTS

Results of the reconnaissance are reported in the following site-specific narratives. Information presented includes measurements obtained and inferences as to possible astronomical implications.

### McPhee Pueblo (Site 5MT4475)

Transit measurements were taken of the center line of the large horseshoe-shaped pueblo roomblock ( $149^\circ - 329^\circ$  T, or true) (Figure 8.3) and of two alignments in the kiva under excavation (Kiva 2): the southern wall of the central hearth ( $78^\circ - 258^\circ$  T) and a line through the sipapu to the center of the ventilator tunnel ( $162^\circ$  T) (Figure 8.4). The horseshoe structure opens to the southeast ( $31^\circ$  east of south) and seems oriented more to fit the lay of the land than to reflect specific astronomical phenomena. The site is generally open to the south and this orientation would provide more sunshine into the court around the kiva. As surveyed during an early state of excavation in August 1978, the structures at the pueblo did not indicate any particularly precise layout; that is, the axis of the kiva (sipapu to ventilator tunnel) is not colinear with the axis of symmetry of the horseshoe-shaped roomblock (they are separated by  $13^\circ$ ); nor is the south wall of the hearth in the kiva perpendicular to the kiva axis--the error here is  $6^\circ$ . The measurements recorded are depicted in Figure 8.5.

Neither the axis of the horseshoe-shaped structure, nor the kiva axis, is directed toward astronomically unique points of the horizon. At the time of construction of this portion of the site (around A.D. 900), there were no bright stars that rose in this direction in the southeast;

Figure 8.3 Center line measurement obtained at McPhee Pueblo (Site 5MT4475). (Adapted from Brisbin [15]).

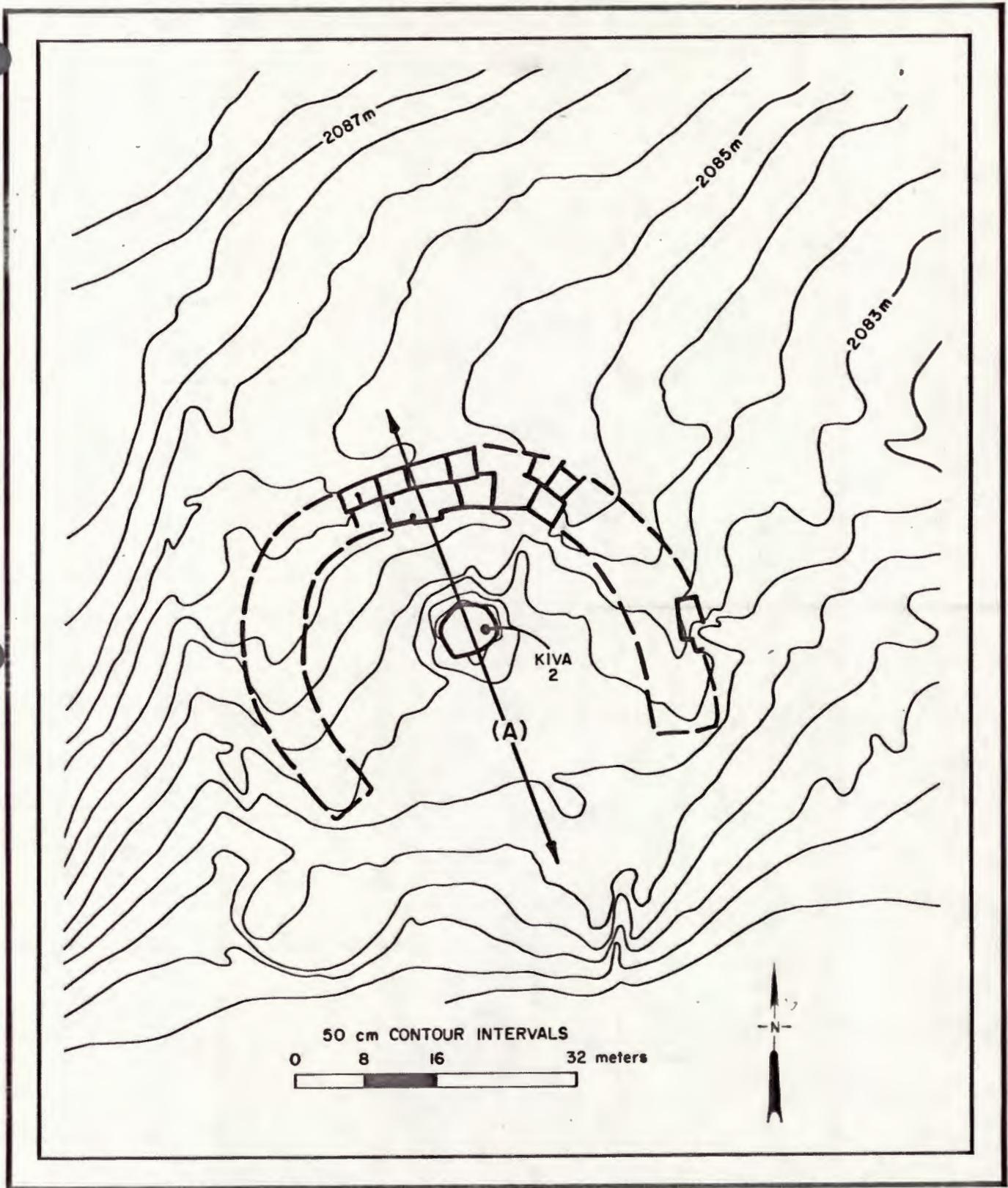


Figure 8.3 Centerline measurement obtained at McPhee Pueblo (Site 5MT4475).

Figure 8.4 Alignments measured at Kiva 2, McPhee Pueblo (Site 5MT4475): (B) north-south axis of structure through sipapu and vent tunnel; (C) along front of hearth.

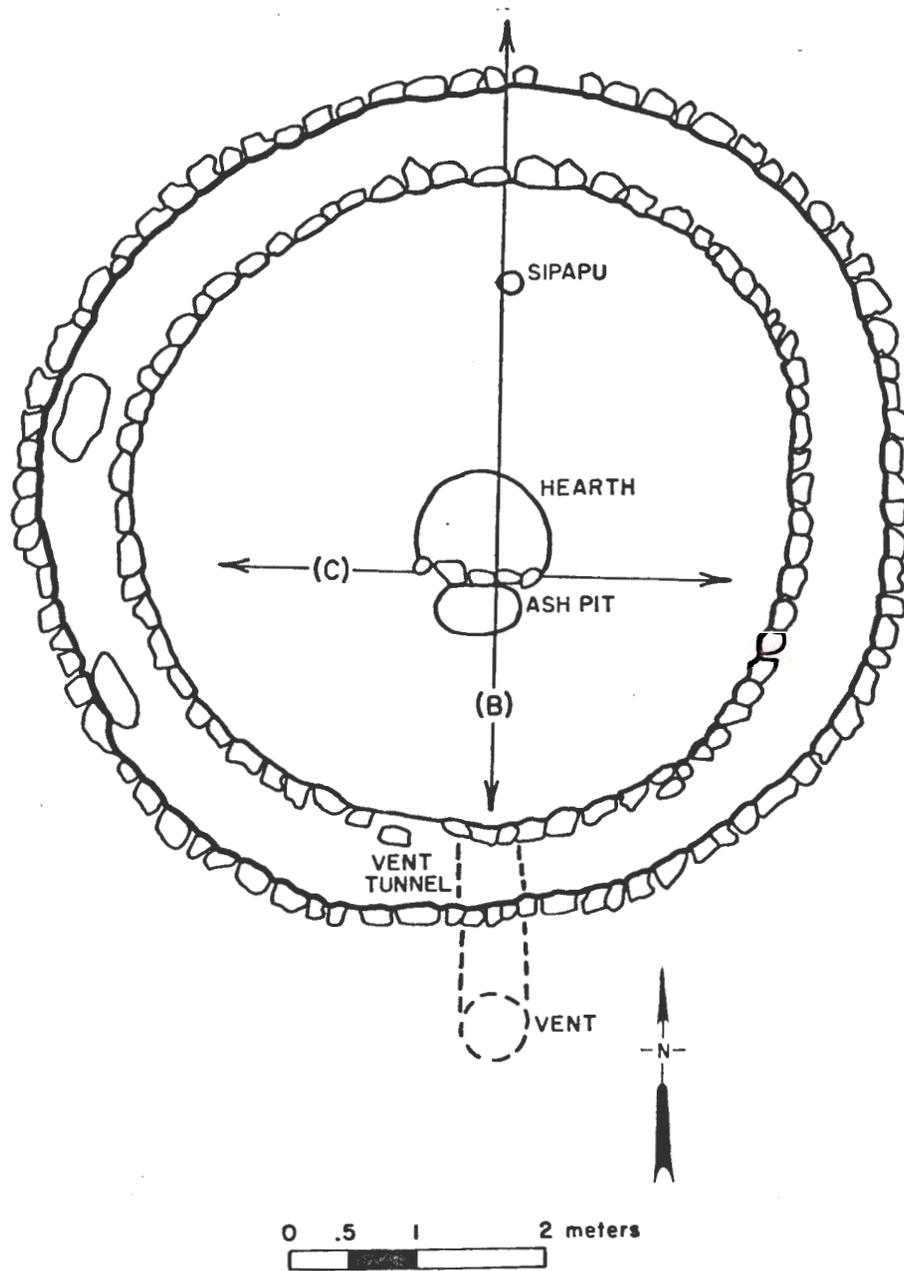


Figure 8.4 Alignments measured at Kiva 2, McPhee Pueblo (Site 5MT4475).

Figure 8.5 Graphic summary of measurements obtained at McPhee Pueblo (Site 5MT4475): (A) north-south axis of roomblock; (B) north-south axis of Kiva 2; (C) front wall of central hearth, Kiva 2.

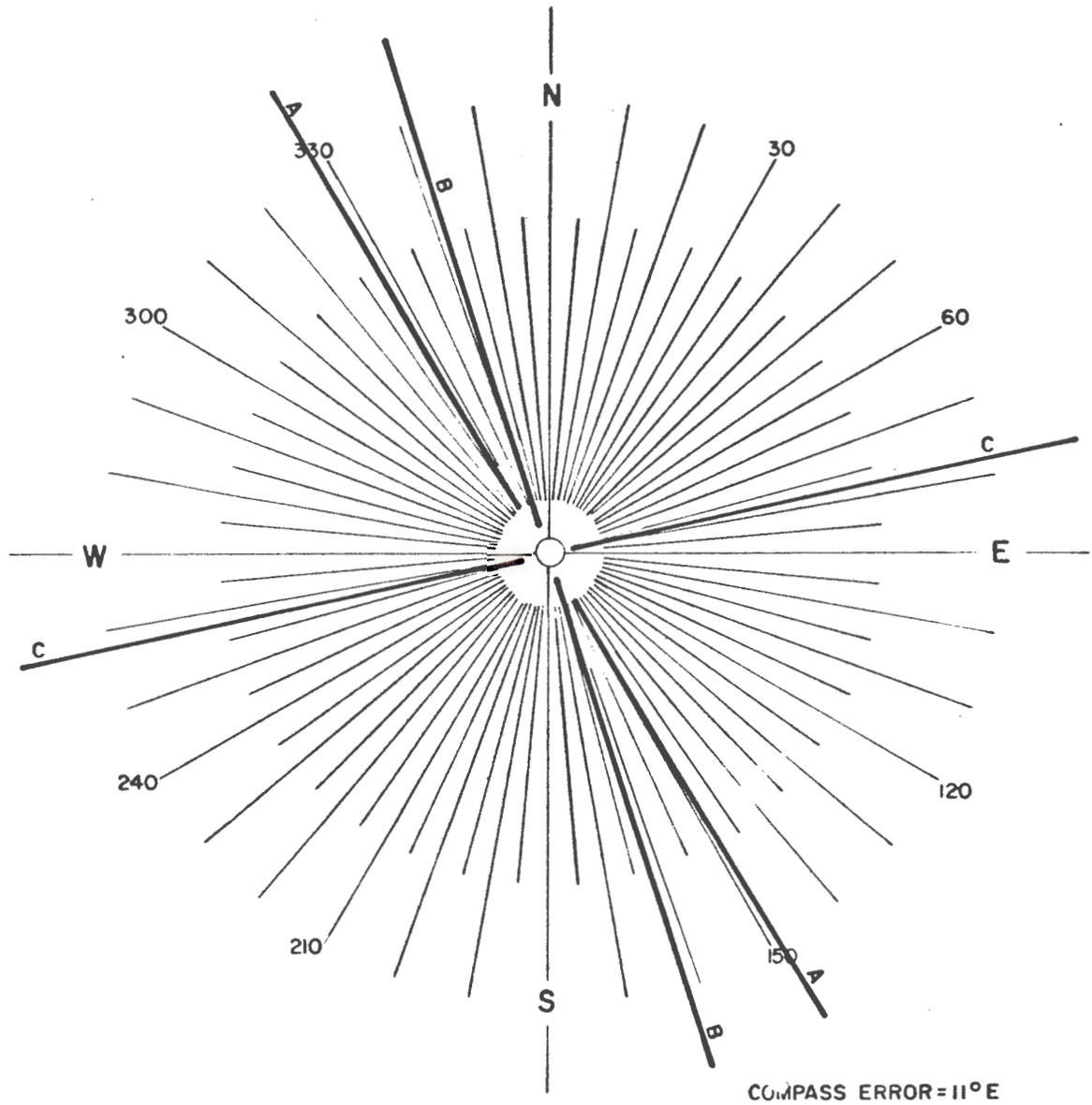


Figure 8.5 Graphic summary of measurements obtained at McPhee Pueblo (Site 5MT4475).

in addition, the structure shows no obvious associations with the movements of the sun along the horizon.

McPhee Pueblo is thought (based on field interpretations) to be an edifice planned and built as a unit, perhaps during a short period by a large labor force. Analysis of the orientations of the major architectural units suggests that topography and winter exposure to the sun were important factors in the site's construction and that astronomical phenomena were unknown or ignored. A comprehensive report of the 1978 excavations at McPhee Pueblo has been prepared by Brisbin [15].

#### Little House (Site 5MT2191)

Transit measurements were taken of the main south wall of the northern row of rooms under excavation ( $72.5^\circ - 252.5^\circ$  T) and of an apparently perpendicular wall that ran from the corner of the single southern room ( $158.5^\circ - 338.5^\circ$  T) (Figure 8.6). The two walls are within  $4^\circ$  degrees of perpendicular, which seems about as accurate as might be expected of a modestly skilled builder. At the time the structure was built (around A.D. 850), one could have sighted along the main wall from west to east to the place on the horizon where the bright star Aldebaran rose; sighting from east to west along the wall would have pointed to within  $2^\circ$  of where Sirius, the brightest star in the sky, set. These two stars have been cited as ceremonially, and perhaps architecturally, important in certain Anasazi sites (Reyman [16]) and in certain Plains Indians structures (Eddy [17]). However, in this apparent seasonal farming structure, the alignment seems to have been accidental. The measurements recorded at Little House are illustrated in Figure 8.7. Analysis did not indicate that such seasonal structures were oriented

Figure 8.6 Alignments measured at Little House (Site 5MT2191): (A) south wall of northern rooms; (B) west wall of south room. (Adapted from Hewitt [18]).

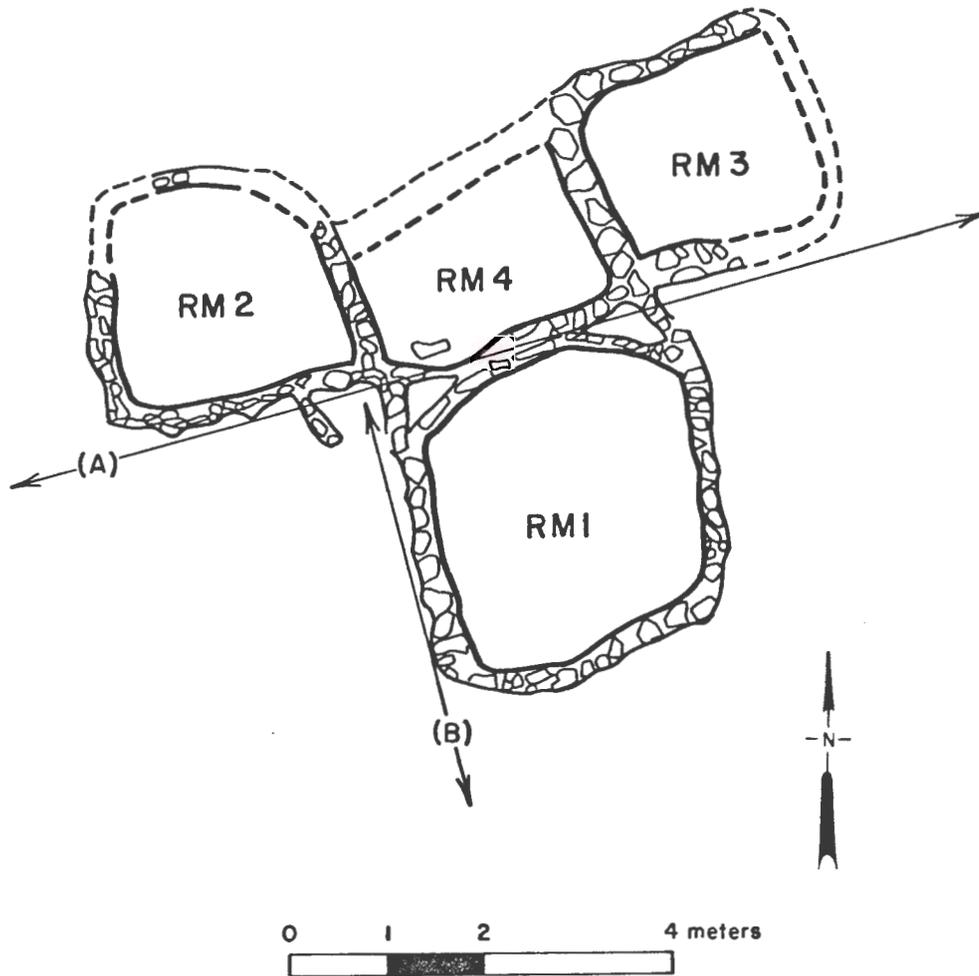


Figure 8.6 Alignments measured at Little House (Site 5MT2191).

Figure 8.7 Graphic summary of measurements obtained at Little House (Site 5MT2191): (A) south wall off north rooms; (B) west wall of south room.

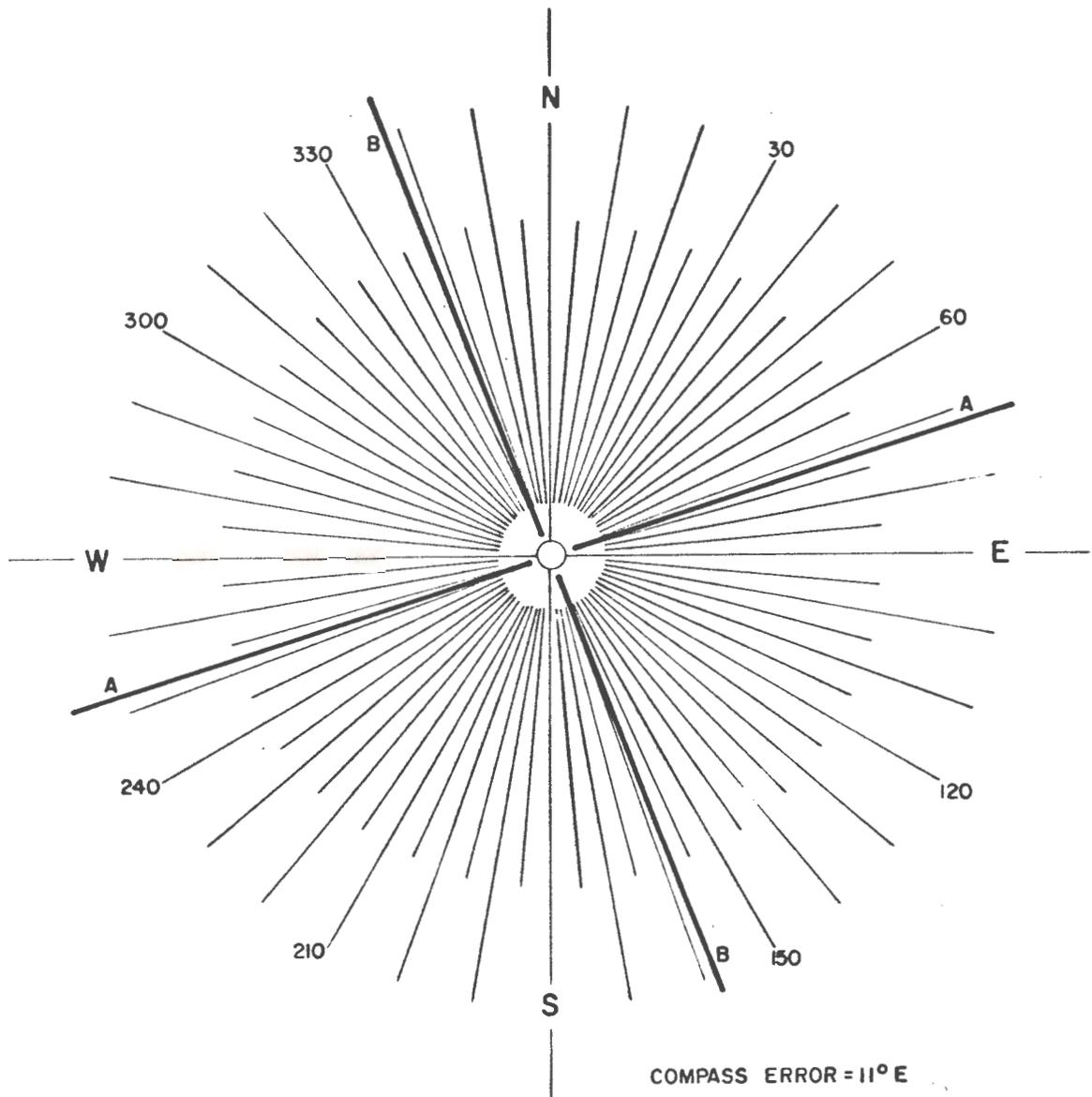


Figure 8.7 Graphic summary of measurements obtained at Little House (Site 5MT2191).

according to astronomical phenomena with potential importance for farming cultures, such as sunrise or sunset at the spring and fall equinoxes. A report of the excavations at Little House has been prepared by Hewitt [18].

#### Cline Crest Pueblo (Site 5MT2663)

Transit measurements were taken along two wall alignments at the central horseshoe-shaped room complex at the site (Figure 8.8). The inner wall of the north arm of the horseshoe is oriented  $157.5^\circ - 337.5^\circ$  T and the inner wall of the south arm is oriented  $135^\circ - 315^\circ$  T. A reading was also taken to establish the compass bearing of the Emerson Ruin (Site 5MT4447) from the Cline Crest site ( $157.5^\circ$  T); this is the same as the measurement recorded for the north arm wall. This coincidence suggests this portion of the roomblock was intentionally laid out to point toward the Emerson Ruin; however, no certain conclusions can be drawn at this point. Similarly, sighting along the same wall from southeast to northwest would have pointed to within  $3^\circ$  of the point on the horizon where the bright star Capella, the sixth brightest star in the sky, set in about A.D. 900, when the site was presumably occupied; sighting along the south wingwall from northwest to southeast would have pointed to where the bright star Fomalhaut rose in A.D. 900. However, these alignments should be presumed to be coincidental until other evidence of similar alignments on the same stars is found. Astronomical measurements recorded at Cline Crest Pueblo are shown in Figure 8.9. It is notable that the structure measured at Cline Crest Pueblo has the same general orientation as the horseshoe room complex at McPhee Pueblo; the builders of both complexes apparently adopted the same orientation strategy during planning and construction.

Figure 8.8 Alignments measured at Cline Crest Pueblo  
(Site 5MT2663): (A) south arm of  
horseshoe roomblock; (B) north arm of  
horseshoe roomblock.

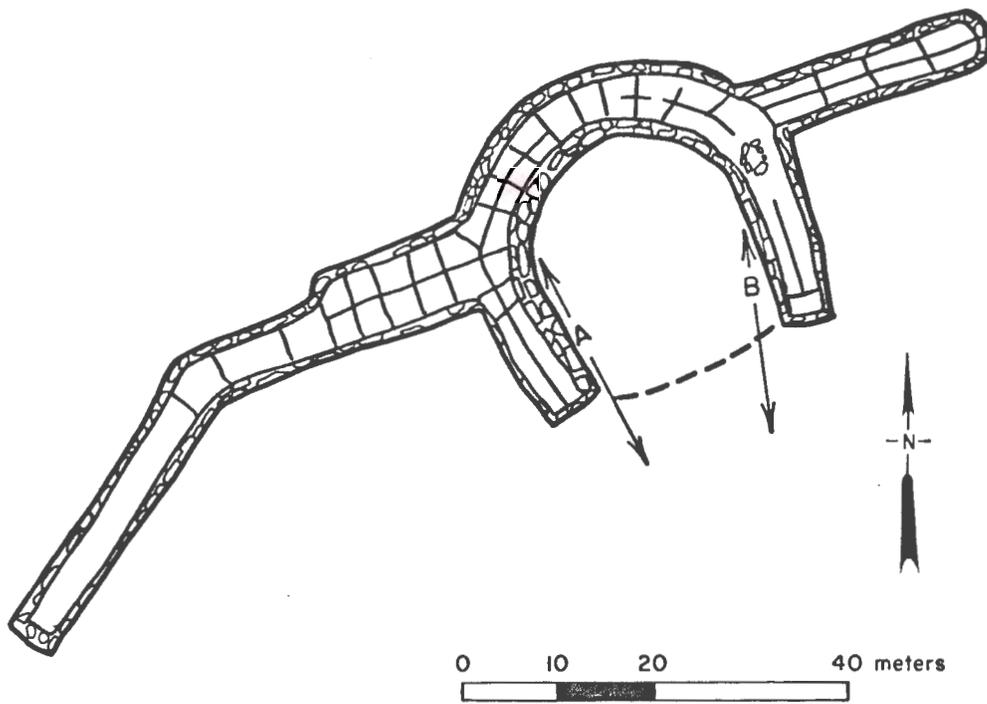


Figure 8.8 Alignments measured at Cline Crest Pueblo (Site 5MT2663).

Figure 8.9 Graphic summary of measurements obtained at Cline Crest Pueblo (Site 5MT2663): (A) south wall of horseshoe roomblock; (B) north wall of horseshoe roomblock and azimuth to Emerson (Sundial) Ruins.

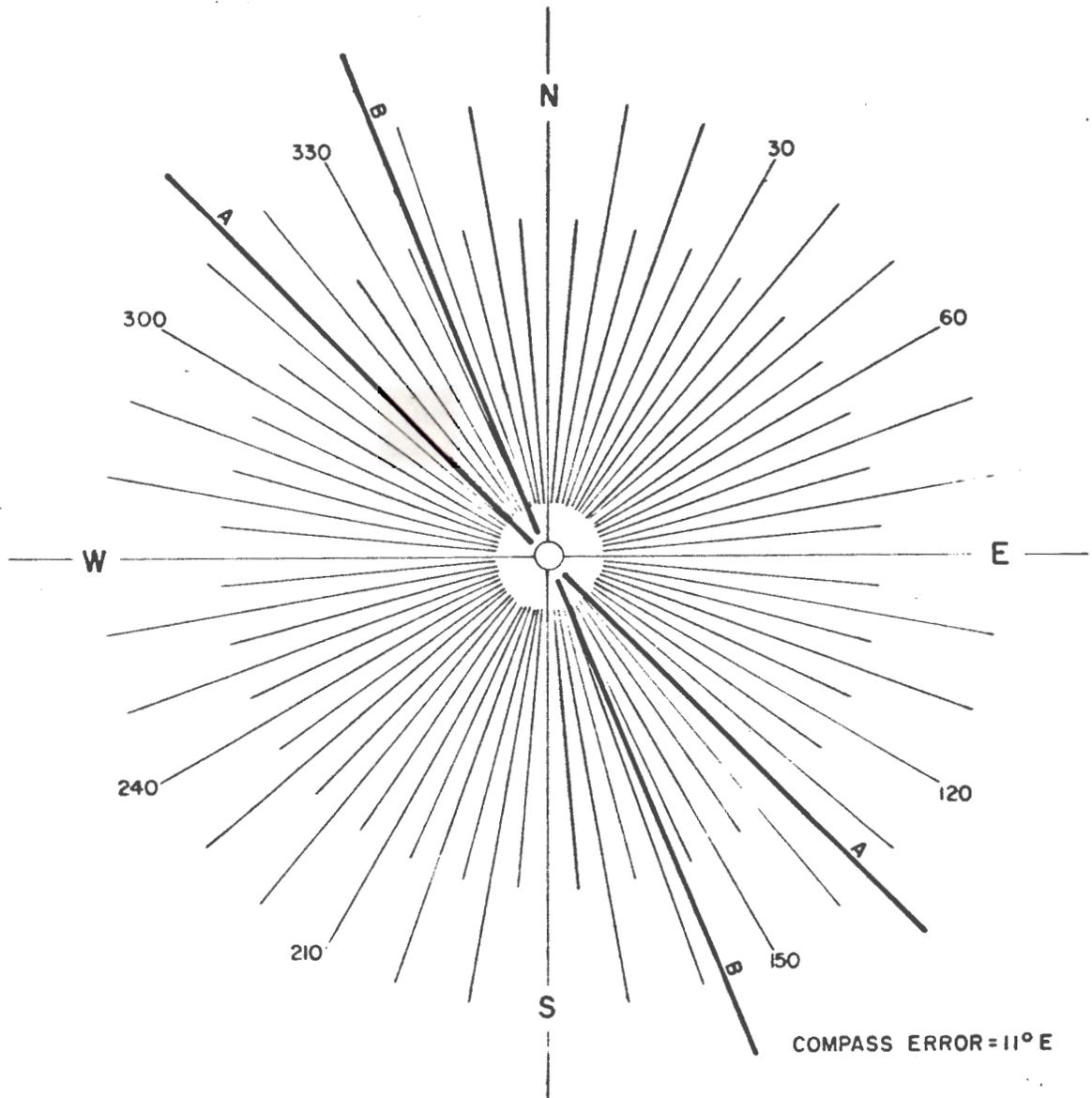


Figure 8.9 Graphic summary of measurements obtained at Cline Crest Pueblo (Site 5MT2663).

Emerson Ruins ("Sundial Palace," Site 5MT4447)

Prior to the archaeoastronomy reconnaissance, this site was regarded as the location in the project area with the most potential for exhibiting evidence of prehistoric astronomical knowledge. The main architectural unit at the site is a circular structure described by J.W. Emerson, a forest ranger who visited the site in 1916, as a "Sun Dial Palace" (Fewkes [10:34-35]). A visit to the site in the spring of 1978 convinced D.A.P. archaeologists that the site is probably a tri-wall structure, similar to the one at the Mud Springs Ruins described by Holmes [19:398-399] and to the example at Aztec Ruins (the Hubbard Mound) excavated by the National Park Service (Vivian [20]). Tri-wall structures, because of their unique construction, are believed to have ceremonial and social implications (Vivian [20:85]).

Transit measurements were taken of the directions of the remains of radial walls that fan out from the center of the circular edifice (Figure 8.10). Alignments given in Table 8.1 are true azimuths as measured from the center; they are compared with values given in Emerson's original map of the site (Figure 8.11) as published by Fewkes [10:35].

Several differences seem noteworthy. First, Emerson identified two walls (between Walls J and K, in Figure 8.10) that were not found in the 1978 reconnaissance; similarly two walls (E and I) were found in the 1978 survey that were not noted in his survey. Second, and probably more significant, Emerson's survey shows the walls as symmetrical about a north-south line; this would make the site especially interesting astronomically, since sky features rise and set symmetrically about this axis. However, the D.A.P. survey does not confirm this situation. A likely explanation is that Emerson made his drawing with this constraint imposed.

Figure 8.10 Alignments measured at Emerson Ruins  
(Site 5MT4447). Letters A through N  
indicate radial walls.

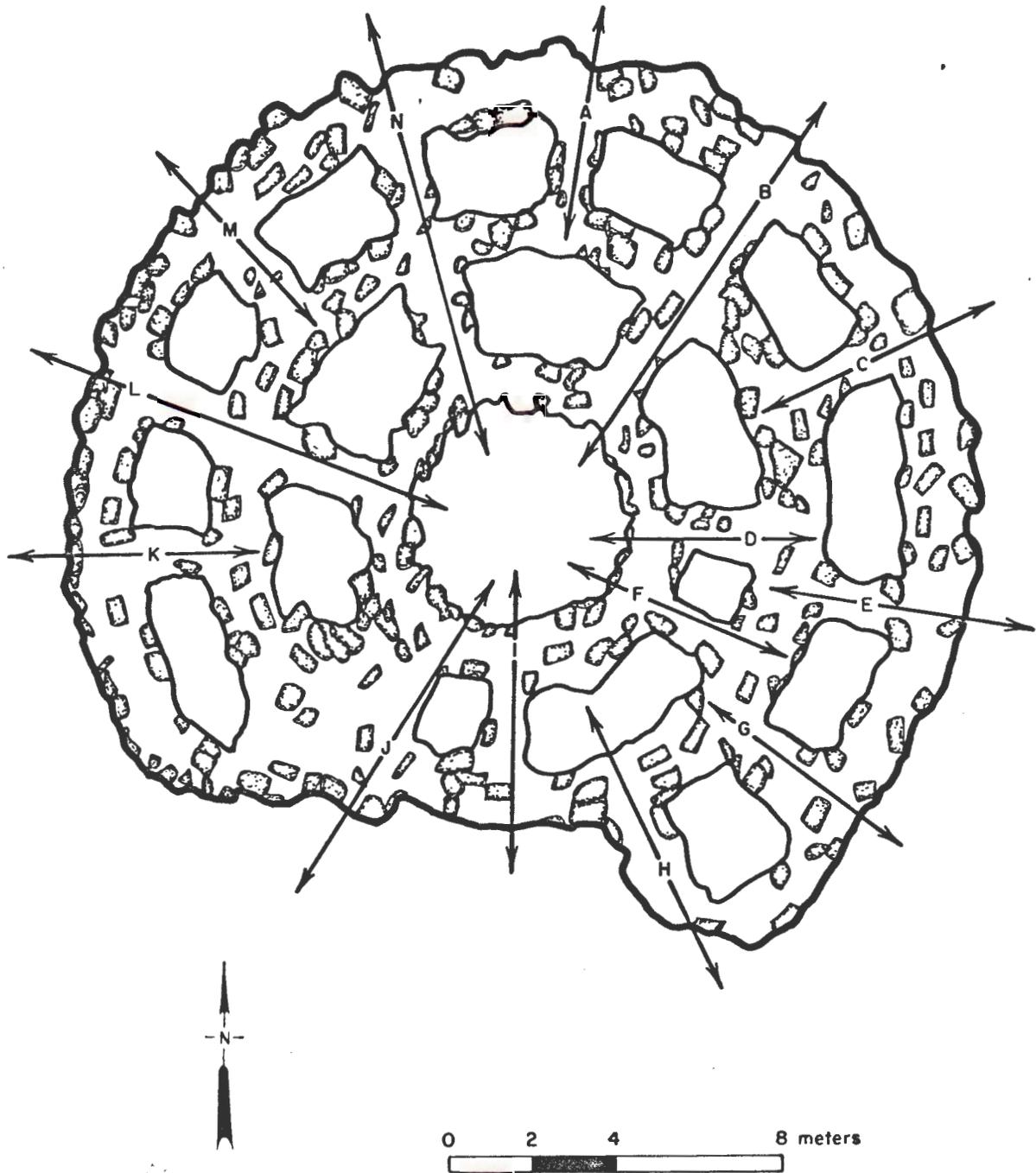


Figure 8.10 Alignments measured at Emerson Ruins (Site 5MT4447).

Table 8.1 True Azimuths Measured at Emerson Ruins Tri-wall Structure

Alignment (Radial Wall)	Azimuth	
	1978 Survey (°T)	Emerson Survey (°T)
A	10	11
B	35	37.5
C	62	60
D	87.5	90
E	99	-
F	112.5	113.5
G	127	130
H	152	152.5
I	178	-
J	213	207.5
-	-	230
-	-	246.5
K	269	270
L	294	300
M	317.5	322.5
N	344	349

Figure 8.11 Schematic ground plan of Emerson Ruins.  
(After Emerson in Fewkes [10:35].)

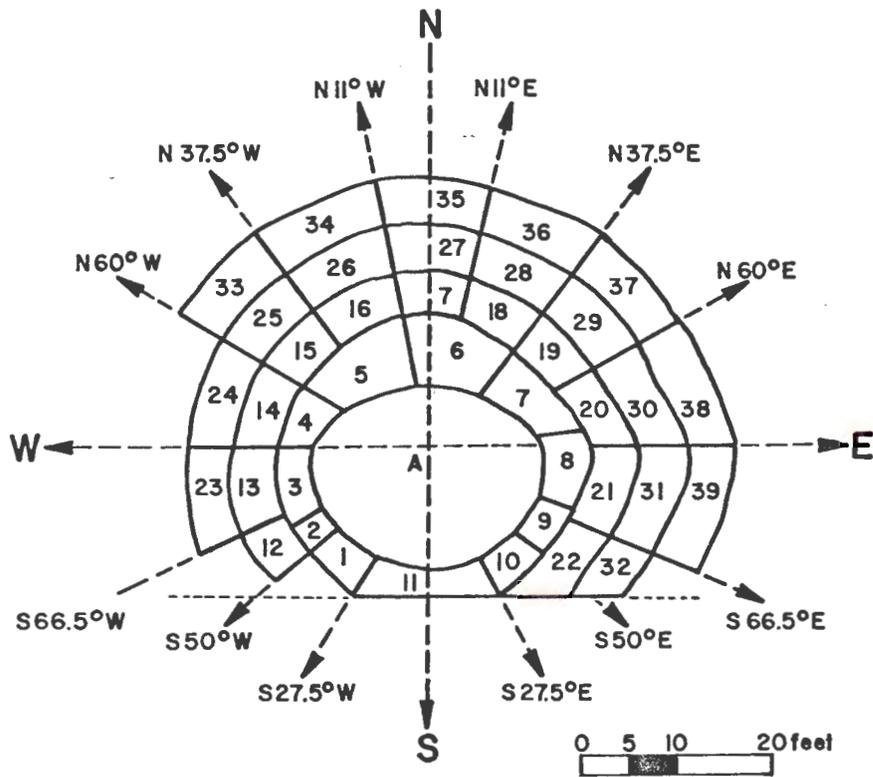


Figure 8.11 Schematic ground plan of Emerson Ruins.

The 14 wall alignments measured in the D.A.P. survey define 28 specific azimuths and it is possible to associate eight of them with places on the horizon where prominent stars rose or set in A.D. 1100, the presumed date of construction of the site. Among these, Wall C (Figure 8.10) marks the direction of summer solstice sunrise and winter solstice sunset with an error of 1.5°.

This analysis suggests that astronomical phenomena may have been considered by the builders of the Emerson Ruin. The orientations of the 14 walls are illustrated in Figure 8.12.

#### Yucca House Ruins

Transit measurements were taken of architectural orientations at three structures at the site: a large (about 40 by 40 m) square enclosure with an intact wall on the north side, a double-walled circular structure (perhaps a double-walled tower), and a square "apartment house" consisting of a row of rooms around a central enclosure (Figure 8.13). In Holmes' 1876 description of the ruin (~~in Jackson~~ [8:399-400]), the first structure is termed the "Lower House," and the square apartment house is referred to as the "Upper House." Holmes' terminology has been maintained in the following summary, and the double-walled circular structure is referred to as such.

The walls of the Lower House are perpendicular within 4°, representing the ability of a modestly skilled artisan. They are not laid out according to the cardinal directions, but are rotated about 10° counterclockwise from true north. It is possible that the builders intended the structure to be oriented in the cardinal directions and that this error represents their level of skill without a compass. It was not particular-

Figure 8.12 Graphic summary of measurements obtained at Emerson Ruins (Site 5MT4447). Letters correspond to alignments illustrated in Figure 8.10.

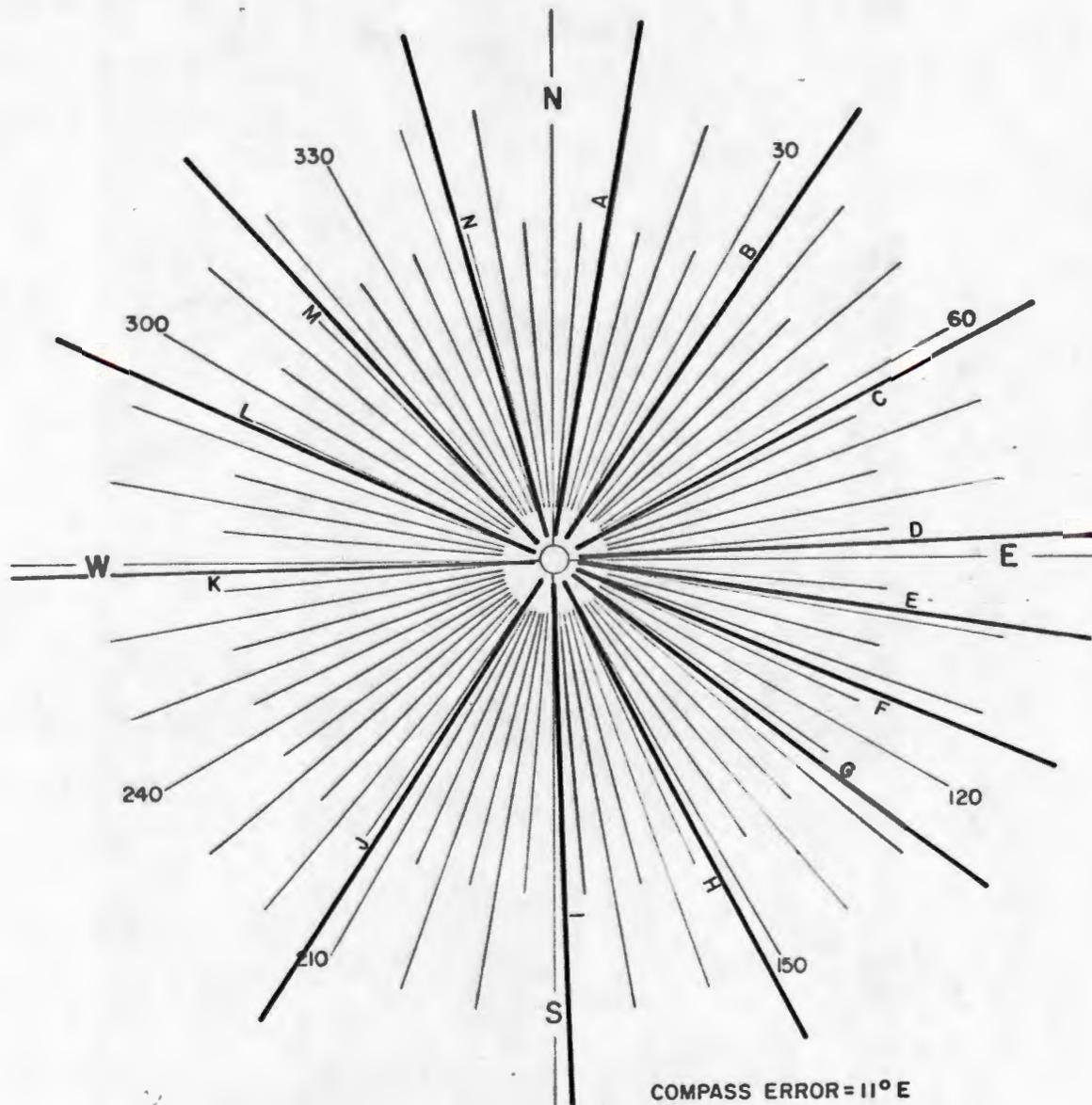


Figure 8.12 Graphic summary of measurements obtained at Emerson Ruins (Site 5MT4447).

Figure 8.13 Alignments measured at the Upper and Lower Houses, Yucca House Ruins. (Adapted from Fewkes [10:35].)

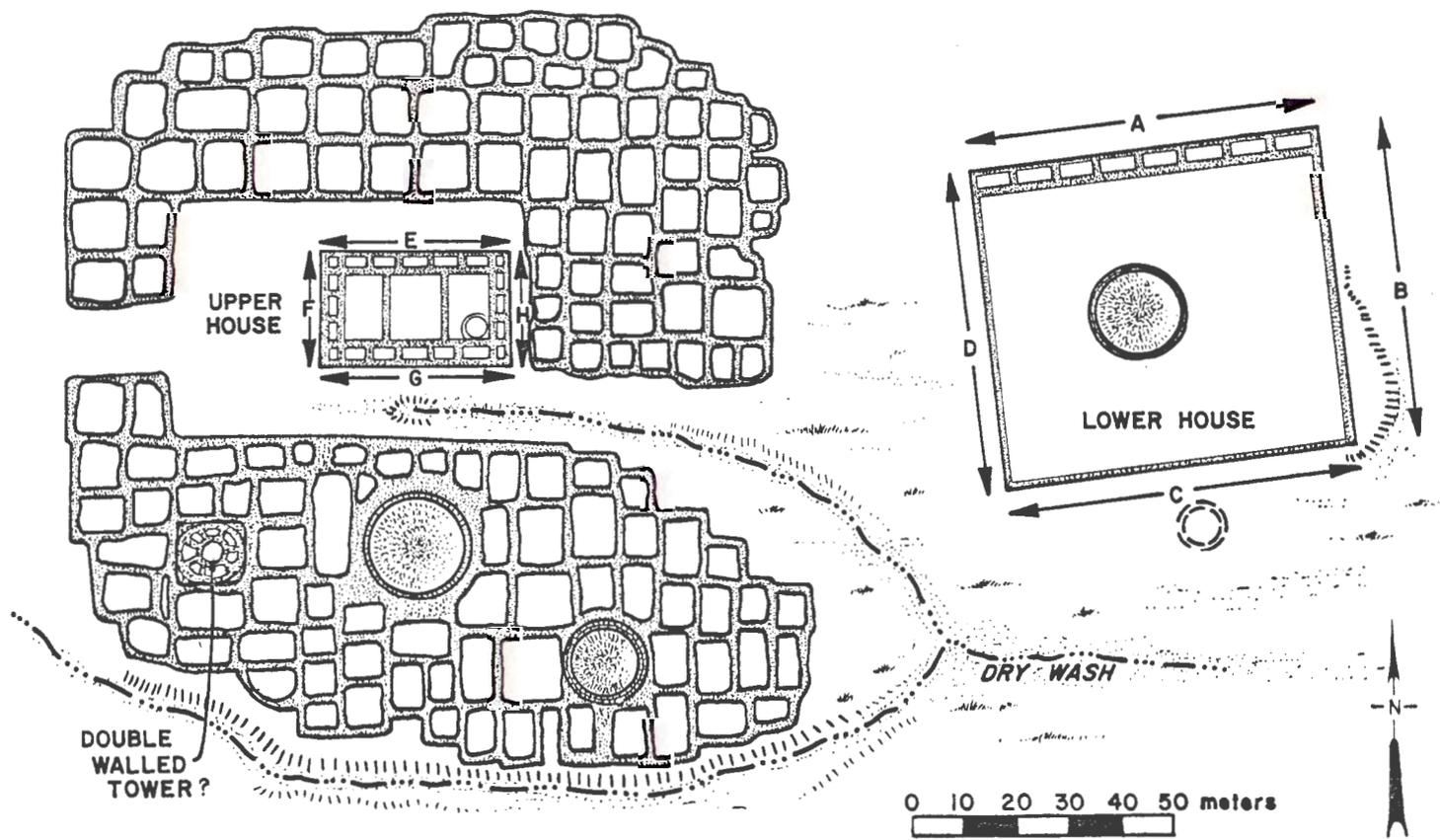


Figure 8.13 Alignments measured at the Upper and Lower Houses, Yucca House Ruins.

ly easy to define the precise cardinal directions in A.D. 1200, when the structure is presumed to have been built, since the present North Star, Polaris, was not as near the celestial pole as it is now. Thus, a  $10^\circ$  error in layout does not seem unusual.

The four walls of the Lower House define eight azimuths, since there is a factor-two redundancy in the direction of sighting along a straight wall. Of these eight directions on the horizon, two come close to where bright stars crossed the horizon (Aldebaran in Taurus and Rigel in Orion) at the time of construction. This seems close to the number that one would get by chance alone. The compass directions recorded for the Lower House are reproduced in Figure 8.14.

The wall orientations of the Upper House are close to the cardinal directions and are perpendicular within about  $8^\circ$ . The degree of perpendicularity again seems to be expected. The east-west walls of the structure (including the high wall) are oriented  $92^\circ - 272^\circ$  T, or within  $2^\circ$  of east-west. The north-south walls are  $8^\circ - 188^\circ$  T and  $177^\circ - 357^\circ$  T, or in error (assuming precise cardinal directions were sought) by  $8^\circ$  and  $3^\circ$ , respectively. One suspects that they were intended to be laid out on the cardinal directions, based on the importance of these directions in ethnographic accounts, and that these errors measure the skill of the A.D. 1200 builders. The compass readings obtained during measurement of the Upper House are illustrated in Figure 8.15.

Transit measurements were made from the center of the double-walled circular structure along radial walls that fan out from the center (Figure 8.16). These were found to be oriented in the true compass directions shown in Table 8.2.

Figure 8.14 Graphic summary of measurements obtained  
at the Lower House, Yucca House Ruins.  
Letters correspond to alignments  
illustrated in Figure 8.13.

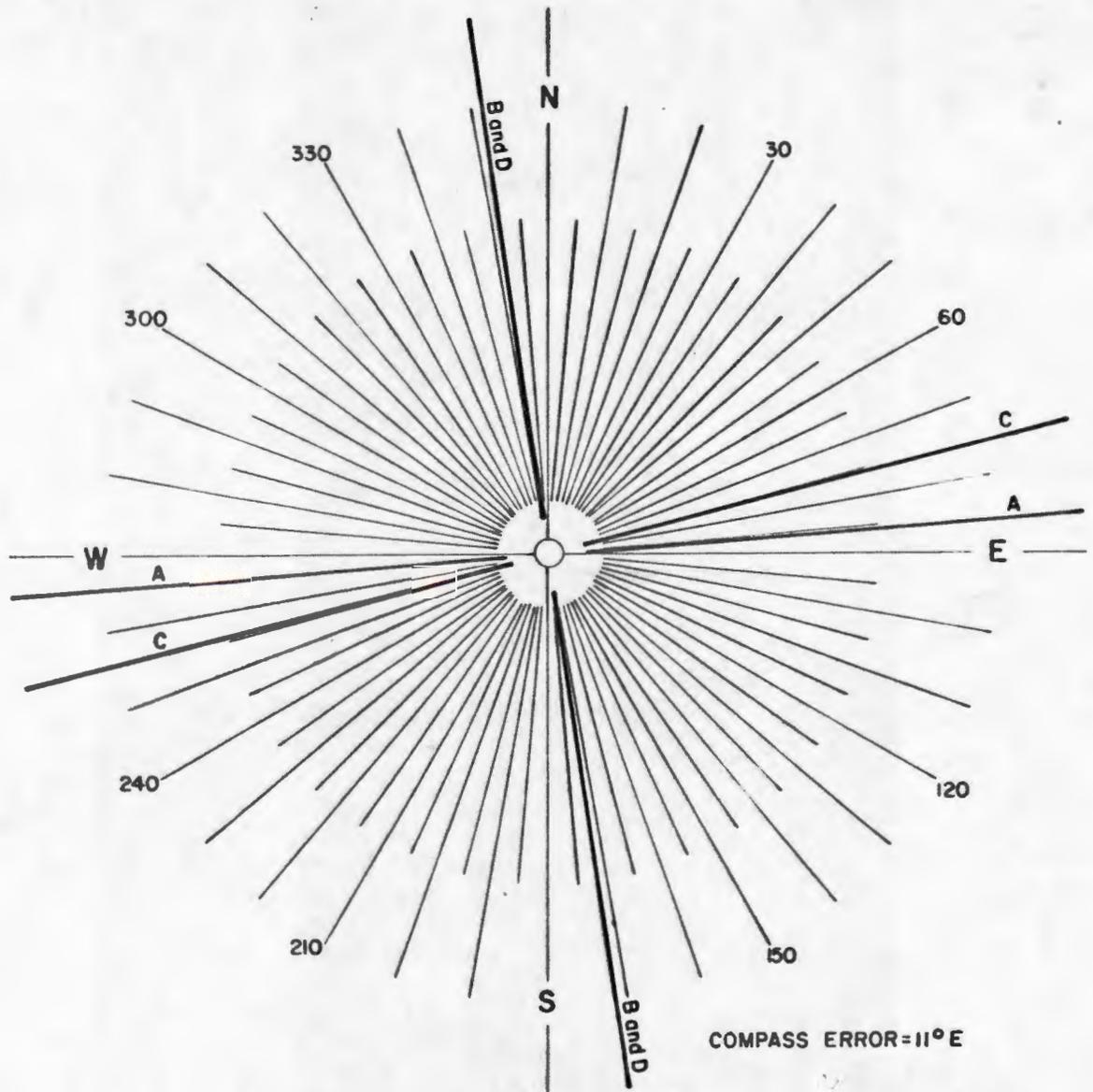


Figure 8.14 Graphic summary of measurements obtained at the Lower House, Yucca House Ruins.

Figure 8.15 Graphic summary of measurements obtained at the Upper House, Yucca House Ruins. Letters correspond to alignments illustrated in Figure 8.13.

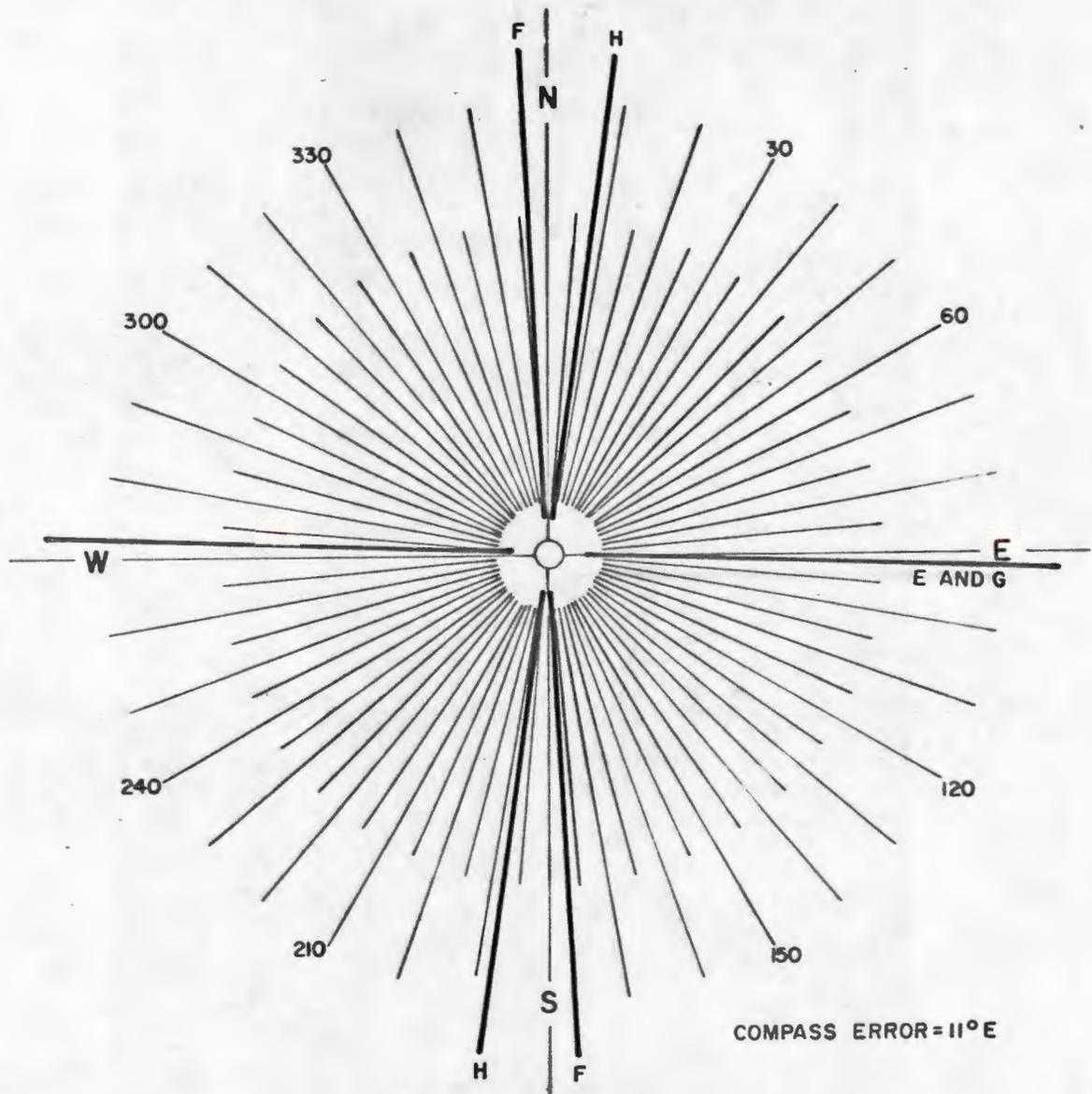


Figure 8.15 Graphic summary of measurements obtained at the Upper House, Yucca House Ruins.



Figure 8.16 Alignments measured at the double-walled circular structure, Yucca House Ruins. Letters A through G indicate radial walls.

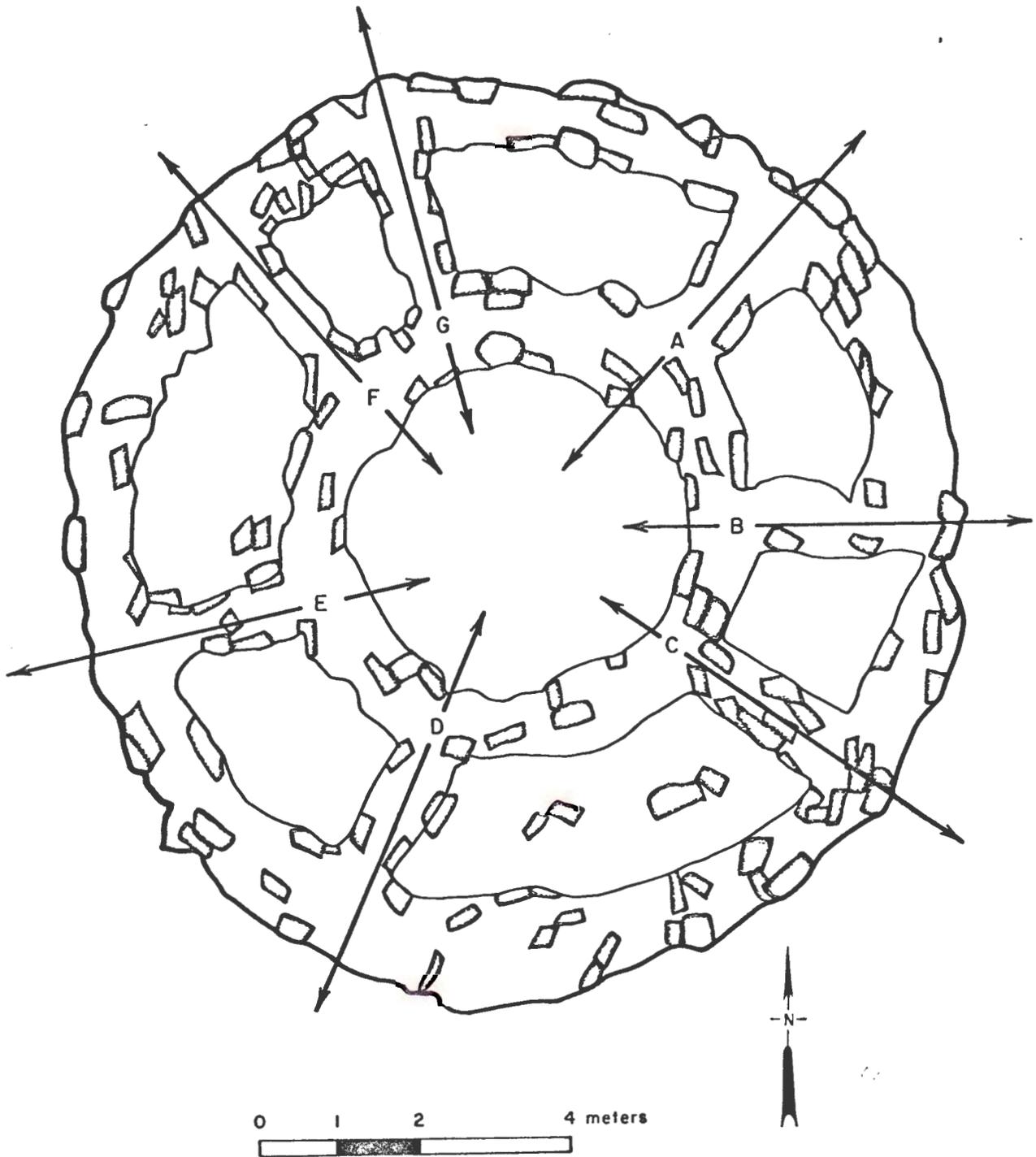


Figure 8.16 Alignments measured at the double-walled circular structure, Yucca House Ruins.

Table 8.2 True Azimuths Measured at the Double-walled  
Circular Structure at Yucca House Ruins

Alignment (Radial Walls)	Azimuth (°T)
A	41
B	87.5
C	122.5
D	200.5
E	254
F	315.5
G	341.5

The radial-wall directions do not exhibit any obvious symmetry about the north-south directions, as might be expected if the structure were laid out astronomically. The seven wall alignments define 14 compass directions; five of these come within 2° of where bright stars rose or set in A.D. 1200, the presumed date of construction for the structure; this is close to what one would expect by chance. The stars are Deneb (19), Vega (5), Arcturus (4), Antares (16), and Fomalhaut (18). The numbers in parentheses give the rank of the star in brightness, i.e., a rank of 1 indicates the brightest star visible at Yucca House, a rank of 2 indicates the second-brightest star visible, etc. One of the walls (Wall C) is laid out to within 2° of the direction of the sun's rise at winter solstice (21 December) and of its setting at summer solstice (21 June). The compass readings obtained from investigations at the double-walled structure are illustrated in Figure 8.17.

#### Mud Springs (Toltec) Ruins

Within the cluster of crumbling roomblocks at this late Anasazi village (occupied about A.D. 1200) is a tri-wall structure first described by Holmes [19:398] (Figure 8.18). Transit measurements were taken of the

Figure 8.17 Graphic summary of measurements obtained at the double-walled circular structure, Yucca House Ruins. Letters correspond to alignments illustrated in Figure 8.16.

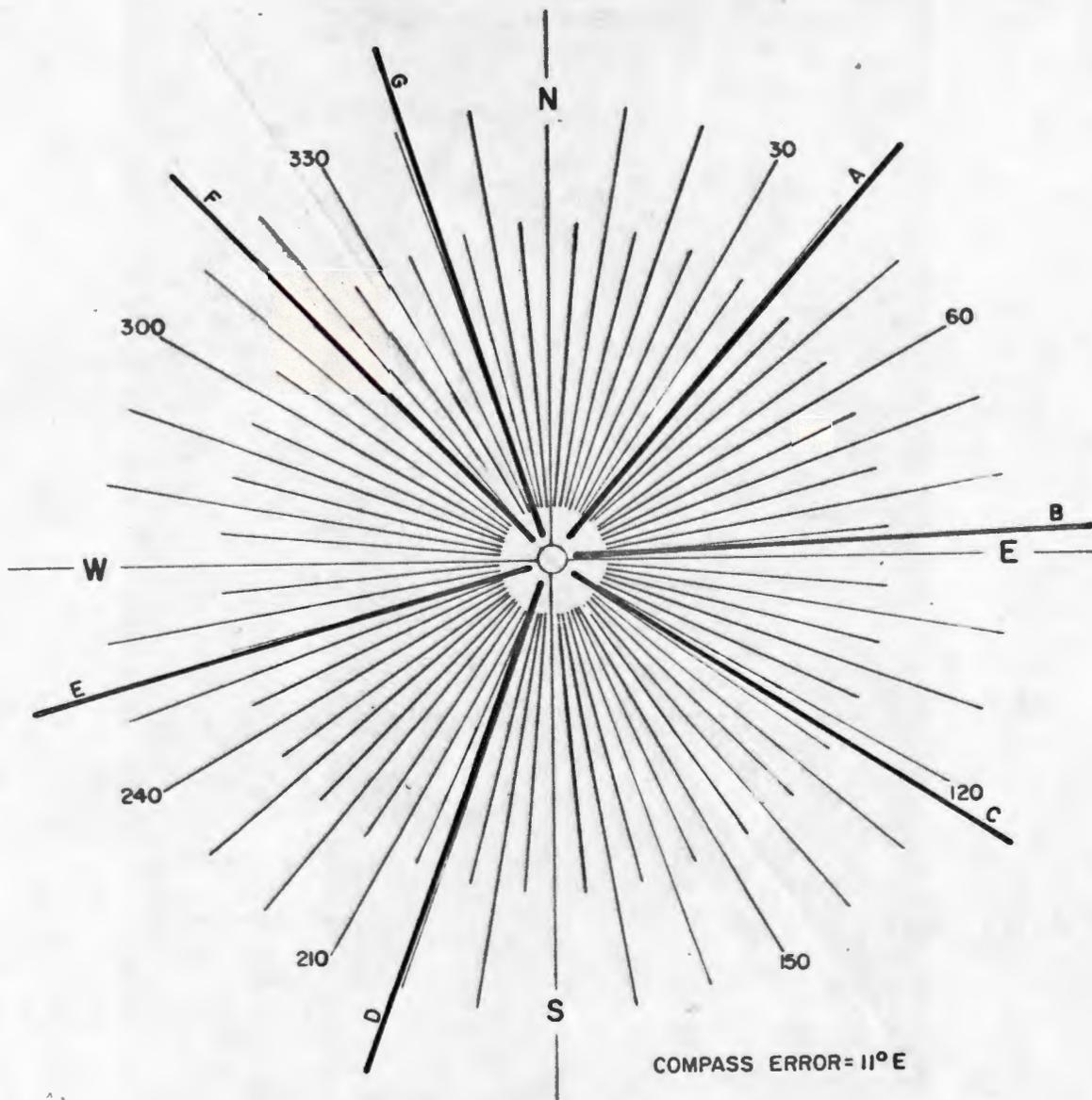


Figure 8.17 Graphic summary of measurements obtained at the double-walled circular structure, Yucca House Ruins.

Figure 8.18 The tri-wall structure at Mud Springs Ruins. Top: plan view of architectural unit incorporating tri-wall structure; bottom: sketch of tri-wall structure. (Adapted from Holmes [8:399].)

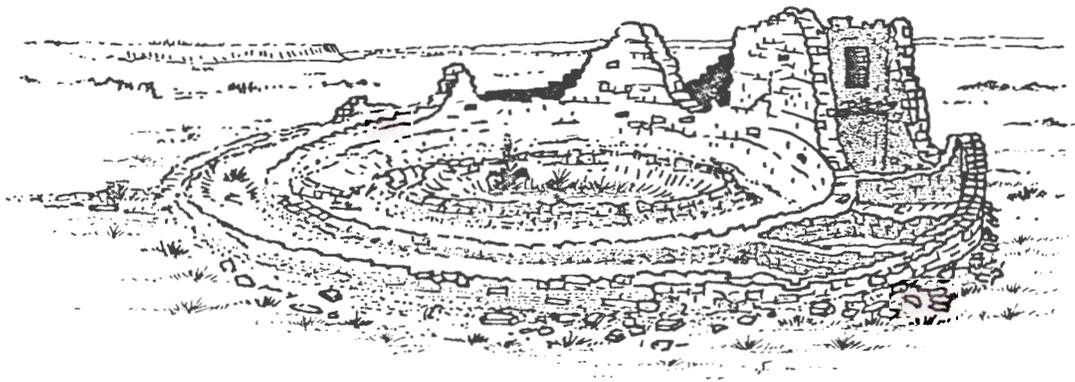
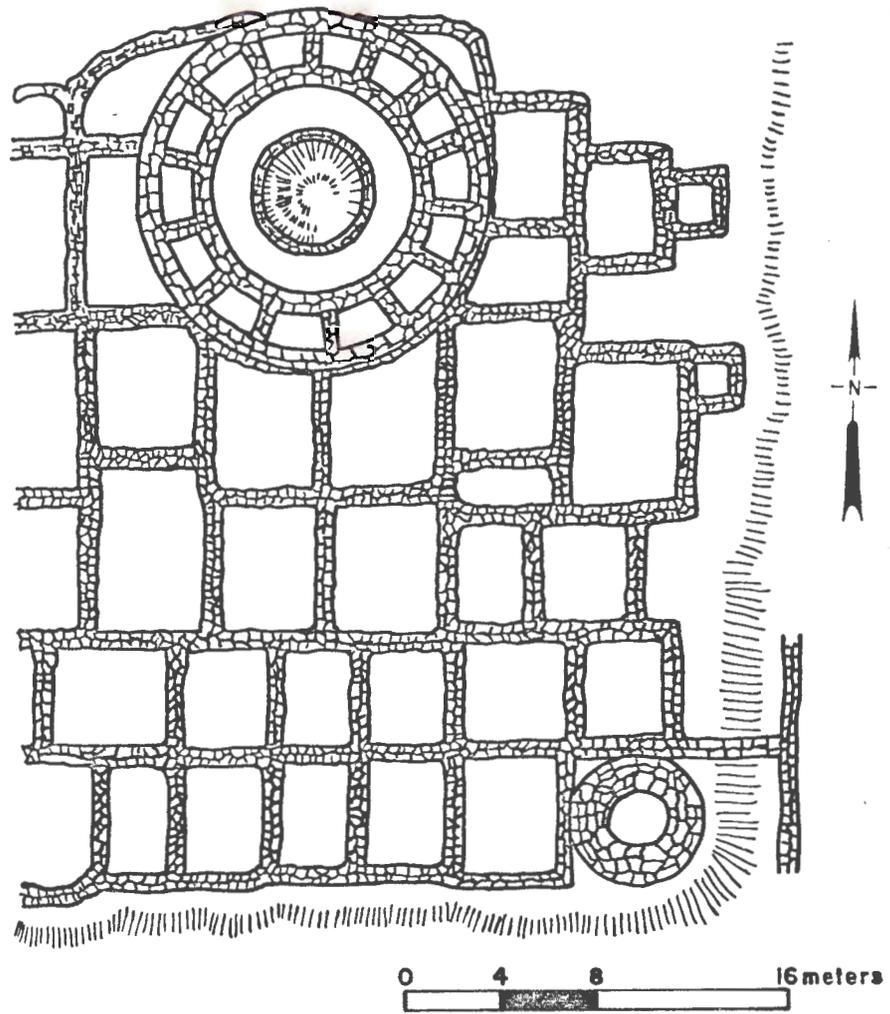


Figure 8.18 The tri-wall structure at Mud Springs Ruins.

compass directions of ten radial walls at this edifice (Figure 8.19).

Directions given in Table 8.3 are true bearings as measured from the center of the structure.

Table 8.3 True Azimuths Measured at the Mud Springs Ruins Tri-wall Structure

Alignment (Radial Walls)	Azimuth (°T)
A	2
B	62
C	82.5
D	131.5
E	179.5
F	202.5
G	241.0
H	254
I	298.5
J	331.5

Walls A and E fall nearly on the north-south axis and may be significant in this regard. The alignment of Wall G, sighted toward the center of the structure, points to within 1° of the place of sunrise at summer solstice at the site; the opposite direction, sighted out from the center of the structure along the wall, points to the place of sunset at winter solstice. Wall B is nearly a continuation of Wall G, on the other side of the center, and thus it defines the same directions with regard to the sun. Wall I, sighted toward the center of the structure, points to within one-half degree of the place on the horizon where Sirius, the brightest star in the sky, rose in about A.D. 1100, the presumed date of construction for the site.

The 10 wall alignments define 20 horizon azimuths that can be examined for correspondence with other astronomical phenomena; half can be

Figure 8.19 Alignments measured at the tri-wall structure, Mud Springs Ruins. Letters A through J indicate radial walls.

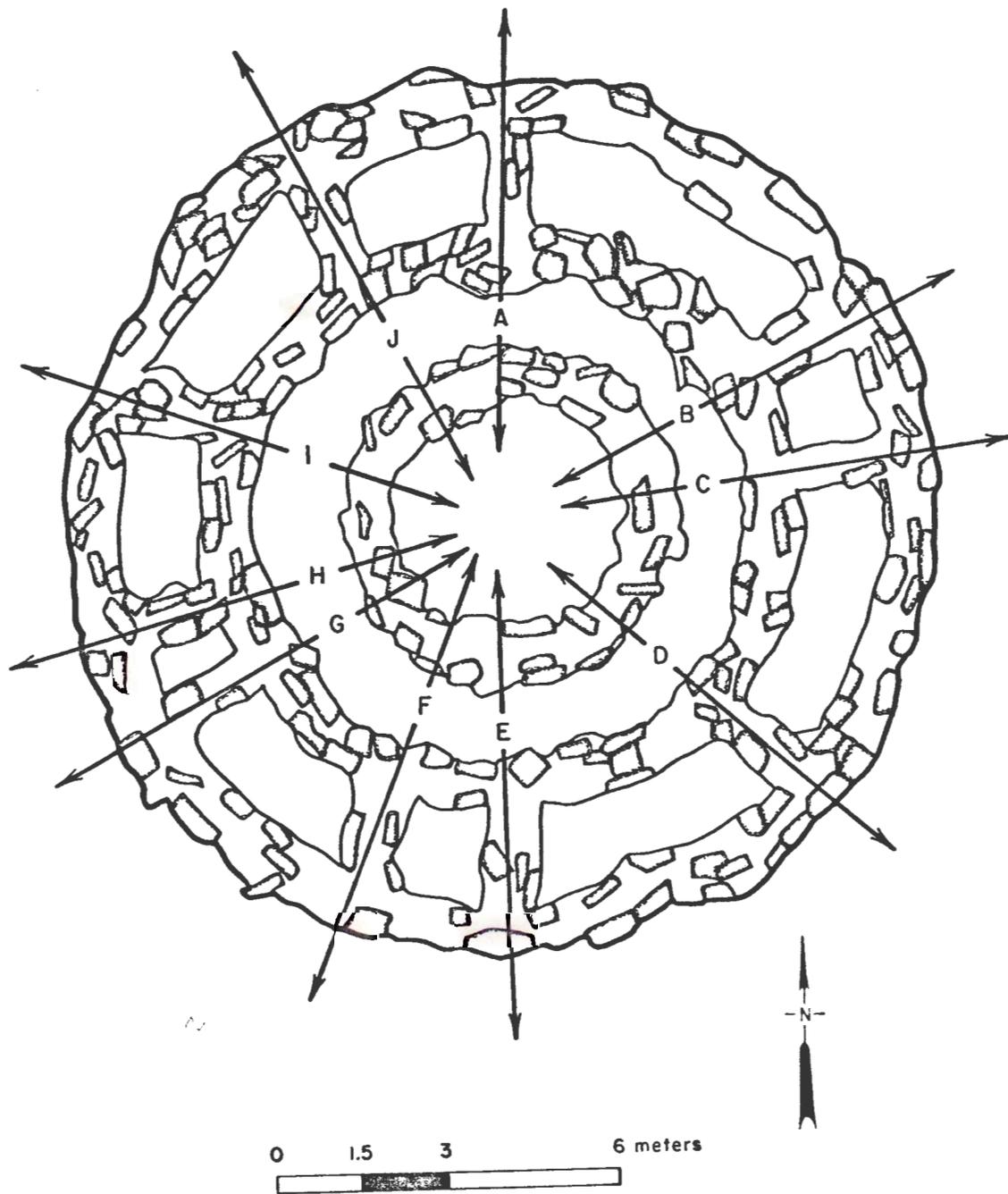


Figure 8.19 Alignments measured at the tri-wall structure Mud Springs Ruins.

associated with places on the horizon where prominent stars rise or set. However, until more is known about the original appearance of the structure it seems unwise to presume that these are more than accidental. The measurements obtained from the structure are graphically illustrated in Figure 8.20.

#### Goodman Point Ruins

Two great kivas have been reported by Pinkley at this large village (in Vivian and Reiter [22:105]). The archaeoastronomical reconnaissance was performed at the structure built on bedrock adjacent to Juarez Springs. Transit measurements were made of several alignments suggested by visible remnants of walls and features: the apparent axis (as defined by two entranceways spaced diametrically opposite on the circular, bounded structure) and a square of apparent footings for four main roof posts (Figure 8.21). Table 8.4 presents the true bearings based on these measurements. The axis of the structure is remarkably close to the north-south line--within about  $2^\circ$ , which is probably as closely as the entranceways, taken as measurement points, could be defined; that is, it could have been constructed with an exact north-south axis. Similarly, the four footing locations are laid out in a square whose sides are also remarkably close to the cardinal directions. The two north-south sides are within  $1^\circ$  of true north-south; one east-west side is within  $3^\circ$  and the other within  $2^\circ$  of the true east-west direction. The closeness to true cardinal directions is notable. Measurements recorded at the Goodman Point great kiva are graphically illustrated in Figure 8.22.

Figure 8.20 Graphic summary of measurements obtained at the tri-wall structure, Mud Springs Ruins. Letters correspond to alignments illustrated in Figure 8.19.

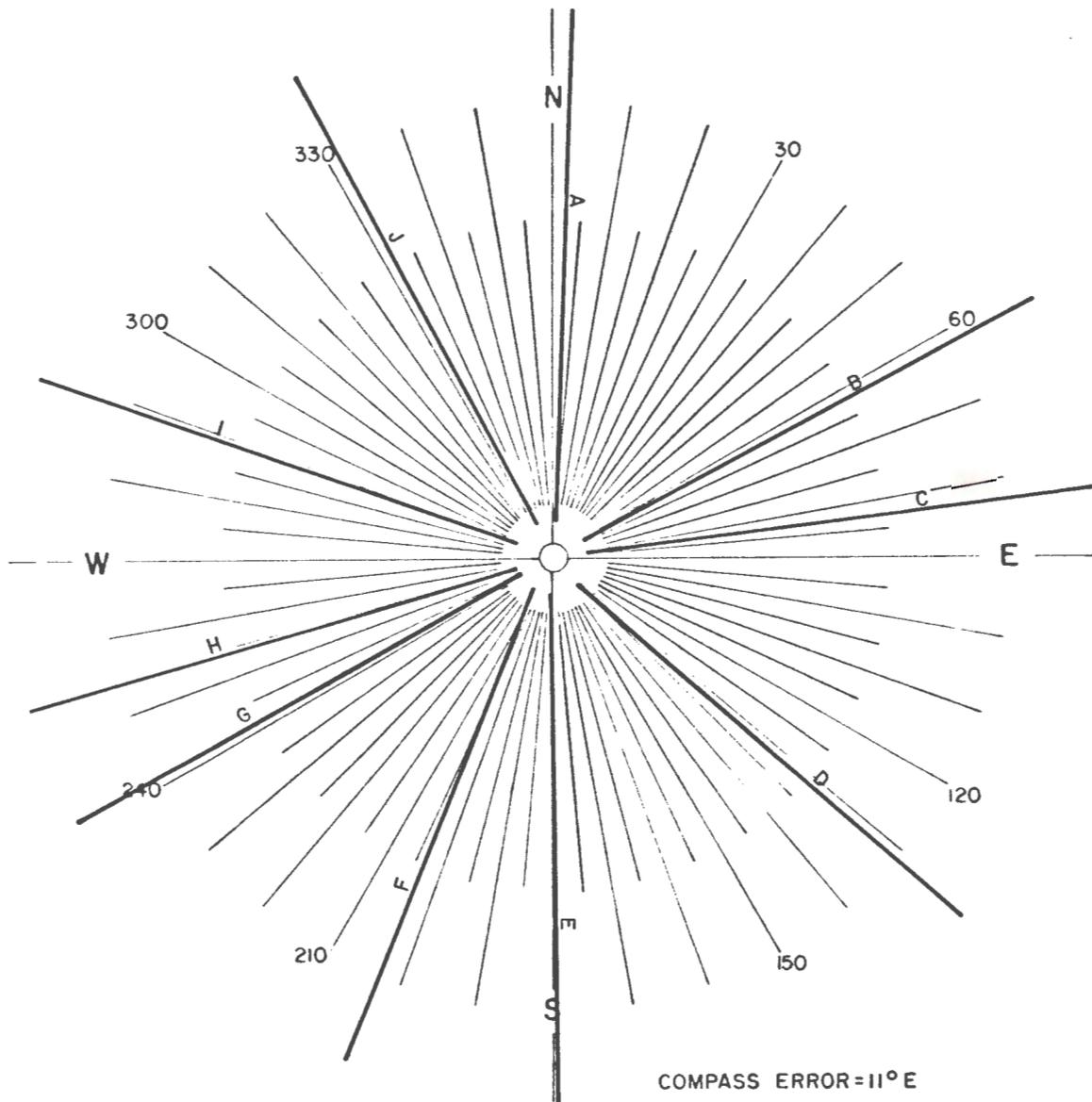


Figure 8.20 Graphic summary of measurements obtained at the tri-wall structure, Mud Springs Ruins.

Figure 8.21 Alignments measured at the great kiva,  
Goodman Point Ruins.

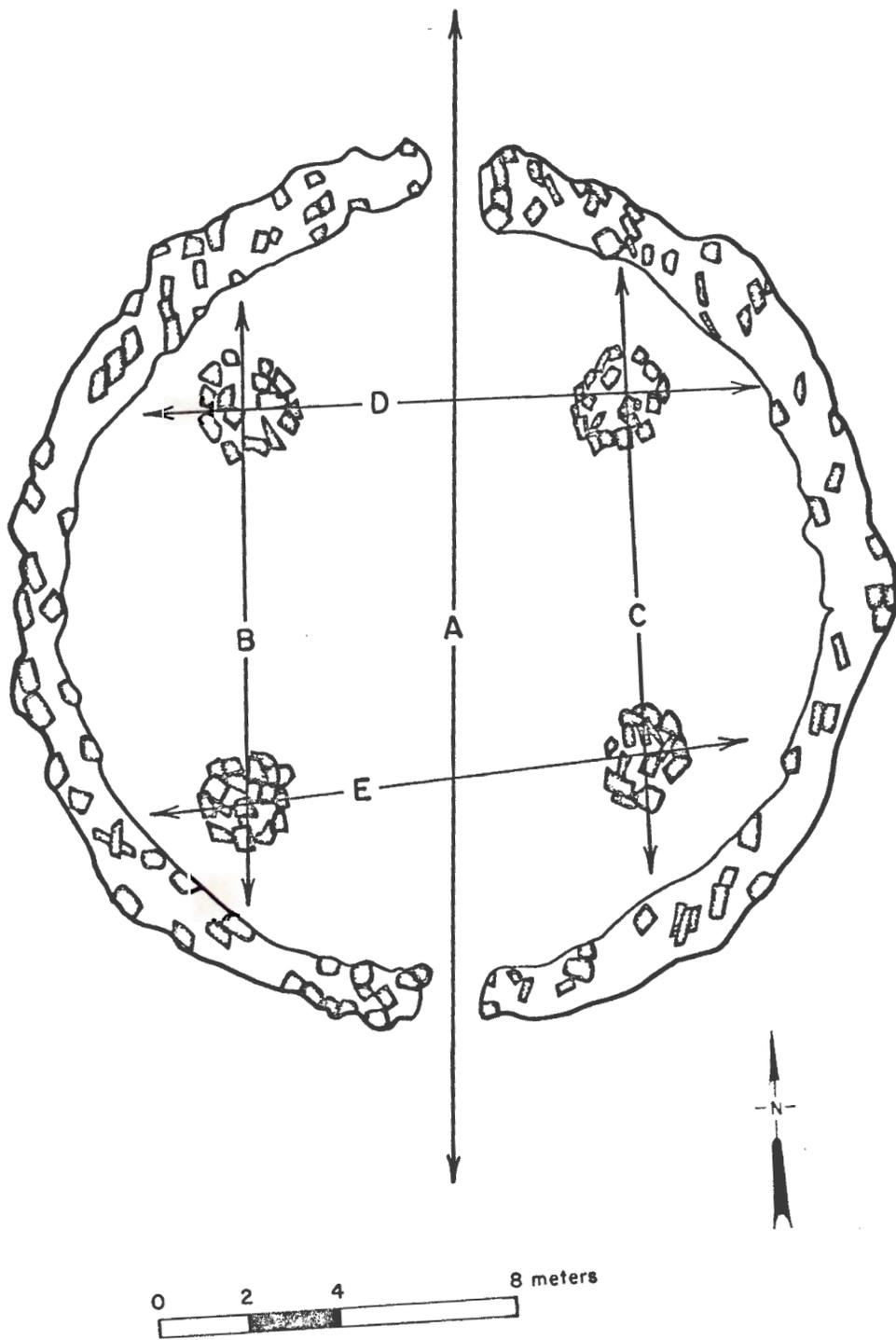


Figure 8.21 Alignments measured at the great kiva, Goodman Point Ruins.

Table 8.4 True Azimuths Measured at the  
Great Kiva, Goodman Point Ruins.

Alignment	Azimuth (°T)
A (through two entrance gaps in outer wall)	3-183
B (through western post supports)	178-358
C (through eastern post supports)	2-182
D (through northern post supports)	92-272
E (through southern post supports)	86-266

Figure 8.22 Graphic summary of measurements obtained at the great kiva, Goodman Point Ruins. Letters correspond to alignments illustrated in Figure 8.21.

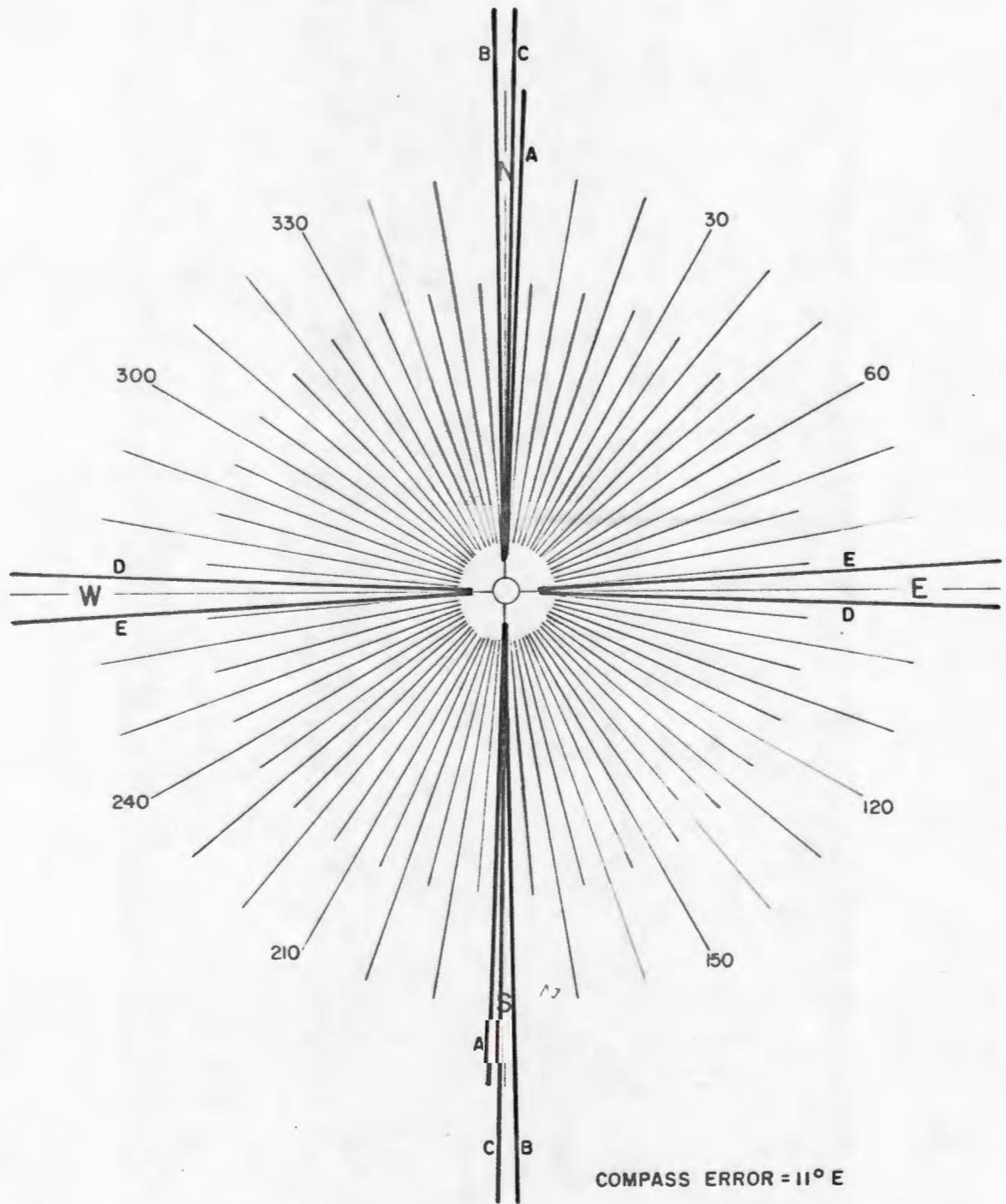


Figure 8.22 Graphic summary of measurements obtained at the great kiva, Goodman Point Ruins.

### Yellowjacket Spring (Surouaro) Ruins

The site is a very large Pueblo II and Pueblo III habitation complex that has been described by several early explorers and archaeologists studying the area (Prudden [9:262-263], Fewkes [10:16-17]). Compass readings were obtained from the large, southernmost roomblock at the site, approximately 600 m south of the "large mound in the village" described by Fewkes [10:17]) (Figure 8.23); the great kiva in the northern units was not measured because of the lack of visible alignments. Transit readings, obtained from the back and east walls of the structure, are graphically illustrated in Figure 8.24. The back wall exhibits an orientation within 2° of the east-west line, while the east wall is oriented northwest to southeast (345° - 165° T). The almost exact east-west orientation of the back wall is perhaps significant and may reflect a deliberate preference by the builders.

Figure 8.23 Alignments measured at Yellowjacket Springs (Surouaro) Ruins: (A) back wall of roomblock in the southern units; (B) east wall of same roomblock.

Figure 8.24 Graphic summary of measurements obtained at Yellowjacket Springs Ruins. Letters correspond to alignments illustrated in Figure 8.23.

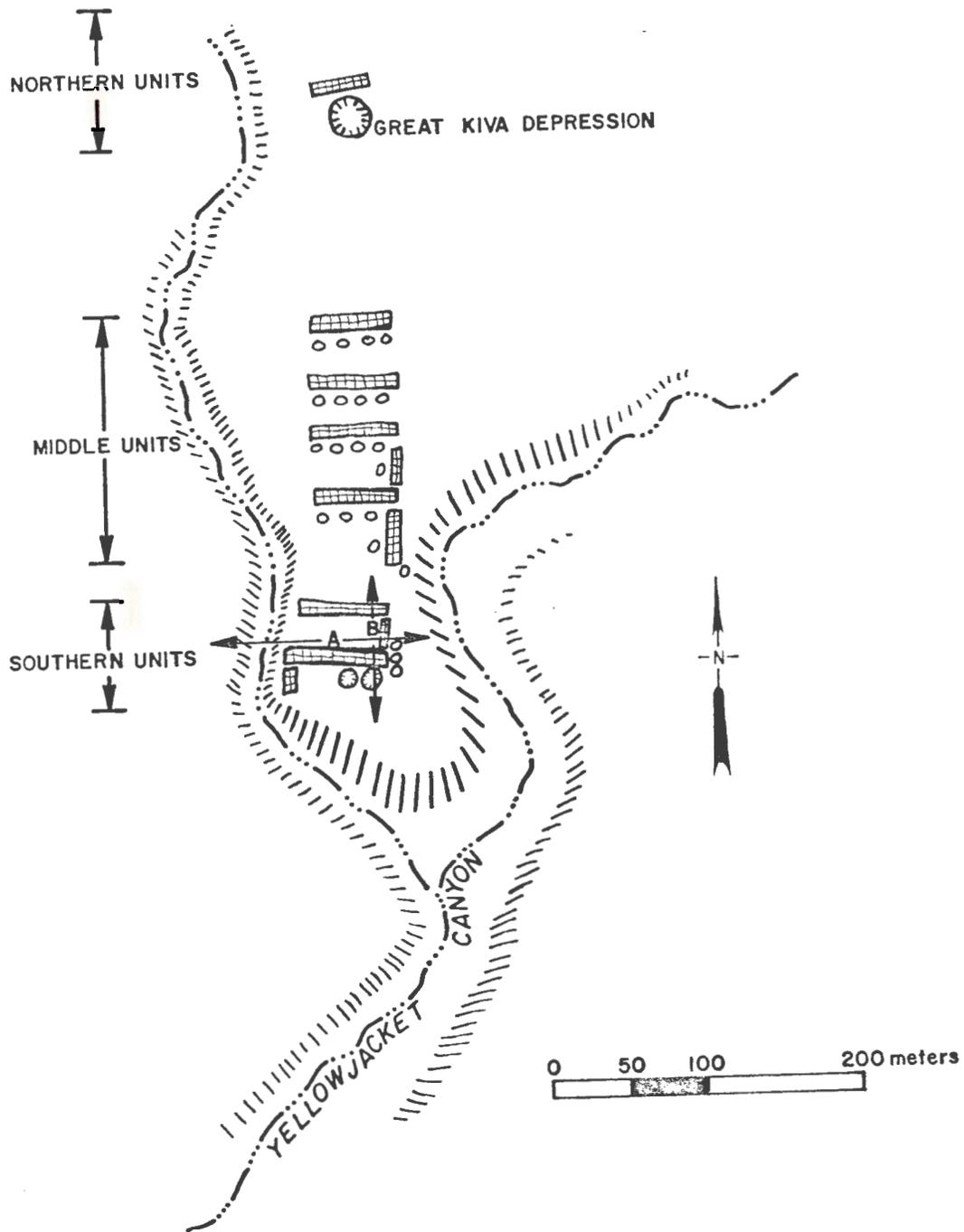


Figure 8.23 Alignments measured at Yellowjacket Springs (Surouaro) Ruins.

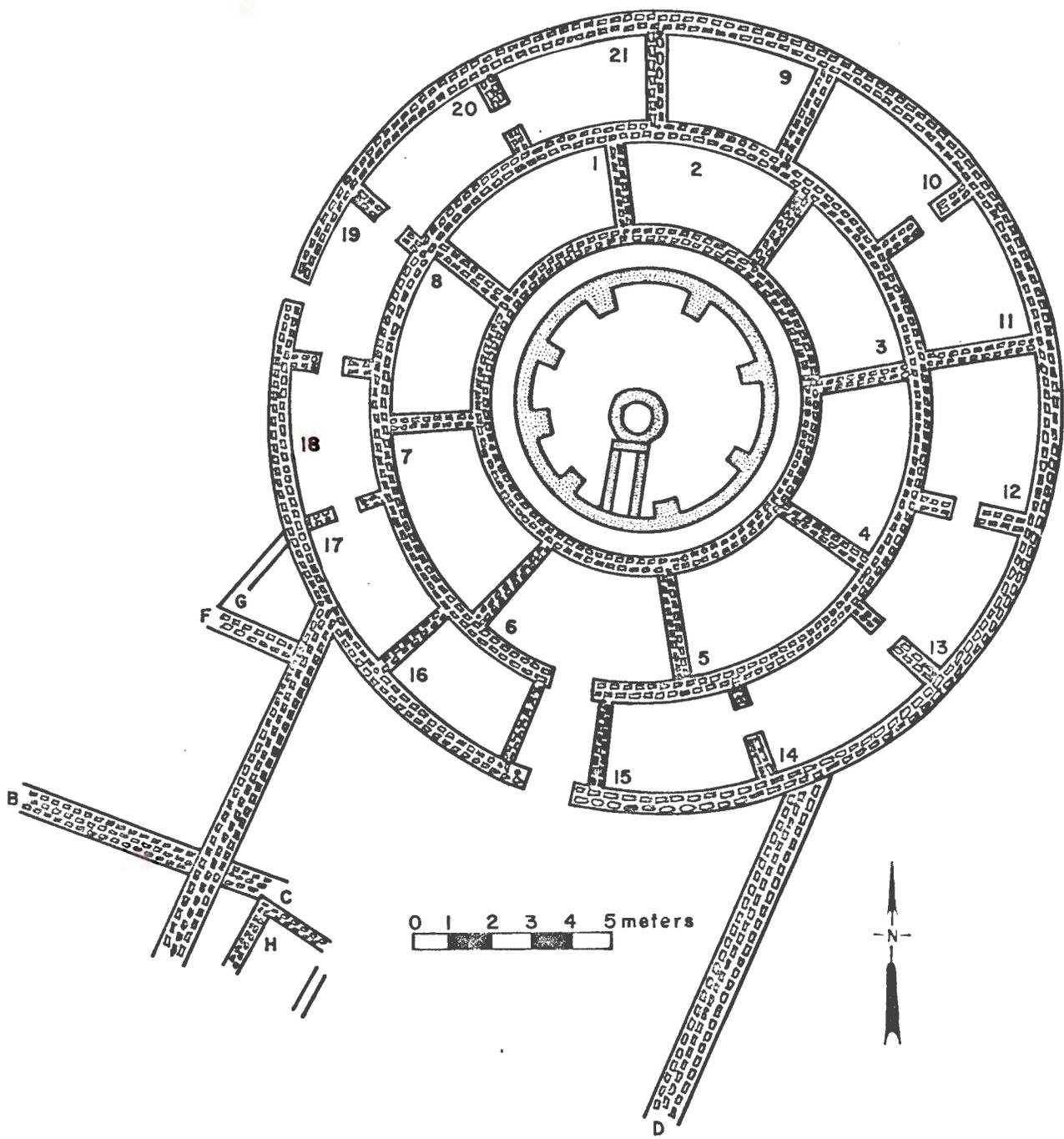


Figure 8.25 Plan of the tri-wall structure at the Hubbard Site.

## SUMMARY AND CONCLUSIONS

The archaeoastronomical reconnaissance produced mixed results although several promising avenues for further study are suggested. Analysis of the measurements recorded at the two large late Pueblo I - early Pueblo II habitations (McPhee and Cline Crest pueblos) reveal no astronomically significant alignments; the same conclusion can be drawn regarding the alignment of architecture at Little House (the Sagehen Flats Locality field house). Architectural alignments at all three sites appear to reflect a preference for maximum sunlight exposure; the room fronts face southeast and outdoor activity areas are to the south of roomblocks.

A comparison of wall alignments in the tri-wall structures at the Emerson and Mud Springs ruins and in the similar structure at Aztec Ruins (the Hubbard Site; Vivian [20]) (Figure 8.25) suggests some possible architectural correspondences and astronomical alignments (Table 8.5). Similarities are seen in three areas: number of outer rooms, angles between the radial walls of these rooms, and orientation of these walls.

The Hubbard tri-wall structure incorporates 14 outer rooms, eight inner rooms, and a central kiva; measurements of angles between radial walls at this structure, based on the original plan map (Vivian [20:6]), average about 25-27°. True azimuths were not obtained for wall alignments because the exact orientation of the structure could not be determined; from the plan map (Figure 8.25) the orientation appears similar to the Emerson and Mud Springs structures. The plan maps for the Emerson tri-wall (Figures 8.10 and 8.11) suggest that 14 outer rooms might be present, if possible missing alignments are considered. This structure exhibits radial wall angles approximating the 25-27° figure obtained for

Figure 8.25 Plan of the tri-wall structure at the Hubbard Site. (Adapted from Vivian [20:9]).

Table 8.5 Possible Correspondences Among Radial Walls of Anasazi Tri-wall Structures

Hubbard Site	Emerson Ruins	Mud Springs Ruins
<u>Outside Walls</u>		
21-9 <sup>1</sup> - (26.5) <sup>3</sup>	A (010) <sup>2</sup> - (026) <sup>3</sup>	A (002) <sup>2</sup> - (40.5) <sup>3</sup>
9-10 - (27)	B (035) - (25)	
10-11 - (28)	C (062) - (27)	B (062) - (60)
11-12 - (27)		C (82.5) - (20.5)
12-13 - (22.5)	E (099) - (37)	
13-14 - (27.5)	G (127) - (28)	D (131.5) - (49)
14-15 - (28.5)	H (152) - (25)	
15-15a- (27.5)	I (178) - (26)	E (179.5) - (48)
15a-16- (14)	J (213) - (35)	F (202.5) - (23)
16-17 - (26.5)		
17-18 - (24)	K (269) (54)	
18-19 - (28.5)	L (294) - (25)	I (298.5) - (96)
19-20 - (34)	M (317.5) - (23.5)	J (321.5) - (23)
20-21 - (20)	N (344) - (26.5)	
<u>Inside Walls</u>		
1-2 <sup>1</sup>		
2-3	B (35) <sup>2</sup>	
3-4	D (87.5)	
4-5	F (12.5)	
5-6	I (178)	
6-7		
7-8		
8-1		

<sup>1</sup>Identifies rooms on either side of radial wall (Figure 8.25); azimuths not measured, as the exact orientation of Vivian's map [19:9] is uncertain.

<sup>2</sup>Wall alignments and true azimuths shown in Figures 8.12 (Emerson Ruins) and 8.20 (Mud Springs Ruins).

<sup>3</sup>Angle (degrees) between this wall and next counterclockwise wall.

the Hubbard tri-wall; discrepancies are noted for the angles between Walls C and E (37°), I and J (35°), and J and K (54°). It is suggested that perhaps some walls were hidden and not measured, or the structure is not symmetrical in these locations. The plan map of the Mud Springs Ruins tri-wall structure, as presented by Holmes [8:399] indicates 14 outer walls (Figure 8.18). This could not be substantiated during the archaeoastronomy reconnaissance and the wall angles appear ambiguous (Table 8.3). Some of the angles are fairly close to 25° or multiples of that figure. The orientation of the radial walls is similar between the Mud Springs and Emerson structures (in Table 8.5, note similarity between Emerson C and Mud Springs B, Emerson I and Mud Springs E, Emerson L and Mud Springs I, and Emerson M and Mud Springs J). A possible conclusion, based on these correspondences, is that tri-wall structures in the Northern San Juan Culture Area were similar in plan, with 14 outer rooms arranged in a symmetrical fashion and with similar orientations. Additional wall tracings and exact measurements would have to be obtained to verify or negate this hypothesis. Unfortunately, these correspondences could not be extended to other similar structures (the examples at Pueblo Del Arroyo, Chacra Mesa, and on the San Juan River near Shiprock) described by Vivian [20:61-79], either because alignment seemed in no way similar (the Del Arroyo structure) or because the data needed were unavailable.

A comparison of the architecture of the tri-wall structures, the Yucca House double-walled circular structure, the Goodman Point great kiva, and the Yellowjacket Spring roomblock with potentially significant astronomical phenomena suggests that the latter may have been taken into

account when the structures were built. The possible significant alignments are summarized in Table 8.6.

Correspondences to true or cardinal directions (important in an astronomical sense in that, to an observer, the heavens would seem to revolve around the true north-south axis and be perpendicular to the east-west axis) and solstice positions occur at several of the sites and probably represent deliberate positioning rather than happenstance (although this has not been statistically tested). The correspondence of Wall I at the Mud Springs tri-wall with the rising of Sirius is probably coincidence, as it is apparently an isolated event.

The data recovered during the reconnaissance thus suggest that the Anasazi may have considered astronomical phenomena in the orientation of certain structures. The data are not sufficient to generate definite conclusions; however, several hypotheses may be used to structure future archaeoastronomy studies undertaken in the area:

1. Local: In the vicinity of the Dolores valley, Anasazi structures (rooms or pitstructures) built and occupied before A.D. 900 (those structures assigned to the Basketmaker III and Pueblo I periods) do not exhibit alignments corresponding to astronomical phenomena. Either prehistoric peoples during these periods were not cognizant of such phenomena or, more likely, solstices and cardinal directions were not afforded symbolic importance.

2. Specialized structures: Double- and tri-walls and great kivas occurring in later Anasazi (post-A.D. 1000) sites do exhibit alignments corresponding to astronomical phenomena. These alignments are also seen in certain large architectural units. The correspondence is to solstices and cardinal directions rather than to prominent star positions.

Table 8.6 Potentially Significant Alignments Recorded  
During the Archaeoastronomy Reconnaissance

Site/Structure	Alignment	Astronomical Observation
Emerson Ruin Tri-wall	Wall C (62° T) Wall I (178° T)	summer solstice sunrise/ winter solstice sunset true north-south
Yucca House Upper House	North-south walls (F and H) East-west walls (E and G)	true north-south true east-west
Yucca House Double-walled circular structure	Wall C	winter solstice sunrise/ summer solstice sunset
Mud Springs Tri-wall	Walls A and E Walls B and G Wall I	true north-south summer solstice sunrise/ winter solstice sunset rise of Sirius
Goodman Point Great Kiva	Alignments A, B, C Alignments D, E	true north-south true east-west
Yellowjacket Spring Roomblock	Back Wall (A)	true east-west

This trend appears to be firmly established after A.D. 1100 and may indicate the presence in Anasazi society of astronomical specialists who directed or were consulted concerning the construction of these structures.

3. Double- and tri-wall structures apparently exhibit the most astronomical correspondences. Certain alignments may be common to most such structures and may provide one line of evidence for evaluating the functional implications of these enigmatic units.

It is emphasized that these are preliminary hypotheses and have been formulated from a local perspective. They are only intended as aids for future studies. Obviously more data must be acquired and evaluated before more definite conclusions can be reached concerning the use of astronomical knowledge by the Anasazi.

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