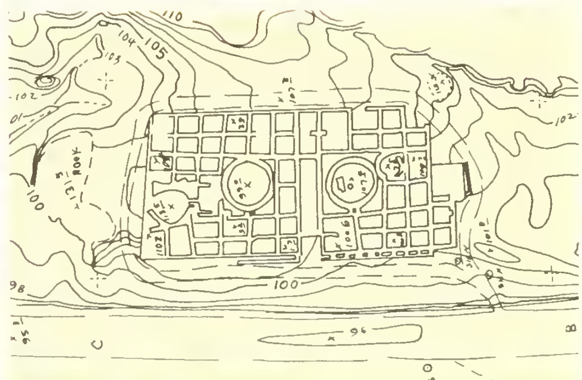
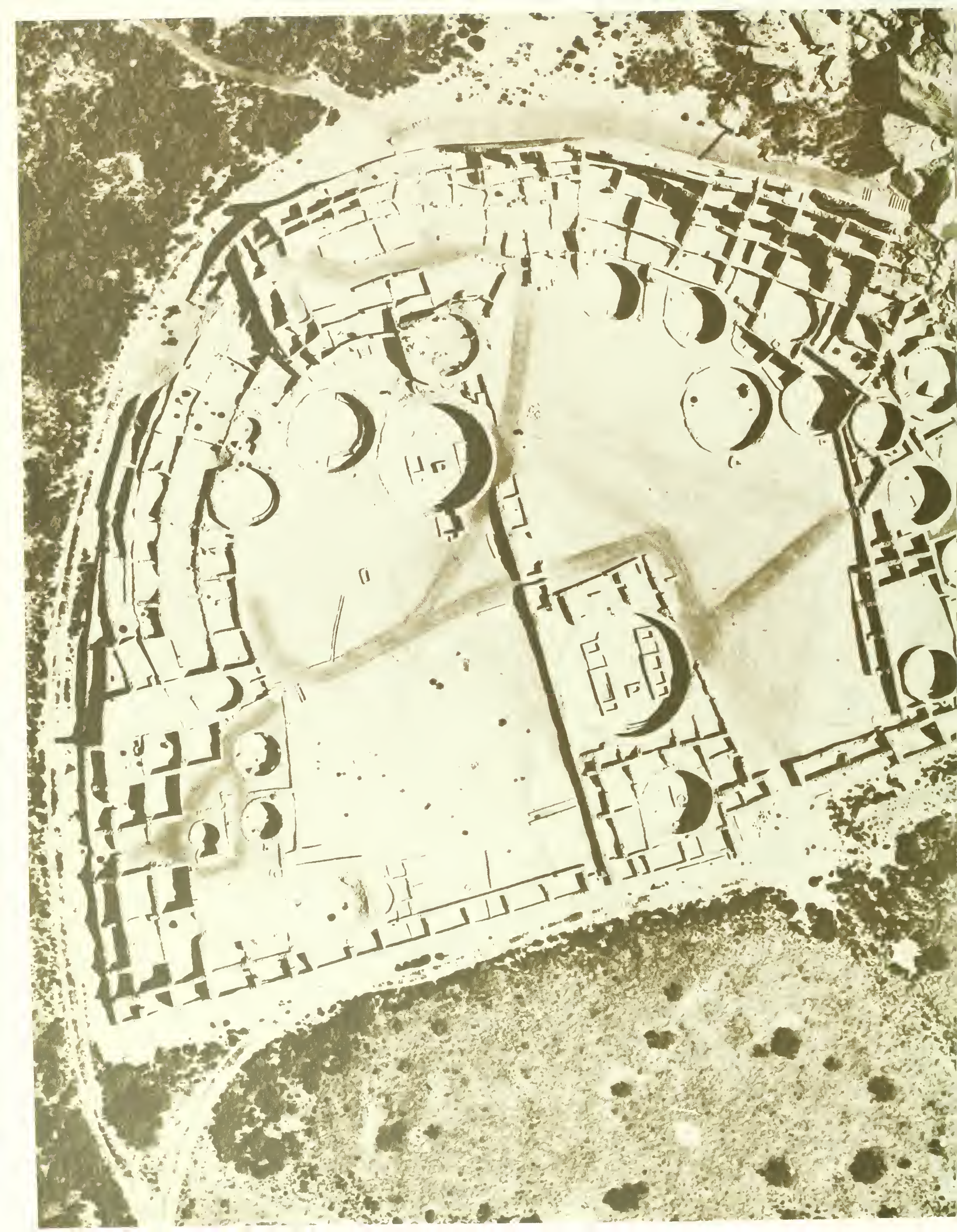
REMOTE SENSING

Photogrammetry in Archeology: The Chaco Mapping Project



SUPPLEMENT NO. 10



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Photogrammetry in Archeology: The Chaco Mapping Project

SUPPLEMENT NO. 10

to *Remote Sensing: A Handbook for Archeologists and Cultural Resource Managers*

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PREFACE

The use of topographic mapping is not particularly unusual in many fields. However, because of the expense involved in making topographic maps from data collected in the field, archeologists have been reluctant to make topographic representations of their study areas.

During the recent archeological effort that the National Park Service put into Chaco Culture National Historical Park, one of the aspects of archeological site documentation and recording that was examined was the use of topographic maps made using the techniques of aerial photogrammetry. This book is intended as an atlas or collection of examples of various uses such maps can be put to.

Discussions of the specific techniques of aerial photogrammetric mapping can be found in the references accompanying this book. The primary purpose of this book is to show examples of topographic maps of large archeological sites made using aerial photogrammetry and to suggest some possible applications for such maps.

Jerry Livingston of the Division of Cultural Research of the Southwest Cultural Resources Center did an excellent job of drafting many of the maps that appear in this book. The final manuscript was read by most of the staff of the Division of Cultural Research who were closely involved with the archeological investigations occurring in Chaco Canyon. To all these people, the authors gratefully acknowledge assistance in preparing this manuscript.

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INTRODUCTION

A major investment in time and effort in archeological excavations has been the production of maps which represent the relative position of artifacts and features found in a site. Maps constructed by field techniques using transit, plane table, and alidade have in the past been considered adequate for archeological recording purposes. From a review of the literature, it is apparent that much of this type of graphic recording was performed by individuals lacking formal cartographic training and skills. However, advances in the field of photogrammetry, the measurement of horizontal and vertical geometry from controlled photographs, make the mapping of large or small ground areas a relatively simple, rapid and economical procedure. The accuracy of measured relationships and the amount of detailed information gained through photogrammetric techniques is far superior to the products of alidade or transit field measurements (Millon et al. 1973; Pouls et al. 176, 103-114; Lyons and Avery 1977, 68-83).

This book will briefly define the basic concepts of photogrammetry for background in understanding the mapping procedures used in the construction of the examples presented herein. Our purpose is to discuss some of the empirical and analytical applications of these detailed recordings of material cultural remains. Others undoubtedly will be developed by scholars conversant with the basic methodology.

Much of the photogrammetric mapping upon which this work is based was done in Chaco Canyon National Monument, New Mexico, now Chaco Culture National Historical Park, during the recent period of intensive restudy of that area. Canyon de Chelly and Tsegi Canyon, Arizona, are the locales for other examples (Fig. 1). In these areas, large stone masonry pueblos were built and occupied from the ninth through the twelfth centuries A.D. (Table I) and lend themselves well to metric architectural recordings (Fig. 2).

It is not our purpose here to present a detailed explanation of the principles of photogrammetry. There are excellent texts on the subject including Wolf (1974) and Slama (1980). For our purposes, it is sufficient to define photogrammetry so that the reader may know that it is a functional tool for archeological and historic preservation studies, planning, analysis and documentation.

> Photogrammetry has been defined in a number of ways, each definition containing one or more of the following elements: technique, science, art, photography, imagery, data, information, mapping. The roots of the word itself are photograph and meter. Thus, a general definition of photogrammetry is expressed as the science, or techniques, of deriving quantitative measurements from photographs. The photographs may be either those taken from an air or space platform or from a terrestrial or ground station. This is a traditional definition which is still valid but which today must be amplified to include the manipulations of quantitative data from remote sensors other than photographic cameras. For instance, reduction of taped data from spacecraft provides maps of many varieties useful in environmental and land use studies. . . . Thus an expanded definition reads: the techniques and sciences of deriving quantifiable information in graphic form from remote sensing instruments. This explanation of photogrammetry purposely excludes interpretation, since interpretation is a separate function which encompasses, in addition to scientific procedures, a distinct element of art (Lyons and Avery 1977, 68).

Fig. 1. Location of study area

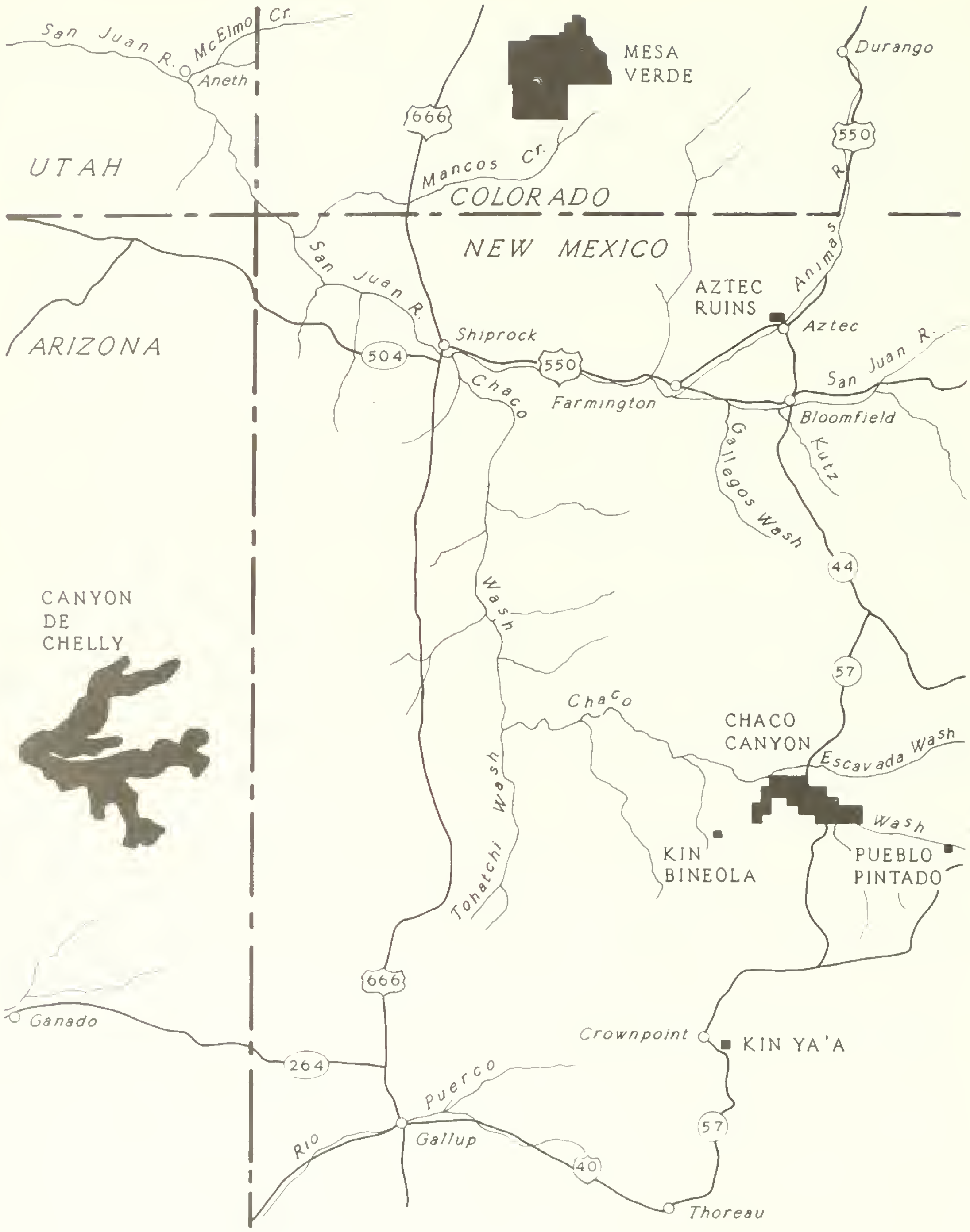
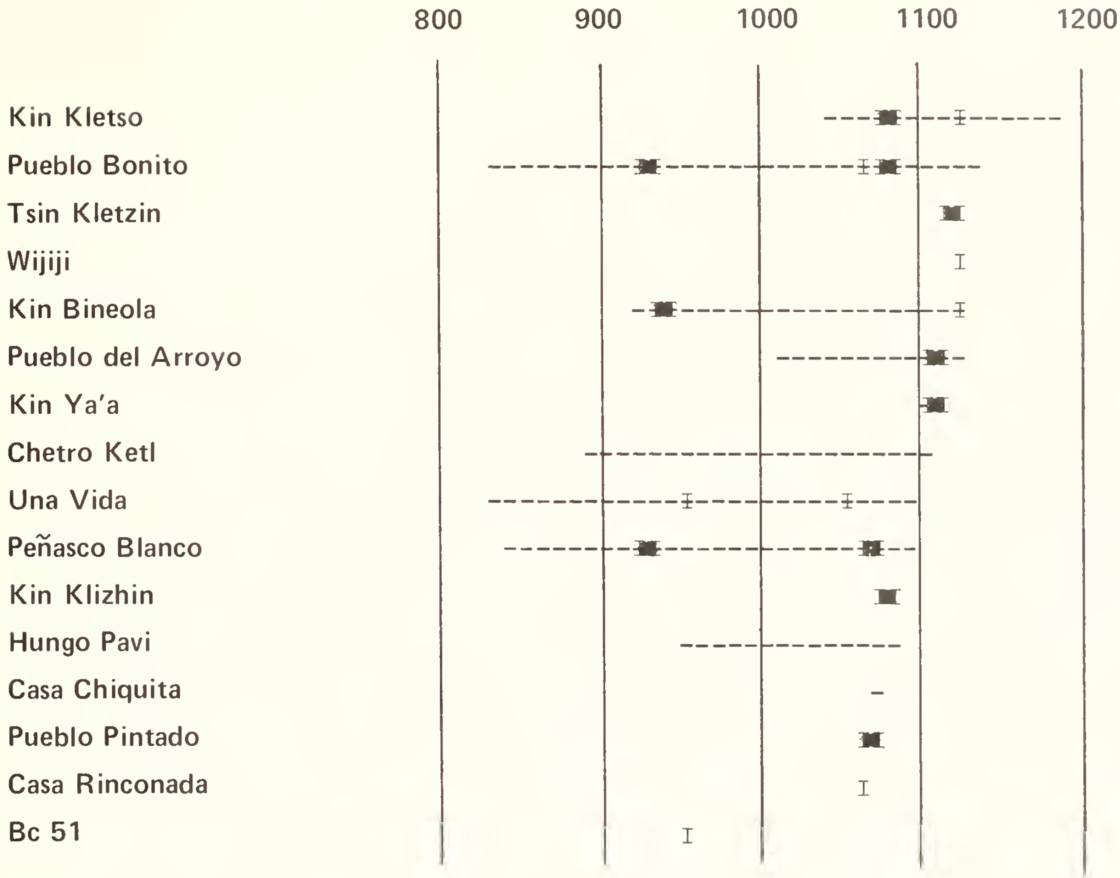


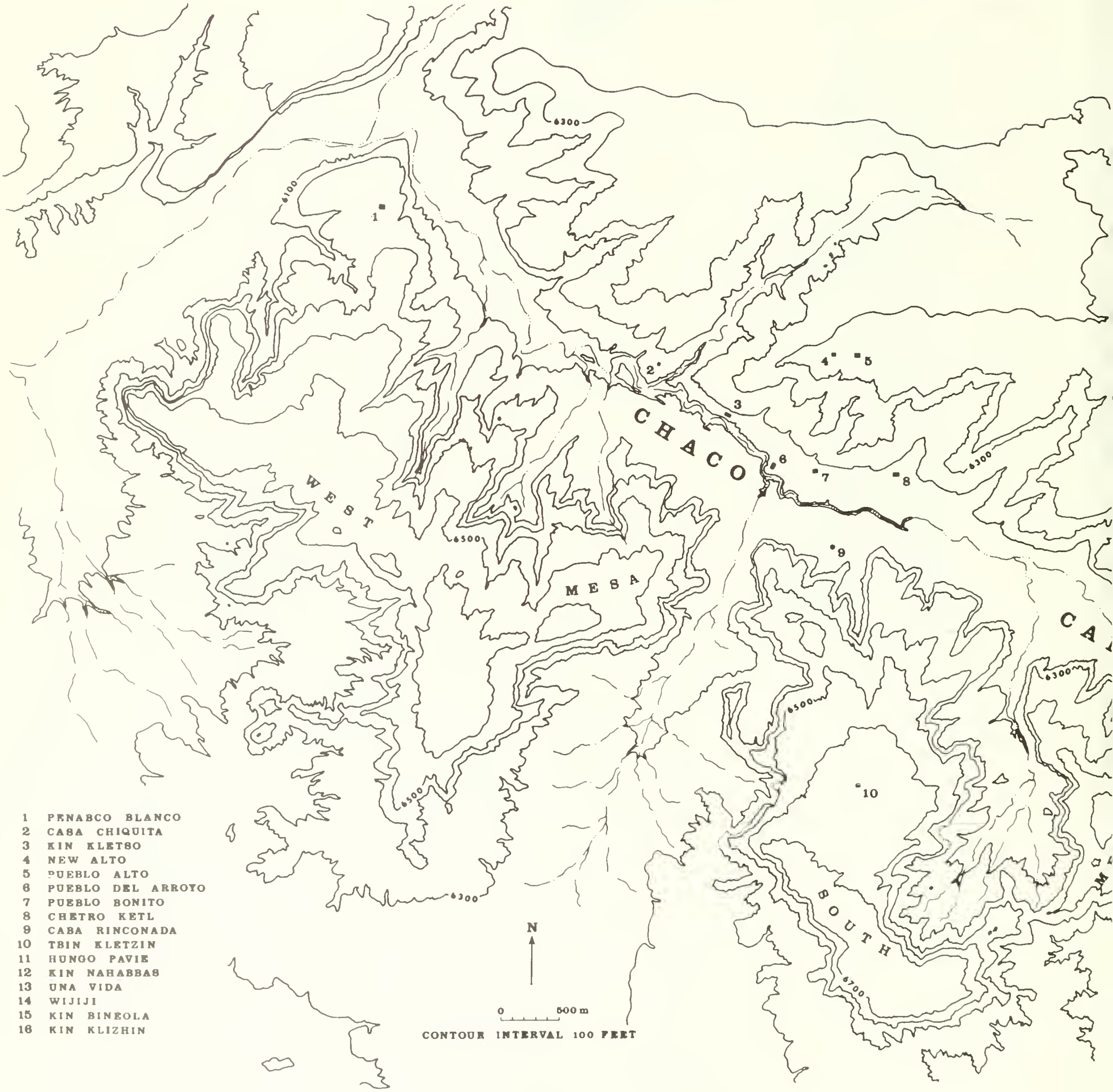
TABLE I

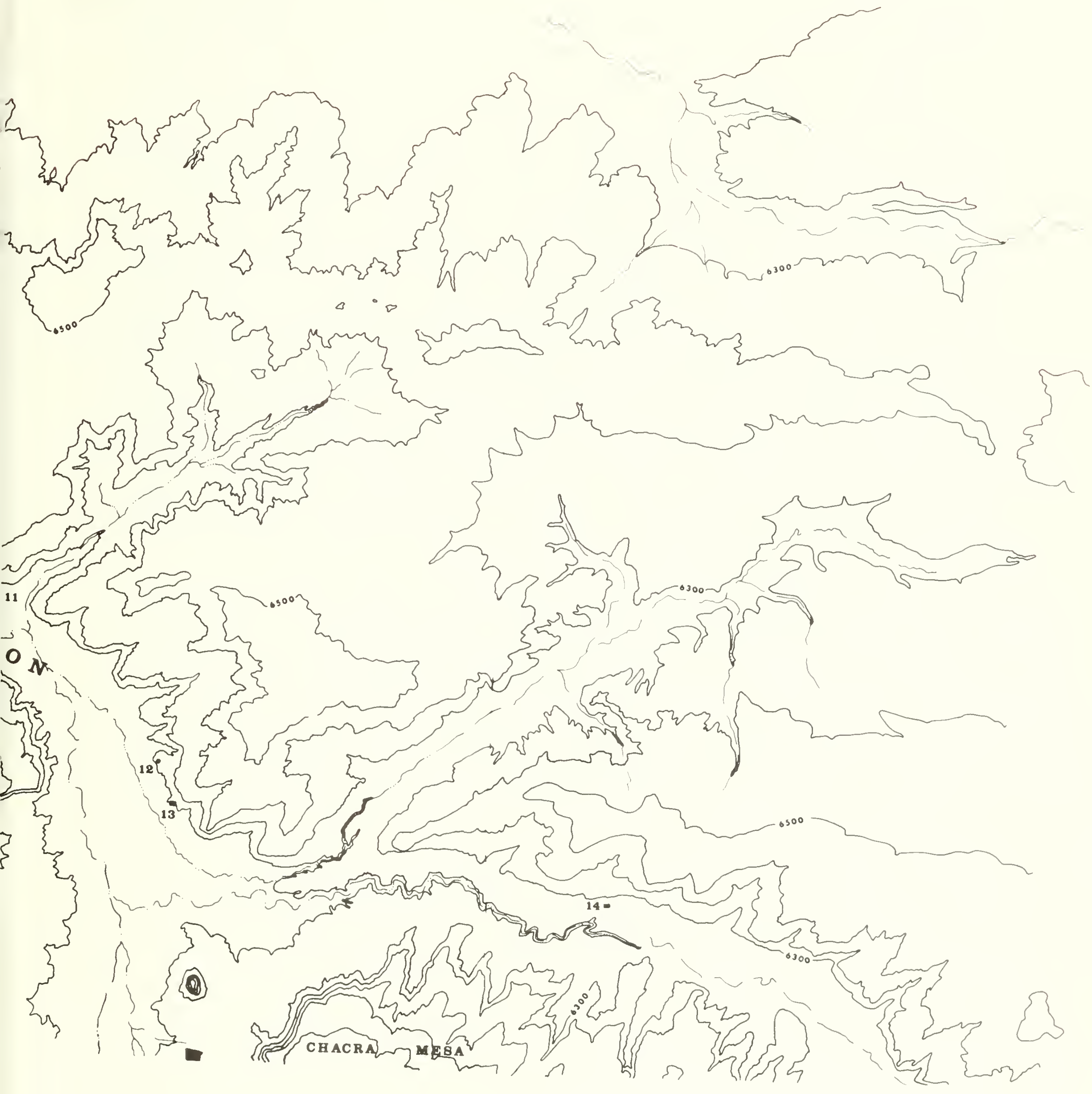
Tree-Ring Dates From Some Major Chacoan Sites



(From Robinson et al. 1974)

Fig. 2. Major sites within Chaco Culture National Historical Park

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CHACRA MESA

Photogrammetry, then, is the science of mapping from measurements taken from photographs of objects rather than mapping from measurements taken from the objects themselves. Scale and displacement errors which are inherent in photography can be controlled and corrected by taking the measurements from a stereoscopic pair of photographs, rather than a single photograph. The only measurements which need to be acquired from the target area itself are a series of horizontal and vertical measurements of easily identified objects within the stereo pair. Usually, white plastic panels are placed in an area to be photographed with these "ground control panels" completely encompassing the area of interest.

A mechanical instrument called a "stereoplotter" is used to visually reconstruct the area of interest and the control measurements are reproduced in scale by the instrument. When the control measurements are correct, all other measurements and relationships within them are also correct. A planimetric map can then be made simply by drawing the locations of objects in the target area.

Vertical measurements in a stereomodel can be taken because of a principle known as parallax difference. All objects in a photograph, except those objects directly in line with the camera axis, appear to be tilted away from the center of the photograph (Fig. 3). Because the human eye also sees objects which are not on the optical axis as appearing to be tilted away from the axis, normal binocular vision interprets the parallax difference between the images seen with the two eyes as a third dimension. When a stereoplotter operator views a stereomodel (Fig. 4), he sees an image that contains vertical relief. An optical mark or dot that is injected into the model by the stereoplotter can be adjusted horizontally or vertically until it is resting on the surface of a predetermined contour or the edge of a particular feature such as a landform or an archeological site. A pencil aligned with the dot can then draw the contour line or feature as the operator moves the dot along the object. In this manner, topographic contours or locations of objects can be included on the final map.

The primary advantage of photogrammetry, then, is to allow the creation of accurate maps based on reliable data without the high costs incurred from mapping operations conducted in field situations. Stereoplotters and operators are very expensive, but they are considerably cheaper to contract for than the per diem encountered in sending a crew to map a large archeological site.

Although the examples of mapped archeological sites in this atlas are taken from work performed by the National Park Service in the southwestern United States, the cartographic techniques, nevertheless, are applicable to mapping physical cultural evidence in any terrestrial environment (Wolf 1974).

Fig. 3. Objects tilt away from the center of a photograph

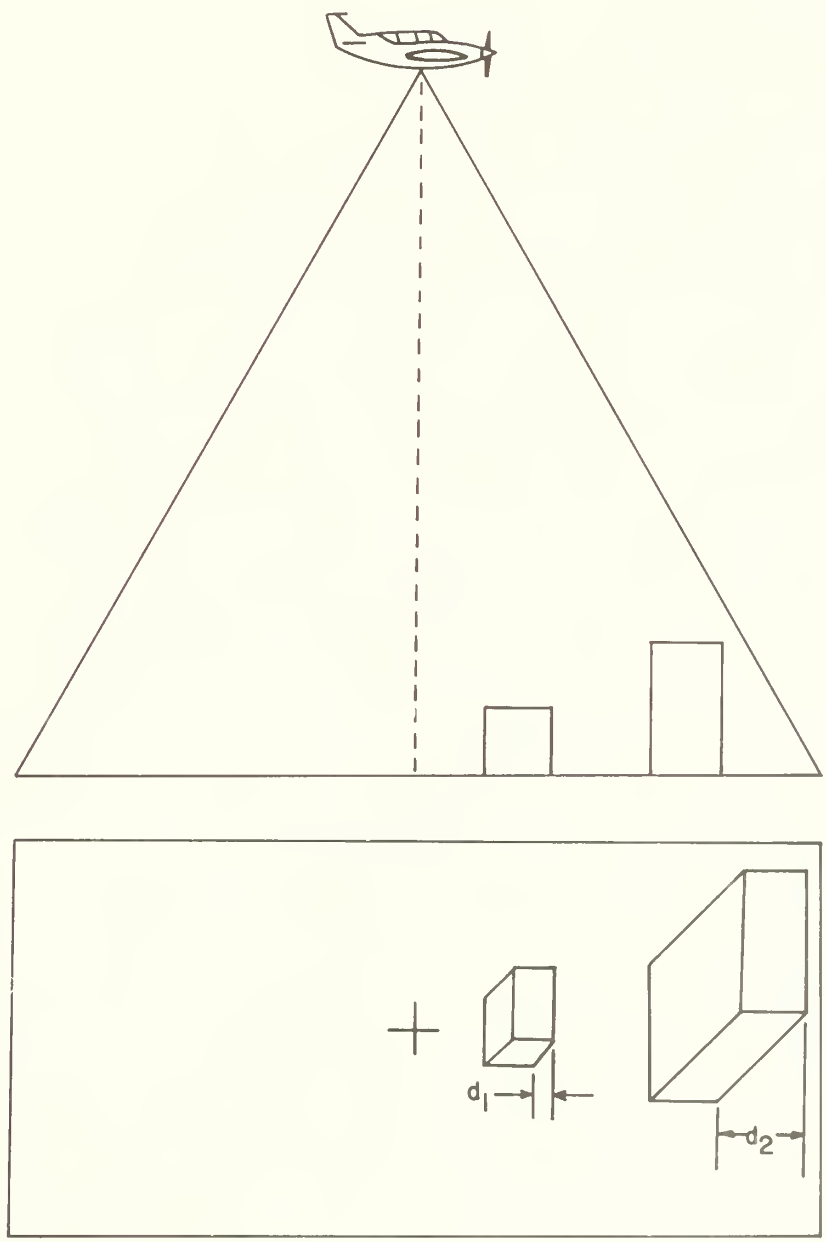
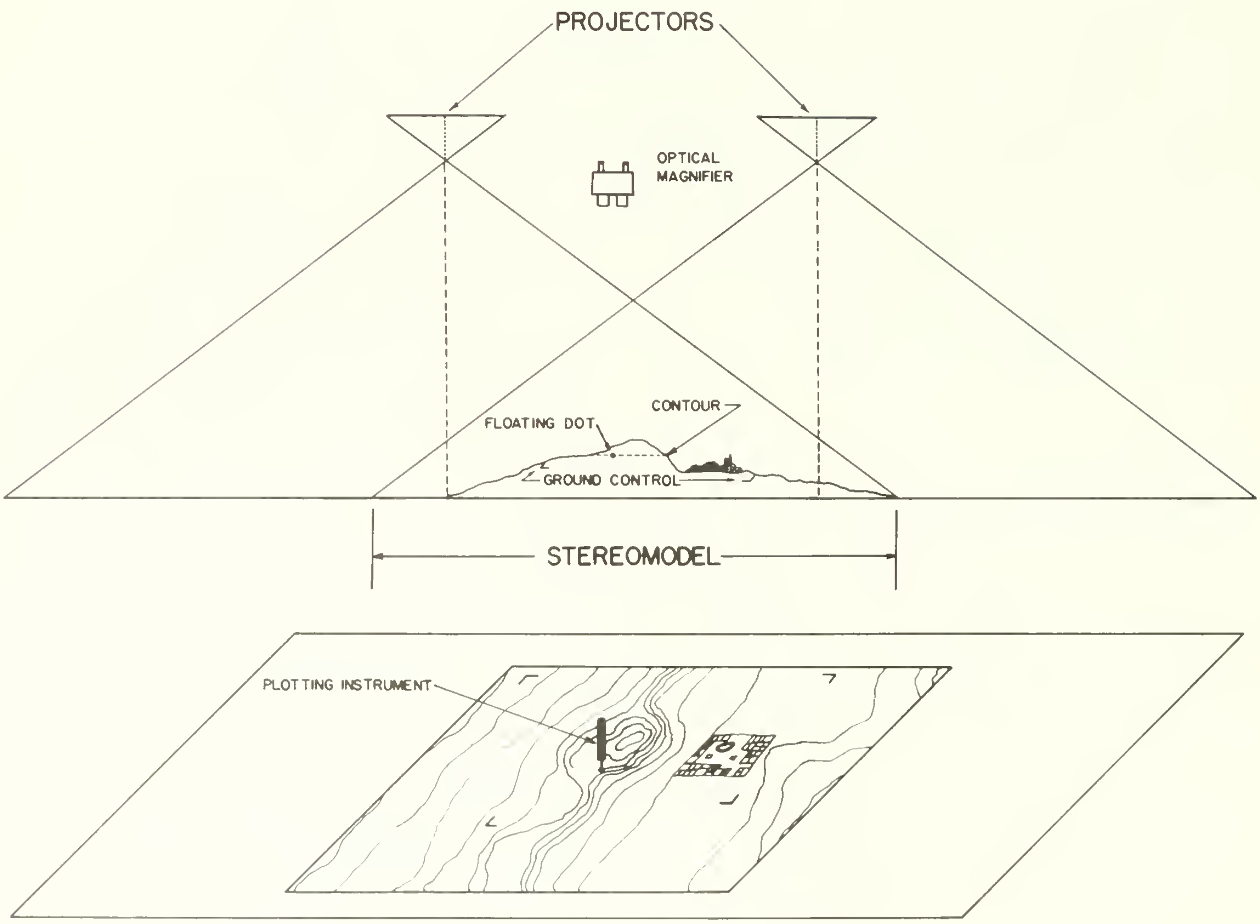


Fig. 4. Schematic representation of a steroplotter



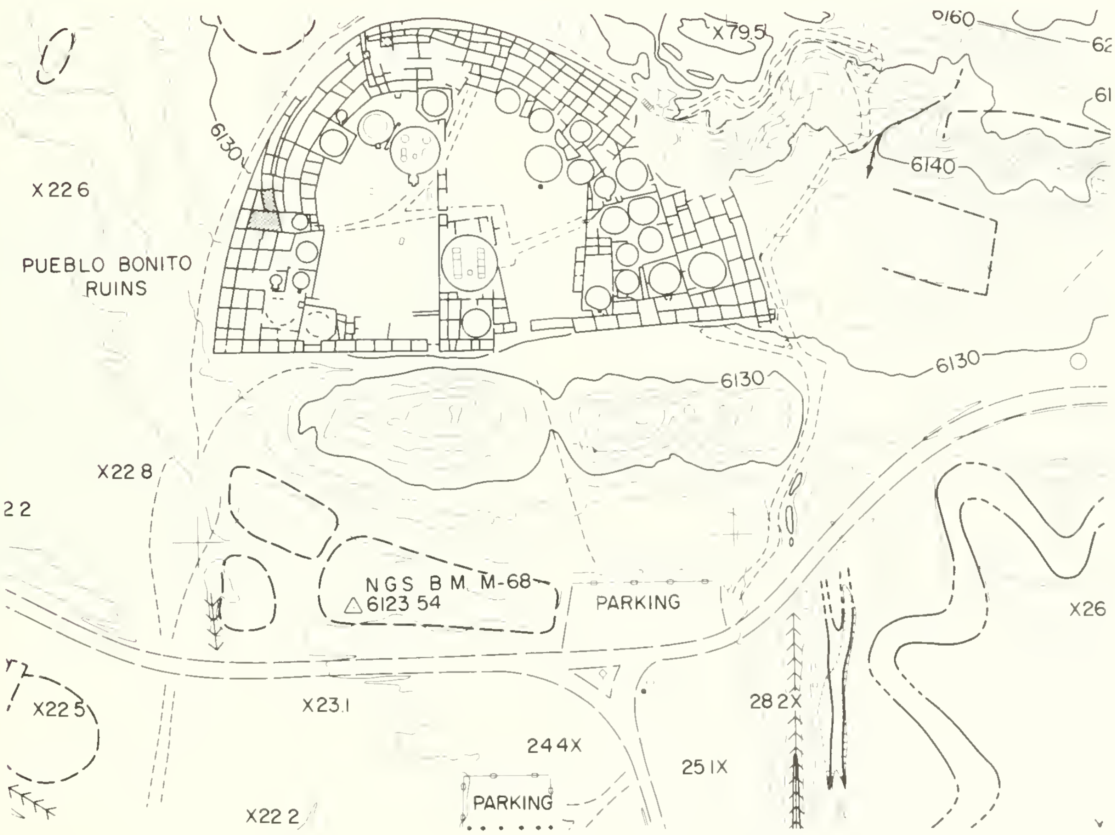
PRINCIPLES OF PHOTOGRAMMETRY

TOPOGRAPHY AND PLANIMETRY

Topographic and planimetric information are the basic forms of photogrammetric mapping. When mapping archeological sites, a primary concern is the accurate representation of the location of architectural features. Stereoplotters are able to indicate the location not only of wall corners, edges, and terminal points and numerous other features, as is the case in most field-generated site maps, but also all the subtle changes in form, direction and variable elevations that occur. Planimetric and altitudinal representations of sites made from photogrammetric data thus closely approximate all the variations which occur within the site being mapped.

Topographic mapping may also include environmental information. Usually, site maps contain whatever internal features archeologists feel are important. Topographic and planimetric information derived from photogrammetric data can portray what the field archeologist finds immediately relevant and important and a great deal more. Nearby drainages, cliffs, mounds, and other topographic features as well as numerous seemingly unimportant data can be accurately located and graphically recorded. Figure 5 is a map of Pueblo Bonito showing the walls, trash mound, cliff, and various environmental features.

Fig. 5. Generalized map of the planimetry of the area around Pueblo Bonito



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1927 The Architectural Evolution of Pueblo Bonito. *National Academy of Sciences Proceedings* Vol. 13, pp. 561-563, Washington.

1928 Prehistoric Pueblo Bonito, New Mexico. *Explorations and Field Work in 1927.* Washington, Smithsonian Institution.

1954 The Material Culture of Pueblo Bonito. *Smithsonian Miscellaneous Collections,* Vol. 124, Washington.

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Pepper, G.H.

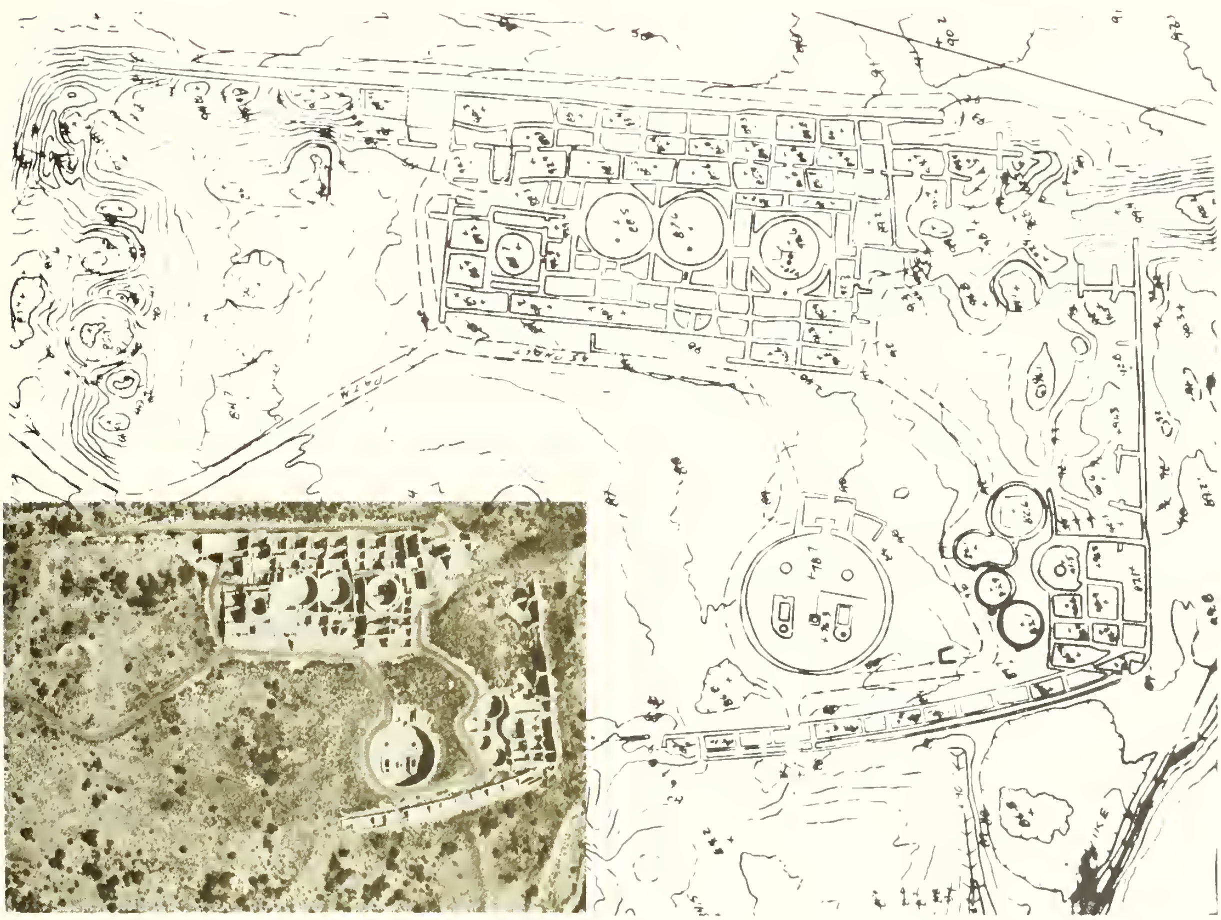
1905 Ceremonial Objects from Pueblo Bonito, New Mexico. *American Anthropologist,* Vol. 7, pp. 183-197, Menasha, Wisconsin.

1920 Pueblo Bonito. *Anthropological Papers of the American Museum of Natural History,* Vol. 27, New York.

Manuscript maps are the first step in the production of a map on a stereoplotter. They are penciled drawings on the plotter table which may later be drafted for use in a publication. Using a clear plastic material as a base, a map is drawn which can be easily reproduced by a diazo or blueprinting technique. This manuscript map can later be drafted with information either deleted or emphasized at the discretion of the archeologist.

Figure 6 is a manuscript map of Chetro Ketl which served as the first step in analytical studies. Because of the low cost of the reproduction of maps in this stage, numerous copies can be produced which can be studied and annotated in the office or the field before producing the final drafted copy.

Fig. 6. **Manuscript map of Chetro Ketl**



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1934 *The Significance of the Dated Prehistory of Chetro Ketl, Chaco Canyon, New Mexico.* University of New Mexico Bulletin with School of American Research, University of New Mexico, Albuquerque.

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1938 The Outer Walls of Chetro Ketl. *New Mexico Anthropologist,* Vol. 2, pp. 4-5.

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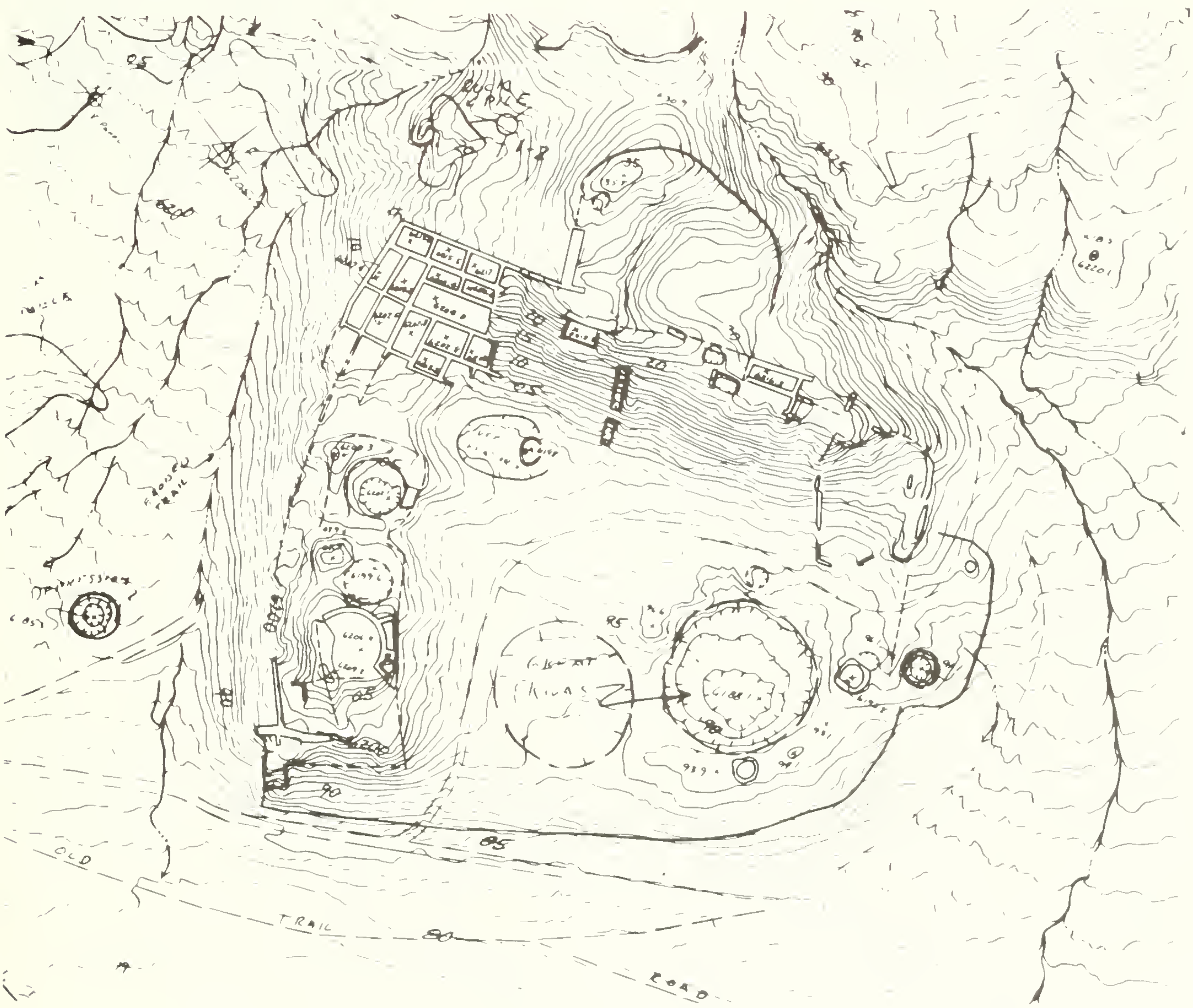
1930 Excavation of the East Tower in Chetro Ketl, 1929. New Mexico State University *Bulletin* Educational Series 4(2), no. 180, Las Cruces, New Mexico.

Detailed mapping of features, for instance the widths of walls, is also possible when mapping from photogrammetric data. Figure 7 shows a manuscript map of Una Vida with the widths of the walls indicated. It can be seen that not all the walls are of the same width, nor are individual walls always of uniform width. This kind of detailed information might easily go unobserved or be disregarded if the site were mapped in the field.

Because the widths of the walls are indicated, it becomes a relatively simple operation to determine the area of the tops of the walls. The volume of fall rock which was removed during excavation and ascribable to a given room can then be divided by this area to give an indication of the height of the walls prior to collapse.

Fig. 7. Manuscript map of Una Vida



DIGITIZATION

Because stereoplotters work in three dimensions, it is possible on more advanced models to obtain permanent records in computer coded form of specific points in three-dimensional space. The three-dimensional co-ordinates of data thus obtained are referable to arbitrary or established horizontal and vertical datum points. The stereoplotter keeps track of how far it travels from the datum to the particular point in the model that is to be "digitized". The plotter operator merely depresses the appropriate level and the digitization equipment transfers the digitial co-ordinates of the point at which the machine is sitting to a computer. The operator can then move to the next point, press the lever, and recover another point. In this manner, the entire site can be captured as a series of points in three-dimensional space. This operation can be done at the same time that the site is being mapped and the cost of having to reestablish the model in the machine can be saved (Lyons and Avery 1976, 83).

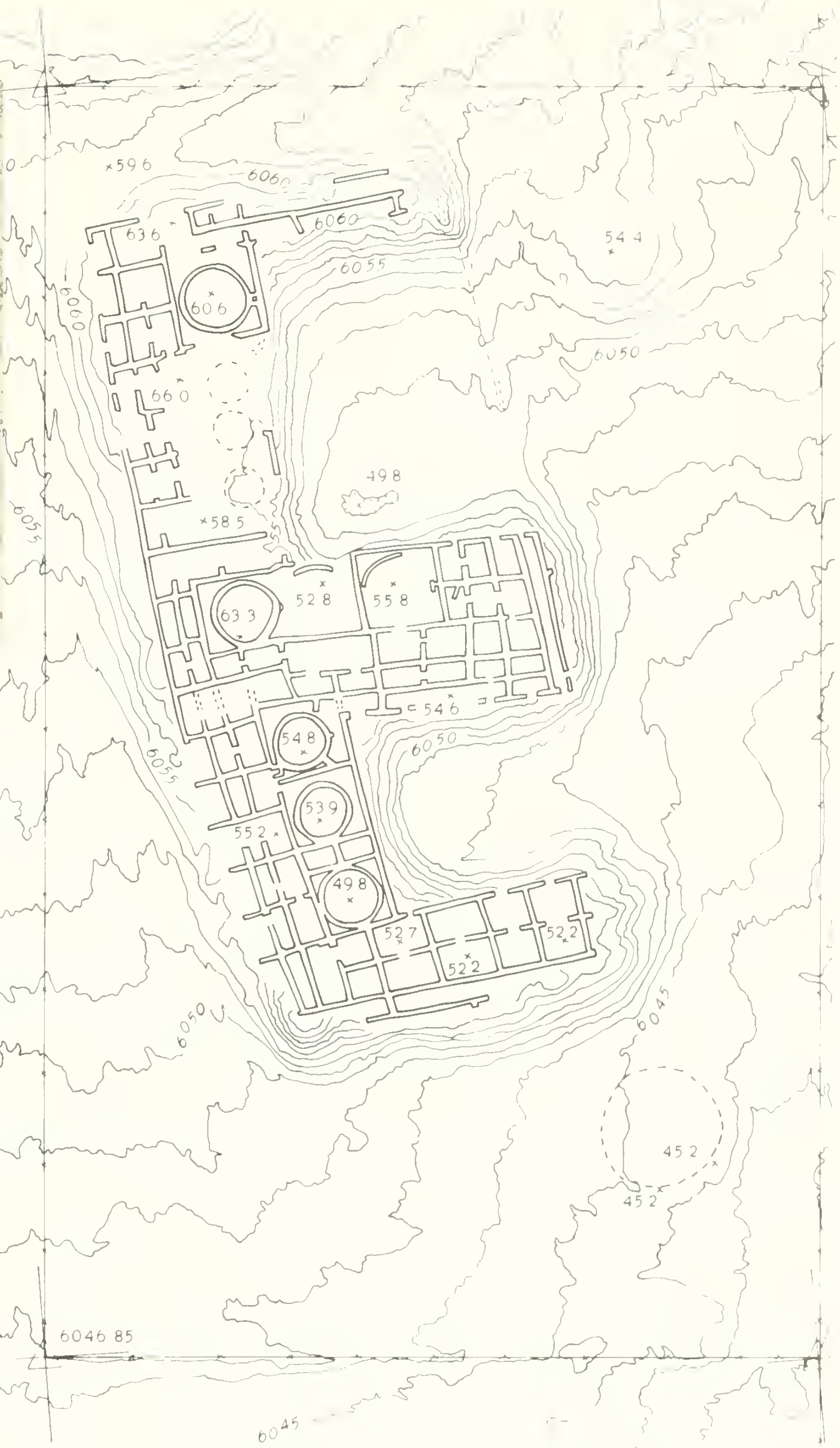
When dealing with archeological sites, particularly when architectural features are visible, the types of points that would be digitized in the manner discussed above are room corners, wall ends, elevations of fill within rooms, changes in the slope of wall tops, and any other data the archeologist might feel is important enough to save.

Once a site has been digitized, many different kinds of computer analyses can be performed. One of the sites in Chaco Canyon that has been digitized is Kin Bineola (Fig. 8). Because of the generally rectilinear shape of this pueblo, it was decided to digitize each wall and assign it a separate and unique identification number. Walls running north and south were given four digit numbers beginning with the number 5. Walls running east and west were given numbers beginning with the digit 4. Kivas (circular rooms) were designated by yet a different number.

Digitized data are processed by a computer in several ways. A useful procedure is to have the computer construct a perspective line drawing of the original site (Fig. 9). This line drawing can be presented from any vantage point, each one of which presents a slightly different perspective of the site. The computer can also draw a series of profiles of walls (Fig. 10). Enlargements of single profiles can be used to spot the location of various architectural features of the site such as doorways, vent holes, viga ends, and the like. This drawing also becomes a permanent record of the profiles of the walls at a particular point in time which could be used later for stabilization or reconstruction purposes.

But not all sites are rectilinear. Figure 11 is a map of Peñasco Blanco, a circular-shaped building. The kinds of computer drawings that can be made of this site are similar to those discussed above. Another kind of computer drawing can also be constructed using digitized data. Digital data along linear gridded transects can be displayed as is shown in Figure 12. This type of representation can also be rotated for viewing from any angle (Pouls, Lyons, and Ebert 1976).

Fig. 8. Map of Kin Bineola



0 60 FEET

Fence Line

× Spot Elevations w/o First Two Digits
Contour Interval = 1 Foot
Datum is Mean Sea Level

Fig. 9. Perspective view of digitized data of Kin Bineola

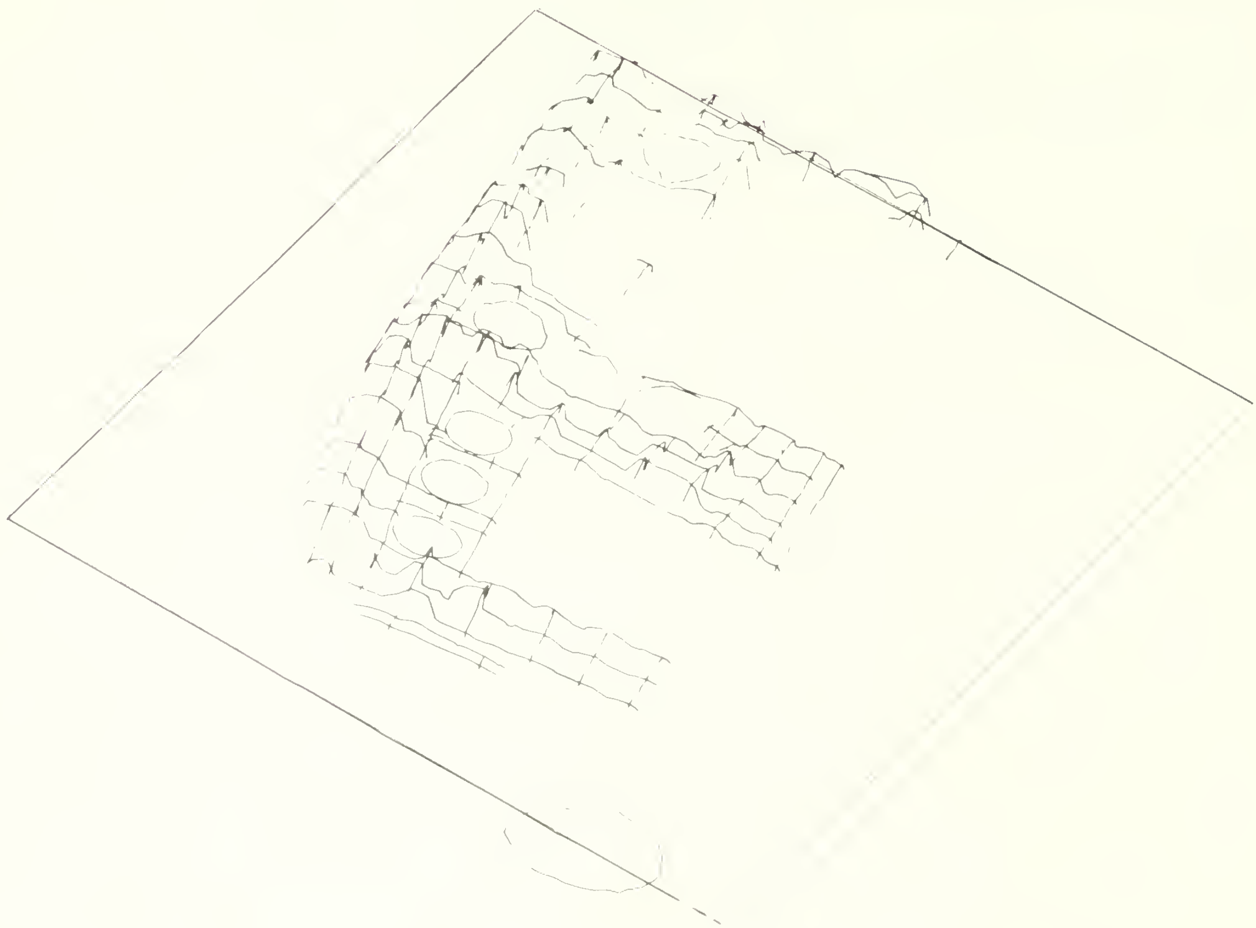
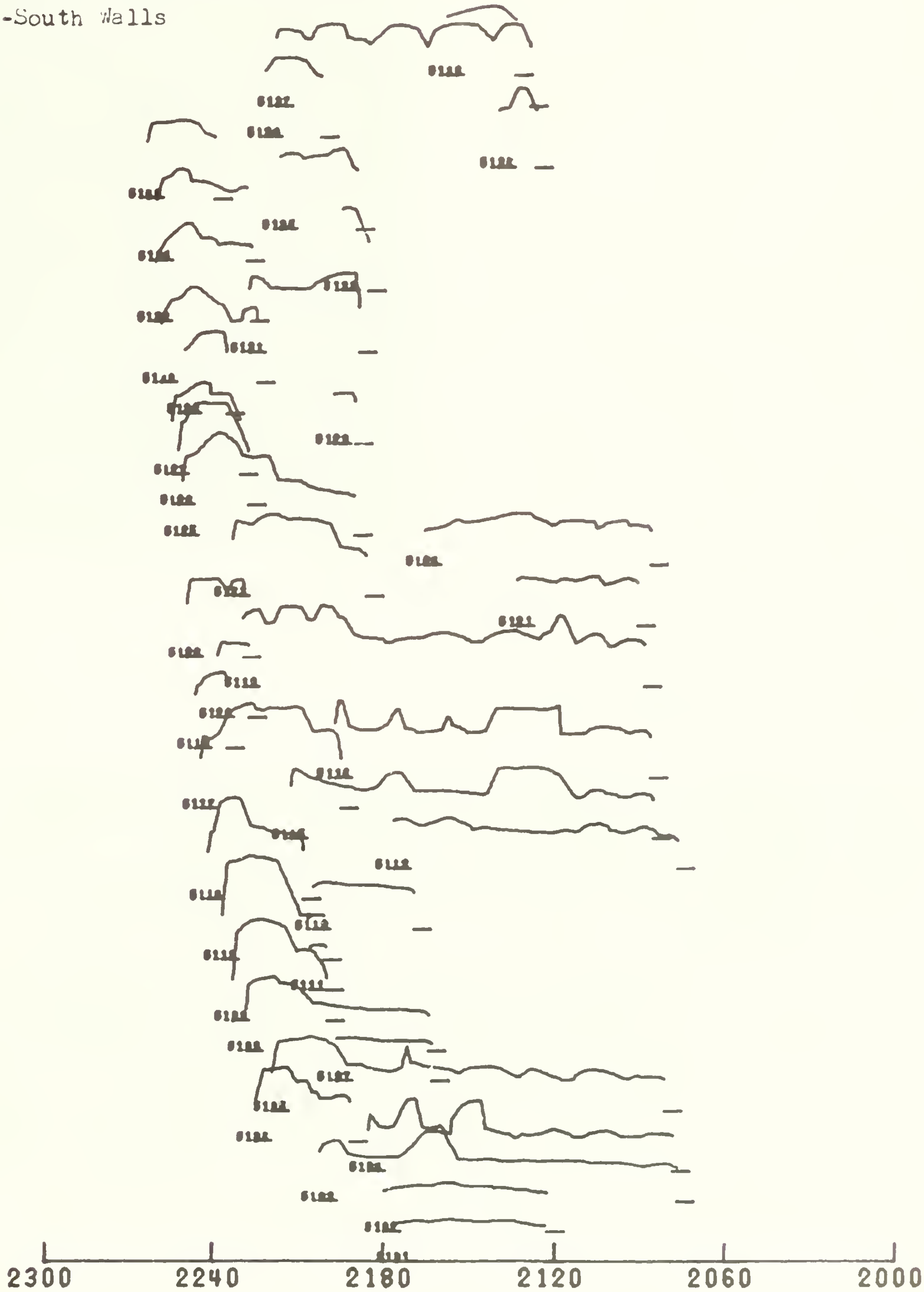


Fig. 10. Profile view of digitized data of Kin Bineola

COMPUTER PLOT OF DIGITIZED WALL DATA

KIN BINEOLA, Chaco Canyon
National Monument, New Mexico

North-South Walls



Aerial Photo of Fig. 11 and Fig. 12.

Fig. 11. Map of Peñasco Blanco

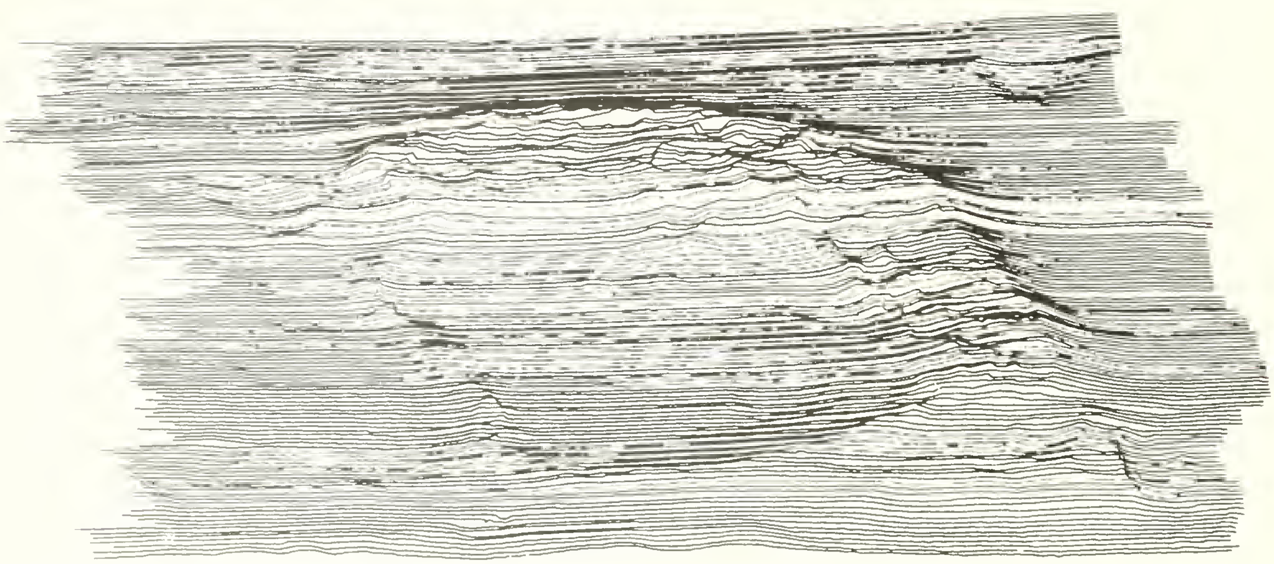
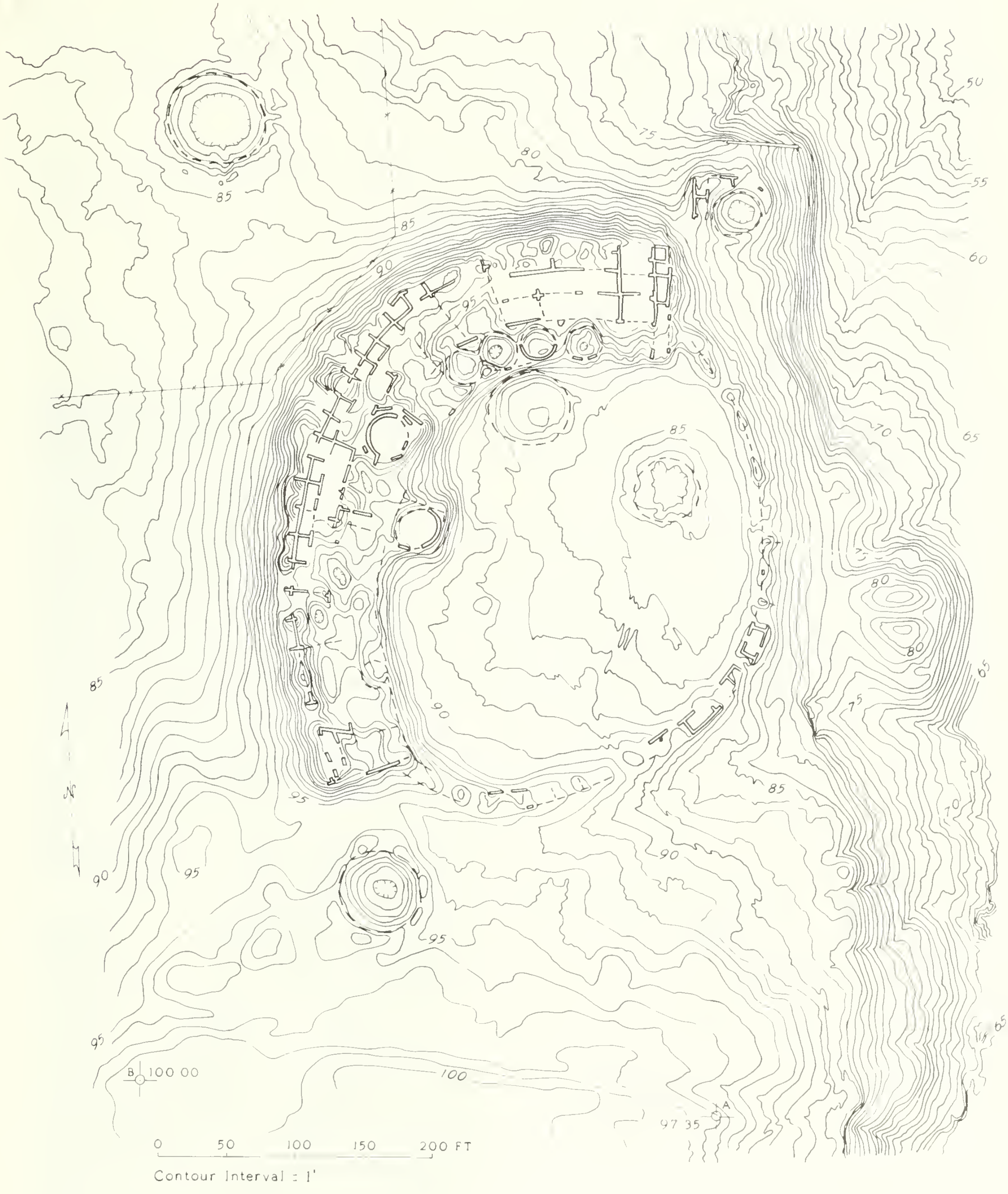


Fig. 12. Gridded view of Peñasco Blanco digitized data



ORTHOPHOTOS

In an orthophoto, a single image produced from a stereo model, all horizontal distances are to scale and all spatial relationships are accurate. In this way, an orthophoto is similar to a map. But an orthophoto has the added advantage of containing all the detail of a photograph. Rocks, trees, walls, roads, or other features which appeared in the original stereopair are reproduced in an orthophoto.

Topographic contours can be superimposed on an orthophoto. This adds to the orthophoto the third-dimensional information normally available on topographic maps. Such information combined with the corrected horizontal relationships and the photographic information makes the orthophoto a valuable tool for archeologists.

The accuracy of this type of map was demonstrated during preparations for excavation of one of the Chaco sites. The site designated 29SJ1010 was selected for testing because of its close association with one of the known Anasazi roadways in the San Juan Basin. An orthophoto with superimposed topographic lines of the site was prepared (Fig. 13). The lines were drawn with an extra fine pen point so that the map could be enlarged without increasing the width of the lines too greatly. Five-time enlargements of the site area were taken into the field to use as aids in laying out the excavation.

A small portion of the site was to be excavated and trenched. The locations of the trenches and features of interest were established on the ground and the map was aligned to check all the locations. It was found that the test trench indication on the map did not line up with the actual trench on the ground. After much rechecking, it was found that the straight edge of the alidade being used for site mapping was not properly aligned with the alidade's telescope. In other words, the map which had been prepared photogrammetrically was accurate enough to show up an error of 24 minutes of arc in an instrument which had been used for mapping other archeological sites.

Fig. 13. Orthophoto with superimposed contours of the Poco Site

APPLICATIONS

SITE DOCUMENTATION / MITIGATION

An important use of photogrammetric mapping in archeology is in site documentation and mitigation. Kin Klizhin (Fig. 14) was mapped accurately and inexpensively though no excavation or extended field work was planned for it. The map constitutes a record of the condition of the ruin at a point in time and thus records data that have potential use should the site deteriorate further or be destroyed (Ebert 1977, 83).

Fig. 14. Map of Kin Klizhin

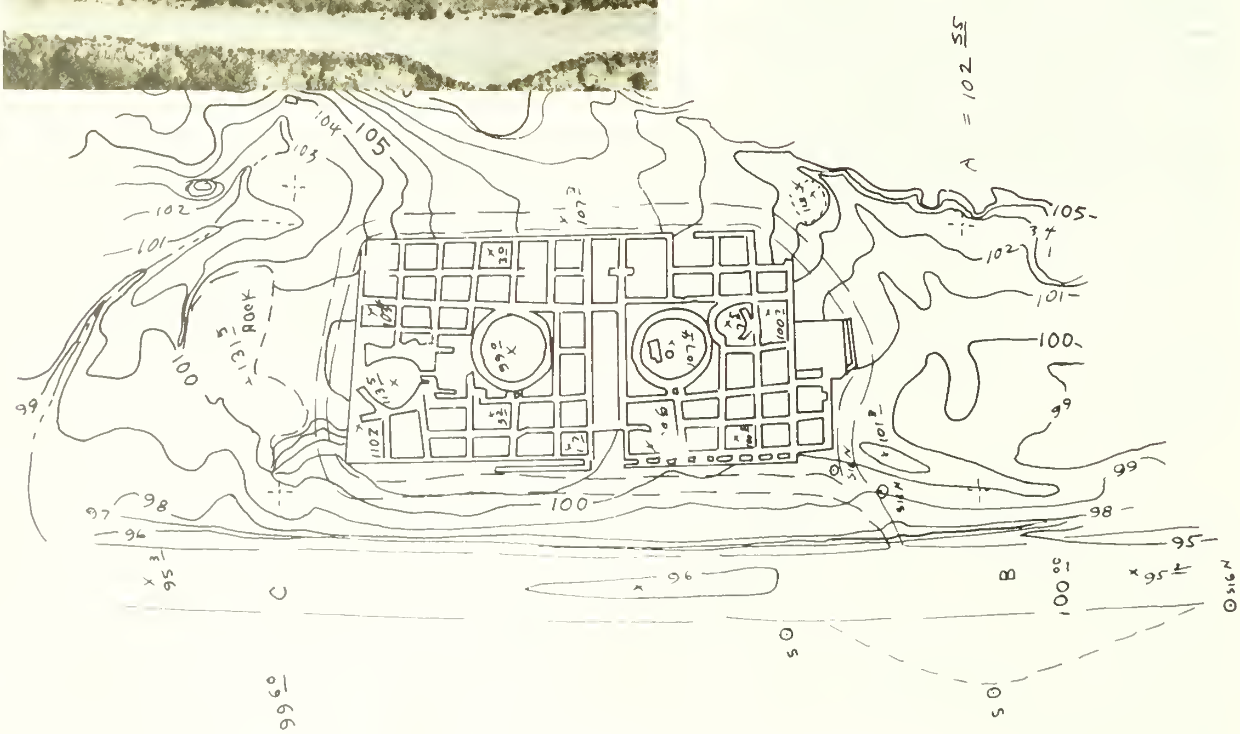
Selected References

Vivian, G.
1938 Stabilization of Kin Klizhin, Chaco Canyon NM, Fiscal Year 1938, Manuscript.

Detailed, accurate maps of archeological sites are storehouses of information which can be used over and over to derive new knowledge. Maps produced by field or other methods are likely to have errors that could be confusing to future researchers. An excellent map prepared by field methods is published in the report on Kin Kletso by Vivian and Mathews (1965). Figure 15 is the photogrammetric map of the same site. There are small differences that can be seen on close inspection. Of particular interest are the widths of the walls. The site report map masks some of the irregularities which occur in the wall widths. Also, the small rooms which occur in the narrow strip along the south wall are only roughly indicated.

It is also important to point out that a site report map can also add information to a photogrammetric map, particularly for a site which has been partially backfilled, as has Kin Kletso. In this case, a row of rooms is indicated in the center of the site which were subsequently backfilled so that no surface expression remains to be picked up by aerial mapping photography. These rooms can then be added to the photogrammetric map if desired.

Fig. 15. Map of Kin Kletso



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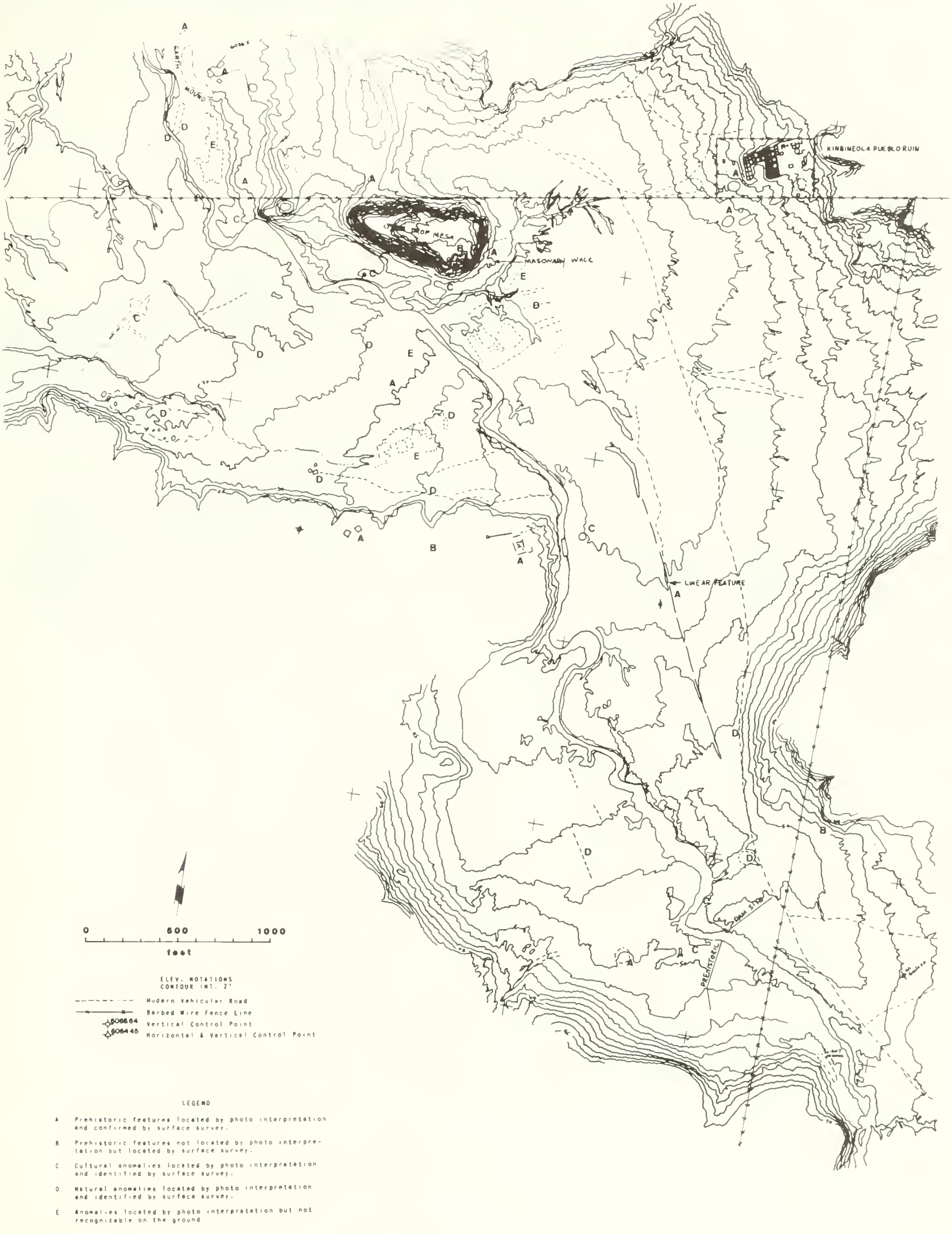
Vivian, G., and T.W. Mathews

1965 *Kin Kletso A Pueblo III Community in Chaco Canyon, New Mexico.* Southwest Parks and Monuments Association Technical Series, Vol. 6, Globe, Arizona.

In the compilation of photogrammetric maps, the mapped area is a function of the scale of the imagery used to generate the map. Small scale photography provides the data base for small scale maps encompassing large areas of ground. US Geological Survey quadrangle maps are examples of this type. All the previous maps have been large scale maps made from large negative scale photographs. But the same techniques that were used to draw individual site maps can be used to make maps of the areas around the site if appropriately scaled photography is used.

During the process of smaller scale mapping, it is a simple matter for the stereoplotter operator to indicate the location not only of obvious known and identifiable features, but also of anomalous features. In this way, it is possible to have the locations of features of possible archeological interest indicated on a map of a large area before any field survey is undertaken. The survey crew is then able to check identified features and anomalies during the scheduled field survey. Such a procedure was used on the area around Kin Bineola. Figure 16 is a map of the site area with anomalous features noted, some 85% of which field survey found to be of archeological interest (Lyons, Hitchcock, and Pouls 1976).

Fig. 16. Map of area surrounding Kin Bineola



Small scale maps also provide information on the spatial relationships of sites. Figure 17 is a map of the Casa Rinconada area which includes the Great Kiva, a large room block, and the excavated Bc sites in the vicinity. Figure 18 is a map of a group of abandoned hogans, some of which were excavated. Both of these maps show the relationship not only of the sites with each other, but also with the terrain and environmental features in the area.

Fig. 17. Map of Casa Rinconada and surrounding structures

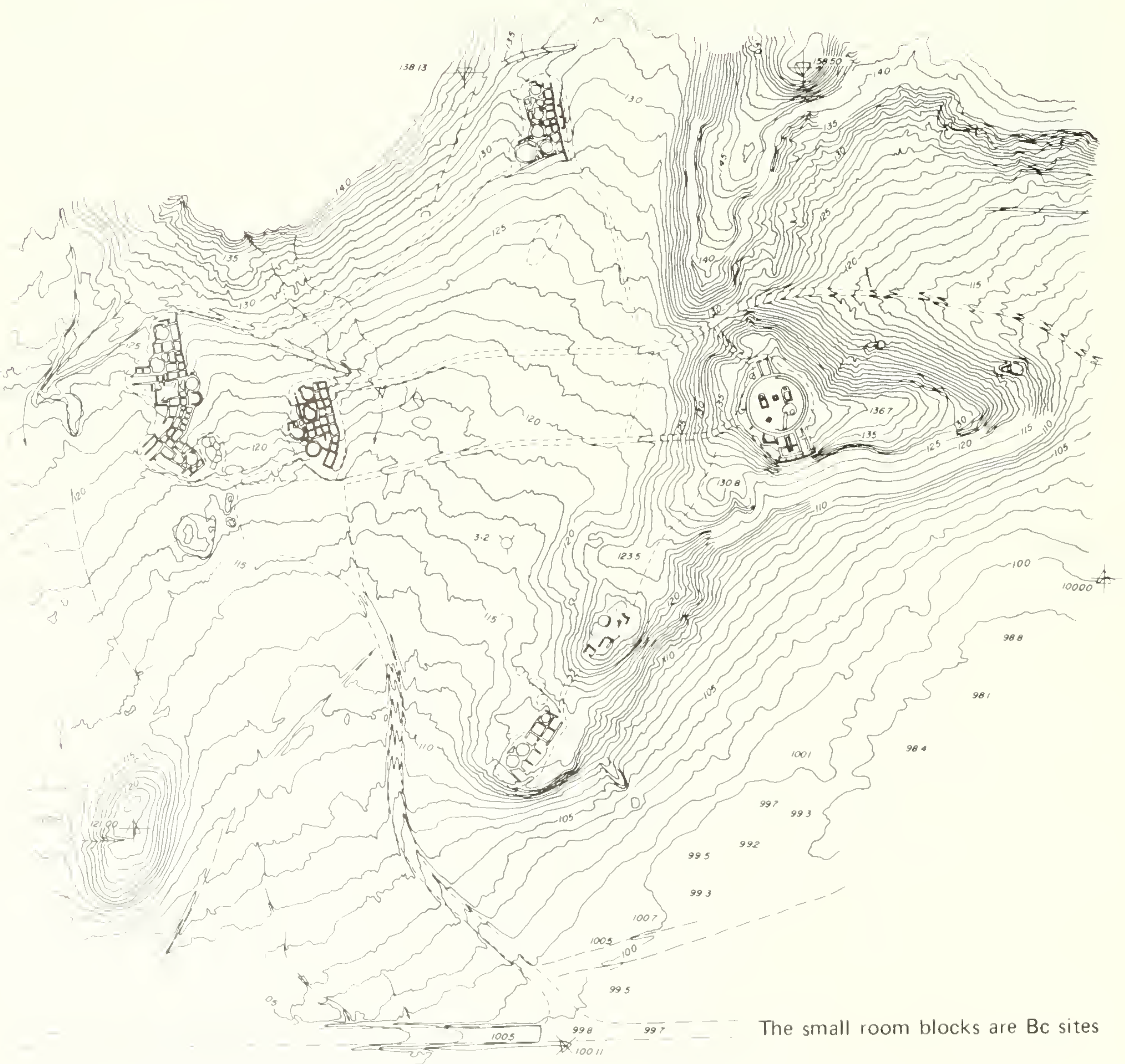


Fig. 18. Map of Navajo hogans at 29SJ1613

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Vivian, G., and P. Reiter

1960 *The Great Kivas of Chaco Canyon and Their Relationships.* School of American Research Monograph No. 22, School of American Research, Santa Fe, New Mexico.

Photogrammetric mapping lends itself, on occasion, to the recording of sites which are difficult to reach and map by traditional field methods. Such a site in Chaco Canyon is Tsin Kletzin (Fig. 19). This site is located high on a mesa and can be reached only on foot. A small field crew can easily lay out and survey horizontal and vertical ground control in one day. However, field mapping would require many days either camped on the site or considerable lost time in hiking to and from the site each day. Aerial photogrammetry solves this problem of site access effectively by photographing the site, then constructing the map in the laboratory.

Another technique, commonly referred to as terrestrial photogrammetry, has been used for some time by architects (Borchers 1977). The method is ground based employing horizontal camera axes. The resulting photographs are then used to create site elevation views, contours based on a vertical datum, and planimetric maps. Two sites, both located in large rock overhangs, have been mapped in this way. Mummy Cave Ruin (Fig. 20) in Canyon de Chelly National Monument, and Keet Seel (Fig. 21) in Navajo National Monument have been mapped for the National Park Service using this method.

Fig. 19. Map of Tsin Kletzin

Fig. 20 Elevation drawing of Mummy Cave, Canyon de Chelly National Monument, Arizona

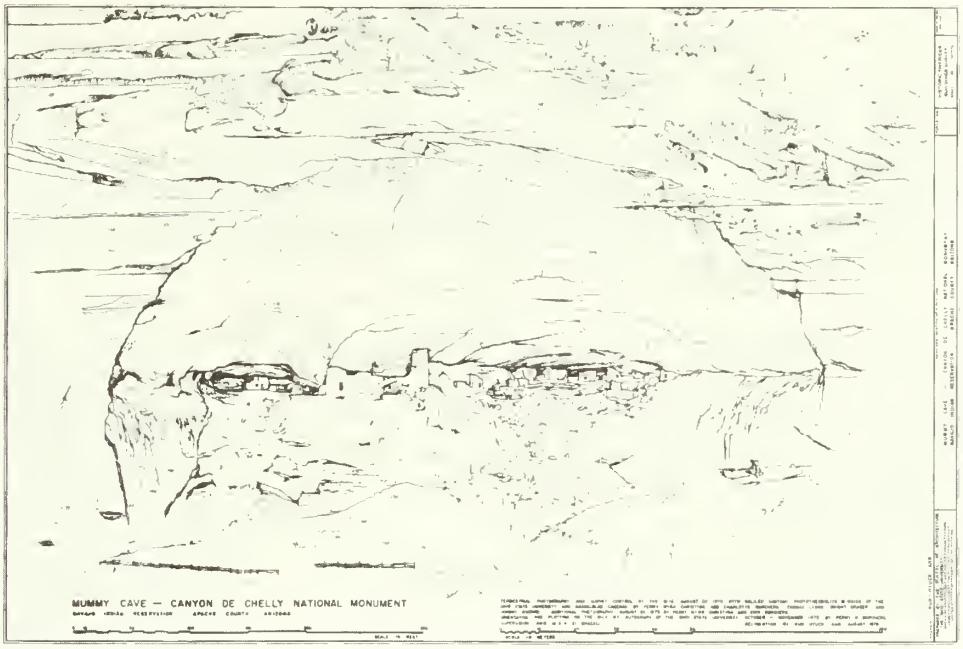
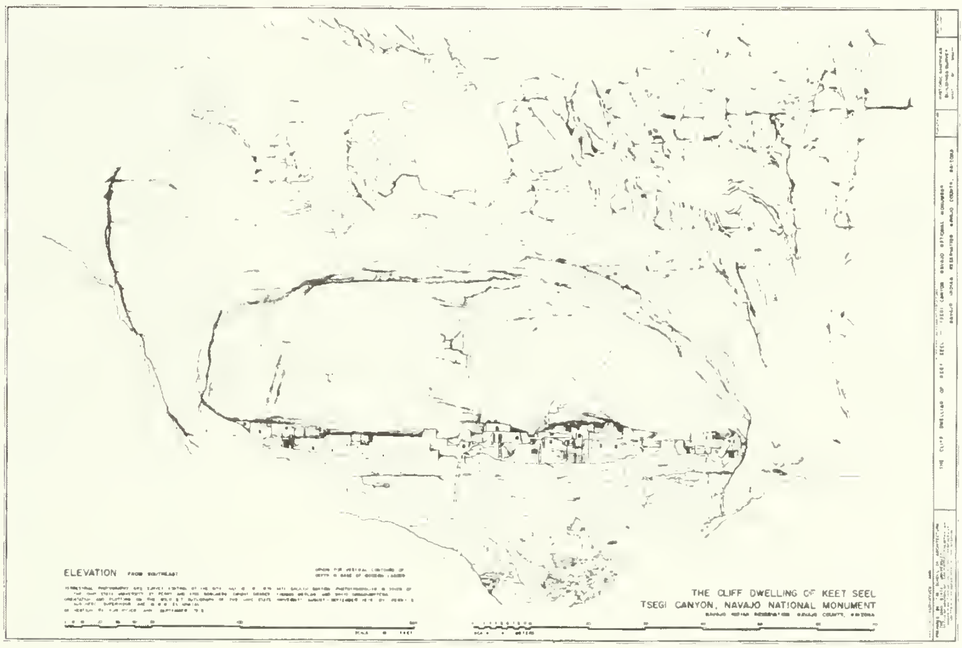


Fig. 21. Elevation drawing of Keet Seel, Navajo National Monument, Arizona



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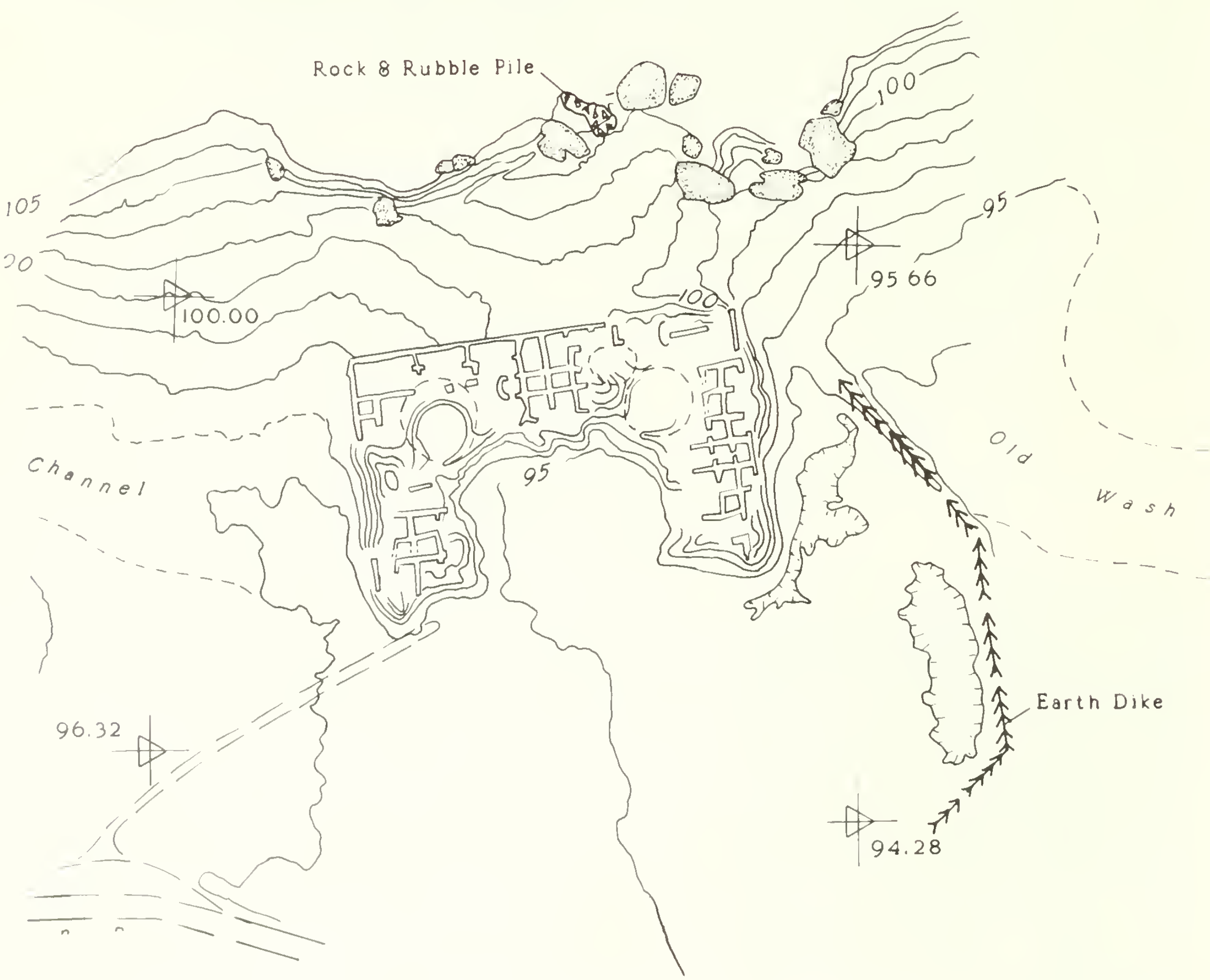
ANALYTICAL TECHNIQUES

RELATIVE DATING OF DRAINAGES

Once photogrammetric maps have been made, the amount of detailed information contained on them make them useful analytical tools as well as excellent instruments of documentation. One type of analysis is determination of relative dates of various environmental phenomena with respect to the archeological sites being studied.

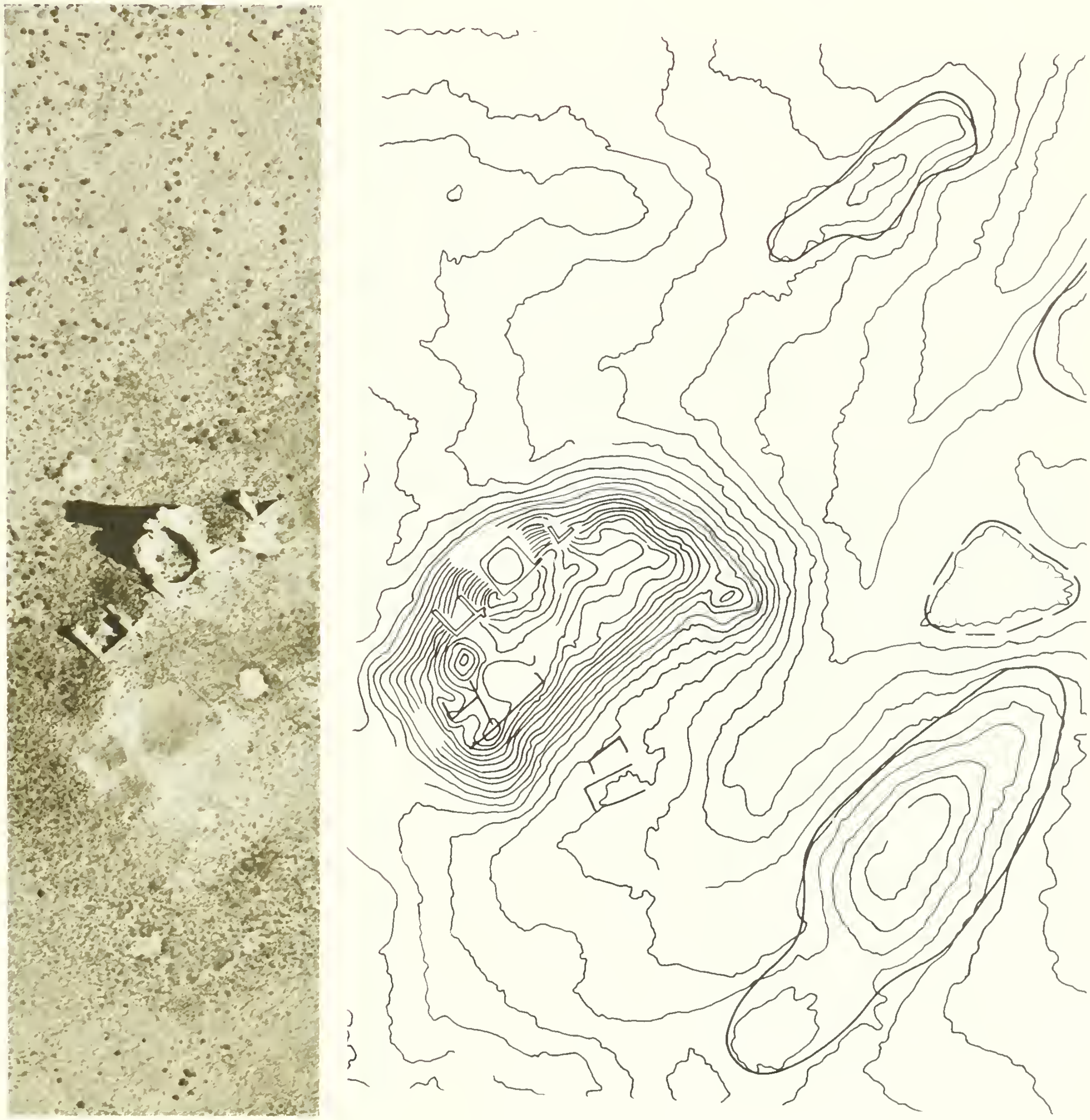
A good example of the relative dating of drainages is apparent in Figure 22, a map of Wijiji Ruin. Here a pattern marked "Old Wash" is clearly seen beneath the west side of the ruin. This drainage was no doubt inactive when the structure was built. Geological and geomorphic techniques can be applied to dating the various drainages in the area and the relative age of the site and the hydrologic features is thus determined.

Fig. 22. Map of Wijiji showing possible old channel scar



Often ideas about the function of a site can be derived from an interpretation of the map of an archeological site. Kin Ya'a (Fig. 23), one of the major Chacoan sites located outside Chaco Canyon, was not an especially large Chacoan community, yet it has a very large trash mound. Tree-ring dates indicate a short period of building and, probably, occupation. This suggests a high consumption rate during the period of occupation. Few of the other Chacoan sites show this pattern of high consumption. Thus, Kin Ya'a becomes unusual and archeologically more interesting.

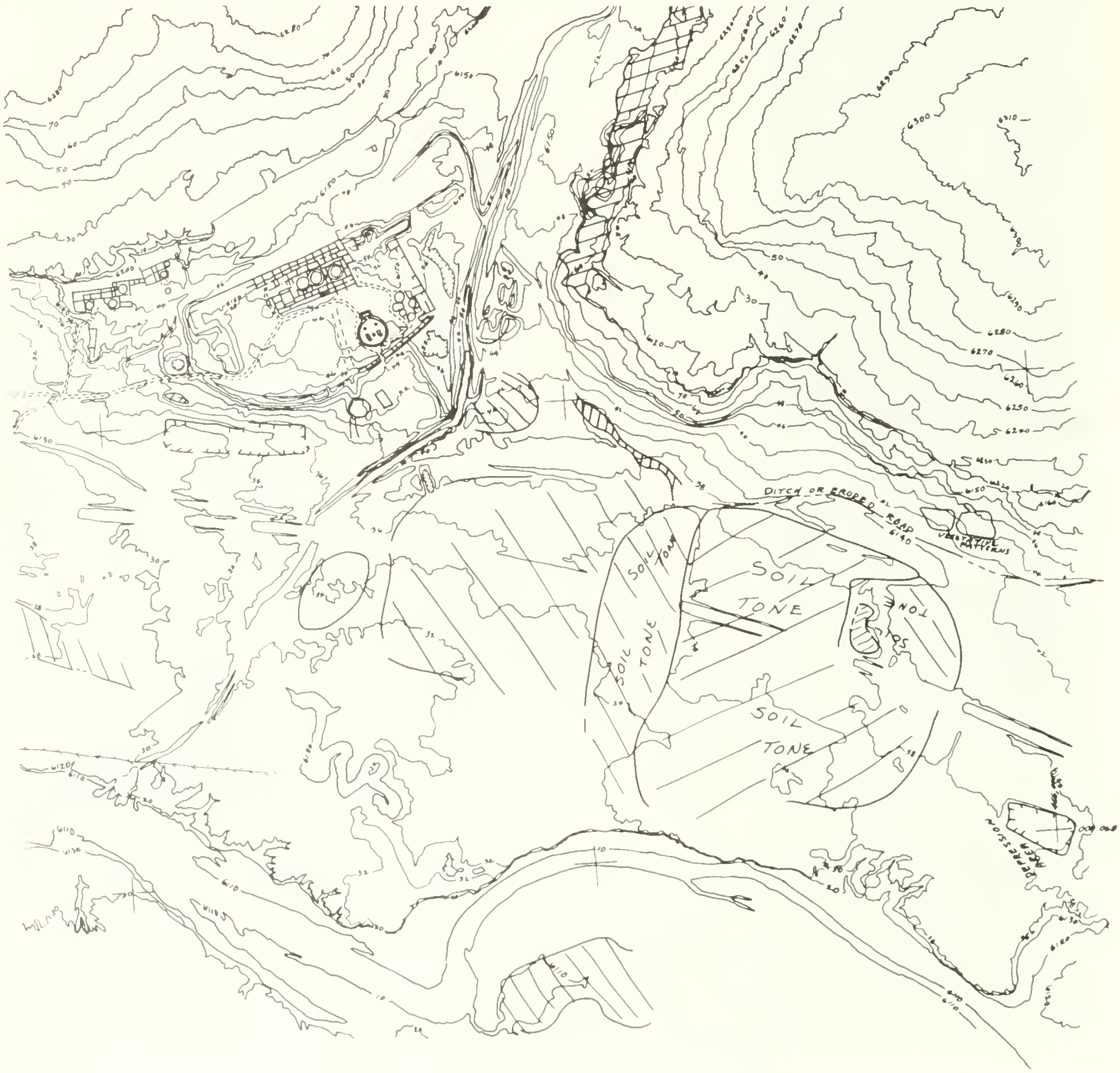
Fig. 23. Map of Kin Ya'a



SLOPE DETERMINATION

Topographic maps are excellent devices to provide information on the slope of various landforms. One such determination was made during the examination of an area in the vicinity of Chetro Ketl which has been used as an agricultural field. Figure 24 is a map of the field and the surrounding area. It was determined that the slope of the alluvium off the edge of the field was approximately 2%. The slope of the field itself is about 1%, or half as much. The surface of the field had presumably been levelled by its prehistoric users in an attempt to reduce velocity of waterflow and enhance irrigation practices (Loose and Lyons 1976).

Fig. 24. Map showing location of Chetro Ketl field

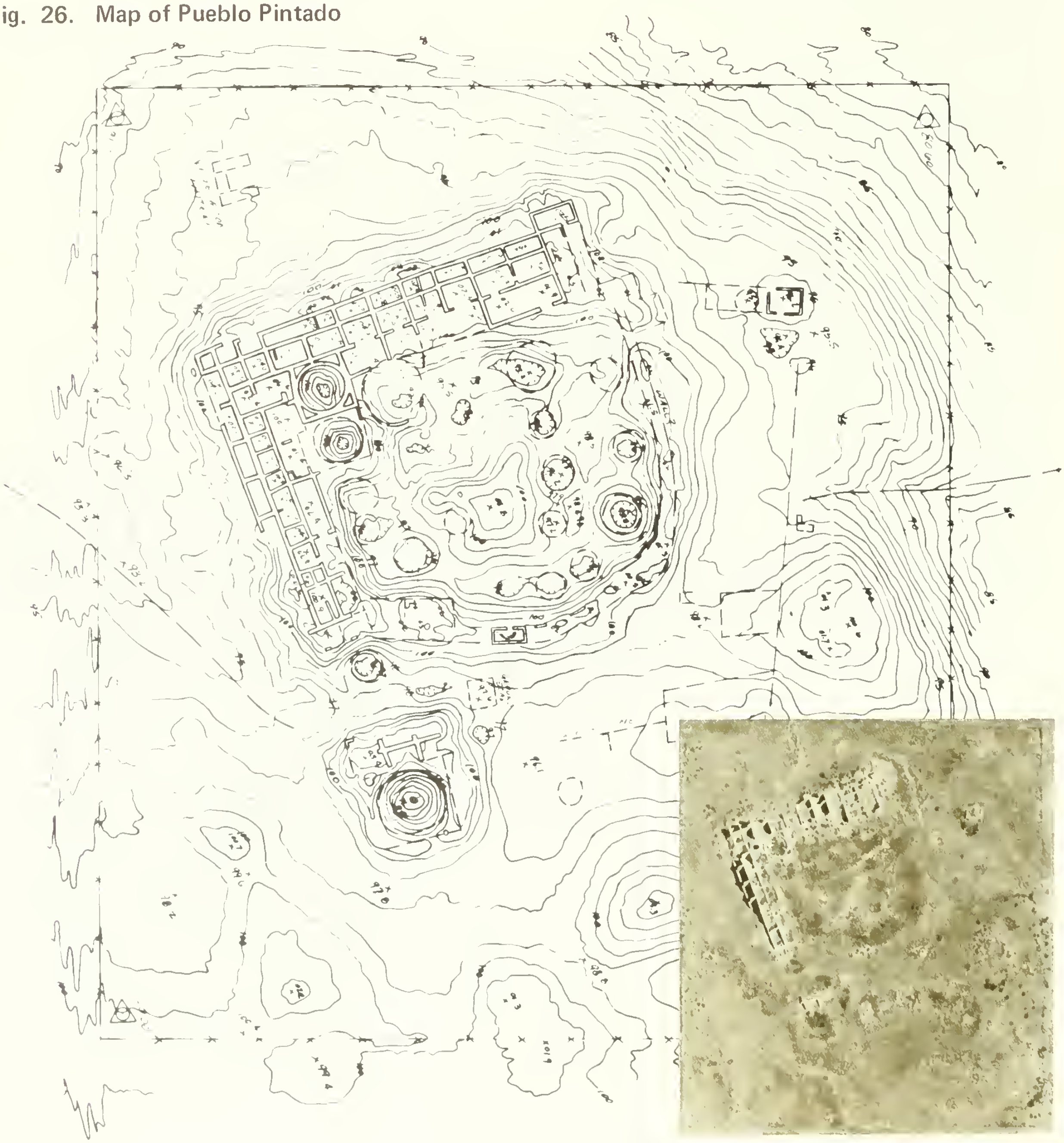


One idea that has been advanced in archeology is that it is possible to estimate the population of a site if the surface area of the site is known. Using photogrammetric maps of archeological sites, it is a simple procedure to outline the maximum extent of the site. For architectural sites such as Casa Chiquita (Fig. 25), wall lines and contour lines can be followed and extended until the area of the site is encompassed. On the Casa Chiquita map, the solid lines indicate walls that are visible on the mapping photography, the dotted lines indicate extended lines of possible prehistoric use areas. This kind of determination can be made not only for sites with visible architecture, but also for sites with no walls aboveground. In this way, it is possible to make an estimate of prehistoric populations without having room counts, and therefore without ever conducting any excavation (Naroll 1962; Cook and Heizer 1968; Drager 1976).

Fig. 25. Map of Casa Chiquita

Microtopographic interpretation of contoured maps often yields important results. This is the procedure of analyzing anomalous patterns in the contours. Figure 26 is a map of Pueblo Pintado. The contours between the southwest fence and the site seem to form a shallow linear depression. When field checked, this turned out to be one of the Chacoan roadways approaching the site which had not been noted previously on the aerial photos. A similar approach is made toward the same corner of the site by a road coming from the southeast. Other road depressions can be noted on many of the maps presented in this book; for example, on maps of Peñasco Blanco, 29SJ1010, and Kin Ya'a.

Fig. 26. Map of Pueblo Pintado



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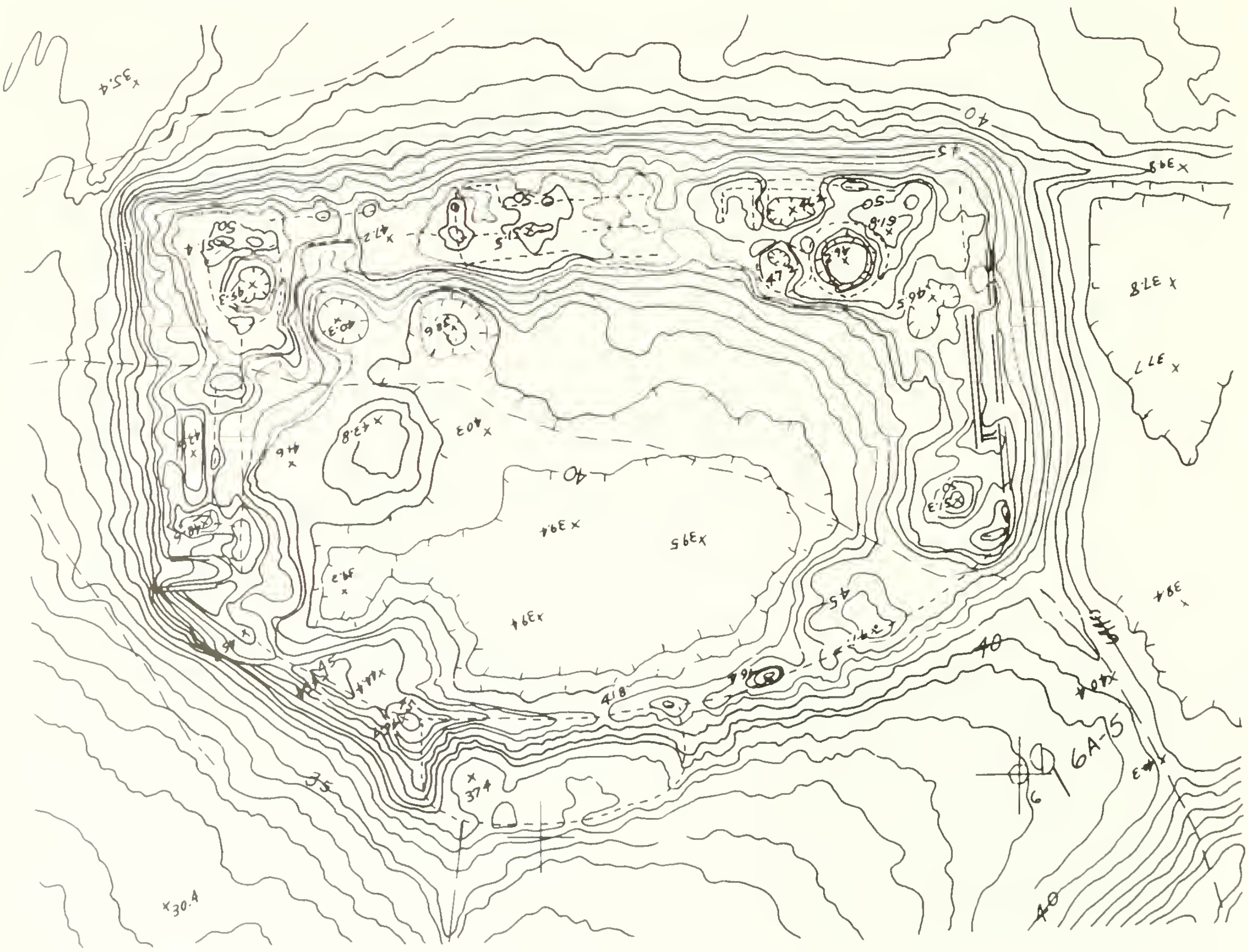
Because topographic maps contain three-dimensional information, it is often possible to compute the volumes of archeological sites. Figure 27, a map of Pueblo Alto, was made prior to excavation. Transects across the site at ten meter intervals were digitized. The data from these transects were then analyzed by a computer program which was initially designed to determine the amount of dirt required for a highway cut-and-fill operation. A datum base was first projected under the site from the topographic information indicated on the map. Later excavation proved the projected base to be within a few centimeters of the actual bedrock on which the site was built. A volume of 18,177 cubic meters for the pueblo and an additional 3,895 cubic meters for the trash mound were estimated. This information can be extremely useful to the archeologist planning the excavation of the site, since the volume can be turned into manhours which can be turned into cost.

Fig. 27. Map of Pueblo Alto

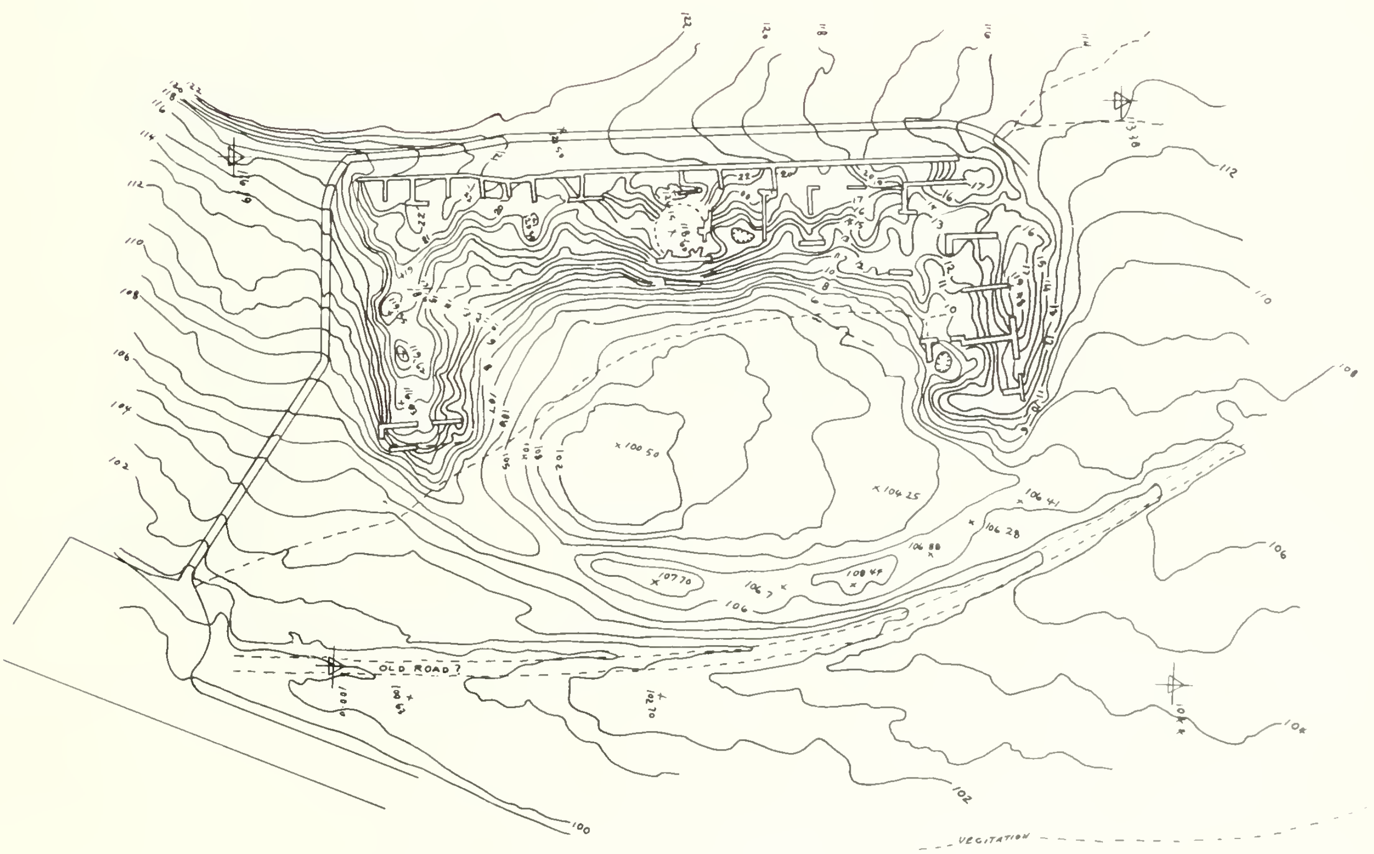


PLANNING AND MANAGEMENT

STABILIZATION

Accurate maps are very useful tools for stabilization efforts. Figure 28 is a map of Hungo Pavi that could be used as a floor plan for its stabilization. The importance of this kind of information can best be illustrated by the occurrence of two earthquakes in the San Juan Basin in a little over a year. The epicenter of one quake occurred about 9 miles from Kin Bineola. Fortunately, no damage was sustained at any of the Chacoan sites. However, it is possible that many of the standing walls could have toppled. The existence of good photogrammetric maps created prior to the earthquakes assures that any walls which might have been damaged could have been reconstructed to their pre-earthquake condition.

Fig. 28. Map of Hungo Pavi



Maps of this type are useful in the planning of development of an area. Figure 29 is the area of Marcia's Rincon in Chaco Culture National Historical Park and shows the excavated portions of site 29SJ627. A park manager can use such data for locating parking areas, rest areas, interpretive trails, or other areas of concern. Sampling transects for vegetative study or soil classification can also be prepared using this type of map.

Fig. 29. Map of Marcia's Rincon area showing site location

One very effective use of mapping of archeological sites is to record the work accomplished during each field season. Figures 30 and 31 are a series of maps made of Pueblo Alto before excavation and after the first field season of excavation. During the first field season, a deliberate attempt was made to clear the tops of as many walls as possible. The map which was made following that season then becomes a map of nearly all standing walls of the ruin. This creates a map which can then be used to direct further research and excavation and is available early in the project rather than when the project is completed, which has been the normal time that a full site map is prepared.

Comparison of phase maps after each field season can provide information on the amount of excavation, on areas requiring further work, on sampling frameworks, on justifications for examining one location instead of another, on which areas are best backfilled and which should be stabilized for interpretive purposes, and many other types of decisions.

Fig. 30. Pueblo Alto before excavation

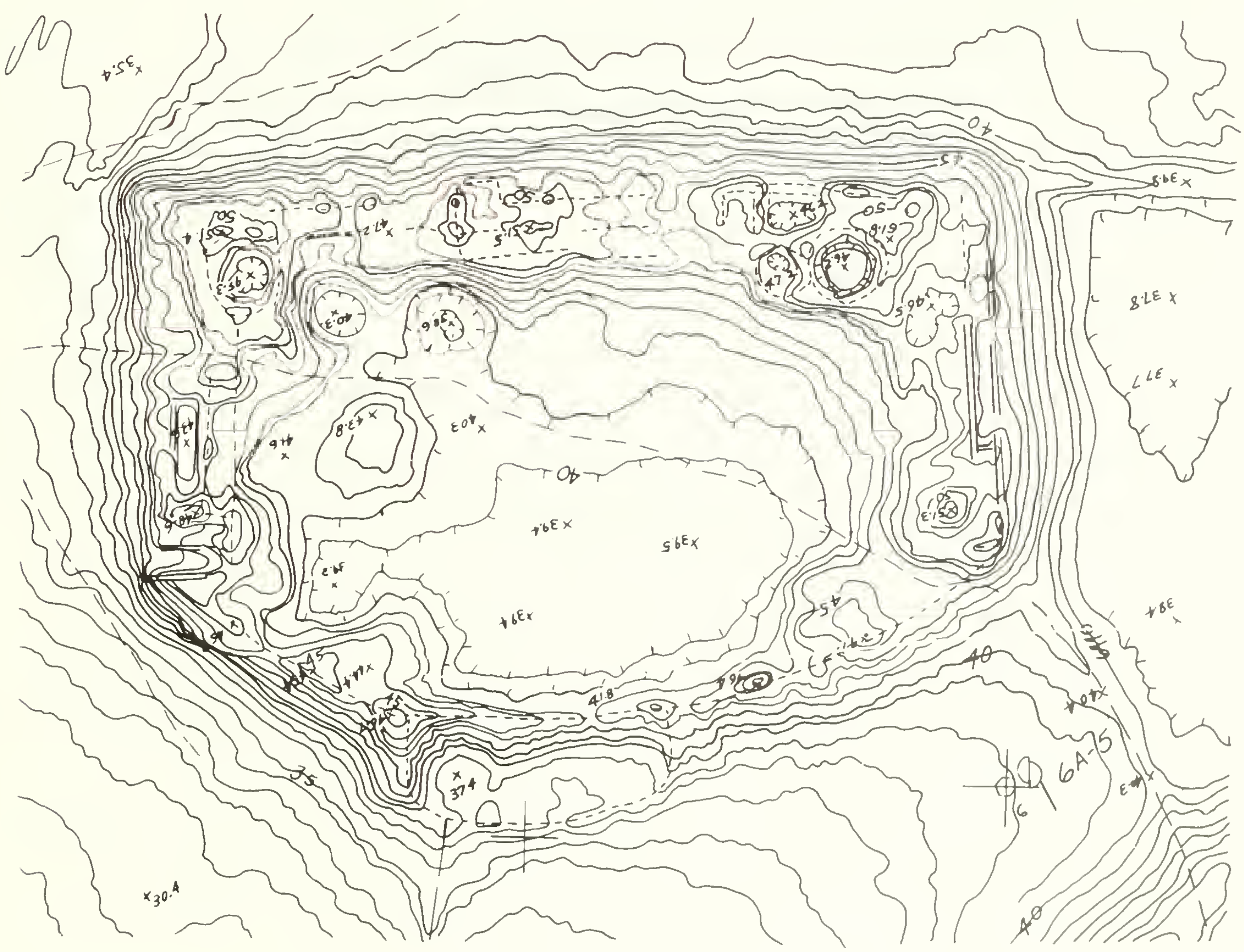
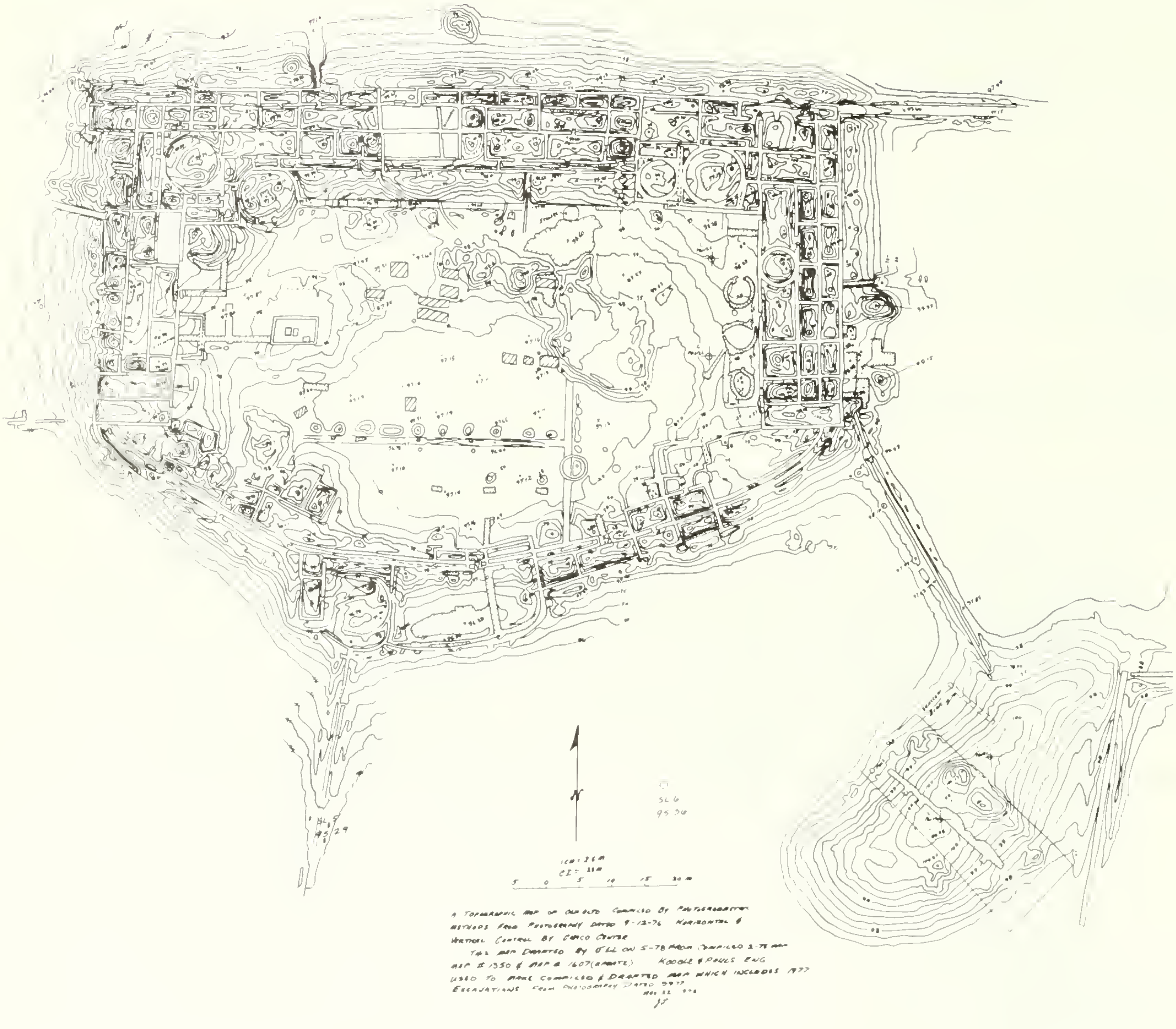


Fig. 31. Pueblo Alto after stripping of walls



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