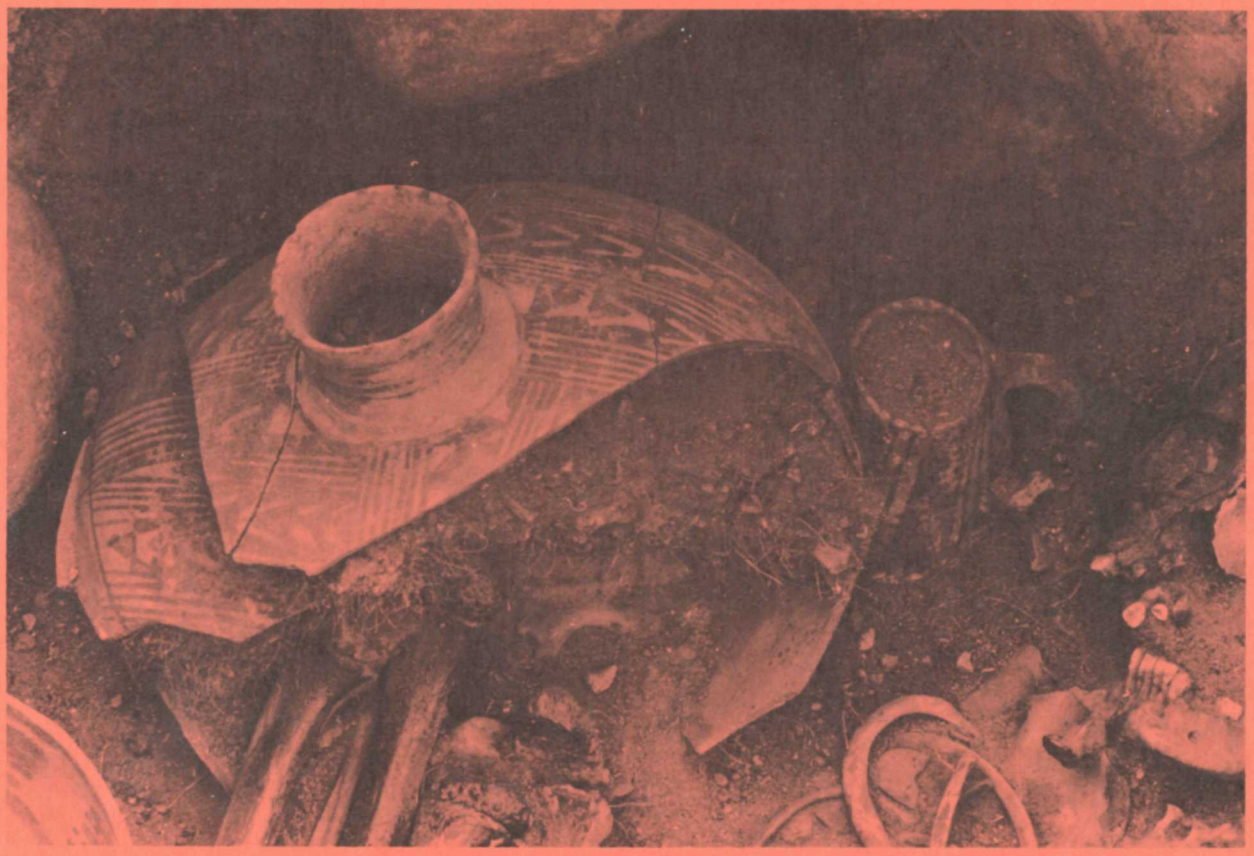
SALMON RUIN ARCHEOLOGICAL INVESTIGATIONS



ARCHEOLOGICAL COMPLETION REPORT SERIES, NUMBER 8

cover photo: Peter B. George

SALMON RUIN ARCHEOLOGICAL INVESTIGATIONS

Cynthia Irwin-Williams

Rex Adams

Paddy C. Johnson

M. Ann Bennett

E. Pierre Morenon

Gordon Alan Davis

Prepared for distribution by
Susan C. Olsen, Archeologist
National Park Service

Archeological Completion Report Series, Number 8
Division of Grants
Office of Archeology and Historic Preservation
National Park Service
Department of the Interior
Washington, D.C.
1975

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Plate 1: Southeast view of masonry wall.

The Salmon Site, located on the San Juan River, ca. 45 miles northeast of the Chaco Canyon, was constructed in the late 11th century by a group originating in that cultural center. Built in the form of a great 'C', it stands three or more stories high and extends 450 feet along the back and 200 feet along the arms (Photograph 1). It is thus one of the largest of these pre-Columbian "apartment houses". The structure itself is constructed entirely of several grades of carefully-worked stone, and the fine-banded masonry and carefully-planned architecture reflects a sophisticated knowledge of architecture unknown outside the Chacoan province. A large depression (ca. 60 feet in diameter) almost certainly conceals a great kiva, the community ceremonial chamber. Preservation at the site is excellent, with roof beams frequently preserved, and entire floors and ceiling intact in some areas. Indications from this and the companion "great house" of Aztec National Monument are that these enormous structures were built as massive coordinated efforts in very short periods of time (about a decade). This is in marked contrast to other large pueblo structures which reached maximum size by eclectic growth through time.

In addition to the two very large "great houses", preliminary information indicated the existence of at least a dozen other somewhat smaller Chacoan communities, all dating from the late 11th century and suggesting a population intrusion of considerable size. However, despite the complexity and development of Chacoan culture, these towns were abandoned before the middle of the 12th century, creating one of the

most pressing unsolved problems in southwestern archaeology. Subsequently, after nearly a century of abandonment and decay, most of them were reoccupied by other non-Chacoan puebloan groups of local or northern affiliation, which, while numerous, were less well-integrated and developed in architectural and other skills.

Many of the Chacoan great houses were excavated long before modern techniques of archaeology had come into existence, and most of these excavations have never been fully published. Therefore, knowledge of this remarkable culture was inadequate to permit any real comprehension of the economic, socio-political and religious order on which it was based. It was felt that the San Juan-Animas centers provide an ideal situation for the study of the Chaco phenomenon at the height of its development. The short duration of their occupation makes it possible to focus on their creation and structure on a nearly synchronous basis, with relatively little complication by temporal development.

Preliminary Excavations at the Salmon Ruin

The basic focal points of survey excavations at Salmon Ruin during the 1971 field season included: (1) the outlining of the parameters of a selected occupational unit of the Ruin; (2) initial construction of a viable excavation methodology which would allow retrieval of the maximum amount of information; (3) the collection of information concerning the environmental setting to which the occupants of Salmon Ruin adapted; and (4) the preliminary determination of the spatial, temporal

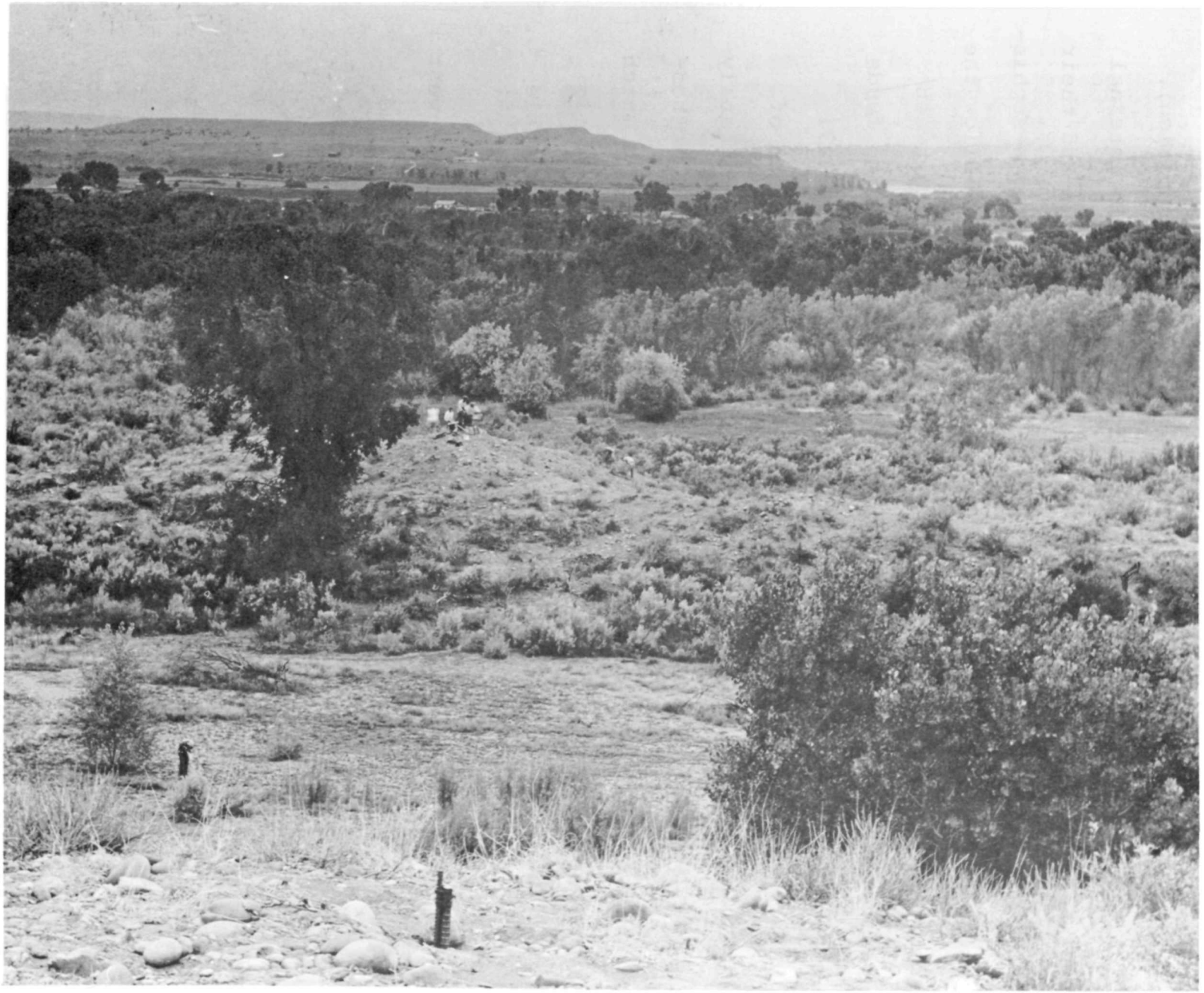

Plate 2: Ruin before excavation looking south.

and cultural relationships between the Chacoan community and the society created by the subsequent reoccupation of the site (sometimes referred to as the "Mesa Verdean" occupation).

1. Essential to the reconstruction of the basic internal structure of the communities which created Salmon Ruin and their economic and social adaptations was the construction of a sophisticated and viable model of data retrieval which would allow the delineation of the spatial and temporal relationships between categories of material remains, while minimizing time and funds expenditure. This model was developed during the 1970-1971 testing excavations at Salmon Ruin, from past excavations of other prehistoric pueblo societies, and from ethnographic analysis of contemporary pueblo societies. The excavational methodology was continually reevaluated and revised to assure a match with the variability exhibited by the Ruin. The following is a synopsis of this excavational methodology and the rationale underlying its implementation.

Survey excavations focused on the exploration of the west end of the Ruin with attention centered on Rooms 1, 2, 3 and 4 (Figure 1), which comprised two east-west oriented rooms and two kivas. Work in Rooms 1 and 2 indicated the existence of complex but readily recognizable stratigraphy reflecting the detailed character of the building's history. By the use of refined excavation techniques, it was possible to identify the strata (from bottom to top) representing: The first floor, the second floor the roof of the original "Chacoan" structure; a zone of nonoccupational debris from the decay of the building during a period of abandonment; the crude adobe and cobble walls,

Plate 3: Stratigraphic record of successive occupations of site.

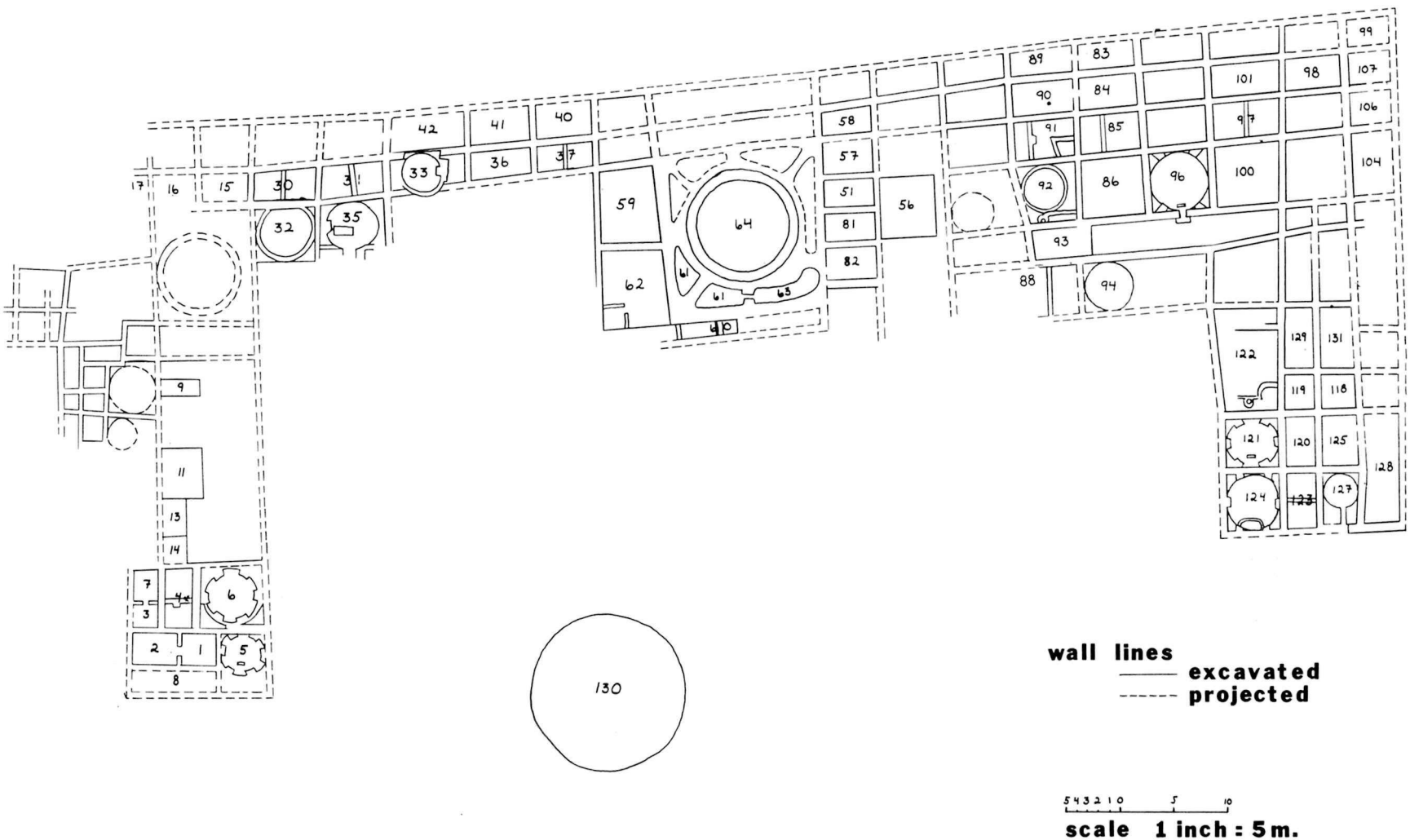
wall lines
excavated
projected
scale 1 inch : 5m.

Plate 4: Burial of juvenile female from secondary occupation of pueblo.

hearth, floor and roof of the later "Mesa Verdean" occupation (Photograph 2). Because of these excellent conditions, it was decided to try to extract the maximum information from this internal stratigraphy in subsequent excavations.

Within Room 1 occurred a well-preserved burial, belonging to the second occupation. The interment occurred in a small cobble-lined, juniper slat-covered pit, which was intruded into the debris of the first occupation. The individual represented was evidently a young girl (about 10-12 years of age), who was placed in the pit in flexed position and accompanied by three pottery vessels and a digging stick (Photographs 3 and 4). In Room 2 was uncovered a partial burial also belonging to the second occupation, and intruded into the debris of the first. The remains comprised two articulated legs belonging to a large individual, severed at the knees, and wrapped in a twilled mat.

Room 3 comprised a kiva belonging to the second occupation of the site. Because of limitations of time and personnel, excavation was limited to a one-meter wide test trench placed along the north-south axis of the structure. The trench revealed the existence of well-preserved plaster on the kiva walls, and the presence of a lined wall niche on the north side of a wattle and daub deflector near the south side. The outlines of the structure indicated that it belongs to the type characterized by six equidistant pilasters. Room 4 was also evidently a kiva of the pilastered type, but time limitations permitted only the uncovering of the uppermost two feet

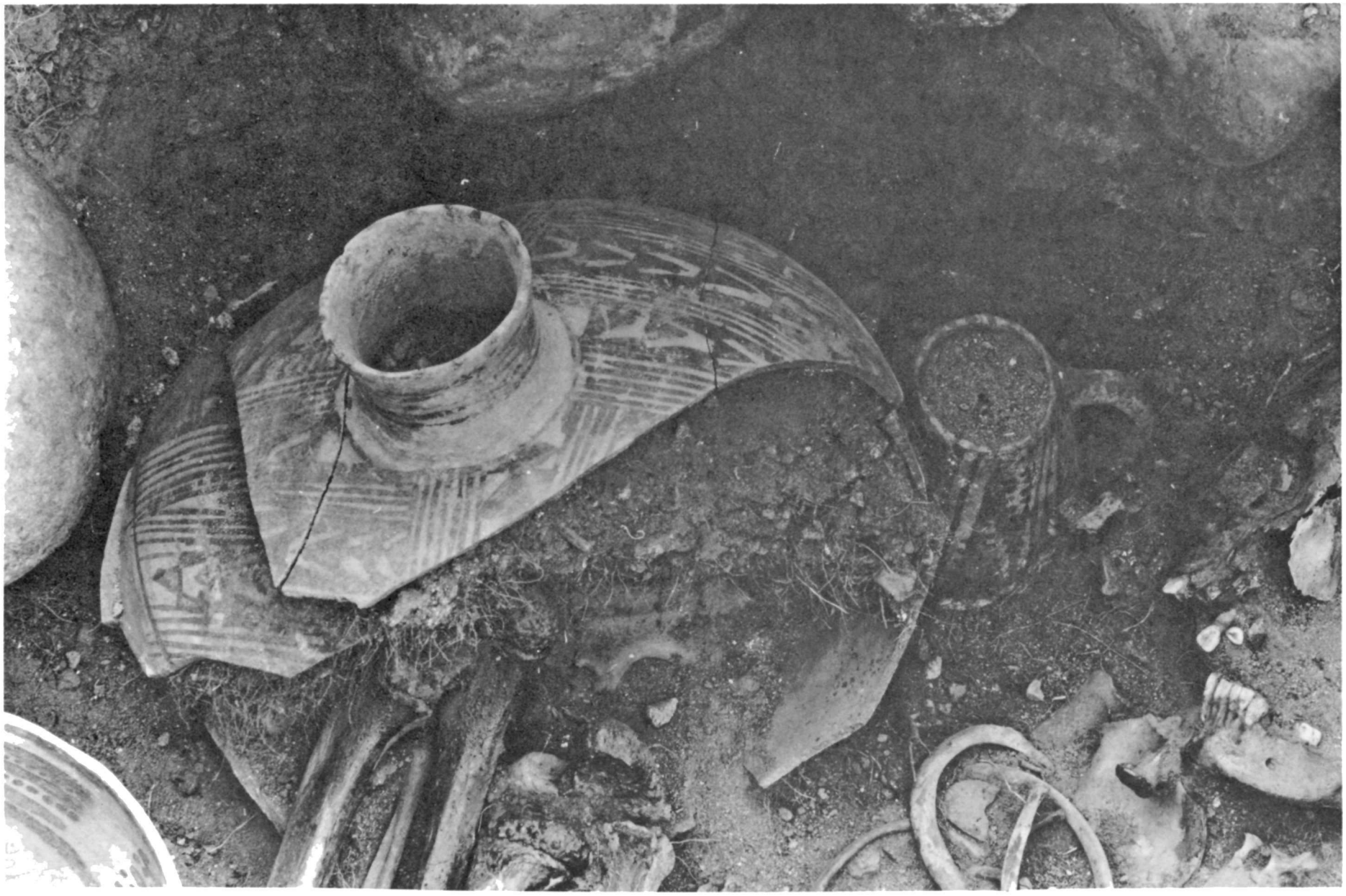

Plate 5: Pottery with burial of juvenile female from secondary occupation of pueblo.

of the structure's outline.

It was determined from survey excavations that each "room" represented a unique problem in stratification which outlined the temporal existence of that particular room. Nevertheless, it was possible to define two broad categories of stratigraphic fill: (1) the class of individual stratigraphic units comprising the "Rubble Fill", which were the result of post-occupational weathering of the Ruin and which contained only limited information concerning cultural behavior; and (2) a class of units together making up the "Occupational Fill", which was the result of direct cultural occupation and which contained materials essential to the interpretation of the structure of behavior. A third category of stratigraphic fill recognized, but treated similar to that of the "rubble fill" was that stratigraphic fill which was the result of the artificial, as opposed to the natural, filling of intersticial spaces between rooms.

The usual case observed, (see Figure 2), was that the "rubble fill" category overlaid those strata belonging to the "occupational fill" category; however, rooms were found which contained trash layers of the second occupation overlying the rubble fill representing the period of abandonment after the primary (Chacoan) occupation.

Basic to the excavation of a room was the placement of a one meter wide "test trench" along the meter grid lines which most closely approached the long axis of the room, (see Figure 2). Through this technique, it was possible to determine the stratigraphic nature of a room prior to its total

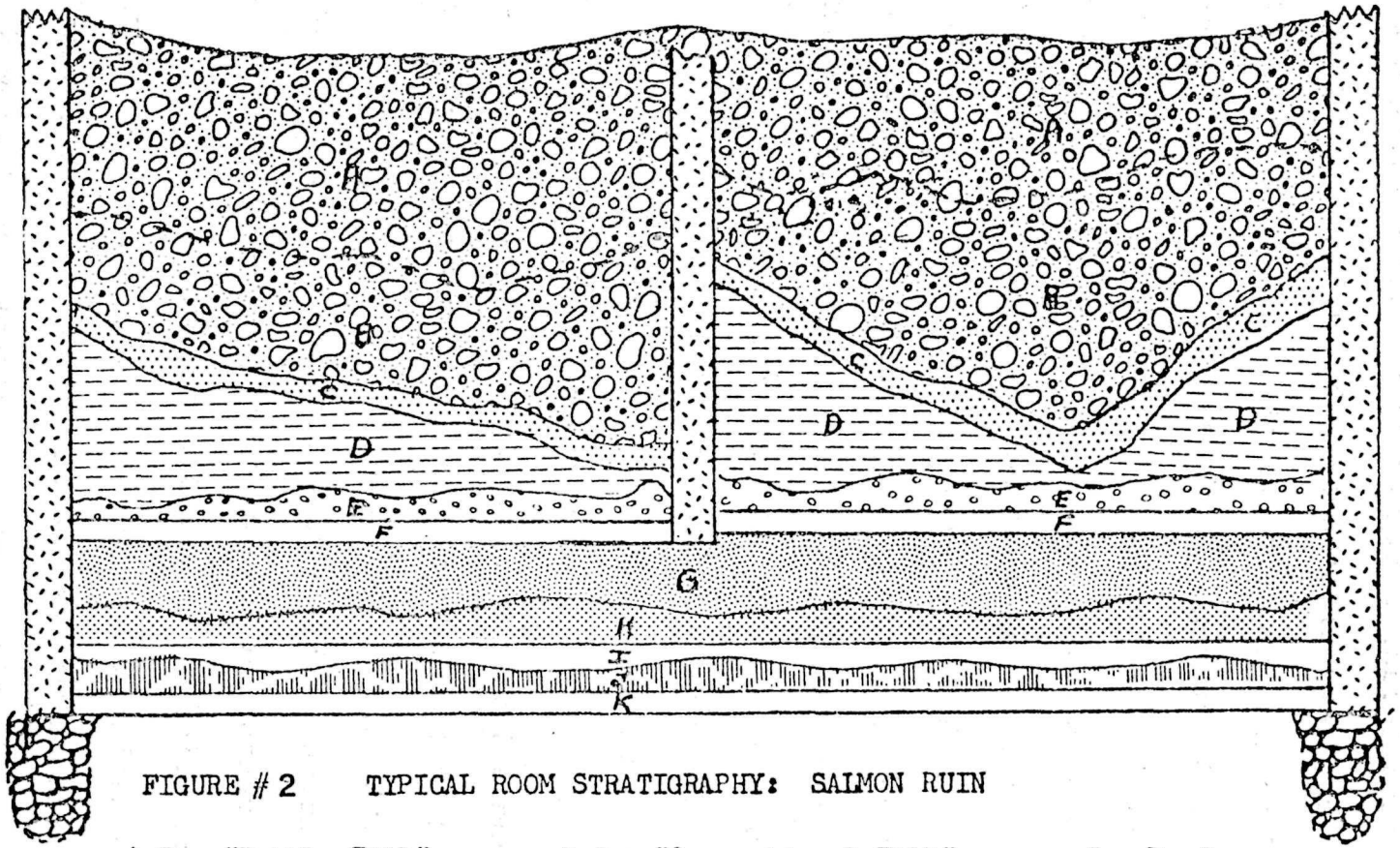

FIGURE # 2 TYPICAL ROOM STRATIGRAPHY: SALMON RUIN

A-B = "Rubble Fill" zone; C-J = "Occupational Fill" zone; C = Roof fall; D = Aeolian fill; E = cultural deposits from secondary occupation; F = Adobe floor; G = Aeolian fill; H = occupational deposits from the Chacoan society; I = Adobe floor; J = occupational deposits from the primary Chacoan occupation; K = Primary adobe floor.

excavation. Utilizing precise horizontal and vertical control, this "test trench" was then excavated in meter squares. If the upper stratigraphic limits of the room belonged to the "Rubble Fill" category of stratigraphic fill, this "test trench" was excavated in natural stratigraphic units, with maximum 30 cm. units imposed for control within these. Where "Occupational Fill" was encountered, the "test trench" was excavated by natural levels and 10 cm. maximum units. Following the excavation of the "test trench", the room was divided into quadrants. These quadrants were excavated as whole units in natural levels, and artificial 10 or 30 cm. levels according to content. Photographic and hand-drawn profiles recorded both test trench and quadrants, so that the complete internal stratigraphic content of a room may be reconstructed in three dimensions.

All earth that was removed during excavations, was passed through a ¼ inch mesh screen to ensure that nothing had been overlooked and all the material remains found were bagged and tagged according to the room, grid designation, depth, stratigraphic context, etc., from which they came.

In addition to the excavations within the building itself, a long-test trench and several test pits were sunk in the plaza to gain information on internal chronology and on possible activity areas within it, (Photograph 5). The stratigraphy of these test areas supports the chronology suggested within the building, of an initial "Chacoan" occupation, followed after a hiatus, by a later "Mesa Verdean" occupation. Activity areas related to outdoor cooking and to turkey raising were encountered, (Photograph 6).

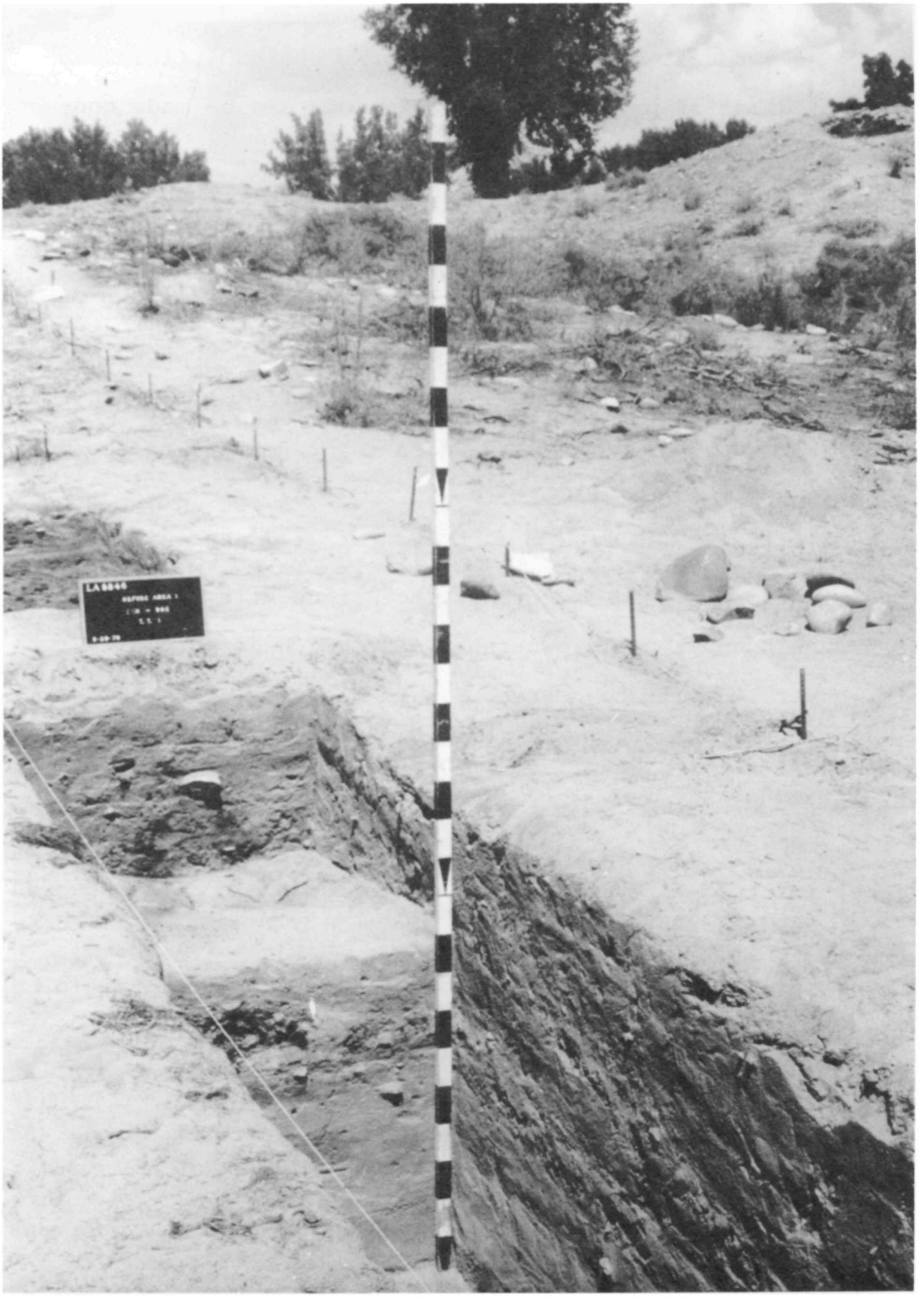

Plate 6: Small cobble-lined earth oven uncovered in test trenching refuse area.

As a result of excavations during the 1971 field season, a number of preliminary observations may be made concerning the occupation of the Salmon Ruin. These observations only reflect those areas of the site which were partially excavated and do not represent variability of the site as a whole. Likewise, any final attempt to analyze the relationships between the Chacoan occupation and that which replaced it must await not only further excavation, but detailed laboratory analysis of all the data recovered during these excavations.

It is important in terms of the philosophy of historic preservation in New Mexico that the Salmon Ruin is owned by San Juan County. This ownership assures the opportunity for the general public to have access to the site.

Public Benefit

The work being conducted at the Salmon Ruin site is the focal point for a cultural complex being developed by the San Juan County Museum.

In conjunction with the excavation and development of the Ruin proper, San Juan County has provided the finances for a modern interpretive museum and research center.

This facility has been completed and will be formally dedicated on June 3, 1973.

In conclusion, the Chaco culture is extremely important to an understanding of cultural and environmental pressures which altered the social fabric of the southwest in the 11th and 12th centuries.

Plate 7: Finely stratified layers of individual trash deposits in test area.

The Salmon Ruin site is all the more important in that it is one of the few remaining Chaco sites which is extant and unexcavated. This provides an opportunity to utilize sophisticated archaeological excavations and analytical techniques which were not available when other sites, such as Chaco Canyon National Monument, were developed.

In addition, the excavation plan has provided for the retention of a signficant portion of the Ruin to remain untouched. This will ensure an opportunity for analysis in the future as even more sophisticated techniques are developed.

When completed, the Salmon Ruin site and the associated cultural center will represent a highly sophisticated research facility. In addition, it will provide an opportunity for the public to visit and understand a major example of this significant cultural group.

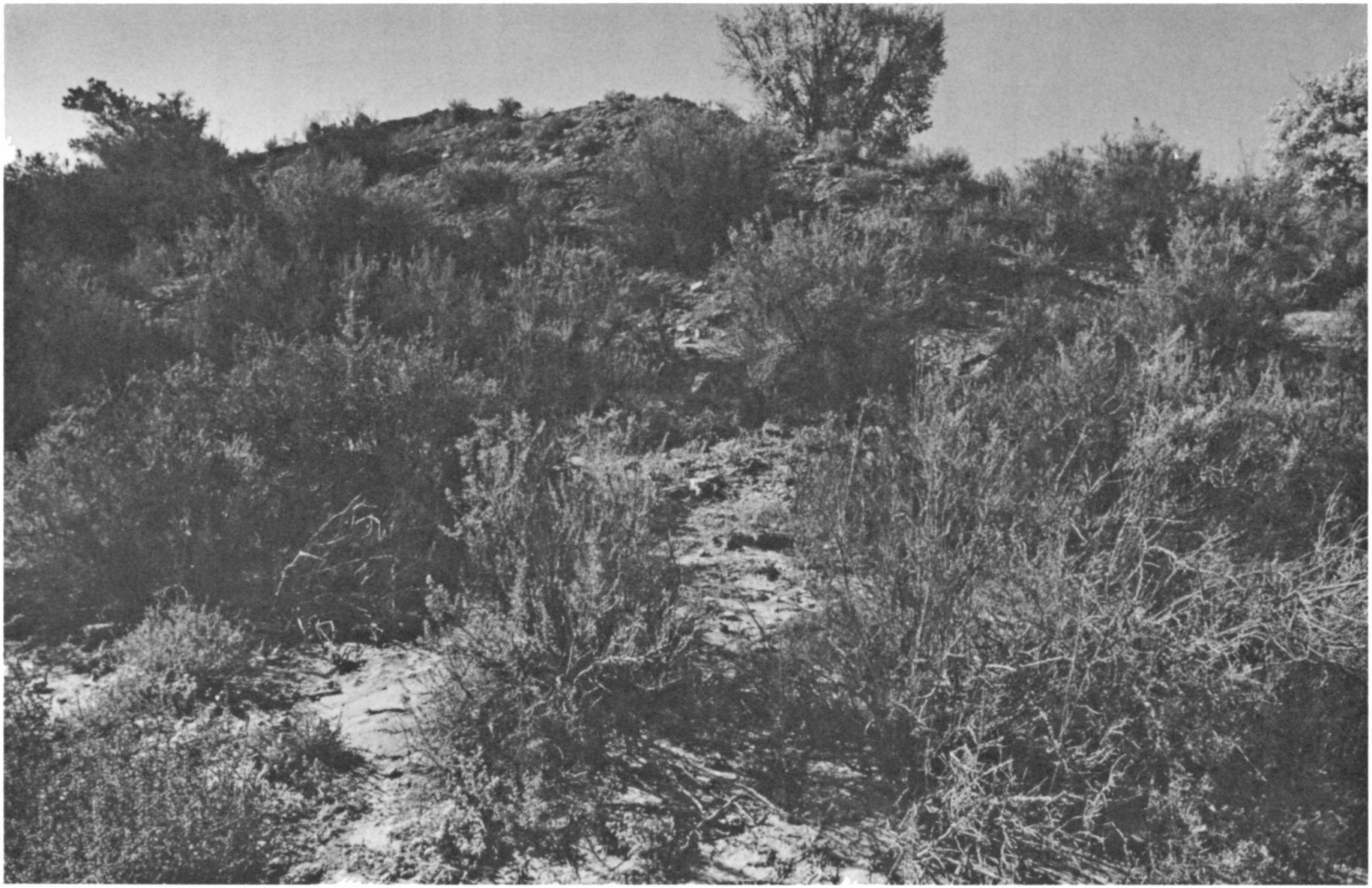

Plate 8: Highest point of Salmon Ruin mound.

Background and Objectives

The present report is designed to provide an interim update on the 1973 operations of the San Juan Valley Archaeological Program under the sponsorship of the National Endowment for the Humanities.

The program, which began full-scale in 1972, was designed to investigate the sophisticated ancient Chacoan culture in the northern Southwest, in terms of its essential structure, its relation to its natural and cultural environment and its relation to other contemporary and subsequent Pueblo developments. The specific focus of the program was on the excavation and analysis of the very large Chacoan town known as the Salmon Ruins. The six substantive goals of investigation originally proposed were:

1) the Salmon site as a living town considered in terms of the socio-political, religious, and other organizations which made it function, and with particular attention to aspects of social control which permitted the massive coordinated effort responsible for its initial creation;

2) the art and architectural, engineering, and planning skills represented, considered in terms of their essential character, and their relation to the structure of society;

3) the economic base on which Salmon rested in its relation to the changing natural environmental context;

4) the Salmon site as a community in relation to other communities within its social environment;

5) an exploration of the potential natural and/or socio-political forces responsible for the abandonment of Salmon and its sister towns; and

6) a comparison of the Chaco community at Salmon with that created by the subsequent Pueblo re-occupation of the site.

Our 1973 approach to investigating the essential structure of the Chacoan and later society which inhabited the Salmon community continued to be focused on the layout, architecture, material culture and other physical remains recovered from the Salmon site and on a consideration of the community in its natural and cultural context. The most significant portions of the program designed to deal with these problems included excavation, regional analysis (survey), ceramic and lithic analysis (see below), spatial and architectural analysis and paleobotanical studies of several kinds. All were integrated through a central data processing system so as to focus on specific questions posed in the research design. Interpretive models were derived largely from ethnography, urban and spatial analytic geography and network analysis. A number of ancillary studies were conducted to provide particular information relevant to these inquiries (e.g., archaeomagnetic analysis, subsurface sensing, dendrochronology, radiocarbon dating, geologic studies, etc.). In addition, a major new facet of the research in 1973 involved investigations in

archaeological preservation (conservation) so that the many "perishable" artifacts recovered (e.g., wood, leather, textiles and basketry) could be permanently preserved.

Many of these aspects of the project were treated in some detail in the 1972 progress report so that the current manuscript comprises an "update" for them (ceramics, lithics and paleobotany); several of them are treated in more detail here (town planning and architectural analysis, preservation, data processing); others still are in progress and will be reported on briefly in this introductory section (dendrochronology, radiocarbon dating, subsurface sensing, aerial photography, etc.).

Investigations at the Salmon Site: 1973

Work at the Salmon site in 1973 was focused on expanding available information on both the original structure and its subsequent modifications (see excavation report and architectural analysis for detail). The original sampling design for penetrating the structure at five equidistant points was adhered to, and expanded to comprise a series of multi-room transects crossing the structure at various angles (front to back, side to side, and diagonally). This was intended to establish the character of intra-community organization by comparing the degree of correlation for materials recovered from each type of room group. Thirty nine ground floor rooms of the primary or secondary occupation have now been partly or wholly excavated.

On the whole, these activities serve to further confirm the initial impression that all or most of the original structure was carefully planned and executed over a relatively short period of time (see discussion of dendrochronology below). Deep testing beneath the sandstone foundations of the masonry structure revealed that the massive walls were footed on deep wall trenches filled with tightly packed cobbles (possibly to provide drainage and/or to prevent settling). These wall trenches were evidently completely planned, laid out and constructed before the above-ground superstructure.

A major concern in 1973 was the initiation of full-scale excavations of the Tower Kiva. As noted in the 1972 report, this large circular community ceremonial chamber (ca. 30 feet in diameter) was located high in the long north wall of the building. It had posed engineering problems for the original builders, which they solved by constructing a series of buttresses around it to support its great weight and height (see accompanying site map). Excavations in 1973 penetrated the structure itself and served to expose the careful and sophisticated character of the masonry and supportive engineering.

By the end of the 1973 season, it seemed evident on the basis of field observations, that during the secondary occupation of the town it had been swept by a disastrous fire which all but destroyed it. However, the inhabitants returned to build again. The fire, although unfortunate for

the townspeople, was beneficial to the archaeological record in that in some areas, materials and objects were abandoned which normally would not have been left. Among them is a very important small statue of a major Puebloan supernatural figure, Lizard Woman, who is vital to production of rain and fertility of crops. This was found on the floor of the burned Tower Kiva, buried under the collapsed roof. In another area a store room was uncovered half full of burned corn. For the primary Chacoan occupation, a number of rooms which had served differential purposes were investigated, including storage and living rooms and a special activity "butchering" room.

On the whole, the impression of two quite distinct societies living in the same physical building was enhanced by the 1973 work. The careful central planning of the initial town was replaced by a much looser organization characterized by strictly ad hoc solutions to housing problems. The two societies were also evidently very differently organized in terms of the function of ceremonial and community life. For the first occupation, only two very large ceremonial community chambers have been detected (the Tower Kiva in the long north wall and the Great Kiva on the plaza); each of these is large enough to serve a considerable portion of the community. For the second occupation, no fewer than 15 round ceremonial kiva structures (many quite small) have been found, possibly reflecting the same kind of decentralization suggested by the differences in town planning, architectural engineering, etc.

Review of Component Projects

Laboratory analysis of ceramic and lithic artifacts and paleobotanical considerations of pollen and plant macrofossils are continuing full-scale; these aspects are considered at greater length in the accompanying relevant sections. Elements of the analysis of the architecture and town planning, which served as the basis for a dissertation for one of the project's staff (Pierre Morenon) are likewise discussed in a separate section. Two other areas of the project which are also discussed in greater detail below produced particularly substantial progress in 1973. These are archaeological preservation and data processing. In the area of preservation, the Salmon Ruin presented an ideal situation for developing and testing techniques and materials for preservation. Some of these applications have been used heretofore rarely or not at all in American archaeology (see below for detail). The newly developed data processing system is now fully operational and is thought to be a major contribution within the archaeological field. As noted in 1972, in view of the size of the program, it was evidently necessary to design a comprehensive data storage and retrieval system. The initial adaptation was organized in terms of the National Archaeological Data Bank System; however, because of difficulties encountered in the application of this system for analytic as opposed to archival purposes, it was decided to shift to the SELGEM data storage and retrieval system developed by the Smithsonian Institution.

Archaeological Program

This shift was completed by the field season of 1973 and the existing 1972 records translated into it. Essentially all aspects of the project data are now handled in computer format: excavation records; regional analysis (survey); geologic observations at the site; botanical sampling and analysis; ceramic analysis; lithic analysis and architectural analysis.

While this is by no means the only computer application in North American archaeology, it is probably one of the two most comprehensive total systems being used (the other was developed by Stuart Struever for the Koster site in Illinois, and is rather differently oriented). The system developed for the San Juan Valley program is very broadly based and structured in the flexible SELGEM format. As such, it should be adaptable to a large variety of archaeological and other problems beyond the immediate objectives of the project. Because of this wide flexibility, a number of universities and musuems in the Southwest have expressed interest in converting their data processing to it. Several of these are, in fact, already in the process of doing so (State Museum of New Mexico, New Mexico Folk Art Museum, University of New Mexico Anthropology Program; Maxwell Museum at the University of New Mexico; New Mexico State University; Museum of Albuquerque). Other institutions which may adopt the system in the near future are the Texas Commission on the Arts and Humanities and the Regional Division of the U.S. Forest Service.

Because of this and because of the number of requests which have

been received for information on the various programs and laboratory analysis developed by the project, it was decided to unite all this information into a manual which will be generally available to all interested institutions and individuals. This manual which is, in fact, simply a byproduct of the programs developed for the use of the San Juan Valley project, will include sections on excavation, ceramic analysis, lithic analysis, regional survey, architectural analysis, botanical collection and analysis, archaeological preservation, and on the formal structure of the archaeological adaptation of the SELGEM system. This publication will be printed by Eastern New Mexico University as a numbered volume in its series Contributions in Anthropology. It is hoped that all or most of the sections will be in print by the start of the 1974 field season. A copy of the section on ceramic analysis is included here as an appendix to this report.

Regional Paleobotany

P. J. Mehringer and K. Petersen (Washington State Univ.) continued their analysis of deep cores from nearby mountain lakes in the region in order to produce the over-all framework of climatic change within which the two societies at the Salmon site existed. Subsequent studies will correlate these very finely understood data to the more difficult alluvial environment surrounding the Salmon site itself. The studies are coordinated with geologic research being done by F. Nials (Eastern New Mexico

University). In addition to the information derived which is of direct relevance to the current program, these investigations produced an unexpected dividend; a "ladder" series of radiocarbon dates indicates that the sediments analyzed go back into the Late Pleistocene (at least 10,500 years) and proceed unbroken to the present. This, together with the excellent quality of preservation in these deep bog strata, have resulted in the longest complete record of vegetation-climatic change in the Southwest. Of particular significance is the fact that the period of erosion and dessication known as the "Altithermal" (2500-5000 B.C.), which has been essentialy unrepresented in the Southwest, is present in full detail.

Dendrochronology

More than 500 wood specimens from 1972 and 1973 were submitted to W. Robinson (University of Arizona Tree Ring Laboratory) for identification and dating. About 150 of these have been analyzed to date and have furnished excellent data both on the chronology of the construction and on the utilization of natural resources by the inhabitants. The first result of this is to confirm our hypothesis that a major portion of the original building was constructed within a very short time. The earliest dates available are all from the construction of the Tower Kiva, further underlining its importance to the community. The dates all cluster around 1088 A.D. and suggest that this was, in fact, the date of its construction.

The next earliest group range from 1089 to 1092 and refer to the transect of rooms just to the east of the Tower Kiva (Rooms 84, 93, 92, 91, 90 and 89 on the accompanying map). The rooms to the west of the Tower Kiva are slightly later still (focusing around 1096). There are relatively few analyzed specimens from the rest of the building as yet, but one from the east wing dates 1105 A.D. for the inside room row. This is in accordance with the predictions by Pierre Morenon based on architectural analysis, that the innermost plaza-edge rooms, and the outermost section of the wings were constructed last.

Of considerable interest is the specific identification of the wood used in construction. The builders of the original town evidently placed great emphasis on quality construction materials, even at the expense of transporting them some distance. In rank order the beams used were of Juniper, Ponderosa Pine, Douglas Fir and White Fir. While Juniper and some Ponderosa Pine are available within a few miles of the site, much of the Pine and all of the Douglas and White Fir must have been transported considerable distances.

The secondary occupants of the town, in keeping with their general architectural tendencies, used principally logs robbed from earlier rooms, some newly cut Juniper and Cottonwood (an inferior wood) in construction. The newly cut Juniper dates in the 1240s A.D., indicating the period of reoccupation.

Archaeological Program

Radiocarbon dating

Radiocarbon dating on samples collected by the project has been done by R. Stuckenrath (Smithsonian Institution) and has served to produce the large scale chronologic framework for regional paleoclimatic studies already noted (see above). Dates already available refer to the deep cores taken from the nearby mountains by P. Mehringer and K. Petersen. Additional dates currently being processed refer to the alluvial chronology nearer to the site itself.

Archaeomagnetic dating

About 35 samples for archaeomagnetic dating were taken in 1973 P. Hammond (University of Utah). Information sought from these analyses is of two kinds: 1) samples removed from ponds are referable to the actual use period of the site during its two occupations (in contrast to the dendrochronologic samples which refer specifically to the dates of construction); 2) samples removed from the burned walls and floors of rooms used during the second occupation should serve to test the field-based hypothesis that the whole structure burned simultaneously. If so, they should also yield the precise date of this event.

Subsurface sensing

Subsurface sensing by magnetometry was done in 1972 and 1973 by P. Hammond (University of Utah) to increase our knowledge of features not readily visible or definable from the surface. The two main areas

which were subjected to this type of analysis were 1) the Great Kiva, in order to better plan for its excavation, and 2) an area in a field about 200 feet from the site where local informants indicate there had once stood another sizable structure which had been completely razed for agricultural purposes in 1906. No surface evidence of this structure is visible at present. Results of the analysis of the Great Kiva indicate massive stone and rubble filling, completely obscuring internal features, so that trenching and excavation will have to proceed with particular caution. The results of the analysis of the nearby field showed the foundations of a large (ca. 50 feet in diameter) circular structure outline. Inasmuch as this is probably an ancillary structure related to the main building, if time permits, it will be tested.

Aerial Photography

After a year's delay due to poor vegetation conditions, a large aerial photographical project was undertaken in 1973. It was in fact somewhat larger than anticipated due to our increasing knowledge of Chacoan road systems and the desirability of following them up. The aerial photographs in color and color-infra red were also designed to show vegetation patterns, geologic structure and any still existing remnants of agricultural-irrigation systems. The photographs have been partly studied for indications of road networks by the principal investigator, and are currently being analyzed in terms of vegetation and geologic

information by Geologist Fred Nials (Eastern New Mexico University) and Paleobotanist Vorsila Bohrer (Eastern New Mexico University).

The preliminary indications of the roadway studies are intriguing indeed. Segments of two well-defined roads have been noted, one near the Aztec Ruins, the other large Chacoan town near the San Juan River The other is much longer and runs from the Chaco Canyon center itself about 25 miles north, to within about 15 miles of the San Juan, where it is obscured by a welter of modern natural gas well roads. The road itself runs in an absolutely straight line and is oriented unwaveringly due north (in fact it follows the modern north-south Range line so closely that the aerial photographic flight line which was laid out on that Range line, maintains the ancient road at that same position on the whole series of flight photographs). It is quite probable that the road was extended the whole distance to the San Juan River. It almost certainly extended almost five miles further than it currently can be traced: the established line of the existing road, when extended an additional five miles, crosses a major tributary to the San Juan River exactly where our regional survey has located another important Chaco town. Of further interest in this line is that this same tributary joins the San Juan River exactly opposite the Salmon Ruin. Limited examination of these roadways in this area indicates that they are wide (20-40 feet) causeways, cleared of rubble, and filled where necessary to level the surface, and that they are frequently

bordered by ditches and/or mounds.

Ethnography

In both 1972 and 1973, the project was fortunate in having the assistance of three specialists in Pueblo ethnography to aid in producing models and hypotheses for testing by means of the available archaeological data (Julius Miller, University of Washington; M. E. Smith, State University of New York, Brockport; William Lee, American University). Miller was particularly helpful in view of his special interest in the social order and mythology and legends of the modern Keres Pueblos. He suggests that elements within Keres society either exist intact or in the form of legend or ceremonial rituals which may provide a key to the complex structure underlying the Chacoan phenomenon. In these is involved a moderately stratified society based on ritual and authority (rather than control of economic resources), and operating through a formalized network of obligations and rights (this is contrast to the situation in many of the advanced cultures of the Old and New Worlds, in which stratification of authority is closely tied with economic stratification). Within the ritual elite of this society is concentrated the totality of ceremonial and esoteric secular knowledge. It is suggested that this kind of base may have permitted the tight social control and exercise of knowledgeable authority which are the necessary prerequisites to the construction of the large Chacoan towns, road networks, etc. This model

has been developed in some detail and is currently being used to design specific tests with the archaeological data.

Other Models

In addition to the ethnographic model outlined, two other approaches are being employed in order to make available a wide range of hypotheses to explain the observed data. One of these is based on spatial analysis and materials used as keys to levels of social complexity, and has been developed by Pierre Morenon in connection with his analysis of the site (see below). The second, developed by the principal investigator, is an application of network theory, derived from sociometry and statistical geography to the analysis of the basic organization of interaction within the community, and its relations to spatial and authority integration. Networking here is measured in terms of degrees of interaction reflected in the statistical relations of material culture from various areas of the site.

Plate 9: Northeast long section of exposed wall.

Excavations

Excavations at Slmon Ruin during the 1973 field season continued along similar lines of investigation that had been defined during the previous (1970, 1971, 1972) field seasons. In addition, certain modifications and refinements of the excavational techniques and recording methods were incorporated into the excavational procedures. A discussion of progress in the major areas of the site will be presented first.

The areas of excavation for the 1973 field season roughly corresponded to the areas that were opened up during the 1972 field season. The excavational team consisted of six crews composed of eight individuals on each crew. Each crew was assigned a separate area on the ruin. These six major areas were: 1) the west wing: an eight-room section on the west wing of the ruin that included several fully and partially excavated rooms from the previous field season. The crew was instructed to finish excavating these rooms that were begun the previous season and to excavate gradually to the north and east in order to define the front or plaza-facing rooms in this area. 2) the northwestern section: a seven-room section between the western wing and the central extension of the ruin. This included several partially excavated and a few fully excavated rooms from the previous field season. The crew assigned to this area was instructed to complete the rooms begun the previous season, and further, to extend their excavations to the east toward the central extension of the ruin, in order to define a larger portion of the rooms directly in front of

the back row of rooms for the ruin. 3) the central area: a seven-room portion of the central area of the ruin. This included several partially excavated interstitial spaces around the "Tower Kiva," and an extremely large partially excavated room directly west of the "Tower Kiva," mentioned previously. Rather than concentrate on completely cleaning out the interstitial spaces around the "Tower Kiva," excavation was begun inside the Kiva itself. This operation required that half the excavational crew concentrate on this Kiva, as it is quite large (measuring more than 9 meters in diameter). The other portion of this crew concentrated its efforts on the extremely large (5 x 7 meters) room directly west of the "Tower Kiva." 4) the mideastern section: a ten-toom segment of partially excavated rooms between the central extension and the eastern wing of the ruin. The instructions given this crew were to complete the previously begun excavations, and if possible, complete a front to back transect of rooms, from the plaza-facing rooms to the back wall rooms. 5) the northeast diagonal transect: a five-room segment running diagonally from the northeast corner of the ruin toward the plaza. There had been no previous excavation in this area before 1973. This crew's instructions were to complete as much of the diagonal transect as possible. 6) the east wing: a ten-room segment of previously partially excavated rooms on the eastern wing of the ruin. The instructions given to this crew were to finish the previous year's excavations, and then to move the excavation gradually

east in order to determine the extent of the eastern back wall, and the back row of rooms.

In addition to these primary areas of excavation under way in 1973, a test trench was begun in the "Great Kiva," which lies in the south central portion of the large front plaza area. This test trench was excavated by members of the laboratory staff during their off working hours, and by members of the other six crews during their off hours.

The extent of excavations or progress in each of the areas that were outlined above will be detailed below.

1. The West Wing. The west wing excavations concentrated on the area directly north of the 1972 excavation areas. The directive was to define intra and inter room activity and connectivity, and also to define the plaza facing rooms. The lack of visible wall tops on the surface necessitated the use of the test trench and search area methods of excavation. The excavations indicated that the primary occupation "Chacoan" architectural units were intensively modified and in some cases even replaced or removed by the secondary occupation peoples. It also appeared that the secondary occupation peoples modified and rebuilt their own architectural units more than once. This is all evidenced by the excavations in this area, which revealed at least two short separate standing sections of Chacoan type walls that were truncated at one or both ends. Of these truncatedsections, the one discovered in the eastern portion of the search

area was a north-south running wall, and seemed to be the front or plaza-facing wall during the primary occupation. The original room that would have been contained within this wall, the Chacoan wall directly to the south, and another missing wall to the west, were considerably altered in form by the placement of a "kiva" type room during the secondary occupation. A small portion of the primary occupation floor level was uncovered in the southwestern portion of this altered area. Cultural material was sparse, but some of the ceramic materials were of the early McElmo type. Because the secondary occupants so intensively modified this particular room area, this small amount of cultural material may be the only primary occupation material recovered for this room.

Using the search area method of excavation to define rooms in this section of the ruin proved to be a most prudent choice. The excavators were able to define at least seven more rooms and the relationships between these rooms, prior to changing to a room excavational strategy. Had they begun excavation with a preconceived notion about the position and orientation of the rooms, they would have had to make extensive revisions of their field notes and forms when the true positions and relationships of the rooms were finally discovered.

This newly opened area proved to be extremely complex in terms of cycles of building, rebuilding and modifying. It was discovered that at least two early secondary occupation rooms had still later secondary

occupation rooms built over the top of them, with the later rooms having an entirely different wall orientation than the lower secondary occupation rooms.

Two of the rooms in this area proved quite interesting. The first of these was pentagonal, and did not conform to the normal four-sided or even circular pattern of most rooms. The second of these was what appeared to be a ceremonial room or special-function room. It is so called because although it was rectangular and above ground or plaza level, it contained several features normally associated with ceremonial rooms: a deflector, recessed hearths, and a number of grooved slits cut into the walls and deflector.

Because of the complexity of rebuilding that occurred in this area, excavation in only one of the newly opened rooms reached the primary occupation level (previously mentioned as containing the early McElmo ceramics).

Other excavations in the west wing area consisted of completing those rooms that were begun in the 1972 field season. This included a total of four rooms. Two of these rooms were secondary occupation kiva-type rooms that had been cleared to the floor in the 1972 field season. The decision was made to go through the floors of these kivas to find the primary occupation floor levels. This was done with some very interesting results. Both kivas had been built inside primary occupation rooms. It

was discovered that in order to construct the southernmost of these two kivas (Room 5) the south wall of a Chacoan room had been completely removed. This was evidenced by a very straight (east to west running) line horizontal stratigraphic break. North of this line, the stratum contained cultural material and a humic or dark color soil, while south of this line the stratum was clean sand containing little or no cultural material.

Below the floor of the second kiva (Room 6) several hearths were discovered which seemed to articulate with the primary occupation floor. There were also several post holes and a number of pits probably used for storage. In the actual floor of the secondary kiva was discovered what appeared to be a closed or clay filled sipapu (spirit hole).

Two burials were recovered during the 1973 field season from the west wing, each one coming from one of the rooms that had been begun in the 1972 field season. The first of these discovered, at the end of the 1972 field season, is the only burial to date from the primary occupation level (Room 4b). The second burial recovered came from a secondary occupation level in Room 4a and contained a Mesa Verde type mug, a Mesa Verde type black-on-white bowl and a corrugated pot.

Some exploratory excavation was carried on in the west wing in the two southernmost rooms (Rooms 1 and 2). The purpose of this excavation was to help define the cobble footings or foundations for the walls, to determine to what extent they were pre-planned and to discover if these cobble

footings might possibly have acted as a rather sophisticated drainage system for the rooms or the site in general.

2. The Northwestern Section. The excavations in the northwestern section of the ruin concentrated primarily on those rooms that had not been completed during the 1972 field season. However, a linear east-west transect was initiated toward the central high mound of the ruin. The objectives for excavation in this area were to determine what inter-room activities could be determined and also, what type of connectivity, if any, existed between the members of the east-west line of rooms.

Only two new rooms excavations were opened in this area and both of these were to the east and directly in line with the previous season's excavations. These rooms, however, did complete the east to west linear transect for this area. The last room on the east end of the transect (Room 37) established a connection between this area of excavation, and the excavation occurring in the central high part of the ruin. The eastern-most of these two rooms was a large rectangular Chacoan room that had been subdivided by the secondary occupants into two smaller rooms. The subdividing wall was placed across the width of the room, making one small room about 1/3 of the original size, while the other room was approsimately 2/3 of the size of the original room. This room was excavated to a secondary occupation floor. In the process of excavation, one burial was recovered in the larger section of the room. It was slightly

above the secondary floor, and had a Mesa Verde Black-on-white bowl with it.

The other newly opened room (36) was excavated to nearly the same depth, however, the secondary level was not reached during the 1973 field season.

The other excavational activities for this area consisted of taking two rooms (that had been excavated to secondary floor level in 1972) down to the primary occupation floors. The westernmost of these two rooms (30a) yielded primary occupation materials at the floor. Below the primary occupation floor was a sterile sandy stratum that probably is the natural terrace that the site rests on.

The second room (31a) that was taken to the primary occupation floor contained a large array of cultural material. Lithic material in the form of large core tools predominated in the cultural assemblage. There were also numerous bones, and ceramic sherds. In general, however, the predominance of lithic material and bone would seem to indicate some type of meat processing room.

An interesting aspect of the secondary occupation was uncovered during the excavations toward the primary floor. Burn lines on the walls of these two rooms, which articulated with the secondary floors, indicated that there were at least two major fires in this area of the ruin during the secondary occupation. This corresponds well to other findings throughout

the ruin of several burned rooms that seem to have been burned more than once.

Excavations in this area also included completing the excavation of a small kiva (Room 33) that was first uncovered in the 1972 field season. The kiva itself was a secondary occupation structure built inside a primary room. Excavation of the kiva was completed in the 1972 season. The goal of the 1973 excavation was to go through the floor of the kiva and find the primary occupation level. This was begun, but weakened foundation caused the eastern wall of the kiva to collapse. This collapse exposed the interstitial space in the eastern portion of the primary occupation room. Within this space, a multiple burial was exposed. The burial pit contained the remains of one child and two adults along with six ceramic grave vessels, and what appeared to be two wooden bows and five arrow shafts. The removal of these burials was accomplished, and clearing operations were begun again in the interstitial space behind the kiva. Approximately 50 centimeters below the multiple burial another burial was discovered. This was an infant who had one ceramic bowl and one ceramic mug buried with it. In addition, the grave also contained a flat cradle board made of what is thought to be cedar.

Excavation in this area was slowed due to the burials. Also, as with the other rooms in this area, the great depths (4 to 5 meters) of the rooms made the removal of the soil a slow process.

3. The Central Area. The excavations in the central area of the ruin produced probably the most spectacular finds of the summer. As mentioned previously, it was decided to concentrate efforts on two areas, the interior of the "Tower Kiva," and the extremely large rectangular room directly west of the "Tower Kiva." Excavations in the "Tower Kiva" progressed quite rapidly in the first part of the field season. The top of the kiva wall was exposed for its entire circumference. A range of masonry styles was observable, denoting the probability of a community-built room. Excavations through the rubble fill went quite well. Then, approximately 50 centimeters above the secondary floor of the kiva, evidence of a major fire began to be uncovered. Charcoal, burned beams, and oxidized adobe covered the entire interior of the kiva. At this point, a most intriguing find was uncovered. Several badly burned human bodies were discovered. Closer investigation and excavation revealed the charred remains of some 15-20 individuals. The remains seem to be of both sexes, and range in age from about two years to mature adults. At first, it was assumed that these individuals had been trapped inside the kiva by the fire that destroyed it. However, the remains were not associated with the floor of the kiva; rather they were in association with the destroyed roof stratum. Evidently they were standing on the roof when it collapsed. Further excavations and analysis may shed additional light on the situation. Excavations also indicated the fire prevented the removal of any materials

from the kiva. A carved stone effigy of a female lizard was found in situ on the kiva floor. Several broken ceramic vessels were found, along with the charred remains of basketry, matting, a cloth bag and sandals. Several figure-8 shaped beads were discovered in a niche on the kiva bench. It should be noted that, although the kiva and most of the kiva features discovered (such as the bench) are primary occupation features, the floor uncovered during the 1973 season was most probably a secondary occupation floor. The primary occupation floor has yet to be uncovered. The walls of the kiva bench were plastered, and the fire was hot enough to fuse the plaster. In some respects, this is good because it preserved some of the paintings that were on the plaster. Efforts for the 1974 field season will be concentrated on clearing the entire kiva floor, and then going through this secondary floor to that of the primary occupation.

The large room directly to the west of the "Tower Kiva" (Room 62) had been partially excavated during the 1972 field season. Efforts were made during 1973 to completely define the size and shape of this room, and also to reach primary occupational levels. The walls of this large room were exposed and in the process a small "ante-room" was found in the southwestern corner of the large room. It appeared that this small room might possibly have been used as a turkey roost. This was evidenced by several post studs in the walls, alternated in height. Excavations were concentrated in the large room. A considerable amount of trash was found,

and the preservation of the organic materials was excellent. In addition to the trash, a secondary floor was discovered. Below the secondary floor, upright posts were found, probably representing ceiling supports for the first occupation. The primary occupation floor was reached in the test trench. However, the entire floor could not be cleared, due to the stabilization crews repairing and replacing the walls of this large room. A very disarticulated burial from the second occupation was discovered in the eastern section of the room near the south and east walls.

4. Mideastern Section of the Site. The objective in this area, approximately half way between the central portion and the east wing of the ruin, was to complete the excavations begun in 1972. Also, it was desirable if possible to complete the front to back transect of rooms, which was designed to check inter/intra-room activity, and front to back connectivity.

Two new rooms (84, 89) previously unexcavated were opened up on the south end of the transect. Adjacent to the plaza, these rooms proved to be secondary occupation rooms that were added on in front of the original Chacoan plaza-facing room blocks. As yet, no evidence has been uncovered to indicate that these secondary rooms were built inside primary occupation rooms. The excavations in the westernmost room in this section revealed two definite burial pits; a possible third burial pit was discovered very late in the field season. The two pits that were

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excavated contained very little in terms of human remains. An outline of the body could be discerned, but the only human remains were the teeth. A pH test of the soil indicated an extremely acid soil as the reason for the lack of remains. Grave goods for the burials consisted of one small bowl and a hematite concretion in one pit, and a small corrugated pot and most of a Mesa Verde Black-on-white bowl in the other. Excavations were halted for the 1973 field season at what appeared to be a secondary floor. The easternmost of the newly opened rooms was not extensively excavated during 1973.

Excavation efforts for the remainder of this area began with a goal of reaching the primary occupational levels in four other major rooms. However, excavations were halted in the two northernmost rooms of the transect when stabilization of the walls became necessary to insure safety of the excavators. The stabilization crews worked in these rooms for the majority of the field season.

The excavation of the two remaining major rooms uncovered some very interesting information. The larger of these two (Room 92) was the central room of the front-to-back transect. It was known from the previous field season to be a primary occupation room that had been considerably altered to accommodate a secondary kiva type room. This kiva was excavated to its secondary floor. In overall appearance, this kiva was slightly abberant when compared to the others at the site. The walls

were made of cobbles, small sandstone blocks and adobe set in a single course. It had no bench, no pilasters, no niches, and no sipapu. However, some of the features in this kiva did correspond to features found in other kivas. It had a circular stepped hearth, a deflector, a small recess in the southern wall, and a very good, deep subfloor ventilator. This is one of two such ventilators as yet discovered at the site. The kiva also had several grooved slits in the walls near the recess. These slits are quite similar to those discovered in the west wing rectangular ceremonial room. Most interesting, however, and unique to this kiva, are what appear to be doorways or entryways leading directly in and out of the walls. There are two such 'entryways'. One is located in the western portion of the kiva wall and the other is located in the eastern wall section. The first of these seems most definitely to be a doorway, as it opens directly into a doorway in the original Chacoan wall. The other is questionable. Only the bottom stone threshold or lintel remained in place. The upper portion of the kiva wall and this 'doorway' were destroyed by wall fall from the second story which had stood directly to the north of this room. If this feature was a doorway, it would have opened into the interstitial spaces between the kiva wall and the original Chacoan wall. If it was not a doorway, it was at least a very large niche. Excavations in this room were terminated at the secondary kiva floor. In the next field season, the floor should be removed to reach the primary occupation levels.

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The room directly to the south of the kiva was a Chacoan type room that had not been altered in size by the secondary occupation. However, it did show evidence of having been used extensively and refloored three times during the secondary occupation. The lowest of these floors indicated no special use other than a "living" unit. It had one hearth centrally located in the room. The middle secondary floor had two hearts associated with it. These hearths were also centrally located but they were slightly to the east of the hearth in the lower floor. One of these hearths shows indications of being intentionally closed: all of the charcoal and ash was removed, and the hearth was filled with clean sand and a thin layer of adobe was put over the top of it. The second hearth contained charcoal and ashes and some buried corn. Also associated with this middle floor were three milling bins located in the western half of the room. This would imply that the room at this time took on a more specialized function than simply a "living" unit. The uppermost secondary floor also had a sandstone lined hearth in association with it. There was also one very large processing metate in association with this floor. After this the room was abandoned as a living unit, and became a trash-collecting locale. From the last secondary floor to the surface the strata were almost entirely trash.

Primary occupation levels were reached in this room. Two definite primary occupation floors were excavated. All indications are that there

is a third floor below the two uncovered during the 1973 field season. The moisture circles of two hearths can be seen coming through the lower primary occupation floor. In addition, a series of three hearths, each built directly or almost directly on top of the preceeding were discovered in association with the primary floor. Excavations in this room were halted at the level of the lower primary floor. Plans for the next field season include determination of whether there is indeed another primary floor below the two that have already been recorded.

5. The North-East Diagonal Transect. This area consisted of a diagonal transect that ran from the northeast corner of the ruin toward the plaza (Rooms 95-99). The basic strategy was to test for any possible variability in intra and inter room activities and connectivity that might have been missed by the other transect strategies. Rather than assume that no diagonal or regional variability existed, it was decided to test for it

Four previously unexcavated rooms were opened on this diagonal transect. The center room of the transect (97) proved to be a large Chacoan type room that had a secondary occupation wall dividing it into two smaller rooms. Secondary floors were found in both of the smaller rooms. The easternmost room was taken to the primary occupation floor in about 1/3 of its total area. In excavating this room to the primary level, two burials were uncovered. The upper burial was that of a child and it was in direct association with the secondary floor. There were no

grave goods with this burial. The lower burial was an adult, and the burial pit was put through the secondary floor into the sterile file. The only grave goods found with this burial were three large corrugated sherds. An unusual architectural feature associated with the primary occupation was a massive staircase. The four "steps" were approximately 30 cm. in height. The staircase is in the southeast corner of the room, and leads to a blocked Chacoan doorway in the south wall. The exact purpose of these steps is not fully understood at this time. The smaller western half of this room was not excavated to the primary occupation levels.

The northeasternmost room of the diagonal transect was a Chacoan type room that did not show any evidence of having been altered by the secondary occupation. The primary floor level was reached in this room and the entire room was cleared to this level. Very little cultural material was found on the primary floor and the room probably had been used for storage. The upper levels of excavation revealed a burned fallen roof. In the northwestern corner of the room, the roof seems to have remained intact for a long period of time before falling. The remains of approximately 19 Mesa Verdean and Chacoan ceramic mugs were found in association with the roof.

The southwesternmost room (96) of the diagonal transect was originally a large Chacoan unit, subsequently modified into a kiva. The secondary floor of the kiva contained ceramic materials, large lithic

processing tools, and two human skeletal bones (one parietal, and one lower arm bone). Excavations indicated that the secondary floor was built directly on top of the primary floor. The two floors were separated by approximately 4 cm. of adobe. In excavating to the primary floor, a large corrugated pot, which had been set through both floors, was discovered. A sandstone jar cover had been placed over the top to the pot. This prevented it from being filled with soil. When the sandstone lid was removed, decomposed organic material, possibly food remains, could be seen in the lower 1/3 of the pot. This material was recovered as a botanical sample. Excavation through the primary floor indicated the presence of trash strata. It is possible that this room was built on top of an early trash dump.

Excavations in this diagonal transect should be continued in the coming field season.

6. The East Wing. Excavations on the east wing of the ruin during the 1973 field season consisted of completing work begun in 1972, and opening up several new rooms.

Room 121a, termed the "painted kiva," because of the paintings on the wall, was cleared completely to the secondary floor. Although it has been termed a kiva, it lacks certain kiva features such as a deflector, sipapu, and ventilator shaft. Extended attempts were made to preserve the plaster and this prevented this room from being taken to the primary occupation levels.

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Room 124a directly to the south of the "painted kiva" was also a secondary occupation kiva that had been placed inside a larger rectangular Chacoan room. In 1972 half of this kiva had been cleared to the secondary floor. The excavations during the 1973 field season cleared the rest of the room to the secondary floor and then the secondary floor was removed to reach the primary floor. During the excavation a situation similar to that of the kiva in the diagonal transect (Room 96) was discovered. In the northwestern section of the kiva a corrugated vessel was found intruded through both the secondary and primary floor. However, this lacked a jar cover over it and it was therefore filled with soil. It appeared that the secondary floor had been laid over the top of the pot after it had been inset in the floor. The primary floor in this room had one hearth in it and some cultural material on it. Excavations were halted at the primary floor level.

Directly east of the above kiva was a large Chacoan room (123 a and b) that had been subdivided by a secondary occupation wall. It was known from the 1972 excavations that the southern half of this subdivided room (123b) contained at least four burials. One burial had been removed during the 1972 field season. The others were removed during the 1973 season. Two of these contained grave goods, one of which was excavated in 1972. The other comprised an infant wrapped in a cloak of cordage, which had probably originally been fur-wrapped. The primary occupation

level or floor yielded a large hearth and some associated cultural material. The northern half of this room (123a) was begun in 1972 and finished in 1973. It had one secondary floor with very little material on it. The primary floor was a continuation from 123b.

New excavations for the 1973 field season in the east wing of the ruin included two new rooms. The objective of opening these rooms was to define the eastern and southern extent of the main ruin. The southeasternmost room (128) was an unusually long and narrow one. It showed no evidence of being altered by the secondary occupation, but appeared to have been used for storage and also for trash. The primary floor has not yet been completely excavated.

The other newly opened room is directly west of this (Room 127). This is a Chacoan room that has had a very small kiva put into it in the secondary occupation. It contains most of the features normally associated with a kiva. There is nothing unusual about it except for its very small size.

In the east wing, future excavations should be aimed at defining the entire eastern back row of rooms.

Modifications in the Excavational Method

The majority of modifications and refinements in the areas of excavation and recording methods centered around the problems of dealing with the diverse and complex stratigraphic situations found throughout the

ruin. One of these important modifications was the manner in which the excavated matrix of different strata were handled in terms of cultural material recovery. It had early been determined that there were two general types of strata at the ruin: 1) non-occupational strata, that is, deposits caused by the filling of rooms with the natural decomposition of the walls and the aeolian and colluvial deposition of sterile strata after the ruin was abandoned, and 2) occupational fill; cultural strata that resulted from materials being deposited while the site was being occupied. In the previous field seasons, all excavated strata were screened. Long hours were spent screening the sterile non-occupational fill. Field observations and analysis of the data recovered from this fill indicated that this was an uneconomical procedure when the time expended was measured against the data recovered. It was decided, therefore, to eliminate the procedure of screening the entire non-occupational fill. During 1973, only one whole control meter square in each room was screened in this particular stratum. This change greatly increased the efficiency of the removal of this stratum, and allowed more time to be devoted to dealing with the occupational strata in each room.

A second major change occurred in the area of recording strata by implementing a systematic, comparable nomenclature. Through previous field seasons' excavations, it was readily observable that each room had its own unique stratigraphic history. In previous field seasons, a

single letter designation was assigned to each stratum in each room. For example, Room 1's first three strata were A, B, and C, and likewise so were Room 2's. It became quite clear that this method was not satisfactory because the strata were not comparable from room to room. A stratum labeled D in one room might be non-occupational fill, while in another room the stratum labeled D might be a floor, or any other stratum. The new system of recording strata employed in 1973 was a coded trinomial method. Using this method, a letter (A-L and X) designation referred to a specific type of stratum. A = surface of ground, while B = non-occupational fill, and C = trash fill, etc. When an excavator had a particular type of stratum in his room, it was given the same letter designation that was given to the same type of strata in all other rooms. The letter code covered 13 different stratigraphic situations. The numerical portions of the trinomial code indicated the number of occurrences in a room of a particular stratum type, and the position of the stratum in the vertical sequence of excavation in any room. For example C-3-04 refers to a C stratum (trash fill) which is the third such trash stratum found in that particular room counting from the surface of the ground down, and is the fourth absolute stratum to have been uncovered in the entire vertical sequence of strata in that room. The field testing of this method during 1973 indicated it to be a much more efficient and accurate method of strata recording. In addition, it lent itself quite well to comparability

and comprehension of strata within rooms and between rooms. The use of the X designation also lent flexibility to the system. So did the use of a system to incorporate strata that did not reveal their presence in the test trench, but were able to be incorporated by the use of decimal points in the recording system.

The entire efficiency of the recording method of field forms was vastly improved over the winter of 1972-1973. Modifications and refinements of the field forms to a checklist type format in 1973, as opposed to the legal abbreviation and computer language of the 1972 field season forms, greatly increased their ease of handling and comprehension by the field personnel, and greatly reduced the possibility of errors in the field. There was no data loss in this change, as the same information was being recorded in 1973 as in 1972.

Data Processing

During the 1972 post-field season of the San Juan Valley Archaeological Project it was determined that the computer storage and retrieval system being used was less than ideal. This was largely because of its non-hierarchical recording system and the prestructured data categories and recording format employed. After several attempts to work with the data in this NCN format, it was decided to look for a different storage and retrieval system, or if necessary, to write one ourselves.

Most existing systems designed for archaeological purposes are plagued with the problem of forcing widely variable data into rigid predetermined categories. Superficially, the use of predetermined categories might seem to be beneficial since it assures comparability in data and recording and should be ideal for the construction of a universal data bank. However, in the long view, this kind of structuring may seriously distort data recording and certainly places limits on what questions can be asked. In this light it is evidently preferable to set up the recording structure according to the particular data range and in terms of the relevant questions being asked by the research design. At the same time, an attempt should be made to cover certain minimal classes of data.

Other archaeological data recording and retrieval systems investigated included the SARG system employed by the Southwestern Anthropological Research Group and that developed by James Brown for the archaeological program at the Koster site in Illinois. The former is

plagued by problems of overly rigid data structuring; the latter is specifically adapted for application at a particular site, and presents some problems in the exclusive use of numeric codes which make it difficult to adapt to other programs. We also experimented with data retrieval systems developed for uses other than archaeology, such as the SOLAR system which was developed for forestry and the GYPSY system developed for musuem archives. Neither of these systems could be fitted to our needs. Finally, at the suggestion of L. Manire (University of Arizona), the SELGEM system developed by the Smithsonian Institution was investigated and proved to be the answer to the problem.

The SELGEM system was developed by the Smithsonian Institution for use in cataloging their many and diverse files. So far it has been applied to a wide range of things, including art collections, natural history specimens and the classification of volcanoes. The SELGEM systems consists of a series of programs capable of a variety of activities including building and updating files, querying files, developing indexes on them, generating reports and preparing tapes for use by other programs such as SPSS or the Biomed statistical package. SELGEM is written in the COBAL language. COBAL has recently been much improved so that the programs it generates are among the most efficient available. It is an excellent choice of languages because it is one of the few available on all brands of computers, and the only one of the universal group that can do input-output

efficiently. This is extremely important when the size of the files used is very large. Its adaptability to different machine size is likewise extremely important. It means that any user can put his data into the SELGEM format and use any available computer. Many other data recording and retrieval systems are written in PL/1, which until very recently was available only on IBM machines. This meant that a data bank was limited to those who had access to an IBM machine. Because of the wide utility of COBAL, there are now SELGEM users employing IBM Univac, RCA, CDC and Honeywell machines. Accordingly, this greatly enlarges the potential data base for a data bank. At this time it is possible to "communicate" directly with other users, such as the Arizona State Museum, and to make use of portions of their data files. This would be impossible without SELGEM since they use a CDC computer while we use an IBM. Another advantage of SELGEM is that it can be run on a relatively small computer without overlaying. The largest program in use fits easily onto a 114 K partition, and with overlays it can even fit into a 52 K partition. Even on large machines on a multi-program environment this is an advantage, since it means that a "job" can be run faster, therefore, more efficiently.

Although COBAL is generally similar for different machines, it still requires some rewriting to fit on the particular brand you use. We have done this for the IBM system. Originally the adaptation was done for

the IBM 360-640 with 128 K of mean storage, and DOS, used at Eastern New Mexico University. Because the production partition at Eastern New Mexico University is smaller than some of the programs original size, these programs were modified by rewriting overlays and by cutting down the number and size of buffers. Eastern New Mexico University does not have tape drives, so the programs were modified for disk use. In addition to modifying SELGEM to run on IBM equipment, we also wrote several programs to interface and adapt the system to IBM equipment. These programs, which are identified by the three-letter prefix SRP carry out such tasks as to load and sort card files for use by SELGEM programs, select tape and disk jumps and do position-by-position editing for changing statistical codes. In keeping with the original aims of the Smithsonian Institution, we have written our programs so that other institutions can use them with as little modification as possible. We have also built a COBAL SYNTAX translater to modify COBAL from non-IBM machines into an IBM-compatible format. This conserves time in converting programs. The general utility and flexibility of the system we have developed was demonstrated recently when the Maxwell Museum of Anthropology, the Museum of New Mexico and the Museum of Albuquerque, in conjunction with the University of New Mexico, adopted the system intact.

In addition to the SELGEM system, we are developing a program-support system for the use of the Graf-Pen, an acoustical digitizer

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(described in the 1972 progress report). The Graf-Pen is used to translate measurements from photographs, maps and artifacts directly into a machine readable format. The program is capable of measuring angles and distances, of making computations to translate the measurements into a different plane, of storing points for use in a plotting program, and of adjusting scales so that all are compatible. The program is based on the FORTRAN language because of its ability to do computations efficiently. The Graf-Pen system is written so as to interface to COBAL programs easily. This sytem is still in the process of testing and is not yet ready for release.

This year the data processing laboratory was able to keep pace with the field and analytic laboratory work with no difficulty. At this point, the files are 95% complete. Field crews turned in field data recording forms to the data processing center once every three days. The forms were then punched and returned to the field crews, usually within two hours of their receipt. Because of SELGEM's modular format, we were able to punch forms that were incomplete at the time they were turned in and to add the missing data later. This kept the computer field files as up to date as possible. Laboratory personnel turned in analytic forms as they were completed. The turn-around for these forms averaged between two and four hours. The system was developed so the cards could be sent by bus to Eastern New Mexico University where they were added to the central

recording file. Instantly needed queries could be returned by telephone. Great success was encountered in the query program in terms of its being able to supply summaries, tallies and abstracts. At this point in time, there are five files in existence: a ceramic file, lithic file, general botany file, general field data file, and a file of locations with a low pH (for use by the Botany Laboratory). Several other files are planned, including a file on regional site survey, one on pollen and one on flotation. This summer approximately 72,000 cards were punched. The two largest files, that on ceramics and the general field file, each have approximately 50,000 unit records (including about 5,500 individual records in the field file and about 2,500 in the pottery file).

One of the most important aspects of the data processing activities was the successful design of workable computer-formatted data forms. These forms extend across the range of operations for the project. They were designed with the intention that the computer should do as much of the work as possible. Information is coded in two ways. One is a variable-format, limited word text method. In this the individual filling out the form is given a choice of words that fits the situation, accompanied with check boxes. These words are keypunched as is. This method is used principally when recording is done by non-computer specialists, or when the file is intended to be used by a wide range of individuals. This approach was used on the field forms and for certain lines of the more specialized

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forms. The other type of data recording consists of fixed position numeric coding. This was used because of its ability to feed directly into statistical packages and to save storage space. It was employed only in cases where the data was being handled and used by a relatively small number of people.

Ceramic Analysis

Accomplishments for the past year in the ceramic analysis division of the Project have been reasonably substantial, in terms of analysis *per se* and particularly in the establishment of a functioning data recording and retrieval system.

In the fall of 1972, while major revisions in the computerized date recording system were underway for the entire Project, preliminary physical testing of some 54 selected sherd samples from the Salmon Ruin was conducted in the Eastern New Mexico University laboratories. Refiring analysis, in particular, yielded some potentially valuable data on the ancient raw materials and manufacturing techniques involved.

It was demonstrated that the so-called "white-firing" clays used in the preparation of black-on-white wares (either as applied slips or entire vessel bodies of the same material) are *not* "iron-free" as might be supposed. On the contrary, all samples tested revealed sufficient iron oxide pigment to render their "white" surface and/or pastes distinctly tan or pinkish-tan in color when fired under adequately oxidizing conditions. While not identified as to precise chemical composition by the tests thus far conducted, the iron content of these clays, in their raw/unfired state, is evidently in the form of the lower oxides having, at most, a slightly grayish coloration. Only upon oxidation, such as induced by heating in a normal oxygen atmosphere during firing, is this iron pigment chemically

altered to a brown or red colored higher oxide. "Diluted" by the natural white color of the clay matrix in which the pigment is found, this "brown" or "red" yields the tan or pinkish-tan pottery colors produced in refiring analysis. The heat-induced oxidation necessary to cause this chemical change is also, as was demonstrated in the laboratory, capable of oxidizing and, thereby, removing the carbon streaks (dark cores) characteristic of the wares involved.

Accordingly, it is suggested that the firing technique employed by the Pueblo potters involved limiting the flow of atmospheric oxygen to the vessels during heating. (Such a technique also provides optimal conditions for achieving dark colors in carbon paints--which can be removed or substantilly faded by excess oxidation.) The evidence does not support the notion that the firing technique involved anything correctly defined as a "reducing" atmosphere. Test data contradicts any suggestion that the iron clay pigments had been reduced from higher to lower oxides during the original firing, or that carbon streaks were produced by the introduction of carbon from a smudge-producing fire. To the contrary, test samples were clearly oxidized during original firing, but only to a limited extent--sufficient to produce "white," rather than gray, surfaces, yet little enough to preclude burning out of carbon paint pigment. It may be added that the rare incidence, in Mesa Verde black-on-white wares, of "red"-on-white patches was easily replicated in the laboratory by over-oxidization of

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of originally black-on-white test samples--a chemical combination of carbon paint substances and clay-borne pigments and/or the clay minerals themselves reacting to yield a pronounced iron oxide coloration.

While the sherd samples subjected to the above laboratory analyses were relatively few in number and not necessarily representative of the entire corpus, they provided preliminary data from which further studies can be directed. Corrugated utility wares, like the painted wares cited, evidenced generally low, though present, iron pigment content. Original firing temperatures for both categories of wares ranged from 700°C. to 800°C., with the majority of corrugated or utility ware samples falling in the 700° - 750°C. range, and the painted wares, in the 750° - 800°C. range. Measurements of apparent porosity or permeability yielded figures substantially consistent - within the 12%-14% range for virtually all samples. Only a few painted wares fell in the higher, 15%-22%, porosity range.

Much of the chief ceramic analyst's time during the fall and, especially, the spring of the 1972-73 academic year was spent in devising and modifying techniques for computerized recording and retrieval of ceramic analysis data. Results of the trial application of preliminary systems (created for compatability with the data bank) from the 1972 summer field laboratory analyses were scrutinized in detail from the advantage point of view of having actually applied this previously untested

analysis-recording methodology to a substantial number of the specific artifacts for which it was designed. As a result, major modifications were instituted, both in data categories included and in the range of variation represented within these categories. Fully revised, the system was then organized into a data record format for the newly adopted SELGEM computer program system (see section on SELGEM system).

By the beginning of the 1973 field season, the four basic recording forms had been developed and printed for summer laboratory use. For every data category on each of these, a "coding list" (or equivalent instructions) was prepared to facilitate the necessary uniform recording of analysis data. At that time, as well, the 1972 procedures for routine processing of newly recovered artifacts were reviewed and modifications introduced where deemed advisable. Cataloging systems were revised and new, detailed record forms/books prepared.

During the 1973 summer field season itself, the ceramics laboratory at the site employed four nearly full-time assistants to undertake the actual analysis of pottery recovered. These students were trained in the application of the new data recording system and in the recognition of the numerous manufacturing techniques and pottery characteristics treated by that system. Sampling techniques (see below) were decided upon by the principal investigator for the project. Working under the constant supervision of the ceramics analyst, the assistants proceeded to process 1,049

selected sherd samples from the 1973 excavations. Record forms were keypunched, at the site, by the data processing staff in preparation for later computer file building.

Analysis and data processing have continued through the fall and winter of 1973-74, with student assistant working a maximum total of eighty hours per week.

The initial summer applications of the SELGEM ceramics format showed the new system to be highly functional and quite capable of recording the recognized range of technological and materials variability in a manner suited to comparative and other studies which are the project's objective. Only very minor changes in category organization and data coding seemed warranted or desirable. Such were instituted prior to the beginning of fall season analyses. All data recorded during the summer was established as a computer data file without modification. A single "edit" program was then run to "correct" data entries to the slightly modified coding system. New data categories that had been added after the summer session were completed for each of the previously analyzed samples, and the data added to the core file.

To date this winter, some 1,300 additional sherds have been analyzed in the Eastern New Mexico University laboratories. Results are currently being added to the existing computer data record.

Excluding provenience data (which is recorded in detail for each

sample), the work completed since the time of the last progress report represents approximately 504,000 data item entries on a total of some 2,400 pottery samples analyzed.

During the fall of 1973, considerable attention was focused on the preparation of a self-contained, self-explanatory ceramic analysis manual detailing the method of application of the SELGEM format recording system. The major portion of this manual, explaining the use of the SHERD ANALYSIS RECORD form, will be ready for typesetting within days. Supplementary sections of the far less complex PROVENIENCE RECORD and RECONSTRUCTED ARTIFACT RECORD forms will follow, as will one detailing the coding system for the PAINTED DECORATION ANALYSIS form. The entire manual is due to be ready, in bound form, for use by the 1974 summer field personnel and for distribution to interested persons outside the project. In the meantime, the printed, looseleaf copy of the manual is being duplicated and made available to project laboratory staff as sections are completed, and has been the basis for all training and research analysis this past fall.

Sampling techniques used during the year have been designed for several purposes, and specific samples selected for each from the 1973 finds: 1) a preliminary comparison of the contents of each excavated room and kiva at the Salmon site, for which a sample was drawn including all sherd materials, from all stratigraphic levels, in two one-meter grid

squares in each room; 2) a survey and complete analysis of materials from the initial construction period (Chacoan) floor levels throughout the site, for which all pottery from the appropriate strata was included (except for three rooms in which, because of the large quantity of material, the size of the sample was deliberately reduced by restricting selection to the contents of two of the four quadrants only); 3) dating and comparison of sub-floor material representing occupation or use of the site prior to the construction of the Pueblo, for which all appropriately stratified ceramics were included in the sample; and 4) a test of the advisability o and/or necessity of continuing the present field practice of excavating "trash" deposits within unoccupied rooms by finely divided, arbitrary levels (for the purpose of identifying otherwise unrecognizable chronological sequences in deposition), for which samples including all appropriate ceramic material from a single grid square in each of two rooms was selected for vertical content comparison.

Artifact analysis and data storage for each of these four problem oriented sample groups is virtually complete. Actual computerized querying and data interpretation will commence shortly.

Most formal analyses of Pueblo materials to date have minimized the lithic inventory in favor of ceramic and archtectural remains. Where treated at all, the analyses tend to be very abbreviated, topical in coverage and inconsistent in terminology. As noted in 1972, it was our hypothesis that there exists a tremendous unexploited potential within this class of material culture, for recording internal social and functional variety. Since no comprehensive prototype of such a system existed, it was desirable to design a computer-compatible analytic system which, while specifically oriented toward the project objectives, might be adaptable to other situations as well. The specific goals of these studies, in terms of comprehending prehistoric behavior patterns at the Salmon Ruin, have been discussed in 1972.

Two basic analytic categories are recognized based on differences in technology of production: chipped stone artifacts and ground stone tools. Within the chipped stone class, four types of analysis were carried out, related to 1) technology of manufacture as reflected by flakes struck off; 2) technology as reflected in cores and core fragments; 3) utilization and retouch of edges of both flakes and cores, in terms of intentional retouch and also in terms of the wear patterns resulting from tool function; and 4) bifacially worked tools.

For the problems relating to production technology, the materials were analyzed in terms of the ten most basic variables believed to be

responsible for observable variety: 1) fabricator (instrument used to apply force); 2) nature of force applied (dynamic, static); 3) angle of incidence of force; 4) force platform/ free-face angle; 5) applied force/ free-face angle; 6) position of point to force contact; 7) treatment of force platform; 8) presence of guide ridges or other free face surface features; 9) support of the core or implement; 10) material employed.

The analysis of flaked tools proceeded through several steps including 1) field provenience data; 2) geometric shape and section as defined by accompanying template; 3) dimensions; 4) material employed; 5) condition; 6) technology of production (see above). Each of these steps was subdivided into a number of numeric or qualitative classes. Subsequently any utilized or retouched edges on a specimen were scheduled for further analysis. This analysis included information on 1) location of worked or utilized edge; 2) contiguous edge class; 3) shape and section of utilized edge; 4) dimensions of edge; 5) description and classification of retouch; 6) dimensions of retouch; 7) position and angle of retouch; 8) preparation for retouch; 9) detailed study of the character of retouch scars; 10) extent and configuration of retouch; 11) nature of utilization; 12) location of utilization; 13) dimensions of utilization; 14) inferred tool function.

Because bifacially worked artifacts present many different analytic problems, they were treated separately (the tools included in this group

are most commonly projectile points, fine knives, drills and unfinished stages of these). Using a series of geometric templates, detailed analysis was carried out on 1) form and section; 2) dimension; 3) condition; 4) material and color; 5) character of retouch (several subheadings); 6) indication of function or wear patterns.

For ground stone tools, two basic functional classes were recognized: 1) nether stationary or semi-stationary milling stones; and 2) active, upper hand stones. Analysis for both classes included considerations of 1) provenience; 2) material and color; 3) shape and cross section; 4) dimensions; and 5) multiple considerations concerning the nature of utilization (e.g., shape and dimensions of utilized surfaces, nature of wear patterns, etc.).

Analytic coding is now in progress for the other much smaller functional classes such as polished stone axes, pendants and other ornaments, etc.

Because over 30,000 items of lithic inventory were recovered in each of the 1972 and 1973 seasons, it was necessary to develop a sampling design which would reflect the larger universe. The design was carried out so as to be as nearly compatible as possible with that used for ceramics 1) two 1-meter grids were randomly selected from each room and all materials analyzed; 2) a more comprehensive sample was taken of materials from the initial (Chacoan) occupation, where recognizable

floor-living surfaces existed; 2) these materials were compared with a smaller sample from the occupational and trash-filled units of the second occupation. These initial sample analyses are nearing completion and will serve as the basis for further sampling designs. It is already apparent, however, that specific activity areas involving the use of lithic implements (butchering areas, milling bins) can be detected. In addition, it is evident that not only form but also material and basic flaking technology varied drastically with functional tool class.

During the summer field season of 1973, the botanical materials recovery program at the Salmon Ruin Site, Bloomfield, New Mexico, was in full operation. Field personnel standardized their recovery techniques by preparing and use a comprehensive Botanical Procedural Manual. The manual included instructions on obtaining spatially coordinated pollen and flotation samples, and on the correct handling of plant material remains recognizable with the naked eye. In it were emphasized three types of excavational situations, each requiring a distinct approach to sample taking. 1) Field personnel collected plant materials and pollen and flotation samples from the surface of the site, in all areas, to use this information as a control on the modern environmental situation. 2) They also took pollen and flotation samples and plant remains from each of the non-occupational fill areas in rooms in order to provide valuable data about the climatic conditions that have existed since the abandonment of the ruin. 3) In any cultural situation the excavators were furnished directions and specific examples to instruct them in sampling and collecting. Cultural situations ranged from various features, such as burials and milling bins, to specific strata which were associated with cultural material (e.g., floor strata). Because of the uniformity in obtaining these botanical samples, and standardized laboratory processing and packing procedures, the data should be comparable for different parts of the excavation. Further,

because of the sampling techniques used, the data should reflect the living habits of the former occupants of Salmon Ruin.

During the summer field season of 1973 excavators gathered over 600 pollen samples and over 400 flotation samples for botanical analysis. In the field laboratory a worker applied a water separation technique on the 400 flotation samples until only a concentrated mixture of seed and charcoal remained. Trained technicians then started separation of seeds from charcoal. As part of their summer work they also supervised the complete inventory of all botanical materials found in the Salmon site. They also spent much time with the excavators on a daily basis, instructing and encouraging them in the correct methods of data collection. In the evening hours they conducted two "flotation schools" for student personnel interested in the laboratory flotation procedures and in the interpretation of flotation data.

Dr. Vorsila Bohrer and Karen Adams (Eastern New Mexico University) and Mollie Struever (University of New Mexico) are continuing the analysis of botanical material during the winter of 1973-1974. The majority of the winter laboratory work has been concentrated on the pollen and flotation samples taken during the 1973 field season. In addition, Vorsila Bohrer and Karen Adams took one productive fall field trip to the Salmon site. There were three major objectives on this trip: 1) to gain more extensive information on the seasonal availability of the

Plate 10: Ruina con Entrada de Dos Pisos.

plant communities in the vicinity of the Ruin, 2) to increase the modern 'voucher' collection of plant specimens, and 3) to search out potential plant resource areas.

In terms of the first objective, to gain extensive information on the seasonal availability of the neighboring plant communities, the field trip was highly successful. It added to knowledge of the growing season and geographic patterns of the plant communities surrounding the site. This type of "External Environmental Observation" is of absolute necessity for a dynamic interpretation of the interrelationships between the Salmon population and their nearby plant communities.

In addition to observing various plants, it was possible to increase the modern 'voucher' collection of plants and seeds by extensive field collecting, and thus satisfy the second objective. This collection will help to identify some of the seed already recovered in the flotation samples in the site, not yet identified. For example, there are numerous seeds of the plant family Solanaceae (the potato-tomato family); the collection of every available Solanaceae in the potential resource area surrounding the site should make possible a more specific identification of the seeds. It may even be possible to take the identification as far as the species level. This modern 'voucher' collection will also serve to verify seed identifications already made.

To complete the third objective on this field trip some very general

plant survey work was done in the area of Gallegos Canyon, an area which has plants that are perhaps useful to man, and which is close to the site. Canyons, especially along the edges of the floodplains, have more surface water or ground water than other areas, thus providing environmental conditions under which certain plant types can grow and flourish. Gallegos Canyon, along with Kutz Canyon to the east of it, provides possible important resource areas, and will warrant much closer examination in the future during the different seasons. Both Canyons are within walking distance of the site, and may offer certain seasonal concentrations of plants not easily available elsewhere in the nearby area.

This fall Karen Adams and Vorsila Bohrer have spent much time sorting and identifying the larger plant remains that were found in the site. Nearly 95% of this material has been examined and certain categories (corn and cucurbita seeds) have been prepared for transfer to the appropriate specialist working in conjunction with this project. The material not transferred to a specialist is being identified by Dr. Bohrer and these identifications are increasing the total numbers of plants, and the variety of plant types known from the site to date. Partly unknown material needing further comparisons with modern plants is being set aside. It is planned to develop a <u>top priority</u> list for the 'voucher' collection in 1974, with special emphasis to include comparative material from certain plant families that will allow more precise identifications.

Botanical Investigations

Most of the remaining winter laboratory time will be reserved for the time-consuming tasks of pollen and flotation sample analysis. In developing a sampling design, a list of priorities was established in terms of information categories, listed as follows:

1. What can be discerned about the Chacoan people who built the original ruin, and are referred to as the primary occupants? What type of plant remains and pollen are found on their living floors? What can be said about them in terms of the use (or non-use) of the plants available to them?

2. What type of information can the plant remains reflect about the functions of the rooms of the Chacoan population? Did the use of rooms vary across the site in any manner (e.g., from the front of the site, in rooms facing the plaza, to the back of the site, in rooms not facing the plaza; from the first to the second story, etc.)?

3. What can be discovered about the secondary occupants of the site, who came in about 100 years after the primary occupants abandoned the site? What types of plant remains and pollen are found on their living floors? How does this compare with the living floor information from the primary occupants within the same room? In the same way, is there variation from room to room?

4. What type of information can plant remains yield about the functions of the rooms of the secondary occupation? When the secondary

occupants subdivided the rooms of the primary occupants, how did they use the various sub-spaces they had made? Did the use of their rooms vary across the site in any manner (e.g., from the front of the site to the back of the site, from the second story to the first)? Can living, storage rooms be defined from the paleobotanical remains.

5. What kinds of information are contained in the various different types of features? What can plant remains associated with the burials reflect about the burial practices of the Salmon populations (both primary and secondary)? Are all burials alike in terms of the plant remains incorporated into them, or are some different, and if different, how? How do milling bins compare in plant content across the site? Do similar seed assemblages show up uniformly, or are there noticeable differences in what types of plants were being processed in milling bins in various parts of the site. How are hearths and their associated artifacts reflected in terms of plant remains? What information is contained in niches in the walls of rooms, on benches in rooms, in pits in rooms? In short, what can various features reveal about the use of plants in the site?

6. Taken as a whole, what information do kivas and other round (possibly fraternity chambers) rooms contain in the way of plant remains? Equally important, what is absent in these rooms that occurs in other types of rooms? What information does a complete analysis of the plaster of these rooms yield about the plastering practices of the Salmon populations,

and perhaps about the time of year when these practices occurred? If sipapus are present, what pollen is contained in them? What pollen and/or plant remains are in the niches in the walls, or on the benches? Can any inferences about ceremonial practices be made from this information?

The above list of priorities is being followed in the current choice in which samples are to be analyzed from the site, and in the order they are being taken under consideration. After some of the first questions are answered, other lower priority questions will be considered, depending on the amount of time available. It is hoped that 100 flotation and 100 pollen samples can be analyzed by the next field season. This should provide a very good data base to answer some questions of prime importance.

Since the amount of time required to totally examine one flotation sample under the microscope often exceeds 30 hours, a method of sampling a fraction of each of the flotation samples is currently being developed. This will cut down the total time necessary for flotation analysis, without loss of information. Mollie Struever has been closely involved with this problem, and after working with various schemes, has begun to draft the final method. She and Paddy Clarke-Johnson (computer specialist) are establishing a statistical test that will indicate what part of each sample is needed to retain the same relative percentages of floral remains. This test will be based on the totally analyzed samples now being processed. Mollie Struever has also been experimenting with further sorting of the

flotation material by particle size, a step in the analysis which allows for more accurate total volume measures, and greater ease of the manual sorting procedure. Upon full development, the scheme will be included in the Botanical Procedural Manual as the final method to be used on all of this year's flotation samples, and on all the samples from further excavation at the Salmon site.

Included on the agenda this fall-winter laboratory season is a re-working of the Botanical Procedural Manual. The field personnel using the manual in 1973 gave constructive feedback which will make it possible to make certain sections clearer, and to add more explanatory information. This manual will prove to be useful, not only to the Project, but to other excavators in other areas who want to be attentive to botanical remains and need technical guidance. All laboratory procedures will also be included in the revised edition. Some of the current work, especially in the area of microscopic flotation analysis with its attendant problems in sampling and sorting, is a pioneer undertaking, and the results promise to be a guide for future archaeological procedures. The manual itself will be one of the first available containing detailed field instructions and laboratory rationale and procedures. The manual will also have a detailed computer codebook written to handle recording flotation materials, macroscopic botanical remains, and pollen data, for easy storage and retrieval within the SELGEM system.

Recently (Leone 1971, Renfrew 1968) it has been suggested that archaeology is expanding to incorporate formal models which are not derived from anthropology. This paper will initially construct a formal model, a model for ranking cultural systems according to complexity, based upon cross-cultural research which appears to be minimally developed by archaeologists and which offers exciting and productive research potential. Assuming applicability of the model, the paper will then develop three hypotheses for the Salmon Ruin and test these hypotheses with architectural data. Finally, the paper will move beyond the empirical results to suggest additional inferences and to include additional sources of information supporting the use of the model.

A Model of Cultural Complexity

Recent work by Carneiro (1967, 1970), Naroll (1970) and Tatje and Naroll (1970) synthesizing cross-cultural data and focusing on cultural complexity in relationship to particular processes, several processes and numerous traits suggest a productive area for developing formal models useful in archaeological contexts. Several assumptions and requirements necessary to a model which ranks cultural systems according to complexity follow.

First, a synthetic and systematic approach to cultural systems is needed to define rigorously states in cultural systems. A system is here defined as "a set of objects together with the relationships between objects

and between their attributes" (Hall and Fagen 1956). In the case of a cultural system the objects are defined as the technic (energy input, control and output), the social (interrelationship between actors), and the ideal (beliefs and values). The specific meanings attached to the three objects follow closely after Parsons (1951), White (1959) and Binford (1962). The attributes of the three objects can be varied but for any particular ranking of cultural systems the attributes must be clearly defined and consistently employed. Twenty attributes will be defined later in the paper, but for the moment it is useful to consider as an example of an attribute of the technic object the amount of energy inputed into the cultural system. Focusing simply on this single attribute it is clear that it would be possible to assign a state to several cultural systems for this attribute alone (as has been attempted by White, 1959).

Second, it is necessary to establish criteria for ranking cultural systems according to complexity. There must be criteria for determining complexity. Thus, in addition to being able to differentiate states of the various attributes within cultural systems, we must be able to determine that particular states are more or less complex than other states. Developing each attribute of the cultural system as a process and developing a scale for each attribute is a requirement. In the case of the preceeding example, increasing amounts of energy input constitutes a criteria for ranking and the attribute when treated in this way becomes a process. It

is clear that developing each of the twenty attributes as processes and as independent scales gives considerable clarity and precision to the final ranking of the various cultural systems.

Third, regularity within cultural systems is assumed. There must be a systematic relationship between the processes. It is assumed that any number of processes can be used independently to assign positions to cultural systems. One might warn that different processes will result in different rankings, and that to use one process over another will bias the ranking. However, here it is assumed that if particular processes result in different rankings that the differences will be minor, and that as the number of processes employed increases the variations between rankings of cultural systems will decrease. Ideally, an infinite number of processes would simply consist of a total description of the particular cultural systems and the assigned levels of complexity in such a situation would be very good indeed. Of course, what is required is the minimal number of processes which give considerable precision to the rankings with a minimal amount of time and energy spent in analysis. If there were a single process that tended to best represent the complexity of the cultural system as a whole then this would be the process to preferentially employ.

Fourth, it is assumed that limited numbers of processes enable generalizations about the cultural system as a whole. Once a scale of

complexity has been established for one or several processes and rankings have been established then it should be possible to make certain inferences about the states of other processes in the cultural systems. If cultural systems were ranked according to the amount of energy inputed into the system it should be possible to make certain inferences about the states of other attributes. One might infer, for example, that those cultural systems with more energy input also would have larger populations, and more agglomerated settlement distributions.

Given these four assumptions and requirements, it is now possible to consider the twenty attributes of the cultural system developed as processes (see Naroll, 1970):

1. increasing command over the environment
2. increasing energy input
3. increasing control of energy throughput
4. decreasing energy output
5. increasing hoarding of wealth (wealth sharing to wealth hoarding)
6. increasing task specialization
7. increasing formality to exchange
8. increasing stratification (egalitarian to rank to stratified)
9. increasing interaction between individuals performing defined tasks
10. increasing formalization of interactions (social distance)

11. increasing stratification within defined interaction nodes or institutions

12. increasing size to interaction nodes or institutions

13. increasing population density

14. increasing settlement agglomeration

15. increasing authoritarianism (consensual to authoritarian leadership)

16. increasing exploitation by a dominant elite (responsible to exploitive elite)

17. increasing complexity in life styles: song, art ...

18. vengeance wars to political wars

19. increasing information

20. increasing number of technical terms

Reviewing the previous argument, it should be clear that any one of the above processes is an adequate base for assigning a relative position of complexity to a number of cultural systems. Once ranking has been established using particular processes, the relative position for the other processes is also established.

Application of the Model to the Salmon Ruin

Applying the model of cultural complexity to the Salmon Ruin is very straightforward. It is only necessary to specify that there is a decrease in cultural complexity at the site through time. If this is true and the model is applicable then through time there should be evidence for decreasing command of the environment, decreasing energy input,

decreasing control of energy throughput, etc. The problem of testing these statements becomes one of adequately controlling the time dimension and employing data that adequately tests these various statements. Time is divided into initial construction and late construction and this division is based on morphological differences, masonry abutment information and dendrochronological data. Happily it is a simple matter to distinguish between the initial and late construction. Traditionally this distinction has been made in the southwest using the terms "Chaco" versus "Mesa Verde." Testing several hypotheses attributable to the model can be done with the masonry data that was collected in the summer of 1972. The research conducted used an attribute approach to the study of masonry, and several attributes were collected partially with the intent of developing this particular model.

Following are three hypotheses and information used to test these hypotheses.

> Hypothesis 1: There is decreasing command over the environment as measured by increasing variability in the resources employed in construction.

Figure (1) in the appendix shows the raw tabulations for several categories of materials used in the initial and late construction. Figure (2) compares summary statistics for the initial and late construction. Using a two tailed Z test allows for the rejection of the null hypothesis that the means of the two samples are the same. An examination of the statistics

and the raw tabulations supports the claim that the late construction shows more variability than the initial construction for the raw materials and supports the proposition that there is less control over the environment as evidenced in the materials used in the late construction as opposed to the initial construction.

> Hypothesis 2: There is decreasing energy input as measured by decreasing amounts of energy expended per unit area of construction.

The unit area of construction is a .50 x .50 meter sample area on the face of each wall. This hypothesis considers amounts of energy expended in construction as a relative measure, and assumes that, per unit area, the initial construction employs relatively more energy than does the late construction. The relative amounts of energy are based on several measures: the proportion of rock in the masonry face, the number of block thicknesses for each wall (one or two), amount of finishing of blocks employed in construction. Figure (3) presents the raw tabulations of stone percentage by 20 percent intervals, for the initial and late construction. Clearly there is a significantly greater proportion of rock employed in the faces of the initial construction. 100 percent of the initial construction has two facings while only 57 percent of the late construction has two facings. This means that the proportion of stone per unit wall is doubled 100 percent of the time for the initial construction, but is only doubled 57 percent of the time for the late construction. However, no significant differences

between the initial and late construction were noted in the production techniques, suggesting similarity in effort in regard to finishing of stone material.

> Hypothesis 3: There is decreasing complexity in life styles as measured by decreasing complexity in design motifs selected for construction.

Figure (4) presents the proportion of associated design elements for the initial and the late construction contrasting observed associations with the expected associations. Expected associations are based on combinations derived from the raw counts of design elements assuming chance associations only. The observed associations are based on the actual associations recorded in the field. The circled associations represent preferred design motifs. Here it is assumed that only those associations where the observed far exceeds the expected should be referred to as motifs. Examination of figure (4) definitely indicates an equal number of motifs in both samples, but the initial construction has motifs that are clearly more complex. The late construction associates design elements of similar kind (for example, design element 4 with design element 4) while the initial construction tends to associate design elements of dissimilar kind (for example, design element 2 with design element 4, or design element 6).

Extensions, Speculations and Additions

The use of the model of cultural complexity facilitates inferences from a limited number of processes to a large number of processes. In

short, it enables the archaeologist to infer considerably more about cultural systems than is convenient to demonstrate empirically. It becomes possible to now expand considerably upon descriptions of cultural systems dynamics at the Salmon Ruin. For example, it is possible to make inferences about the political organization at this site through time. We might expect decreasing authoritarianism. It is also possible to make inferences about stratification within the population at the site through time. We might expect decreasing stratification in the population. Such inferences are supported by the model. Interestingly, some of the possible inferences are also testable. For example, degree of stratification conceivably could be tested with material remains associated with burials.

The use of masonry data to test various hypotheses based on a model of cultural complexity also suggests propositions that can be tested with other material items. There is no reason that the particular hypotheses developed in this paper could not also be tested with other material remains. Such an approach assumes that there are relationships between cultural processes which should be reflected in a number if not all material items. This is an assumption that must be demonstrated. But the point is clear: regularity in cultural systems and processes linked to cultural systems dynamics can make use of varieties of material remains. Masonry should be as convenient an artifact as pottery, ground stone, or chipped stone.

The particular model has been used to make sense of the variability through time at a particular site. However, this is clearly only one of numerous possible applications. One particularly useful application would be on a regional basis. That is, using a model of cultural complexity to develop hypotheses applicable to a region. Sites within regions could be ranked, relationships between sites within various regions could be systematized, the relationship between cultural systems and the environment could be developed, and relationships between regions could be developed using a model of cultural complexity. For example, more complex cultural systems relate to the natural and social environment in different ways than do less complex cultural systems. Specific hypotheses concerning regional dynamics become possible once a ranking of sites, sets of sites, assemblages or regions has been accomplished.

Once again focusing on the Salmon Ruin it is possible to speculate about the position of the site in the San Juan region through time. It is inferred that through time there is decreasing formality in exchange, that the number of traded items and the variety of trade items declines in the region. It is inferred that there is decreasing stratification within defined interaction nodes, that there is declining differentiation between sites. It is inferred that the distances raw materials travel declines. It is inferred that the number of regional projects, involving the regional population as a whole declines. In short, it is assumed that the decline in cultural

complexity at this particular site reflects similar dynamics in the region as a whole. Alternative approaches are possible. For example, it might be inferred that this site individually is changing differently from other sites or from the region as a whole. If this is true, then the amount of energy flowing to this site in relationship to other sites in the region should decline; the degree to which this site contributes to regional projects should decline. . . .

In conclusion, it might be useful to include some additional masonry data that supports the application of a model of cultural complexity to the Salmon Ruin. Research has been conducted along several independent lines using masonry data as the sole testing base. These independent lines support the view of decreasing cultural complexity:

First, the spatial distribution of distinct room shapes is very patterned in the initial as opposed to the late construction. It is possible to clearly specify three distinct rectangular room shapes in the initial construction and demonstrate the clear spatial distribution of these room shapes relative to each other and within the site as a whole. Such is not possible with the late construction. This information suggests more distinct functional areas and distinct activity distributions for the initial as opposed to the late construction. Such a suggestion is congruent with the argument of decreasing complexity.

Second, examination of the construction sequences, renovation, renewal and addition of structures suggests different land use patterns through time at the site. The initial construction is defined by large scale extensive building and addition of large room blocks. There is also a more clear pattern to the building sequence. Thus, even though different wings of the site were probably not constructed at the same time, it is clear that a pattern was maintained. It is clear that certain building regulations were maintained, that certain land uses were preferentially maintained. The shift from a patterned and regulated land use pattern to a less patterned, less tightly regulated land use pattern is congruent with the argument for decreasing cultural complexity.

MATERIAL CATEGORY	DESCRIPTION	INITIAL CONSTRUCTION NO.	INITIAL CONSTRUCTION PCT.	LATE CONSTRUCTION NO.	LATE CONSTRUCTION PCT.
1	FINE SANDSTONE	59	69	22	49
2	MEDIUM SANDSTONE	9	10	12	27
3	COURSE SANDSTONE	18	21	3	7
4	QUARTZITE	0	0	1	2
5	ADOBE	0	0	6	13
6	OTHER	0	0	1	2
TOTALS		45	100	86	100

FIGURE 1: Frequencies of Raw Materials For Initial And Late Construction (Based On Second Observation Of The Attribute Face Material).

INITIAL CONSTRUCTION

MEAN	1.523	STD ERROR	.089	MEDIAN	1.229
MODE	1.000	STD DEV	.822	VARIANCE	.676
KURTOSIS	- .642	SKEWNESS	1.075	RANGE	2.000
MINIMUM	1.000	MAXIMUM	3.000		

VALID OBSERVATIONS 86

LATE CONSTRUCTION

MEAN	2.111	STD ERROR	.223	MEDIAN	1.542
MODE	1.000	STD DEV	1.496	VARIANCE	2.237
KURTOSIS	.226	SKEWNESS	1.251	RANGE	5.000
MINIMUM	1.000	MAXIMUM	6.000		

VALID OBSERVATIONS 45

FIGURE 2: Descriptive Statistics For The Initial And The Late Construction (Based On Second Observation Of The Attribute Face Material)

STONE PERCENTAGE

CONSTRUCTION UNIT	0-20	20-40	40-60	60-80	80-100	TOTALS
INITIAL	0	0	6	39	15	60
LATE	1	3	21	15	1	41
TOTALS	1	3	27	54	16	101

FIGURE 3: Frequencies Of Stone Percentages For The Facings Of Initial And Late Construction.

DESIGN ELEMENTS

	DESIGN ELEMENTS	02 OBS	02 EXP	03 OBS	03 EXP	04 OBS	04 EXP	05 OBS	05 EXP	06 OBS	06 EXP	07-10 OBS	07-10 EXP	11 OBS	11 EXP
INITIAL CONSTRUCTION	02	.10	.19	.10	.13	.34	.22	.01	.02	.17	.07	.00	.01	.10	.05
	03			.04	.02	.02	.07	.01	.01	.02	.02	.00	.00	.02	.02
	04					.02	.06	.00	.01	.01	.04	.01	.01	.01	.00
	05							.00	.00	.00	.00	.00	.00	.00	.00
	06									.00	.01	.00	.00	.00	.01
	07-10											.00	.00	.00	.00
	11			N = 679										.00	.00
LATE CONSTRUCTION	02	.02	.01	.08	.08	.10	.08	.01	.00	.00	.00	.00	.01	.07	.02
	03			.26	.14	.06	.27	.00	.00	.00	.00	.01	.04	.08	.07
	04					.20	.14	.01	.00	.00	.00	.04	.04	.04	.07
	05							.00	.00	.00	.00	.00	.00	.00	.00
	06									.00	.00	.00	.00	.00	.00
	07-10											.01	.00	.01	.01
	11			N = 167										.02	.01

FIGURE 4: Percentages Of Associated Design Elements. 02 = ; 03 = ; 04 = ; 05 = ; 06 = ; 07-10 = Assorted Irregular Shapes; 11 = .

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Conservation or preservation can be defined as an operation to prolong the life of an object by preventing or retarding its natural or accidental deterioration, while restoration is usually thought of as replacing particular portions and reconstituting it to its supposedly original state. Conservation in the United States is at present heavily oriented toward the fine arts, and interest is only rarely shown for the care of archaeological and ethnographic collections. Since many musuems and archaeological preservation projects have tended to specialize somewhat in the materials with which they have chosen to work, various preservation techniques on non-organic and organic objects have been developed independently and the information remains scattered and not readily available.

There is very little in the professional literature concerning preservation of North American archaeological specimens, and no standard manual exists. The single outstanding resource text in the field of archaeological and ethnological preservation, The Conservation of Antiquities and Works of Art (Plenderleith and Werner 1972), relates primarily to European and Middle Eastern museum specimens at the British Museum. Most European museums and archaeologists are probably more informed about archaeological conservation techniques which have been developed than many of their American counterparts.

In order to properly apply a preservative to an archaeological specimen, it is necessary to know something of its physical and chemical

properties and the possible processes of decay or deterioration related to that object. Archaeologically recovered objects may be classified, based on their chemical composition, into non-organic and organic materials. Non-organic materials include metals, ceramics, glass, stone, plaster, gesso, and mosaics. Organic materials include paper, parchment, leather, textiles, basketry, wood, ivory, and bone. Each type of material responds to archaeological environments in different ways according to the particular characterisitics of that material and the characteristics of the environment from which it is retrieved. The organic materials are more susceptible to deterioration which may be chemical, physical, biological, or a combination of all three.

In a totally arid desert climate there should not be any major deterioration of materials. In the American Southwest some objects are found in a better state of preservation than others because of local differences in the micro-environments. Archaeological objects tend to adapt to their new environments upon burial until they become fairly stable. Upon excavation this equilibrium is disturbed, causing renewed deterioration since the object must readapt to another new environment.

A constant relative humidity should be maintained to prevent unnecessarily rapid deterioration of archaeological objects. After being excavated, organic materials such as wood, bone, textiles, and leather are adversely affected by low relative humidity conditions and would be

better kept in an atmosphere around 60% R. H. Metal archaeological objects such as copper should be kept in an atmosphere of 40% R. H. or less to prevent any chemical reaction with chlorides (Majewski 1972:8).

When performing archaeological preservation, it is important to be continuously conscious of the kind of material with which one is working. A preservation technique used successfully on one class of material may ruin another class of material. Conversely, a technique used on one material found in a dry state probably cannot be used successfully on the same class of material when found in a damp condition, without damage or destruction.

As much potential damage can occur by excessive preservation of archaeological materials as by not preserving them at all. If objects appear to be able to survive the ordeal of excavation and transportation to the laboratory, it may be best to apply no preservative, at least until the object can be studied in the lab. The Salmon Ruin is an atypical situation in that a museum laboratory is adjacent to the archaeological site. In any case, field archaeological preservation techniques should be reversible and any chemical used sparingly.

In archaeological conservation, prior to initiating any treatment, the field conservator should formulate the treatments necessary for all possible conditions, and treatments which can be executed in both the field and laboratory. Many types of archaeological materials are likely

to be found at Salmon Ruin and elsewhere in the Southwest, and there are many complex variables (e.g., the condition of the material and the physical environment) which have to be considered. If later laboratory treatments are necessary, they can be conducted with a knowledge of all the chemicals with which the material has previously been treated.

The techniques outlined below were tested at the Salmon Ruin site and, with modifications depending on particular cases and conditions of use, may be suitable at other sites in the Southwest. Recommendations for alternatives are included with their sources, since archaeological conservation remains somewhat experimental in nature.

Techniques: Organic Materials in General

Organic materials found and treated at the Salmon Ruin site during the summer of 1973 will be the main subject of discussion here. The Salmon Ruin site has produced considerable artifactual material of a highly perishable nature (E.G., wood, basketry, textile matting, juniper root fiber, and cordage). These items are rarely found in the United States in an archaeological context, except where arid conditions allow for their fortuitous preservation. Because the above organic materials are not commonly preserved, they must be given a high degree of priority in preservation attempts.

Organic materials derived from plants and animals such as bone, wood, basketry and textiles, must be handled delicately if they are to be

kept from deteriorating rapidly. When these organic materials are found in a damp condition, they should not be allowed to dry out quickly. In many cases, with exposure and dessication they literally turn to dust. Many of these materials should be sheltered from direct sunlight while being excavated and treated in situ.

Techniques: Basketry, Matting, Cordage

1. Problems

Archaeological matting in the past was often allowed to disintegrate for lack of application of preservatives. Matting and cordage, upon excavation, is often found to be in very friable condition. It is often so deteriorated that little of the actual fiber remains, leaving but a mere skeleton or cast of the former object. In a dry environment, such as at the Salmon Ruin, this material may be in a dry flaky condition ready to turn to dust. Matting is rarely found archaeologically in damp environments.

Basketry items may have more in common with wood, in that upon excavation in an arid environment they are susceptible to shrinkage. In damp environments baskets may be little more than black powder due to fungal growth.

2. Techniques used at Salmon Ruin

Solutions to liquid latex and of polyvinyl alcohol were used in an attempt to consolidate matting and basketry during the process of excavation. However, the materials were in poor condition and using these

solutions, only a cast of the material remained. However, soluable nylon (trade name Dupont Elvamide Nylon Resin 8062) used on textile matting, basketry, and cordage at Salmon Ruin worked rather well.

First, loose dirt is cleaned from the material using an air bulb. It may be possible to wash dirt off textile matting, basketry or cordage using 100% ethanol. Then a weak solution (perhaps 2%) of soluable nylon solution which has been warmed is sprayed on. Several thin solutions are better than a thick one. (See Appendix 1 for instructions for making and using soluable nylon solution.) The solution should be allowed to soak in well between applications. Depending on conditions, this is followed with several applications of higher percentage solutions. When the material has become relatively stable, it may be pedestaled, undercut, and removed to the laboratory where it can be placed on a screen to remove loose dirt from the underside. The soluable nylon adds strength and flexibility (rather than the rigidity which might result from using the resins or shellacs commonly used in the past).

If basketry, matting or cordage is found in a damp condition in situ, the soluable nylon solution may bloom (turn white). In this case acetone should be used sparingly as a drying agent first. Then the soluable nylon may be sprayed on with a hand triger spray bottle. No two archaeological situations for basketry, textile matting and cordage are the same. Accordingly, weaker or stronger solutions of soluable nylon

may be necessary. The number of soluable nylon coats which can be applied depends upon the drying rate for the preceeding coats of nylon.

3. Other Techniques

If textile matting is quite damp, polyethylene glycol 1000 (PEG 1000) may be used. Another alternative is to dry the item with acetone, then use soluable nylon when it is completely dry. If textile matting is dry, any synthetic resin can possibly be used in small amounts (Dowman 1970:139). Matting and basketry can also possibly be preserved using methyl methacrylate emulsion which can be removed later in the lab with toluene or acetone.

Basketry items were sometimes treated in the past with beeswax and benzine impregnation for preservation and then coated with celluloid and acetone to improve the appearance. This method should no longer be used due to discoloration, rigidity, and possible resulting stickiness.

4. Suggested references

Arch. textiles - Dowman 1970:139-140

Laudermilk 1937:281

Leeman 1972:235-241

Plenderleith and Werner 1972:120-123

Arch. basketry - Dowman 1970:140

Techniques: Juniper Root Fiber

1. Problem

At Salmon Ruin Juniper Root fiber was used for matting, bedding and roofing insulation material. If the excavated dry fiber is found to be too flaky or if *in situ* fiber is found to be damp, several alternatives exist to physically strengthen it.

2. Techniques used at Salmon Ruin

Experiments were conducted at Salmon Ruin to find the best preservatives for both damp and dry fiber. Because much of the fiber here was relatively dry, some was wetted to simulate damp *in situ* conditions which might be encountered in the future. The following experiments indicate various solutions used on both dry and damp fiber and the results. The following solutions were mixed by volume unless otherwise stated. The samples were immersed once briefly unless indicated. A = immersed dry; B = immersed wet.

		Observations
1. PVA Emulsion - 25% in H_2O	A	firm but flexible
	B	firm but flexible very good results; would be good for wet fiber
2. PVA Emulsion - 10% in H_2O immersed 9 hours	A, B	no improvement
3. PVA Emulsion - 10% in H_2O	A, B	little improvement
4. PVA Emulsion - 50% in H_2O	A, B	brittle, did not penetrate

		Observations (cont.)
5. Glycerin - 15% in ethanol	A, B	crumbly, undesirable
6. Polyvinyl alcohol - 10% in hot H_2O	A, B	too stiff, undesirable
7. Butvar - 4% in ethanol (by weight)	A	somewhat flaky
	B	fiber fairly firm good results; would probably be good on damp *in situ* fiber
8. Soluable nylon - 4% in ethanol (by weight)	A	flexible, good results
	B	slightly more strength; satisfactory results
9. PEG 400 full strength	A, B	oily; undesirable
10. PEG 400 - 50% in H_2O	A, B	undesirable
11. PEG 400 - 25% in H_2O	A, B	oily and flaking; undesirable
12. PEG 1000 - 50% in H_2O	A, B	stiff, waxy; undesirable
13. PEG 1000 - 25% in H_2O	A, B	stiff, slightly waxy still fragile; undesirable
14. PEG 1000 - 10% in H_2O	A	fragile, flaking, undesirable
	B	slightly waxy, undesirable
15. PEG 1000 - 10% in H_2O soaked 10 hours	A, B	flaking & fragile; very poor results
16. PEG 1000 - 50% in ethanol	A	very waxy
	B	wax on surface undesirable

		Observations (cont.)
17. PEG 1000 - 25% in ethanol	A	oily
	B	flaky
		undesirable
19. PEG 1000 - 10% in ethanol	A, B	severe flaking; undesirable

Techniques: Wood

1. Problem

Badly deteriorated wooden artifacts are all too familiar in archaeological contexts. Deterioration may be due to insects and various bacterial organisms that dissolve much of the carbohydrate portion of the wood, leaving primarily only resistant lignin. When partially decomposed archaeological materials such as beams and posts are exposed to drying, shortly after being excavated, they rapidly break down into fragments or dust. Archaeological wood at Salmon Ruin was found in both deteriorated and solid condition.

2. Techniques used at Salmon Ruin

Experiments conducted on fragile and slightly damp wood from Salmon Ruin are listed below.

A. 10% PEG 1000 in H_2O (by volume) soaked 12 hours
Result: soft

B. 10% PEG 1000, 70% ethanol, 20% H_2O (by volume) soaked 12 hours
Result: slightly darkened somewhat less fragile than A (cf. Dowman 1970:137)

C. 10% PEG 1000 in Ethanol (by volume) soaked 12 hours
Result: slightly darkened, stronger than A or B

3. Observations

Experiment C worked best and will be tried next season.

4. Other Techniques

It is sometimes better to let archaeological wood dry out very slowly. Wood can be enclosed in a polyethylene bag with thymcl crystals in the bottom (1.8 gm thymol per kilogram). The fragment may be left in the bag for one year or more so that the wood will gradually adjust to the laboratory environment.

Wood may be wrapped in close-knit net and soaked in the following solutions for the following periods.

PEG 1000	10%	week 1 and 2
Ethanol	90%	
PEG 1000	25%	week 3 and 4
Ethanol	75%	
PEG 1000	50%	week 5 and 6
Ethanol	50%	

At end of the period it is removed from solution and dried.

The following is recommended if the archaeological wood is fairly damp.

Remove some of the H_2O with an acetone bath, then soak in solutions as recommended above.

Polyurethane resin can be used as a sealer if necessary.

5. Suggested references

Dowman 1970:135-138

Mitchell 1972:19

Mitchell and Forbes 1962:477

Plenderleith and Werner 1972:124

Techniques: Botanical Remains

1. Problem

Plants, pollen and leaves excavated may be so delicate as to be mere impressions. However, they can be preserved for identification purposes if they are not allowed to become overly dried out. As a preventive measure, the following preservative solution may be used:

45% H_2O
45% Ethanol
10% glycerine
Add one drop of pentachloriphenol as a fungicide
(Dowman 1970:152).

2. Techniques used at Salmon Ruin

Experiments involving preservatives for burnt maize specimens from Salmon Ruin included the following.

A. Polyethylene glycol (PEG) 1000 - 10%, Ethanol - 70%, H_2O - 20%; samples soaked for period of 12-24 hours. Result: greasy, semi-glossy film on surface.

B. 25% PEG 1000 (by volume) in Ethanol - 12-24 hours. Result: greasy film, semi-glossy.

C. 10% glycerine in Ethanol - 12-24 hours.

D. 45% H_2O, 45% Ethanol, 10% glycerine - 12-24 hours

Observations: The specimens treated according to C. and D. appeared less brittle. Treatments for burnt corn specifically may frequently be unnecessary due to its stable nature.

3. Suggested references

Dowman 1970:152

Techniques: Leather

1. Problem

Leather will be preserved in waterlogged situations or in a completely arid soil. Leather recovered from water will be black but leather recovered from relatively dry soil may vary from brownish to black. The nature of leather recovered from "dry" sites varies according to the acidity of the soil, but usually it is hard and brittle (Leene 1972:248).

2. Techniques used at Salmon Ruin

A small piece of fragile leather found at Salmon Ruin during the 1973 season was preserved moderately well with soluable nylon. However, this technique needs to be examined more fully.

Both wet and dry archaeological leather may be immersed in molten (40°C) carbowax 1500 (Union Carbide) for several days, then removed from the solution and the surface wiped clean with ethanol. The leather is considerably softened and cleaned. Repairs (e.g. stitching, piecing) can then be performed. Leather may also be dipped in water

soluble acrylic resin and then dried between two glass plates (Iwasaki 1969:31).

Early treatments of leather have included the use of cod-oil and tallow or sulphonated castor oil and water (Leene 1972:250). These are not recommended since they tend to leave the leather sticky.

3. Suggested references

Dowman 1970:138

Guldbeck 1972:91-92

Iwasaki 1969:31

Leene 1972:248-251

Waterer 1972:11-12

Werner 1963:126; 1968:267

Techniques: Bone

1. Problem

Under very dry conditions all the organic materials are lost from bone and only the calcium salts (hydroxyapatite) remain. The bone becomes very fragile and flakes easily. Under acidic soil conditions calcium salts are leached out and only collagen remains (bone becomes rubbery and can be tied in knots). The bone eventually disappears and leaves only a white stain in the soil.

Archaeological Conservation

2. Techniques used at Salmon Ruin

Bone preservation at Salmon Ruin involved stabilization of dry fragile bone using 4% Butvar (B76 - 3864) by volume in ethanol. The Butvar may be sprayed or dripped on the bone after it has been dusted with a hand air bulb. If *in situ* bone has too much moisture, acetone may be dripped or sprayed to remove the moisture before the Butvar is applied. Butvar is absorbed into the bone and adds strength because of its crosslinking action. Results were fairly satisfactory using Butvar.

3. Other techniques

A. Bone in dry powdery condition:

Use PVA-AYAF (middle grade polyvinyl acetate resin) made by Union Carbide.
Dilute PVA in acetone (methanol dries it out), may be used in same manner as Butvar (Werner 1963:126).

B. Damp bone:

Use polyvinyl acetate emulsion (trade name Dupont Elvacite). Dilute with H_2O to approximately 10% or thinner. "Elmer's Glue-All" is a form of PVA emulsion.

C. Following the cleaning and restoration of bone, it can be dipped in a transparent preservative such as Duco, Ambroid, or Gelva mixtures which are the consistency of water (Bass 1973:255, 258).

Bone in good condition may be cleaned with a damp cloth or brush. If necessary, more intensive cleaning can be performed with either "spirit soap" or a weak solution of ammonia and water.

Formerly, bone in fragile condition was treated with Alvar,

Celluloid, or melted paraffin. These solutions tend to darken specimens, while Butvar or PVA do not.

4. Suggested references

Bass 1973:255, 258

Dowman 1970:133-134

Guldbeck 1972:136

Mohammed Sana Ullah 1946:80

Plenderleith and Werner 1972:151-156

Werner 1963:126

Techniques: Wallpainting

1. Problem

Archaeological wall paintings vary considerably in structure. For this reason careful examination must be made to determine the condition of preservation and materials involved in each situation. Each preservation job is usually a special problem.

While excavating in an area with wall paintings, care must be taken to prevent rapid deterioration. Sun shades may reduce drying of the wall plaster. The sometimes paper-thin multi-layered wall paintings crack, flake, or peel away from the wall upon drying out. Kiva wall paintings at Salmon Ruin were composed of red hematite on gypsum whitewashed adobe plaster and were found to be in very fragile condition and in danger of peeling off in layers. The sun tended to bleach the wall

paintings and the use of soluable nylon as a consolidant during the 1973 season stabilized the outer layer but increased the plaster's peel-off rate. Other techniques will be tested in subsequent seasons.

2. Other techniques

Recommendations for preserving wall paintings include the Strappo technique, which involves the removal of only the paint layer. This technique is suitable for use where the paint has little adhesion to the fine plaster and the whole surface is flat (Dowman 1970:129).

There are two other methods for transferring wall paintings. The "back removal" method involves impregnating the wall with a water-insoluble colorless lacquer and attaching a paper and cloth facing. The "front removal" method is a stripping or pulling technique applied when the painting is taken from the wall in situ (Gettens 1951:63-64).

A variety of consolidants for wall paintings have been suggested. For example, Werner suggests a 5% solution of soluble nylon in ethanol or methanol (1963:127). Watson Smith, who was in charge of preserving Kiva murals at Awatovi, experimented with various stripping solutions and found the following formula worked best:

100 cc Alvar 7-70
100 cc Acetone
60 cc Ethylene Dichloride
20cc Dibutyl Phthlate

Alvar is very difficult to obtain in this country. The task involved stripping successive layers of paint (Smith 1952:40).

Majewski mentions a number of materials which have been used to consolidate the flaking paint of archaeological wall paintings, including 1-5% polyvinyl alcohol in H_2O, 5% polyvinyl acetate in alcohol, an acrylate methacrylate copolymer (e.g., 5% Acryloid B-72 in xylene), or a concentrated lime water solution (1972:11).

3. Suggested references

Bliss 1948:218-223

Dowman 1970:128-131

Flamm 1965:4

Gettens 1951:59-72

Majewski 1972:11-12

Rosenquist 1963:143

Smith 1952:33-52

Werner 1963:125-127

Techniques: Consolidation of Stone and Adobe

1. Problem

Stone found at archaeological sites may be in good condition and need no treatment. In other circumstances it may be badly deteriorated and crumbling. Ground water rises by capillary action and evaporates from a stone or adobe wall just above ground level. Alkali (soluble salts) in the ground waters of the American Southwest means that salt is formed on the stone or adobe along the evaporation lines leading to deterioration of the wall.

Archaeological Conservation

No preservatives for sandstone and siltstone have yet been attempted at Salmon Ruin. Consolidation of extensive areas would probably be expensive and involve considerable equipment, labor and experimentation.

2. Potential techniques for Salmon Ruin

Soluble salts may be extracted by applying wet paper pulp to the surface using repeated applications. The pulp dries and absorbs the salts. This may be an impossible task on *in situ* walls.

Former methods used for ruins preservation include concrete, sodium silicate and synthetic waxes. All proved unsatisfactory. Satisfactory agents for stabilization of adobe or stone have included: 1) cement-strengthened soil with the following mix may be used: 1 part cement to 9 parts of a mixture of soil and sand. This is not desirable for use on adobe walls. 2) Pencapsula, a polyurethane resin, was developed for use on sandstone and adobe and does not serve as a cementing agent. Stone sprayed with it is highly resistant to erosion. However, spraying has not been effective in maintaining an adobe wall. 3) Soil seal, a methacrylic compound, is used 1 part with 9 parts water on raw earth surfaces. 4) Chevron Research Product 69R 5612 is a petroleum-derived water-proofing compound for mud bricks (Steen 1971:60-62).

3. Other techniques

A. Silicon ester for sandstone and siliceous limestone

which will be kept indoors. (Kennedy 1960:20; Plenderleith and Werner 1972:310)

B. PVA in toluene and acetone or Bedacryl 122x or Elvacite. (Dowman 1970:125)

C. New York University Conservation Center is experi menting with a formula made from water, barium hydroxide and urea to strengthen and harden limestone.

4. Suggested references

Dowman 1970:125

Flamm 1965:6; 1966:3

Kennedy 1960:20

Mohammed Sana Ullah 1946:77-79

Plenderleith and Werner 1972:302-311

Steen 1971:59-64

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APPENDIX I

Basic Chemicals Needed

1. Butvar B76-3864 - P. V. butyral (Monsanto)
   Butvar is soluble in alcohol. It has similar properties to PVA but stronger for dry non-metallic objects. It crosslinks.

2. Carbowax 1500 (Union Carbide)

3. Pentachloriphenol - commonly available at lumber yards under the name "Penta."

4. Polyethylene glycol 1000 (Dow Chemical)

5. Polyvinyl acetate emulsion
   Trade name Elvacet (DuPont de Nemours & Co.) It is soluble in H_2O.

6. Polyvinyl acetate resin - AYAF (Union Carbide)
   It is soluble in acetone, methylethyl ketone, ethanol and methanol.

7. Soluble nylon - trade name Elvamide 8062 nylon resin (DuPont de Nemours & Co.)

8. Ethanol - need Federal Government approval.

9. Methanol - usually available in hardware stores.

10. Acetone - usually available in hardware stores.

APPENDIX 2

Instructions for making soluble nylon solution

Use of Soluble Nylon on Basketry, Textile Matting and Fiber

Soluble nylon - trade name Elvamide from DuPont (Nylon Resin 8062); could substitute Calaton CA $4/lb.) from I. C. I. Organics.

Use gram scale and measure weight of beaker to be used for holding Ethyl Alcohol.

A 200 ml. beaker weights about 100 gms.
Weigh out 25 gms soluble nylon
Weigh out 600 gms or app. 635 ml ethyl alcohol

Ethyl alcohol (ethanol) - CH_3CH_2CH
Boiling point 78.3°C.
Very inflammable
Evaporation rate 7.
Storage stability - absorbs H_2O on storage

Warm ethanol in pyrex beaker. If possible place square piece of glass over top of beaker to reduce evaporation of alcohol. Put glass thermometer in beaker and heat alcohol to around 50°C. Add soluble nylon a few crystals at a time. Mark line on beaker for alcohol level so that additional alcohol can be added to compensate for that which evaporates. (One can also place tin foil over beaker if glass is not available.)
Stir occasionally.
This is the fast method of making the solution. If time allows, leave solution of ethanol and soluble nylon in closed jar for a day or more until the soluble nylon has "melted" down to syrup, then warm and stir.

Spray on soluble nylon with hand trigger sprayer. No two archaeological situations will be the same, therefore stronger or weaker solutions may be needed for various situations.

When applying soluble nylon solution, it is better to start off too dilute than too thick. In case solution is applied too thick and looks glossy, try spraying with 100% ethanol to disperse it.

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Plate 11: Artifacts in place as found in 13th century kiva, room 6.

Plate 12: Painted wall in 13th century kiva, room 121 A.

Plate 13: 11th-13th century kiva, room 64, destroyed by fire while in use.

Plate 14: Mealing bins from 13th century.

Plate 15: 13th century burial.

Plate 16: Stabilization of north wall, room 62.

GPO 891-195