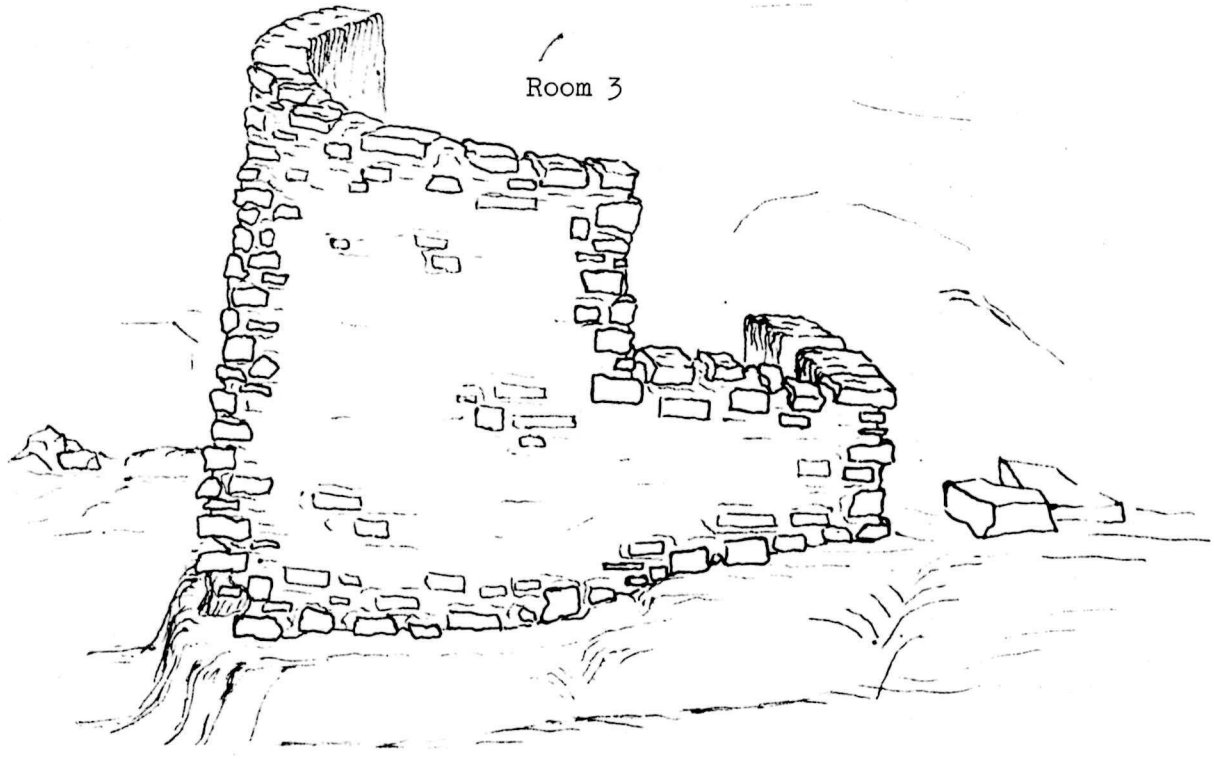
SNAKE HOUSE RUIN 1978

Stabilization of Snake House Ruin

by

Susan L. Breternitz Goulding



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The National Park Service is charged with the preservation of a number of major archeological ruins in the southwestern United States. The maintenance of this resource has been a concern since the inception of the National Park Service, and a number of good ruin stabilization projects have been done. However, the efforts over the past 30 years have suffered from lack of funds, sometimes less than fully trained personnel, and more important, a lack of enthusiasm for research and development of new means of stabilization. The practical developments in fabrics since World War II, especially in metals, cloths, construction materials, and plastics, suggest that new materials may be readily available for stabilization, but these materials are not employed by those responsible for ruin stabilization. However, this pattern is now changing.

The development and exploitation of new techniques quite often does not occur accidentally, but results from planned research to meet specifically defined needs. In response to a citizen inquiry into the preservation of a specific archeological site, the National Park Service, working in conjunction with the Bureau of Land Management and the Bureau of Reclamation, initiated a program to begin developing a material for in situ preservation of pictographs and petroglyphs. Experts in rock art and preservation were sought and a research program initiated under the capable hands of Dr. Christy G. Turner, Anthropology Department, Arizona University; Dr. William J. Burke, Chemistry Department, Arizona State University; and Dr. Richard Bradshaw, then a graduate student at Arizona State University. Some of the conditions of this research were that the stabilization material must not cause visible color or composition change of the rock, must not accelerate deterioration of the rock, and must allow water and salts to pass through the rock as if untreated. More importantly, the application of the material must be easy and the material itself inexpensive. Some eight months after the initial laboratory testing began, we were requested by the Bureau of Reclamation to make the first on-site application at the Davis Pool pictographs site in Glen Canyon--a site destined for inundation.

Burke and Bradshaw had evaluated in the laboratory a number of potential materials which might be useful in the stabilization of stone. They settled upon one material that was most promising. In May 1976 we applied methyl methacrylate to the Davis Pool pictograph site. We met with some success in the application, finding a general increase in hardness of the rock panel. But the success was limited. There were a number of variables which impinged upon the application of the material in the field, variables which were not anticipated in laboratory tests. Research continued in 1977 and 1978. Attempts were made to resolve problems of application using chemicals which would work under a specified range of temperatures. Research was also expanded to include studies in the possible use of methyl methacrylate

in the preservation of adobe. But as with most scientific research, progress was generally limited by availability of funds and, of course, sometimes frustrated by results other than those anticipated by the experimentation. There were also administrative problems to be resolved before a material which would work could be developed. There were those in the historic preservation field within the National Park Service who are not favorably disposed to the development of the chemical method of perservation.

Throughout the research period, a number of tests were made in the field, both on experimental recently constructed walls and on archeological sites destined for imminent destruction through inundation, or erosion by natural or human forces. Methyl methacrylate is generally applied only in instances where all conventional means of stabilization have failed. And it is for this reason that methyl methacrylate was used at Snake House.

The current project is also an obvious example of the application of chemistry to archeological problems. Dr. D. A. Breternitz was charged with the responsibility of stabilizing Snake House. He encountered a problem in the field which could not be resolved by traditional stabilization techniques. Breternitz had met Burke at the National Park Service's First Conference on Scientific Research in 1967. Breternitz decided that methyl methacrylate could be applied to stabilize the stone prior to the application of more traditional stabilization techniques at Snake House. With the capable assistance of Drs. Burke and Bradshaw, and assisted by Ms. Barbara Ustasiewski, methyl methacrylate was applied to the ruins at Snake House in the summer of 1978. To be sure, there were problems in the field application of the material and concern on the part of the researchers. But working under the most primitive conditions, the application of methyl methacrylate appeared to be successful.

In the spring of 1979 a number of people visited Snake House to evaluate the effects of the methyl methacrylate in the stabilization. It is apparent now that the use of methyl methacrylate at Snake House has resolved one of the major problems faced in the stabilization of this ruin. The data, fully reported here, confirmed the utility of the research conducted by Dr. Burke and outline a potential new use of methyl methacrylate in stabilization.

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Chief
Midwest Archeological Center

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ACKNOWLEDGEMENTS

A special thanks is extended to the working crew which consisted of David A. Breternitz, Jim L. Firor, Mike J. Hilton, Todd R. Metzger, Enrique Monterroso, Greg "Charlie" Nelson and Shelli L. Nelson. Conditions were close and primitive, but everyone gave 101% and without their long, tedious hours the stabilization would not have been accomplished.

I would like to give a special thanks to Todd R. Metzger, the chief foreman of the stabilization. When I became ill and had to leave the project five days before it was completed, all notes and responsibilities became his. He did an excellent job and once again, most of the report would have been impossible without him. He also wrote the Soils Appendix and aided in much of the actual preparation of the report, adding to many of the chapters.

Dr. William J. Burke and his co-workers, Mr. Richard Bradshaw and Ms. Barbara Ustasiewski, carried out the necessary work with the methyl methacrylate and adjusted to field conditions extremely well. The conditions were less than perfect for the application, but all calculations and necessary changes were made so that the methyl methacrylate would create as good a bond and foundation as we needed. Their work was superior, given the field conditions under which they had to operate.

The National Park Service, Southwest Cultural Resources Center, conceived the project and continued to support it even when some modifications became necessary. They were more than understanding and their time and efforts made the whole project possible. They deserve many thanks for all of this work. I would especially like to thank Larry V. Nordby and Ronald Ice for their continued interest.

The Navajo National Monument staff was also extremely helpful, especially Superintendent Frank Hastings and archaeologist Norman Ritchie. Norm also provided me with many useful sources and records.

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An extra thanks goes out to my father, David A. Breternitz, for

without his confidence in me I would not have been given the responsibility for writing this report and would never had the opportunity to work in the area. He is constantly an inspiration.

Special thanks to Dr. Burke for his drawing used on the cover page.

I would also like to thank anyone that I have left out. Anyone and everyone who had anything to do with the project has my deepest gratitude.

Finally, I would like to thank my husband, Douglas Goulding, for continuing to give me the confidence and incentive that produced the final copy of this report. His inspiration and suggestions were necessary for the completion of this report.

INTRODUCTION

Snake House is a 19 room cliffdwelling located in a detached portion of Navajo National Monument in Northeastern Arizona. It is located high in the west wall of Nitsin Canyon, around the corner and slightly east from Inscription House, which is built in the same rock formation (Fig. 1). Snake House is situated at approximately the same level as Inscription House and the only approach to the ruin is a steep sloping slickrock outcrop of Navajo sandstone (Fig. 3).

The first documented record of visitation is in 1925 (West 1925: 36) but it may have been previously excavated by the University of Utah expedition under Cummings. The generally accepted inscription of 1866 in Inscription House Ruin, may mean that these same visitors also saw Snake House, though they never acknowledged its presence (Ward 1975).

The ruin is constructed in Kayenta style masonry which can be characterized by having shaped and unshaped stone with a heavy use of spalls both as true levelers and for non-useful, aesthetic purposes. Spalls are both chunk and flat pieces of sandstone. The masonry typically includes sloppy masonry and uneven rock aligning with overlappying adobe, rocks and chinking. The mortar is highly weathered due to exposure and is soft and flaky on the surface, but increasingly hard toward the core where it is harder than most of the stone utilized in the masonry. The rock is also highly weathered and powdery. The ruin contains hand and toe holds, petroglyphs, including a snake for which it is named, plaster (Rm. 15), wood (Rm. 3), and there are element stains on the back of the rockshelter wall. Overall, the structures are very exposed to the elements, and their weathered conditions reflect this fact (Fig. 4).

Weather Records

The trader at Inscription House trading post maintains a rain guage and partial weather station. The following figures were obtained from him by Norm Ritchie.

1978 - 7.73" of rain
1977 - 8.58" of rain
1976 - 6.84" of rain
AVG - 7.71" of rain over the three year period.

In addition, the trader supplied the information that winds blow the strongest in April, from the west.

Weather records at a weather station set in Inscription House Ruin in 1968, 1969 and 1970, show the following averages:

TABLE I
WEATHER RECORDS

	Temperature		Humidity	
Date	High	Low	High	Low
May-October, 1968	73°F	52.4°F	36%	21%
March-August, 1969	78°F	68°F	43%	26%
June-July, 1970	81°F	61°F	47%	32%

The weather at Navajo National Monument differs substantially from that in Nitsin Canyon so those records can not be used for comparison. Each canyon in the region is slightly different; thus, this is as close as we can come to understanding the weather in the Snake House area and possibly how and why it has had such an effect on the exposed ruin.

SITE DESCRIPTION, AREA DESCRIPTION

"Why visit such a hazardous land?" (Bernheimer, 1929:3). Charles Bernheimer came to know the hazardous land well, and though he talked of the dangers, he loved the area and described it well. He describes the

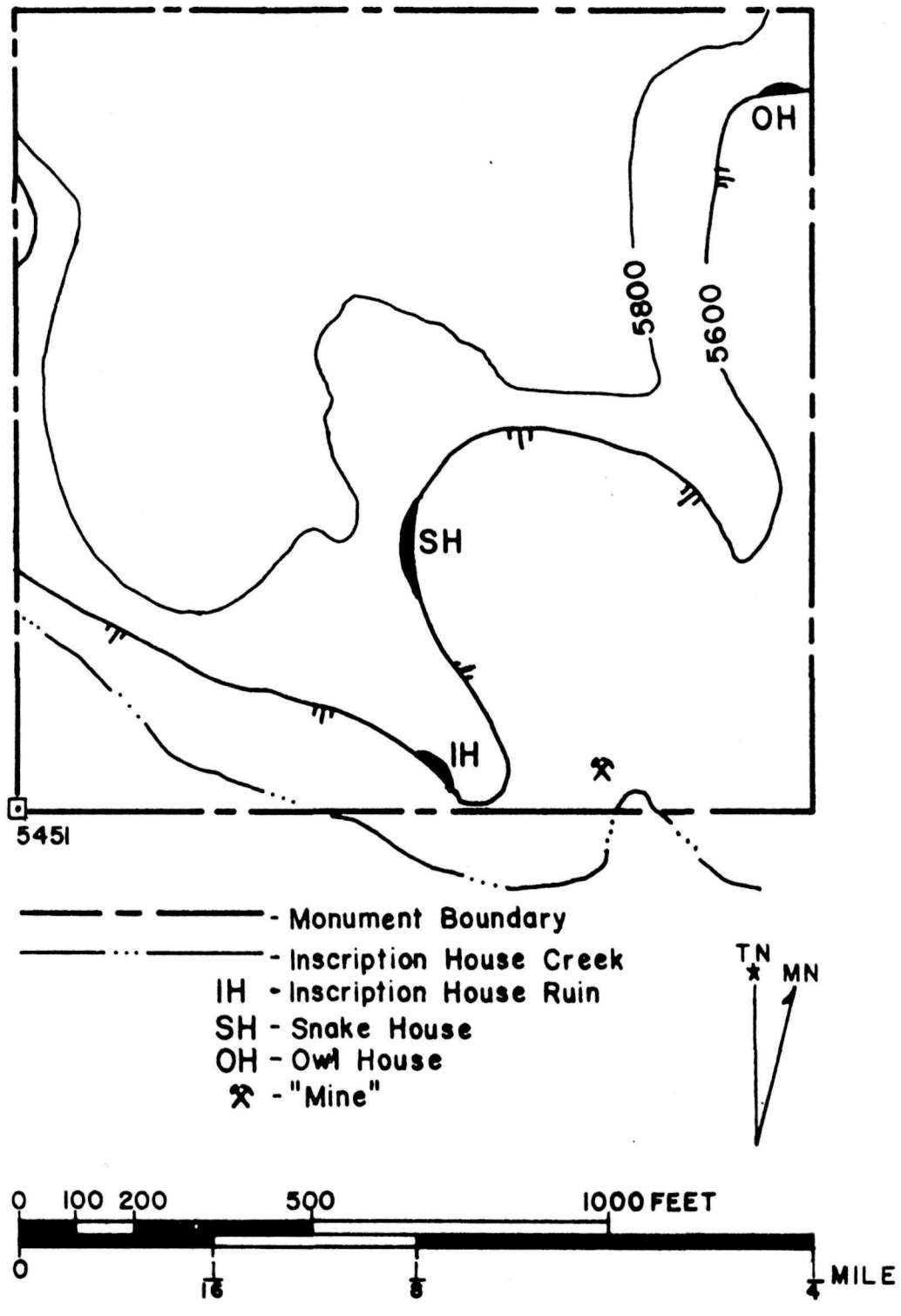


Figure 1. Overall map showing the location of Inscription House, Snake House and the mine. (Map drawn by David A. Breternitz.)

Figure 2.
Snake petroglyph. Body is pecked, mouth is ground. Upper design pecking is supposedly a map of the canyons.

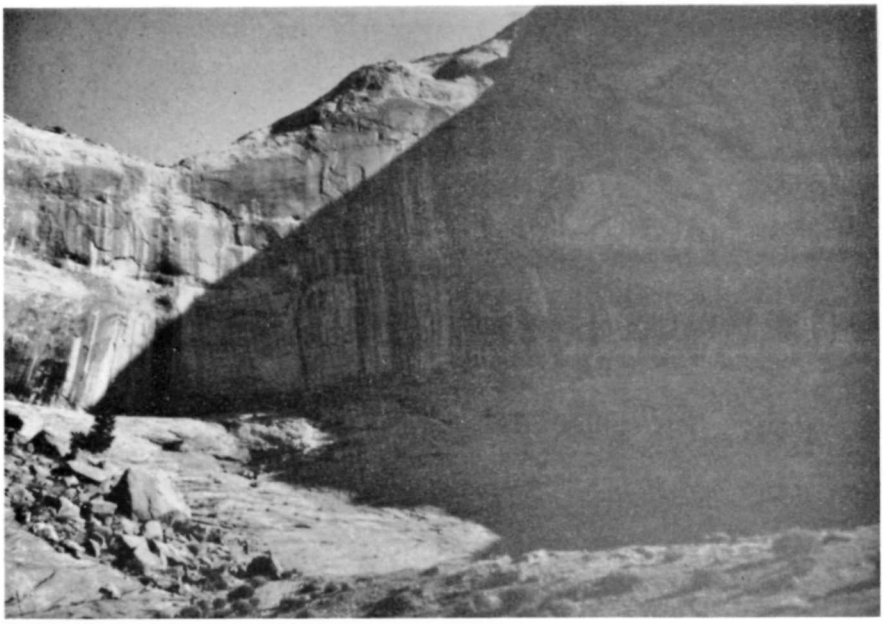


Figure 3.
Snake House location in cliff band.

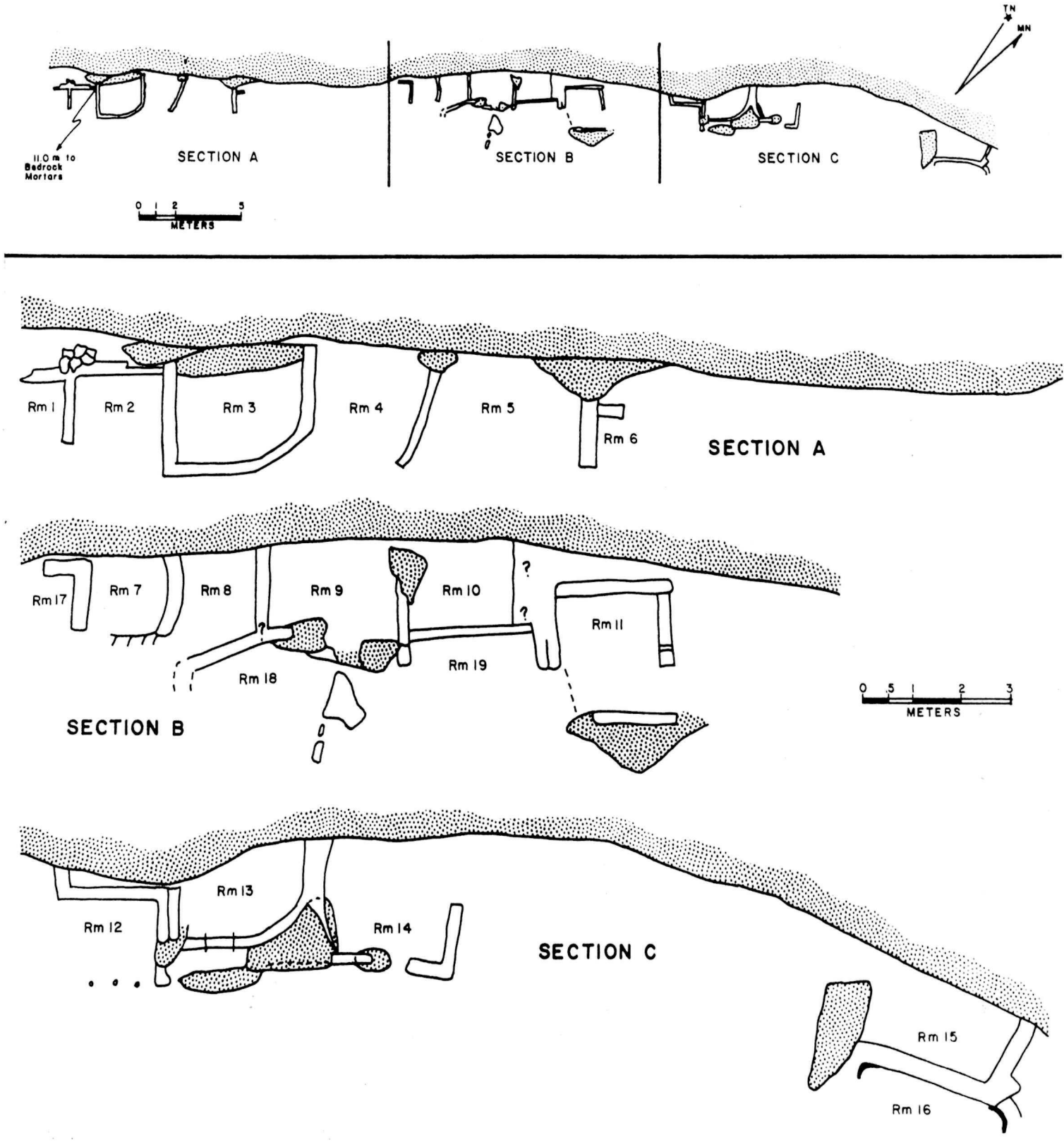


Figure 4. Map of Snake House Ruin. Map drawn by David A. Breternitz.

general area: "It is very different from deserts you normally picture, neither flat nor uniformly sterile. It is very rocky. Sandstone, lime and shale are readily mouldable (sic) by the climatic influences. The formation is Wingate and Navajo sandstone at higher altitudes" (pg. 6). "The theory advanced by John Wetherill and the other geologists that the cross banded sandstone in which these caves and arches abound had its origins in ancient, now hardened, sand dunes" (pg. 7).

The canyon that Snake House is situated in is Nitsin Canyon. This canyon has been visited by many with almost as many different spellings. The following table gives the year, the person and the spelling of the name. "The name means 'cut cheek' and apparently refers to a fight between Navajo and Paiute in the area in the late 1800's" (Norm Ritchie - Personal Communication, 1978).

TABLE II

Nitsin Canyon Spellings

Publication Date	Who	Spelling
1909	Cummings	Neetsin
1910	Douglas	Neet sin
1911	Fewkes	Nitsi (Neetsee)
1914	Thomas	Nitsi
1921,29	Bernheimer	Neetsin
1930	Cummings	Nitsin
1932	McGregor	Nitsie
(Brewer 1940 in Van Valkenburg 1962)	Wetherill	Nietsin
1956	MNA Survey	Neets'in
1962	Turner	Nitsin
1968	Judd	Neetsin
1975	Ward	Nitsin
1977	Breternitz, S & D	Nitsin

NATURAL ENVIRONMENT

The Snake House area is a canyonland plateau environment with more frequent precipitation and lower temperatures than the surrounding lowlands. The former is a better environment for horticulture (Ward, 1975:22).

There is a noticeable lack of talus and alluvial fans, and the bare cliff faces possess very little vegetation (Fig. 5, 6). Where the soil is sufficiently accumulated, occasional stunted and scattered junipers and pinyon pine grow. Most of the area is overgrazed and eroded and has an occasional juniper and pinyon with a general cover of sagebrush and Blackbrush. Recent overgrazing and erosion have effect the prior characteristic "Upper Sonoran Life Zone" assemblages (Ward, 1975:22). The natural vegetation and animal life are quire sparse and limited. Along the washes and canyon bottoms are cottonwoods and some pinyon pine and juniper where soil is sufficient. Pinyon pine is also common on some of the mesa tops. Informants told us that there was also some oak on the mesa tops above Snake House, but it was not observed. Other vegetation present consists of Russian thistle, blooming nightshade, cactus, yucca, and a few wild grasses and flowers. Sporabolis sp. (dropseed) and Orysopsis hymenoids (Indian ricegrass) are two types of the available native and continuing types of vegetation since the Anasazi occupation. Blackbrush and sage are also scattered among the canyon bottoms and mesa tops.

The fauna are both native and domestic. The native fauna consist of coyote, squirrel, chipmunk, lizards, snake, crow, hawk and various other birds. The domestic fauna are sheep, cattle, horses and dogs.

SITE BACKGROUND

Sanke House seems to be a rather obscure ruin. With the amount of literature on Snake House it would look as though the stabilization crew were some of the few visitors ever to the ruin. However, this is not

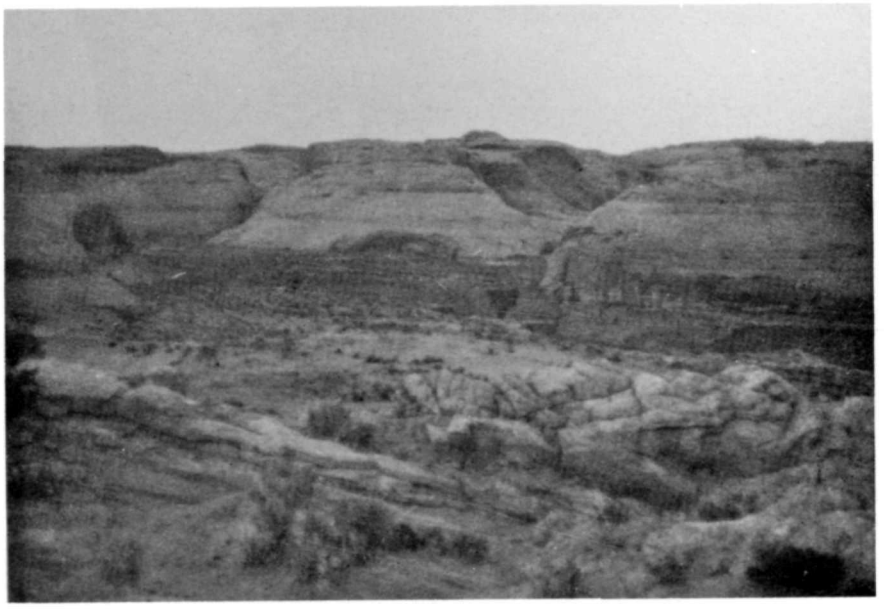


Figure 5.
General view of the Snake House area showing geology and formations.

Figure 6.
View of general vegetation in area.

actually the case. Snake House has been explored and had many of its artifacts removed. In fact it may even have been excavated at some time by the University of Utah expedition under Byron Cummings, but the exact date is unknown and actual verification has not been found. The Snake House area has been visited by countless people but it remained unnamed until recently, when someone referred to it as "Snake House" due to its snake petroglyph. It has been referred to in recent timesalso as Ruin A, with Owl House to the east called Ruin B (see Fig. 1). However, these references have been confused with the Ruins A and B in Jesse W. Fewke's "Preliminary report on a visit to Navajo National Monument, Arizona" (1911). His Ruins A and B are located near Marsh Pass nowhere near the present Snake House. Thus, the references by Kidder, Guernsey and Fewkes all seem to refer to the other Ruin A, not Snake House.

A time line effect may help at least group the small amount of background information that has been pieced together. Fewkes describes in 1911, two ruins in the west canyon of Nitsin which are not yet in the Monument. One of these is probably Inscription House, the other may be Snake House (Fewkes, 1911:4).

M.D. Thomas mentions the area in his diary. During August 11-13 his crew was in the Inscription House area and on August 12 he found 5 ruins and on August 13 found 3-4 small ruins. One of these is probably Snake House (Thomas 1914, August 11-13).

Earl Morris kept notes on Bernheimer's trip and in his July 30, 1921 notes he says they "spent the afternoon visiting Inscription House and the surrounding areas". This no doubt included Snake House (Morris 1921).

On June 6, 1924, the Bernheimer Expedition was again in the Inscription House Area, and most likely entered or at least noticed Snake House, though they make no reference to the Ruin.

George West wrote "Around the corner and in the same cliff, probably 450 yards distant and approximately 300 feet above the canyon floor we found a ruin with thirteen rooms and some wall pictures, one of a snake six feet long and a good example of the usual circle. These ruins have been excavated and nothing but the building remains" (West 1925: 36).

Noel Morss commented that "The most important group of ruins is centered in Inscription House" (1931:1). . . "Inscription House is primus enter pares in an extensive array of cave houses, many of them of considerable size" (ibid.:10). Becuase he was so interested in the Inscription House area in general he no doubt explored Snake House.

SCOPE OF STABILIZATION

The scope of work for the 1978 field season began with the 1977 specifications and was elaborated on and extended in the 1978 specifications, National Park Service contract #CX-7-0297-0053, both by Ronald J. Ice.

Originally, the scope of work called for the stabilization of Snake House to be completed during the summer of 1977. The United States, acting through the National Park Service, Southwest Regional Office, Santa Fe, solicited proposals for excavation at Inscription House and stabilization at Inscription House and Snake House. Because of the isolated location and difficulty of access to both Snake House and Inscription House, the two jobs were awarded to one institution, the University of Colorado.

Work specified was to be performed in accordance with the Antiquities Act of 1906, the Historic Sites Act of 1935, and the National Historic Preservation Act of 1966, and finally in accordance with the policies and standards of the National Park Service.

Necessary work primarily consisted of remudding/patching, resetting isolated stones or stone sections and resealing separated abuttments. All jobs were to be completed with an unamended earth mortar. Originally, it was proposed to replicate the mortar by pulverizing loose blocks of aboriginal jacal daub or rush-and-mud blocks available in the ruin and add water. However, in the 1978 specifications, it was stated that the mortar taken from the mine that the Breternitz crew found in 1977 would be used as the source. This was to be mixed with water which runs in the bottom of Nitsin Canyon.

All stabilization work was to be documented with detailed before and after photographs as well as descriptions of the work done and the materials used (see Appendix F).

Initially, the contract specified 22 stabilization tasks, which stated the exact location and room number, and were given corresponding numbers for the records (see Fig. 27). Eventually two more stabilization tasks were added. These tasks ranged from easy 15 minute repair jobs for one person, to larger scale operations which took up to one day for two people to accomplish.

Because Snake House is truly a "ruin", caution was taken not to rebuild or duplicate but stabilize in the true sense archaeological features and structures which would be endangered without this stabilization. No extensive rebuilding was attempted.

Initial preservation work at Snake House was attempted during August, 1977 by the University of Colorado under the direction of Dr. David A. Breternitz. Berternitz's crew encountered unforeseen problems when repointing and repairing wall joints in Room 3. Wisely, operations were curtailed when the stabilizing mortar failed to bond to the stone wall. It was decided that research would be done and until an answer could be found

to this problem the ruin would remain unstabilized. Some of the stones were friable, crumbling when only the slightest pressure was applied. The surface of most of the stones were easily abraded, with rock dust appearing on the fingertips when the stones were rubbed.

The area of this extreme erosion was in the eastern portion, namely Rooms 3 and 17. The room in the worst shape and the most danger was Room 3.

The probable reason for this erosion is the extreme exposure of these rooms. All of the elements strike this area of the ruin, especially sun and wind. The sun has baked the rocks and wind has stripped the grains and turned the surface to powder. Consequently, when the rocks were dampened for stabilization, a thin layer of the rock was washed away, then when the mortar was applied and began to cure, it drew the moisture from the stones, pulling off an additional layer and falling out of the wall. The mortar did not bond or remain in the wall.

Stone and mortar samples were submitted to Dr. Burke from Arizona State University. In conjunction with the National Park Service, Midwest Archaeological Center, Dr. Burke has been working with a chemical additive to bond sandstone. Applications of the additive to rock panels at Painted Rock Reservoir and Lizard House have been at the least, moderately successful. It was suggested that the additive, methyl methacrylate, could be used to stabilize decomposing stone at Snake House, seeing as all other methods of stabilization had failed and the ruin, especially the west end was in an "emergency status".

Because of the policy which precludes the application of irreversible materials, the National Park Service hesitated to agree on the methyl methacrylate applications without further investigation. In March 1978,

Messrs. David A. Battle (Regional Historical Architect), Douglas Hicks (Exhibit Specialist: Preservation) and Larry Nordby conducted an on-site inspection of Snake House. The poor state of the ruin reported by David A. Breternitz was observed by all. Mr. Battle questioned the durability of the stabilization mortar. As a result of the questioning of durability, Nordby collected samples of the aboriginal mortars from Snake House and Inscription House, stabilization mortar used by Breternitz and the stone at Snake House for laboratory analysis.

The following analyses were then conducted by Nordby on all mortars:

1. The specimen was broken down into particles using a rubber-tipped soil mortar and porcelain pestle.
2. The material was placed in a graduated cylinder in 100 ml. dry measurements, and then the cylinder was filled to the one litre mark with water.
3. The cylinder was agitated by hand and the layers of the components were observed after 24 hours. These amounts were recorded.
4. A small amount of undiluted nitric acid was added to the Snake House aboriginal mortar and the stabilization mortar to determine if the clay was highly betonitic. It was not.

Results were recorded as the percent of the wet volume of the mortar sampled:

TABLE III

MORTAR COMPOSITION

Inscription House Original	Snake House Original	Snake House Stabilization
75% fine sand	69% fine sand	67% fine sand
25% clay	30% clay	33% clay
trace organics	1% organics	trace organics

The durability of the mortar was explained by this analysis.

Stone specimens (small in size) were predampened and placed into a lump of stabilizing mortar. Five pieces were pressed into the mortar in an attempt to determine the bonding properties of the stone and mortar. Two of the five crumbled upon application of enough pressure to press them into the mortar. Questionable durability was affirmed.

Nordby returned to Snake House and used materials and techniques described by Breternitz in repointing and re-laying stone. The following method was used on the northeast wall (exterior) of Room 13.

1. Mortar was taken from the same mine used by the Breternitz crew, crushed into small components and sifted through a 1/8 inch screen.
2. Mortar joints were cleaned to a minimum depth of 2 inches. Each joint was dampened prior to direct stabilization.
3. Mortar was mixed with as little water as possible. Joints were packed as tightly as possible. Pre-wet chinks were inserted wherever structurally or aesthetically desirable.

Approximately 24 hours later, mortar was checked for curing progress and Munsell color was recorded. Some cracking had occurred due to rapid curing in the morning sun, but the mortar had established a minimum bond to the stone. No problems were noted.

However, Nordby's test was of extremely limited scope. Only this single locus was tested. Dr. Breternitz's assertions that stone deterioration is more advanced at other locations is thus supported. The extreme western sections of the site (Rooms 3 and 17) were the problem areas. Nordby's test was done in a "low problem" area.

Obviously, the pressing problem at Snake House is the decomposition of

the original stone due to exposure.

The staff of the Southwest Cultural Resource Center and Navajo Lands Group recommended the following specifications:

1. That the Breternitz crew return and continue stabilization efforts on all necessary segments of the ruin, using an unamended earth mortar as was used before.

   (a) Mortar used would be as dry as possible.

   (b) All joints were to be cleaned to a minimum of 2 inches when possible and dampened prior to packing of the joints with mortar.

   (c) Chinking (pre-dampened) would be applied wherever structurally and aesthetically desirable.

   (d) Curing rate would be controlled with damp burlap covers being applied to newly stabilized areas immediately (no plastic sheeting was to be used).

   (e) No change in mortar components or mixture.

   (f) All voids would be filled.

   (g) A list of repairs was to conform to that composed by Breternitz, transmitted to Ron Ice on January 25, 1978.

2. In situations Breternitz deemed fruitless to utilize unamended mortar because of the extreme friability, the stone adjacent to the area to be repointed shall be treated with methyl methacrylate prior to stabilization. The mortar will remain unamended.

   (a) Repairs made with fresh stone to fill voids shall also be treated with methyl methacrylate. No methyl methacrylate shall be sprayed on entire wall sections.

However, it was impossible to apply the methyl methacrylate without

soaking the wall and wall area with the chemical. Thus the mortar that remained in situ was treated also, but the stabilization mortar was untreated. Before, during, and after photos and records were taken. Complete explanation is given in Appendix E. Nordby was on the site during the application and realized, along with the stabilization crew, that this was the only way to apply the methyl methacrylate. Room 3 is the most eroded room in the ruin. Methyl methacrylate was not applied to any other room or wall section. The results and outcome will be observed for a period of time to judge the true worth of methyl methacrylate and the outcome of Room 3.

(b) Mixture of methyl methacrylate will be made so that minimal color change occurs in the stone. Munsell colors should be recorded before and for a period of time after the application.

(c) Photo documentation to identify the methyl methacrylate treated areas and stones.

> "The foregoing stipulations are beneficial because of the emphasis of the present work leaves the original fabric as unaltered as possible, except where structural failure is likely. This procedure conforms closely as possible with present National Park Service methods. Wholesale committment of the cultural resources at Snake House to somewhat untested material is avoided. At the same time these specifications avoid complete abandonment of the ruin to the vagaries of natural deterioration" (Ice, stabilization specifications).

FIELD CONDITIONS

The stabilization camp was almost two miles away from the site (see Fig. 14). A four-wheel drive vehicle transported the crew part-way to the site, then a walk of over a mile was necessary to reach the ruin. The walk consisted of climbing in and out of two 40 to 80 foot deep arroyos, and walking on loosely packed sandy stretches (see Fig. 10). All materials both for stabilization and sustaining the crew throughout the day had to be

packed into the ruin. Tools for stabilization included: buckets, tubs, grouting tools, whisk brooms, trowels, burlap, canvas, notebooks and camera gear. Water, both for stabilization and for drinking, had to be carried into the ruin. Drinking water had to be carried in from the base camp daily. It took most of two days, both at the beginning and the end of the project to transport the necessary tools and supplies.

Also, when the methyl methacrylate was being applied, all supplies and chemicals had to be carried in and out daily (see Fig. 15). It took 1.5 hours per worker every morning for three days just to prepare and pack the supplies to be carried into the ruin.

Evenings were quite cool, but days were hot. Because the ruin is so exposed and the cliffs light in color, the solar reflection and the heat were intense, even though the work was being done in late May and early June.

Scorpions proved to be a problem. They are attracted by the cool dampness beneath the wet burlap. Several were found in the early morning when the burlaps were rewet. More than once, crew members came very close to painful contact with the small, green poisonous scorpions.

Access to the ruin, which is high on a shallow sandstone ledge, was difficult. A steep climb was necessary over a worn sandstone outcrop which was smoothed by elemental exposure.

Availability of resources was another problem. The mine for the stabilization mortar was below the ruin in a sinkhole on the canyon floor (see Figs. 7 and 8). The soil had to be mined, broken down into small particles, sifted and then carried in full buckets up the slick rock face of the ruin (Fig. 9). All water for mixing the mined soil with which to produce the stabilization mortar had to be taken from the canyon bottom, because at the time the prehistoric "lake" which lays below the ruin was not holding water. The only area in the vicinity with a deep enough pool

to fill the Jerry can and Hudson sprayers was to the southwest of Inscription House (see Fig. 10).

MATERIALS USED IN STABILIZATION

Soil was mined from below the ruin from the same mine that had been found and used in the summer of 1977. Soil was extracted from the sink hole with picks and crowbars. Then the raw material was taken by the bucket-ful to the processing area. This area was just below the sink hole, in the cut bank of an erosional stream in the bottom of Nitsin Canyon. There was some shade that allowed at least minimal comfort for the workers. A large tarp was laid over a shady area and the soil was dumped in chunks onto the tarp. Heavy pick handles were used to crush the material which was then broken down into smaller particles and screened through a 1/16" mesh window screen (see Figs. 11-12). One bucket took approximately 25 minutes to process. The buckets were then carried up the cliff face one or two buckets at a time and mixed very dryly with water from the wash at the bottom of Nitsin Canyon to make a workable mortar. A total of 72 buckets of dry soil were used in the stabilization process (for more information see Appendix E).

Slabs and incomplete prehistoric metates were used at the mine to grind up the crude soil into smaller particles. The slabs were from the cliff bases and cutbank erosion areas. Those that were metates were eroded or discarded, probably from either Inscription House or Snake House.

Water for the stabilization was difficult to obtain. It was necessary to utilize the local natural water supply because it was logistically impossible to bring water which met the requirements for adequate stabilization. The prehistoric masons had the same restrictions. The small stream which runs in Nitson Canyon arroyo, just below Inscription House and Snake House Ruins is a spring fed stream containing large quantities of dissolved salts, chlorides and sulfates. In addition, assorted solid

Figure 7.
Sinkhole containing mine; erosional cut in background.

Figure 8.
Same sinkhole with mine, but different vein- used for the last part of stabilization.

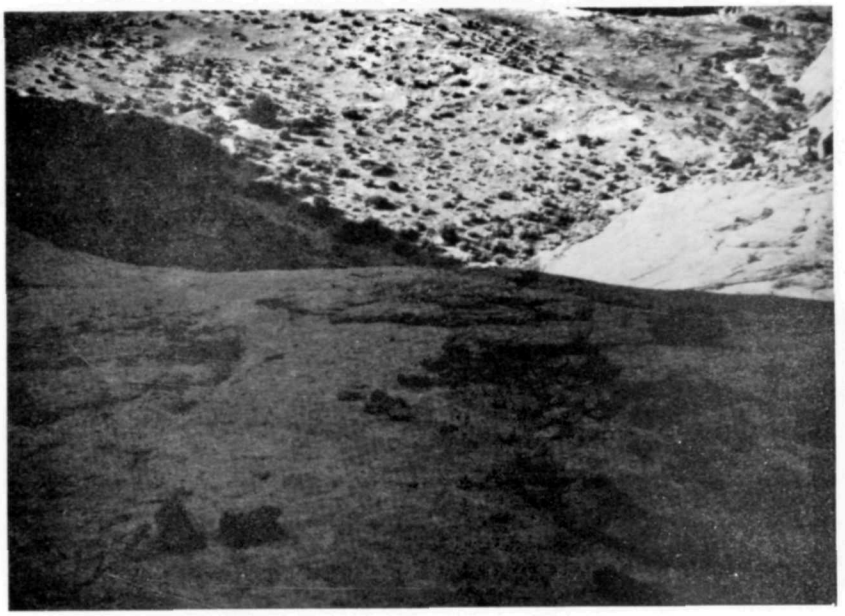


Figure 9.
From Snake House looking down slick rock approach. Note person in upper righthand portion of photo used for scale.

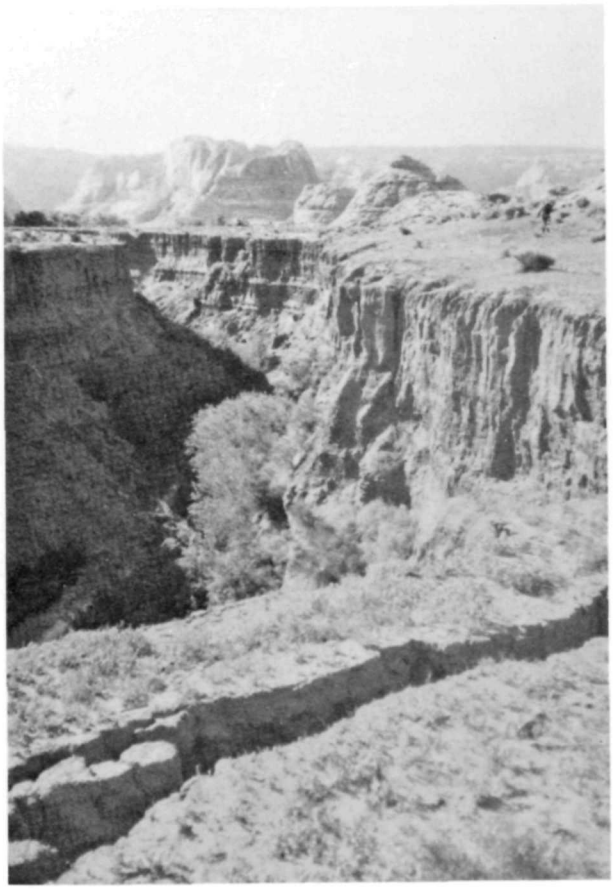


Figure 10.
Erosion channel which the crew had to cross twice to get to Snake House and also stabilization water further to the north and west.

organic matter in the form of larvae, fish, plants and great quantities of cow and sheep excrement were found in the water (see Fig. 13). A small pool formed approximately 150 m. southwest of the mine. Thus, it was necessary to fill the Jerry cans and Hudson's and then place them on pack-boards and carry them up the slick rock to Snake House. This use of non-potable water caused some concern because some impurities will affect the quality of the mortar, plus, if non-potable water is used for the curing process it might cause stains to develop on the surface of the mortar and masonry. However, under certain conditions, there is a degree of permissible impurity in which the development of stains will not occur and acceptable mortar can be made with water which is not suitable for drinking. In these instances solid organic debris was removed from the water either through sedimentation, skimming of matter from the water's surface, or through filtration. It should be stressed, however, that detrimental effects often do not become apparent until the later stages of stabilization or in the life of the ruin itself.

Because of the polluted nature of the water source, it was necessary to conduct skimming, filtration and sedimentation tests in order to purify the water a step above the condition it occurs naturally. These were the only purification methods to take place because of logistics, the allotted time frame, cost factors and mainly due to a general lack of knowledge in water quality and its effect on mortar and masonry.

Water was mixed with the soil to form our stabilizing unamended earth mortar. It was also used to wet joints and burlap bags, stabilizing stones and spalls and finally for tool cleanup. A total of 187 gallons of water were used.

Stone was used as replacement and to fill voids. The stone which

was used was solely the fallen rubble in the ruin. No outside stones were used as there was an ample supply of unmodified, slightly modified and shaped stones available. Thus, we were able to match the stone types in each wall.

Spalls were readily available also. There were all sizes and both the flatchink and chunk variety. The masonry structure of Snake House contains many spalls, so this was matched in the stabilization. About half of the spalls were true or leveller while the other half were solely aesthetic. Also, many of the walls were constructed with a spall type core. Many small stones were pushed into voids requiring less adobe when the structures were constructed. This procedure was followed by the stabilization crew.

Methyl methacrylate, as stated before, was used only in Room 3. All of the chemicals were brought in from Arizona State University, and all of the application was supervised by Dr. Burke. For a complete explanation see Appendix F.

Sand. Midway through the stabilization process unforeseen changes occurred in the composition of the alluvium, resulting in the incorporation of a soil higher in clay content into the unamended earth mortar.

This mortar was applied to Rooms 13 and 14 and upon final drying resulted in extreme cracking and a darkening of color. In an effort to correct this problem, decomposed sandstone was added to the soil mix, until a proper textured soil was achieved. Portions of the poor quality mortar were removed and replaced with the new established mix. Although there was a marked reduction in the cracking, and a lightening of the color, the quality of the final product was less than hoped for; however, it was not bad enough to warrant redoing. A total of 8 buckets of sand were used.

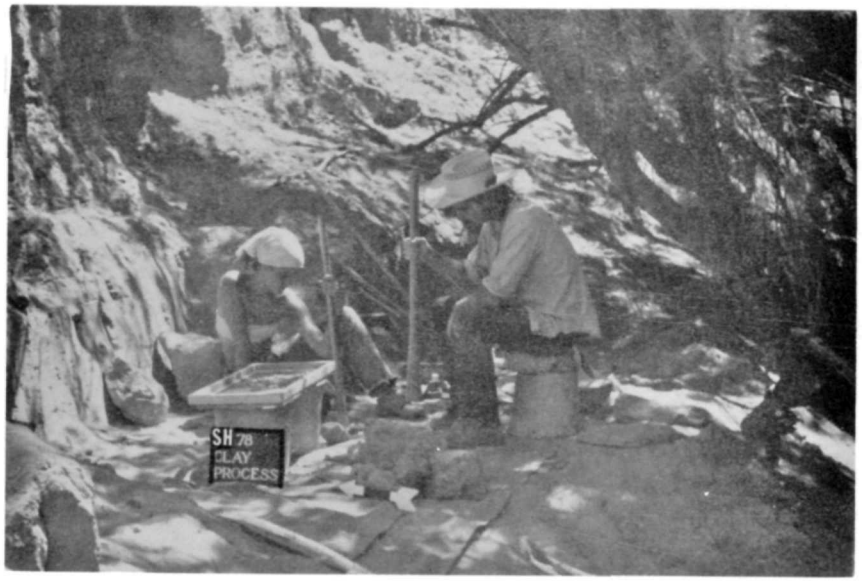


Figure 11.
Mine processing.

Figure 12.
Mine processing.

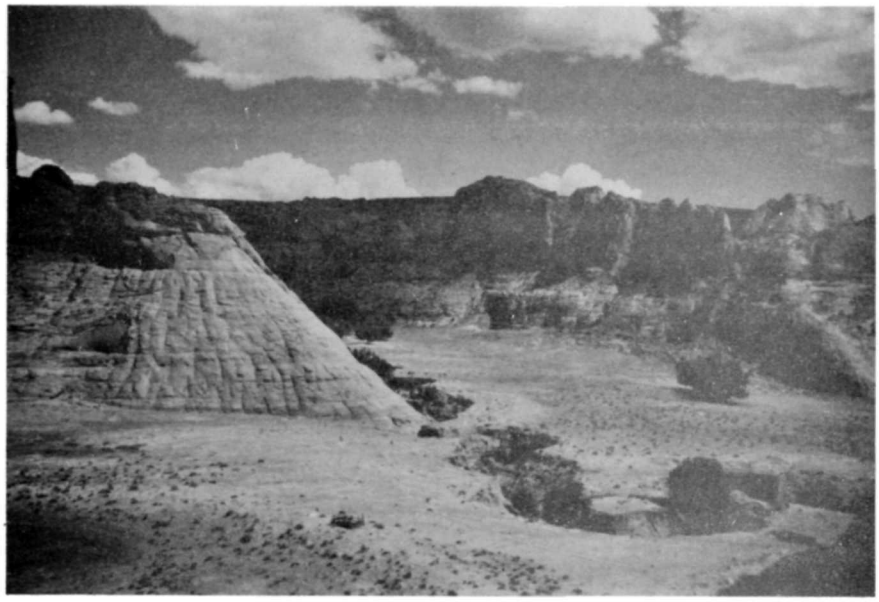


Figure 13.
View from Snake House into Nitsin Canyon
and erosional channel.

Figure 14.
Stabilization camp.

Munsell Correlation

Snake House Ruin is so exposed that every room has several different Munsell Color Codes for both stones and mortar. Stone and mortar have weathered at different rates and have reacted according to their exact location in the overhang. The rooms themselves seem to fit into somewhat of a pattern in regard to color and immediate location and the corresponding exposure. The following table explains this rationale.

TABLE IV

Munsell Correlation to Exposure

MORTAR				STONE			
Munsell	Room	Job	Location	Munsell	Room	Job	Location
5YR 6/6 reddish-yellow	3 3 17 19 11 11 11 12 14 14 15 15 15 3	1 2 4 5 7 8 9 10 16 18 20 21 22 23	central and eastern sections of the Ruin	5 YR 6/6 reddish-yellow	3 3 17 19 12 3	1 2 4 5 12 23	spread out over the entire Ruin
				5YR 7/4 pink	3 11 12 13 14	3 7 13 14 16	four rooms in the center, plus part of Room 3
5YR 7/4	3 11 12 13 14 14	3 7 13 14 15 16	central exposed areas of the Ruin	5YR 6/4 light reddish brown	14 14 14 15 15 15	15 16 17 20 21 22	all east end of Ruin, outside walls of Ruin
5YR 6/4 light reddish brown	12 14 14 15	12 15 17 19	back or inside walls in the Ruin	5YR 7/6 reddish yellow	11 12 14	6 11 18	central rooms

TECHNIQUES

Deep grouting - entails stabilizing areas where the mortar has fallen from between the joints and needs to be brought flush with the original mortar (see Fig. 27). This procedure was done on the following jobs: 1, 2, 3, 4, 5, 6, 8, 9, 12, 14, 18, 19, 22 and 23.

Relay - stones that are loose and need to be reset in place. This was done on jobs 2, 3, 7, 9 and 14.

Reset - refers to relaying loose stones but pertains particularly to those stones in the cap (the top two or three courses of masonry). This was done on jobs 4, 6, 11, 12, 17, 20 and 21.

Rebuild wall ends - this entails relaying abutted or bonded wall ends to support the remaining standing wall. This was done on jobs 5, 13 and 15.

Fill hole (voids) - this means filling actual holes where the wall has been knocked or loosened. This procedure does not pertain to the upper courses but section of the middle of the wall where sections remain intact above the voids. This was done on jobs 10 and 24.

Base erosion - this refers to the relaying of the base of a wall. Some sections of wall have bad erosion due to water, elements and rodents. The following jobs fit into this category: 1, 14, 16 and 18.

Methyl Methacrylate - See Appendix E. This method was used to stabilize sections of the ruin that were beyond help with traditional methods of stabilization. This was done on jobs 1, 2, 3 and 23.

SPECIAL PROJECTS

As mentioned, previously unforeseen problems were encountered with the masonry and mortar of Room 3. The following is a hypothesis of what happened. The weathering of the stone involves the reaction of materials

solutions and atmospheric gasses. Because the grains of quartz in the sandstone are usually bonded together with calcite, and because all minerals are acted upon by carbon dioxide dissolved in water, the solution of carbon dioxide and water react with calcite and form a soluble product which in turn goes into solution. This causes leaching within the stone resulting in a reduction in the stone's abrasive index, which eventually causes the grains to dislodge themselves from the main stone body.

It can only be surmised that the leaching of these particles was magnified on Room 3, because it was afforded the least protection from weather factors than the other rooms.

Because of these additional weathering problems, it was necessary to apply methyl methacrylate. It was hoped that the chemical would alleviate further deterioration, and bond the stones and mortar together.

After the methyl methacrylate treatment it was necessary to grout and accomplish the individual tasks. Finally the wall was painted and antiqued. Room 3 (Jobs 1, 2, 3, and 23) alone represented 70 per cent of the total man-hours spent in the entire 19 room ruin. This does not include mining, kneading or notetaking and recording in the room (see Figs. 16, 18, 19, 20, 21, 22 and 23).

Extensive before and after Munsell color recordings were taken of the room (see Table 6 and Fig. 17). The Munsell color recordings were taken on May 31, June 1, June 2, June 5, June 6, June 7 and June 8, 1978 and March 29, 1979 (see Tables 5, 6 and Figs. 15-23).

METHODS - RATIONALE

The reason that Snake House was stabilized with methyl methacrylate is twofold. First, because Room 3 was extremely weathered and traditional stabilization was not workable, it was in danger of collapsing. To avoid

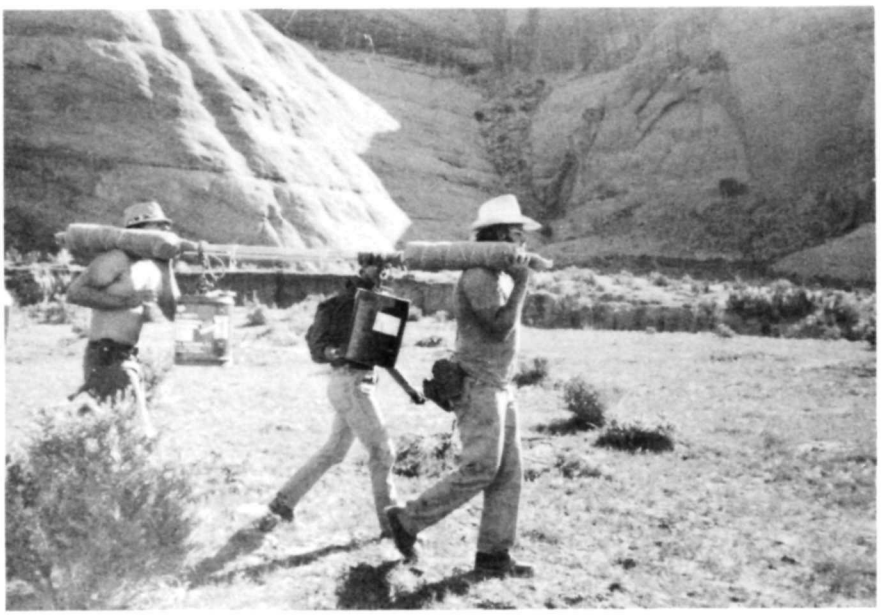


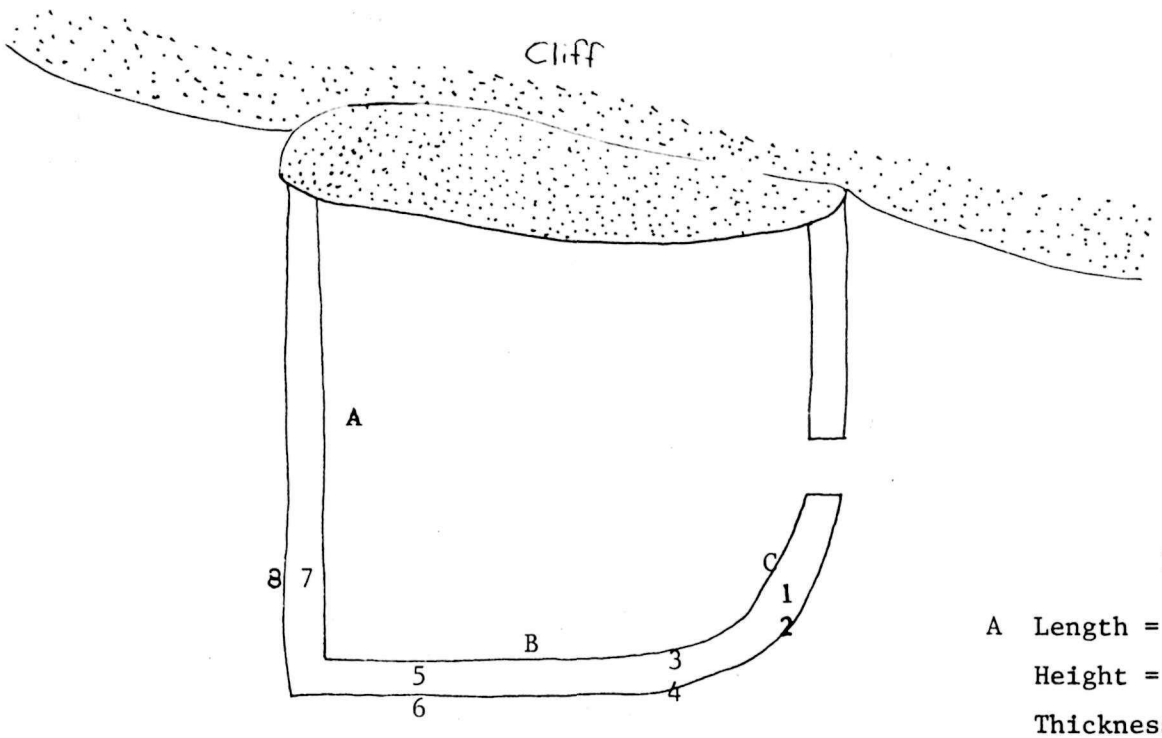
Figure 15.
Transportation of methyl methacrylate to site.

Figure 16.
View of Room 3 before any stabilization attempts. Notice the lack of cliff overhang in the area.

TABLE V

Room 3, Total Time

Specific Aspect	Stabilization Team	Methyl Methacrylate Team	Materials
Application of methyl methacrylate	24.25 hours	30.00 hours	25 gallons methyl methacrylate
transportation of methyl methacrylate	32.00 hours	10.50 hours	--
Grouting Room 3	25.00 hours	--	--
Laying stone Room 3	1.00 hour	--	--
Mortar Room 3	--	--	7.50 buckets mortar
Painting Room 3	12.50 hours	--	--
Experimenting Room 3	5.50 hours	--	--
TOTAL HOURS	100.75 hours	40.50 hours	



INTERIOR

A Length = 2.10-2.19m
Height = 2.26-2.32m
Thickness = 17-28cm

B Length = 2.72m
Height = 1.10-2.70m
Thickness = 25-30cm

C Length = 61cm
Height = 51-92cm
Thickness = 27-30cm

A, B, and C correspond to Munsell areas on the interior wall.

EXTERIOR

N

Numbers 1, 3, 5, and 7 correspond to Munsell areas high on the exterior wall.

Numbers 2, 4, 6, and 8 correspond to Munsell areas low on the exterior wall.

Figure 17. Sketch of Room 3 Munsell areas.

TABLE VI
Munsell Color Code

May 31, 1978 9:00 a.m.		* June 1, 1978 12:30 p.m.	
STONE	MORTAR	STONE	MORTAR
1. 5 YR 4/6 yellowish red	5 YR 4/6 yellowish red	* 5 YR 5/6 yellowish red	5 YR 4/6 yellowish red
2. 5 YR 4/4 reddish brown	5 YR 5/4 reddish brown	* 5 YR 4/6 yellowish red	5 YR 4/6 yellowish red
3. 5 YR 6/6 reddish yellow	5 YR 5/4 reddish brown	* 5 YR 4/6 yellowish red	5 YR 5/6 yellowish red
4. 5 YR 4/4 reddish brown		* 5 YR 5/4 reddish brown	
5. 5 YR 5/6 yellowish red		* 5 YR 5/6 yellowish red	5 YR 5/8 yellowish red
6. 5 YR 4/6 yellowish red		* 5 YR 5/4 reddish brown	
7.			
8.			
A.			
B.		* 5 YR 5/8 yellowish red	
C. 5 YR 6/4 light reddish brown	5 YR 7/4 pink	*	5 YR 5/8 yellowish red

---

June 2, 1978 10:00 a.m.		* June 5, 1978 12:45 p.m.	
1. 5 YR 4/6 yellowish red	5 YR 4/6 yellowish red	* 5 YR 5/6 yellowish red	5 YR 5/6 yellowish red
2. 5 YR 4/4 reddish brown	5 YR 4/6 yellowish red	* 5 YR 5/6 yellowish red	5 YR 4/6 yellowish red
3. 5 YR 5/6 yellowish red	5 YR 4/6 yellowish red	* 5 YR 6/6 reddish yellow	5 YR 4/6 yellowish red
4. 5 YR 5/6 yellowish red		* 5 YR 5/6 yellowish red	5 YR 5/6 yellowish red
5. 5 YR 5/4 reddish brown		* 5 YR 5/4 reddish brown	5 YR 5/6 yellowish red
6. 5 YR 6/6 reddish yellow		* 5 YR 6/4 light reddish brown	5 YR 6/6 reddish yellow
7. 5 YR 5/8 yellowish red	2.5 YR 6/6 olive yellow	* 5 YR 6/6 reddish yellow	5 YR 6/6 reddish yellow
8. 5 YR 4/6 yellowish red	5 YR 5/8 yellowish red	* 5 YR 4/6 yellowish red	5 YR 6/6 reddish yellow
A. 5 YR 5/8 yellowish red	5 YR 6/6 reddish yellow	* 5 YR 6/6 reddish yellow	5 YR 6/6 reddish yellow
B. 5 YR 4/6 yellowish red	5 YR 4/6 yellowish red	* 5 YR 4/6 yellowish red	5 YR 6/6 reddish yellow
C. 5 YR 5/6 yellowish red	5 YR 4/6 yellowish red	* 5 YR 6/6 reddish yellow	5 YR 5/6 yellowish red

Munsell Color Code

June 5, 1978 1:00 p.m.

	STONE	MORTAR
1.	5 YR 5/6 yellowish red	5 YR 6/6 reddish yellow
2.	5 YR 5/6 yellowish red	5 YR 4/6 yellowish red
3.	5 YR 6/6 reddish yellow	6 YR 7/6 reddish yellow
4.	5 YR 6/8 reddish yellow	5 YR 6/6 reddish yellow
5.	5 YR 6/6 reddish yellow	5 YR 6/6 reddish yellow
6.	5 YR 6/4 light reddish brown	5 YR 6/6 reddish yellow
7.	5 YR 6/6 reddish yellow	5 YR 6/6 reddish yellow
8.	5 YR 5/6 yellowish red	5 YR 6/6 reddish yellow
A.	2.5 YR 5/6 yellowish red	2.5 YR 6/6 olive yellow
B.	5 YR 5/6 yellowish red	5 YR 6/6 reddish yellow
C.	5 YR 6/6 reddish yellow	5 YR 5/6 reddish yellow

* June 7, 1978 9:45 a.m.

	STONE	MORTAR
*	2.5 YR 5/6 red	2.5 YR 5/4 reddish brown
*	2.5 YR 5/4 reddish brown	2.5 YR 5/4 reddish brown
*	2.5 YR 5/6 red	2.5 YR 5/4 reddish brown
*	2.5 YR 6/4 light reddish brown	2.5 YR 6/4 light reddish brown
*	2.5 YR 6/6 olive yellow	2.5 YR 5/6 red
*	2.5 YR 5/6 red	2.5 YR 5/6 red
*		
*		
*		
*		
*	2.5 YR 5/6 red	2.5 YR 6/4 light reddish brown

June 8, 1978 1:30 p.m.

1.	7.5 YR 5/4 brown	7.5 YR 6/4 light brown
2.	7.5 YR 6/4 light brown	7.5 YR 5/4 brown
3.	10 YR 7/4 very pale brown	10 YR 7/4 very pale brown
4.	10 YR 7/4 very pale brown	7.5 YR 7/4 pink
5.	10 YR 7/4 very pale brown	10 YR 6/4 light yellowish brown
6.	7.5 YR 6/4 light brown	7.5 YR 6/4 light brown
7.	7.5 YR 6/4 light brown	7.5 YR 6/4 light brown
8.	7.5 YR 6/4 light brown	7/5 YR 6/4 light brown
A.	10 YR 7.4 very pale brown	10 YR 7/4 very pale brown
B.	7.5 YR 6/4 light brown	7.5 YR 5/4 brown
C.	7.5 YR 6/4 light brown	7.5 YR 6/4 light brown

* March 28, 1979 10:20 a.m.

*	5 YR 6/4 light reddish brown	5 YR 6/4 light reddish brown
*	5 YR 6/4 light reddish brown	5 YR 6/4 light reddish brown
*	5 YR 6/3 light reddish brown	5 YR 6/3 light reddish brown
*	5 YR 6/3 light reddish brown	5 YR 6/3 light reddish brown
*	5 YR 5/4 reddish brown	5 YR 5/4 reddish brown
*	5 YR 5/4 reddish brown	5 YR 5/4 reddish brown
*	5 YR 6/4 light reddish brown	5 YR 6/4 light reddish brown
*	5 YR 6/4 light reddish brown	5 YR 6/4 light reddish brown
*	5 YR 5/4 reddish brown **	7.5 YR 5/4 brown
*	5 YR 6/4 reddish brown	7.5 YR 6/4 light brown
*	5 YR 6/4 light reddish brown	5 YR 6/4 light reddish brown
	Bl 5 YR 5/4 reddish brown **	

** Treated, no paint

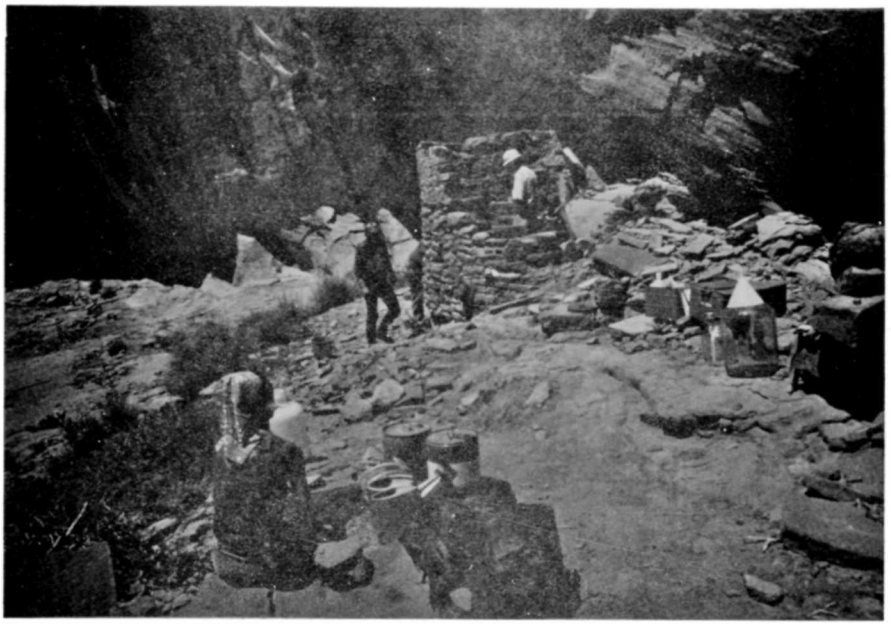


Figure 18.
Inspection and note taking procedures before methyl methacrylate application.

Figure 19.
Careful handling and preparation of methyl methacrylate by Arizona State University team.

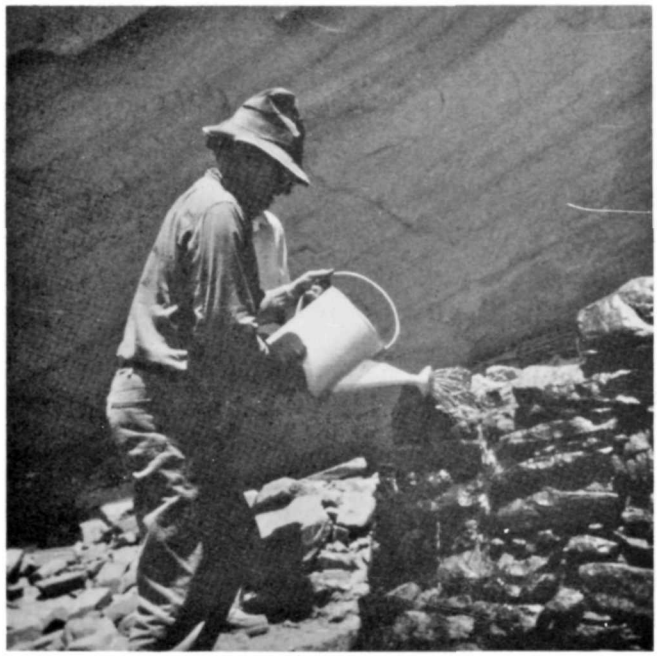


Figure 20.
First application of methyl methacrylate, note application procedure.

Figure 21.
Second application of methyl methacrylate on highest portion of Room 3.

Figure 22.
Close up of coated area still wet, and uncoated natural stone.

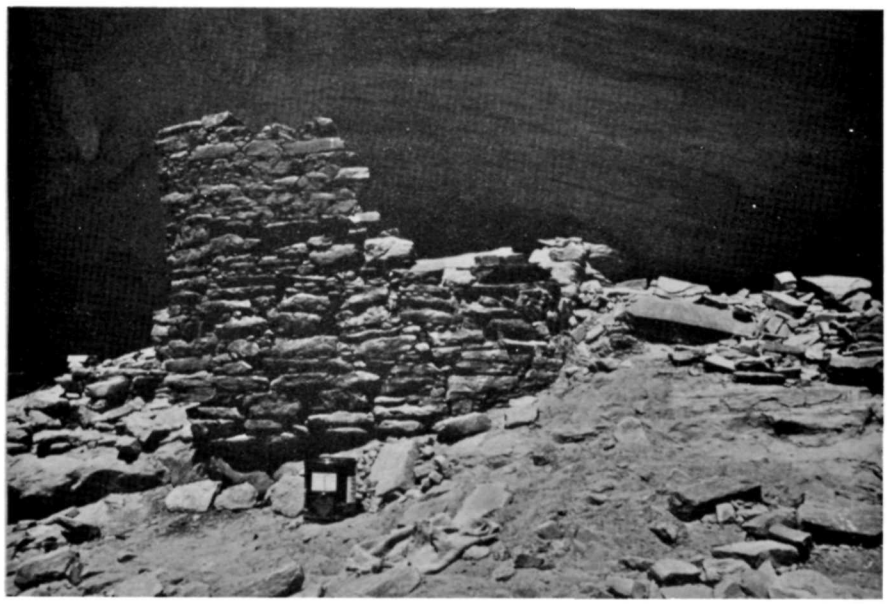


Figure 23.
Room 3 after the final application of methyl methacrylate.

the collapse some alternative form of stabilization was needed. Methyl methacrylate was the only known feasible method in the case of Snake House. Second, even though there was much skepticism about the use of methyl methacrylate, Room 3 needed quick attention. Because the walls were in such bad shape, the opinion of all was that we could only try. If the methyl methacrylate caused the walls to fall more, it would still be no different than if we had left the walls alone. If the methyl methacrylate does bind the walls sufficiently, we will know that it is a possibility in future stabilizations.

Painting

Painting, or white washing, is a process in which liquified soil is applied to the masonry walls of a structure in a manner which is similar to painting the walls of a modern house.

The purpose of painting a wall is to produce a uniform appearance through the blending of colors. Probably the most important factor is that the soil in its liquified state penetrates all, or most, small cracks, gaps and holes and upon drying, serves as a temporary coat which enhances the walls resistance to weathering and erosional factors.

The paint itself is an unamended earth mortar which has been kneaded and then brought, with the addition of water, to a point between its plastic limit and liquid limit, but to where there is still some particle cohesion.

The application of the paint is accomplished by dipping a 2 to 4 inch paint brush into a bucket of soil paint and then evenly spreading it over the entire wall. Application should only be done on walls which are free of moisture and have a surface temperature of no more than $90^{\circ}F$.

Within four hours after the initial application, areas which had been

missed or only received a light application became evident and additional paint was added to these areas. The walls were then allowed to dry for a minimum period of 24 hours. Following this drying period, the walls were then lightly sprayed with water. This process removes all loose and unwanted fragments of paint which no longer served to add to the stability and appearance of the structure. The walls were then allowed to dry and were then lightly brushed down with whisk brooms solely for the purpose of appearance. During the entire soil painting operation, no covering was done to the walls; they were permitted to "cure" in the existing atmosphere and temperature.

Vinegar Tests

As mentioned previously, the water used for stabilization purposes contained chemical and organic debris which has made it unfit for human consumption. It also raised questions concerning its suitability for stabilization and if any adverse effects would arise, in the stability and appearance of the ruin. As a result of using non-potable water for stabilization purposes, stains appeared on the masonry following the submergence of stones into the non-potable water, after the water had been applied in great quantities by whisk brooms, and following masonry contact with the burlap bags and canvas tarpaulins which had been saturated with the non-potable water.

Vinegar was used as a mild acid in an attempt to eat away the stained layer from the masonry. In an effort to find the correct mixture of vinegar with potable water, so as not to eat away too much stone, the following proportions were tested on six stained samples:

	Proportions					
Vinegar to Water	1	2	3	1	1	1
	1	1	1	1	2	3

The application of the vinegar solution was with a small, pint spray bottle. The vinegar solution was sprayed on the stained surface and then immediately flushed with potable water.

The best vinegar solution for the experimental removal of the stains was one part vinegar to two parts water. The proportions two to one and three to one vinegar to water were too strong for the stone and rapidly eroded away the exterior surface. The proportions one to one either had no effect on the stains, or served to intensify them. The one to three proportions had little effect on the stains.

The actual application of the vinegar to the stained masonry found within the ruin was done with proportions of one part vinegar to two parts water. The technique of spraying the acid with a spray bottle followed by flushing the surface with potable water was repeated. The results of the application were negative. The one to two proportions of vinegar to water only intensified the stains. A second application was tried and again the same results were observed. The proportions were switched to two parts vinegar to one part water and again only an intensification in the stain was observed. Following these observations the application of vinegar in any form was abandoned.

As of yet the cause of the stains is still unknown. They may be attributed to the use of nonpotable water or they may have been caused by elements contained within the stone or on the surface of the stone which react to water. Analysis of the stone through spalling revealed that the stain layer remains only on the outer extremities of the stone's

exterior surface, and was measured at 1 mm in thickness. There is no evidence of interior staining.

Antiqueing or Tooling

This process was done with a trowel and whisk broom to take away the newly stabilized look and blend the original with the stabilized mortar. Any hardened lumps or cracks in the mortar were roughed with a trowel and then whisk broomed to remove marks. This process also removed the shiny gloss that new mortar tends to give.

Experiments

Professor Enrique Monterosso of the National Museum of Guatemala was an added benefit for the stabilization team. He has run major stabilizations in Guatemala for the past 20 years. His introduction of ideas has extended the southwest concept of stabilization and has provided many educational insights.

Enrique Monterosso took sand and soil in different proportions and mortared two rocks together. He did four samples in the sun and four samples in the shade. He said we should use sand in Room 3. Because of its exposure he said the mortar from Room 3 would bond better with more sand. The sand does not shrink in direct sun, as clay does.

The grout gun was an experiment in Room 15 (Job 19). One-quarter of a bucket of mortar was used in Room 11, about one cup was used on Job 7, and in the west wall, Job 24, 2/5 of a bucket was pumped through the grout gun into the wall. The mortar was too thick to pump through efficiently.

Suggestions from Enrique Monterosso hastened the mining process. After the clay was mined it was beaten with pick handles on tarps. These pulverized particles were then sifted and a bucket of ready clay was available every 25 minutes, quite a cut in previous processing time (Breternitz:2 (1978)).

Kneading time was cut 14-16 minutes rather than the previous 30 minutes. The kneading was done directly in a bucket. No more than half a bucket could be kneaded at one time. The mortar was mixed drier, except when large sections of wall needed to be re-laid. At one point the soil source make-up changed slightly, due to increased clay content and then the mortar had to be mixed even drier or it became too sticky to work with.

Rocks were often set in their original position and simply grouted in place rather than removing them and making a platform of mortar and shifting the position slightly. Enrique Monterosso wet some spalls, but not all of them. Usually he removed the adobe mortar from the trowel by quickly and accurately flinging it into the void.

PROPOSAL AND RECOMMENDATIONS FOR CONTINUED MAINTENANCE

Money is too often spent on a one-time stabilization job that is never maintained. Without continued maintenance the money is wasted. The purpose of stabilization is to combat erosion and deterioration of ruins. But the stabilization is never a completed job, it is a method used constantly over time as a barrier against further erosion. Any ruin that is in need of stabilization needs structured, continued observation and maintenance. The original inhabitants were continually refaceing and repairing their dwellings. For the same reason, continued stabilization is necessary.

At Snake House this proposed, continued maintenance is basic for preservation. Twice a year the ruin should be checked. These times should be late May and late September. Any basal erosion, fallen stones, fallen grout, loose capstones or other stability problems should be repaired at this time. All old stabilization should also be checked. If the ruin

was maintained at these times, the stabilization materials, money, and necessary time could all be cut from original stabilization cost or any cost of stabilization that would be done after a void of time. It is important to continue stabilization, otherwise the original stabilization is a waste of time, labor and money. All maintenance should be documented and recorded following the form in this report. The maintenance should also be done by archaeological stabilizers who are familiar with the area, building type and process.

CONCLUSIONS

Snake House is a small, eroded, isolated ruin. It was probably visited by many people over the years, but it seems to be avoided in both the early and recent accounts of the area. A few off-hand mentions are made, but little attention was given the ruin. Part of this is probably because the nearby Inscription House is more interesting, being bigger and containing more features, but this should really make no difference. Snake House is more than an eroded pile of deserted stones and mortar. It symbolizes strength and endurance, if only to a small degree. It contains Kayenta masonry, unique building styles, pictographs, plastered rooms, hand and toe holds, wood in place, multiple stories and an incorporation of fallen bedrock and bedrock outcroppings with the structures. It shows adaptation. It represents a time period, way of life, and possibly a better understanding of ourselves.

Sites of this type must continue to be stabilized in the future as an assurance of preservation of all aspects of life and a glimpse into the past. We must also keep in mind that small ruins such as Snake House were as much a part of the Anasazi way of life as large dwellings such as Keet Seel and Inscription House.

It should be stressed that stabilization is an interdisciplinary effort. To be able to stabilize a particular structure or ruin it is necessary to utilize a wide diversity of knowledge. Factors effecting the areas to be stabilized include: weather, natural vegetation and animal life, geology and soils and availability of resources.

Weathering and erosional forces will directly affect the stabilization and crew, natural vegetation and animal life can give some clues as to what may have been in the vicinity at the time of occupation and will also reflect the climate. The geology and soils will be directly related to many of the necessary materials. Soil and rock must match the original and with knowledge of what it is in the area, this can be matched. Finally, the availability of sources, including sand, clay, water and stone must be known before stabilization can begin. All of the conditions must be available in proper proportions or stabilization is useless.

Because stabilization should always be maintained it is important to record the pertinent factors. If a reporting form like that used in this report was followed for all stabilization, the necessary information would be readily available and in consistent order. Each report would obviously have some unique features, but I propose the following features be contained in all stabilization reports: Introduction, site and area description, natural environment, site background (previous work done, who, what, where, when, why), scope of stablization, field conditions, materials used, techniques, any special features, method and rationale, tests, conclusions, references and additional area references. Appendices should include overall survey form, tables of the major jobs and time distribution, estimated and actual labor evaluation, individual site records and photos and any additional features needed.

With all of this information supplied to the reader, he can immediately get a clear, total picture of the stabilization. Also, if over time the maintenance must eventually be done by a different crew, all of the pertinent information is available to them. Finally, it also explains the process to the general public.

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Figure 24. View of the ruin from below. Shows exact location of rooms on the edge. At the far right edge of the photo, on the level of the ruin, are the hand and toe holds which lead to a pass over the mesa above the ruin.

Figure 25.
General view of the Kayenta masonry and techniques. Note uniform stone size, messy adobe and shallow nature of the overhang.

Figure 26.
Example of plastering and niche in Room 15.

APPENDIX A
RUIN STABILIZATION INVENTORY

Ruin Snake House Ruin

Location: a detatched portion of Navajo National Monument in Northeastern Arizona. It is in a west alcove in the northern wall of Nitsin Canyon around the corner, and slightly north of Inscription House. It is in the same slick rock formation.

PRESENT STATE OF RUIN:

a) Description: nineteen rooms, all in varying stages of erosion. Kayenta masonry with heavy chinking. Walls are simple. Evidence of plastering, roof lines, hand and toe holds, petroglyphs and slight room modifications. There are no remaining floors. Ruin is highly eroded due to exposure.

b) Approximate last occupation date: Tsegi phase; A.D. 1250-1300 (?).

c) Human deterioration factors: some recent modification and stacking of stones in Room 3, probably to corral sheep. Excavation, pre 1925.

d) Discovery: Initial discovery not readily discernible. First specific reference George West, 1927, "Exploration in Navajo Canyon, Arizona", Yearbook of the Public Museum of the City of Milwaukee, Vol 5, 1925.

e) Other related sites in the vicinity: Inscription House and Owl House.

BUILDING TECHNIQUE:

Type: Adobe x Jacal x Brick x Masonry x Wattle/Daub_____

Other some plastering, typical Kayenta masonry SEE FIGURE 25

Material used in construction:

Adobe x Stick x Grass x Rock x Other_____

Plastering and special features: Room 16, a possible kiva, contains plastering on the north wall. Room 3, interior, contains beam seats with remaining wood. Room 19 has a cut groove in the cliff wall behind it to channal water run-off from the room to an open space. SEE FIGURE 26

Roof construction: Beam seats in Room 3, for a second story. Along the back row of rooms there is evidence of roof lines, in the form of mortar and mud on the cliff line.

Floor construction: None visible.

STATE OF CONSERVATION:

1) **Condition of walls:** Many are undermined. Basal erosion and wash due to cliff line water run-off. Ruin is extremely exposed.

2) **Condition of plaster:** crumbly and powdery on the surface.

3) **Condition of roofing:** Only beam seats, small portions of wood and mud lines remain of roofs.

4) **Condition of floors:** None

5) **Structural stability, condition of foundation:** Most are undermined. Foundation footing is unstable, usually being sterile soil or bed rock.

RUIN STABILIZATION INVENTORY

STATE OF CONSERVATION, continued:

6) **Erosion near soil level:** water and leaching.

7) **Vertical runs of water:** All along the back row of rooms are water runs. After sever winters and Springs all of the rooms are affected.

8) **Cracks:** deep cracks in most walls, due to sun baking and weathering.

9) **Traces of fire or other natural disasters:** Room 11, possibly intentional. Evidence of fire in Room 19, cause unknown.

10) **Other:**

PHYSICAL ENVIRONMENT:

Rain: Recent figures unkown. Between 1976-1978 there was an average of 7.7".

Snow: No recent figures known.

Moisture damage: noticable on surface of stones, on mortar and washing of joints.

Wind: In April there are strong winds from the west. In the fall there are also strong winds.

Exposure: There is no actual over-hang to protect the Rooms. The exposure is to the east.

Vegetation, plants in structure: NightShade

Vegetation in area: Russian Thistle, NightShade, Pinon, Juniper, Cottonwood, Yucca, cactus, drop seed, Ricegrass, wild flowers and grasses.

Fauna types in the area: Sheep, coyote, cattle, horses, squirrel, chipmunk, lizard, snake and birds.

Fauna disturbance: Evidence of sheep and birds in the ruin.

Natural damage: Wind, rain, snow, freeze, rock fall and sun-baking.

CONCLUDING FIGURES:

Previous stabilization: None

Overview photo of Ruin for reference:

SEE FIGURE 24

Date work began: May 25, 1977

Date work completed: June 10, 1977

Persons involved: RB, DAB, WJB, JLF, SLBG, MH, EM, TRM, CGN, LVN, SLN, BU.

Total man days of work: 203

Functional Name: Petroglyphs

Feature Number: 2

Description: There are several petroglyphs across the cave back at Snake House. The largest is a snake approx. 6 feet long. This seems to be the origin for the name of the ruin. The body and head seem to be pecked, while the open mouth, most likely a more recent addition, is ground. Just above the snake is what is supposed to be a map of the canyon system. There are several other petroglyphs along the cave back. Some are pecked, some are painted white.

Location: Cave back

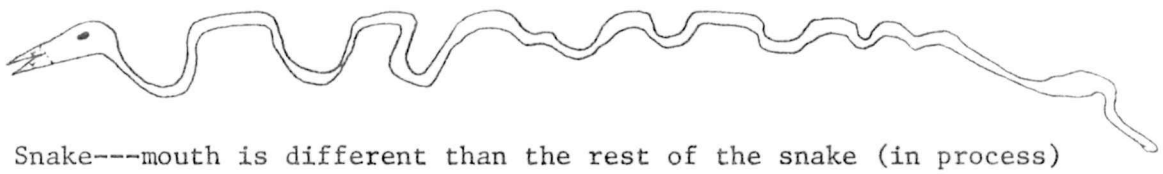
Height:

Width:

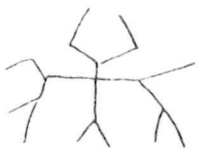
Thickness:

Other:

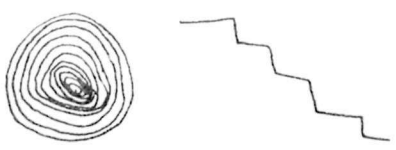
SKETCH MAP:



Snake---mouth is different than the rest of the snake (in process)



Map of the canyon system



All done in white.

Misc. petroglyphs.

APPENDIX B

MAJOR STABILIZING JOBS, MATERIALS AND TIME FACTORS

Room No.	Job No.	No. of People	Total mortar	Total new stone	Spalls	Total Hours	Methyl methacrylate hours
3	1	TRM	3½ buckets	21L, 1M, 1 sm	30-40 sm T 20 sm F 30 m L 20-30 m T	1 hr	
3	2	All	2 buckets	4 sm	80-100 sm T 125-150sm F 151 L	12 hrs.	
3	3	All	1 bucket	5 sm	10-15 sm T	4.5 hrs.	
4	4	EM	2 buckets	--	10 sm F 10-15 sm T 10-15 m L	2 hrs.	
17	5	EM	5½ buckets	3 L 3 M 12 sm	35-40-m T 30 sm L 40 m F 30-40s-m F	6 hrs.	
19	6	SLB, LVN DAB	17 buckets	3 L	20-30L core 20-30s-m F 25-30 m T	8.5 hrs.	
11	7	EM	2 buckets	--	6-10 m T 5 m F	1 hr.	
11	8	EM	3 buckets	--	15 m T 15 m F	2 hrs.	
11	9	SLB	1½ buckets	--	10-20 m T	1.5 hrs.	
12	10	TRM	1½ buckets	2M	4 L T 20 sm T 10-15sm-m F	0.75 hr.	
12	11	TRM	3/4 bucket	--	10-15sm-m T 10-15sm-m F	0.5 hr.	
12	12	EM	3 buckets	--	10 m T	1 hr.	

MAJOR STABILIZING JOBS, MATERIALS AND TIME FACTORS (continued)

Room No.	Job. No.	No. of People	Total mortar	Total new stone	Spalls	Total Hours	Methyl methacrylate hours
12	13	TRM	14 buckets	1L, 3M, 2 sm	20 sm L 25 sm F 61 T 20-30 sm T 26 sm T	5.5 hrs.	
13	14	TRM	10¼ buckets	3L, 3M, 4 sm	20 s-m F 20 s-m L 10-15s-m T	4.75 hrs.	
14	15	EM, SLB	4 buckets	8L	10 m L 20 m T	4.5 hrs.	
14	16	SLB	1¼ buckets	5M L	10-15 sm F 20-30 m T 10-20 m L	2.25 hrs.	
14	17	SLB	1 bucket	4 sm	12sm-m T 10sm-m L	1 hr.	
14	18	TRM	1 5/8 buckets	5M	10-15 L 20-30 s-m T 25-35 s-m F 3 L T	2.25 hrs.	
15	19	TRM, SLB	2½ buckets	2 sm	50-60 s-m T 2 L T 15-20 s-m F	2 hrs.	
15	20	SLB	3/4 bucket	--	10 m T 10 m L	1.25 hrs.	
15	21	TRM	1¼ buckets	--	25 s-m T 15 sm L 15-20 sm F	4 hrs.	
15	22	TRM	3/4 bucket	--	6 L T 25-30 s-m T	2 hrs.	
3	23	GCN, SLN	1¼ buckets	--	--	8.5 hrs	114.75 hrs. (total for Rm. 3)

MAJOR STABILIZING JOBS, MATERIALS AND TIME FACTORS (continued)

	Room No.	Job No.	No. of People	Total mortar	Total new stone	Spalls	Total Hours	Methyl methacrylate hours
	11	24	EM	8 buckets	6L, 4M, 4 sm.	20-30 m T 40-50 s-m T 15-20 sm F 20-30 s-m F 10-15 sm T 5-10 L	2.5 hrs.	
TOTALS	8 different rooms	24 jobs		88 11/12 buckets	38 S, 21 M, 26 L, 5 M-L	all sizes @ 567 T @ 440 F @ 231 L	81.25 hrs.	114.75 hrs

APPENDIX C

TIME DISTRIBUTION

Activity	Time
Mining	228.50
Kneading	45.75
Samples - Experiments	18.50
Notes - Records	23.25
Photos	24.00
Grouting	35.00
Laying stone	62.75
Painting	12.50
Clean-up	43.50
Miscellaneous	
Hauling equipment, etc.	57.75
Camp set-up, clean-up	62.00
Methyl methacrylate	
Experiments with methyl methacrylate	5.50
Transport of methyl methacrylate	42.50
Application of methyl methacrylate	54.25
TOTAL HOURS	715.75
TOTAL MAN DAYS	89.00

APPENDIX D

LABOR

Actual stabilizing time, which does not include mining, kneading, setting up or gathering materials, was projected and estimated before the work began.

Projected time estimates: 15 working days with 8-10 people

Actual time: Approximately 12 working days with 8 people and 3 working days with 6 people.

Projected methyl methacrylate estimates: 2-4 days with 7 people.

Actual methyl methacrylate time: 2 days with 7 people.

Projected days to move in and out of camp: 7 working days

Actual time to move in and out of camp: 7 working days
(includes travel time from Boulder)

In actual work, there were two additional jobs added to the task list which were not figured into the estimated times. There were also approximately 57 man-days of work (mining, kneading, photographs, records, etc.) that were not figured into the stabilization time count.

Stabilization was done over a period of 15 days, with two-three people stabilizing whenever possible. There were seven crew members for twelve working days and five crew members for three days.

In March of 1979, a team of people returned to the site for one day as a winter check on the stability of the stabilization and to record Munsell colors on the methyl methacrylate portions of Room 3. Photos and notes were taken at this time.

APPENDIX E

SOILS

by Todd R. Metzger

MORTAR DESIGN

Before the process of comprehensive stabilization could begin it was necessary to develop a mortar design which would duplicate the aboriginal mortar, not only in color and texture, but in its particle content of sand, silt and clay.

The first step in developing the mortar design is locating a geologic formation which will yeild soils which have undergone primary and secondary decomposition. In this instance the alluvial deposits found within Nitsin Canyon met these requirements.

Structurally, the types of sediment deposits found can be classified as a collection of mineral or rock particles which have been weathered or eroded, transported and modified, by many different processes including illivation, mixing and chemical action, and then redeposited according to particle size (Shackley 1975: 2). This process has been repeated many times since the Pleistocene Age.

Generally speaking (Hunt 1972: 141-144), the alluvial deposits found are of the late Pleistocene and Holocene Ages. The Holocene alluvium can be distinguished stratigraphically from the Pleistocene by the content of archaeological material. The early and late Holocene deposits are differentiated by the type of archaeological material; the old fill predates the development of pottery. Subsequent to these deposits is another period of arroyo cutting and alluviation around the twelfth and thirteenth centuries. The present cycle of arroyo cutting began during the latter part

of the nineteenth and early twentieth centuries.

The second step in developing the mortar design is determining the soil type, which refers to the soil texture. The term soil texture is an expression of the predominant size or size range of the particles, and it has both qualitative and quantitative connotations.

Qualitatively, it refers to the "feel" of the soil material, whether coarse and gritty or fine and smooth. An experienced soil classifier can tell by kneading or rubbing the soil with his fingers whether it is coarse-textured or fine textured.

Quantitiatively, soil texture refers to the relative proportions of various sizes of particles in a given soil. The traditional method of characterizing particle in soils is to divide these particles into three ranges known as textural fractions or separates: sand, silt and clay.

Generally, silt-, sand-, and clay-sized particles are formed by the physical weathering of rocks, and clay-sized particles are formed by both physical and chemical weathering of the rocks. The formation of clay particles from rocks can take place either by the build-up of the mineral particles from components in solution, or by the chemical breakdown of the minerals.

SOIL TYPES

Sand: Sand consists of fine grains of various rocks, mostly quartz. It varies in size from one-quarter inch in diameter to about the smallest grain you can see with the naked eye.

Silt: Silt is rock ground up so fine you cannot see individual grains with the naked eye. Silts will tend to hold together when wet and compresses. Too much water will make them spongy.

Clay: Clay is a natural, earth material that is sticky when wet, and very hard when dry. The grains are too fine to be seen with the naked eye. There are numerous clay types, some will shrink and swell greatly, others will not.

Particle Sizes

Gravel:	2.00 mm to 154.20 mm
Sand:	0.06 mm to 2.0 mm
Silt:	0.002 mm to 0.06 mm
Clay:	Less than 0.002 mm

TESTING OF SOILS

The third step involves the testing of the soils. The following tests are the methods by which the soil texture was determined. Soil layers, or veins, were located within the soil stratum exposed by the recent down-cutting. A small, pinch-sized specimen was extracted from the layers, crushed with the hand and then rubbed with the fingers, giving a general idea as to the particle distribution, whether sandy or clayey, or both. If a sample was determined to have a high sand content it was further examined.

The second test consisted of placing a small pinch-sized sample into a 30 ml vial, filling it with water, shaking it vigorously, and allowing a period of time to elapse in order for the particles to settle. Basically, this test gave a rough estimate of the amount of sand, which is a heavy particle and would settle out first, and the amount of clay and silt, which would remain suspended for a lengthy period of time because of their fine and light qualities. This test, however, did not distinguish between clay and silt, but as a general rule, although both are fine and light, they will distinguish between themselves in a 24 hour period. Silt is of a different structural styling and is slightly heavier than the clay particles, which, depending upon type, will remain suspended for as long as 36 to 48 hours.

A third test, which served as an indicator as to how well the soil will react in an open environment, as well as how well a particular sample will match in color and texture to the original mortar, consisted of making "pattey cakes". This procedure involved four samples; two were mixed with 4-parts soil to 2-parts sand (decomposed sandstone was used), and two were mixed evenly with 2-parts soil to 2-parts sand. Of the two 4-parts soil to 2-parts sand samples, one was mixed with a high content of water and placed in the shade to dry, and the other was mixed with a low content of water and placed in the sun. The same was done with the other samples. Upon drying, the results indicated that both samples mixed with a high water content and placed in the shade to dry, showed the least amount of cracking and the best bonding between the mortar and the masonry. From these results it was decided that upon application of the mortar to the structures it would be necessary to work in the shade whenever possible and to keep the mortar as wet as possible; and that as the degree of sun light increases, the amount of water in the soil mixture should decrease.

SEDIMENTATION TESTING

The simplest method by which soil texture and particle distribution are determined in the laboratory is by the process of sedimentation.

The concept of sedimentation lies within Stoke's Law. According to Stoke's Law (Shackley 1975:116-117), the terminal velocity of a spherical particle settling under the influence of gravity in a fluid of a given density and viscosity is proportional to the square of the radius where u is the settling velocity, r is the particle radius, v is the fluid viscosity, g the gravitational acceleration, and p_s and p_f the densities of the solid particle and the fluid respectively:

$$u = \frac{2}{g} \frac{r^2 g}{v} (p_s - p_f)$$

The method of sedimentation consists of the following (taken from Cox 1976):

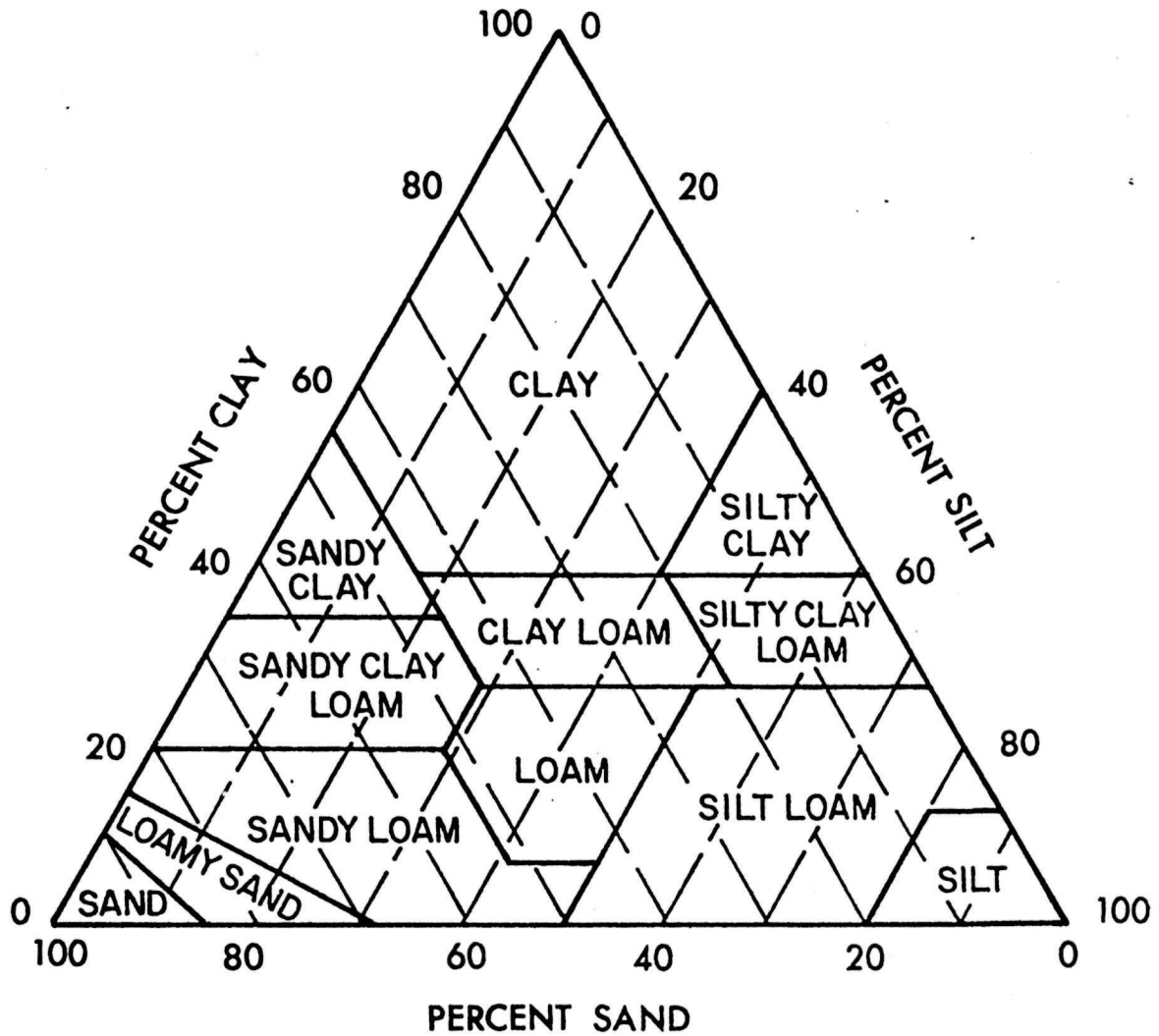
1. Weigh 40 gm air dry soil and place it in large erlenmeyer flask.
2. Add about 300 ml of distilled water.
3. Add 100 ml, 10% sodium hexametaphosphate (calgon water softener will do), and 100 ml 6% hydrogen peroxide.
4. Shake vigorously over a 24 hour period, preferably leave it on a reciprocating shaker (10 minutes will suffice).
5. Transfer the mixture to a 1000 ml graduated cylinder, wash all the contents out from the flask with distilled water to the cylinder. Fill the cylinder to the 1000 ml. mark.
6. Shake the cylinder at least 30 times; if a froth develops add one or two drops of amyl alcohol.
7. Place the cylinder on the table and start the timer. Place the hydrometer (ASTM Soil Hydromete 152H temperature 68°F) and thermometer in the cylinder gently and note the hydrometer reading at 40 seconds. Note the temperature. Take the next reading after 60 minutes.
8. Use the following formulas to determine the percent of sand, silt and clay:

Sand (2.0 - 0.05 mm)	$\frac{100 \text{ (corrected*40-second reading)(100)}}{\text{Weight of Sample}}$
Conventional Clay (0.005 mm)	$\frac{\text{(corrected*60 minute reading) (100)}}{\text{Weight of Sample}}$
Conventional Clay (0.002 mm)	$\frac{\text{(corrected*120 minute reading)(100)}}{\text{Weight of Sample}}$
Silt (0.05 - 0.005 mm)	100 - (Sand + Clay (0.005 mm)

* A 2 degree correction factor needs to be added or subtracted to each reading above or below 68°F.

Silt (0.05 - 0.002 mm) 100 - (Sand + Clay (0.002mm)

9. Use the textural triangle to classify the soil classes.



Sedimentation tests were performed prior and subsequent to the field season, under laboratory conditions. The following are the results of those tests which were performed by both Nordby and Metzger:

Table 1

Sedimentation Tests

	Nordby Original	Nordby Unamended	Metzger Unamended
Sand	69.0%	67.0%	69.2%
Silt	--	--	7.0%
Clay	30.0%	33.0%	23.0%
Organic	1.0%	trace	0.8%

IDEAL SOILS

The ideal soil used in creating the unamended earth mortar has a particle content of approximately 60-70% sand, 20-25% clay, and 0-10% silt. It can be roughly classified as a Sandy loam, or Sandy clay loam, textured soil.

Soil Types for Building.

Sand: Sand by itself is not good for mortars because the particles will not pack down, or together, it needs something else such as clay as a bonding agent. Coarse sand should be used in place of fine sand because fine sand is similar to silt in its properties.

Silt: Silts by themselves are not good for mortars, although they will hold together. They are not strong, and they are difficult to compact. Silts also lose strength and become soft when they

get wet. In wet freezing weather they swell and lose their strength.

Clay: The level of clay should be high enough to provide good cementation but not so high as to cause reduced strength or create potential cracking problems. Extreme caution should be taken when using clays, for certain types exhibit extreme shrinking and swelling upon the absorption or desorption of water, which can ultimately cause cracking and lead to deterioration of the mortar.

MORTAR DUPLICATION

The fourth step in mortar duplication involves the actual making of the unamended earth mortar. All mortar was extracted from the soil stratum by means of a fireman's pry bar and a pickaxe. Samples, taken in large chunks, were transported to the processing area where they were to undergo pulping. This involved the crushing of the soil chunks with a pick handle, screening the loose material and then repeating the process until the soil became a fine powder. The soil was then transported to the site where it would await mixing. The soil matched the Munsell soil chart as 5 YR 7/4 light reddish brown.

All mixing was done in 2½ gallon buckets which were filled no more than half full. The soil was mixed with enough water to bring it to its liquid limit, to ensure thorough mixing, and then slowly reduced to its plastic limit with the addition of dry soil. Masonry built using plastic mortar has a better bond strength than masonry built using dry stiff mortar. After the batched materials were together, they were mixed from three to five minutes; less mixing time may have resulted in nonuniformity, poor workability, low water retention, and a reduced strength of the mortar.

All mortar application was completed in the shade, when possible. The mortar upon application, was high in water content, within workability,

to ensure that the balance between needed moisture retention and the evaporative losses was attained. Additionally, areas receiving mortar application were heavily moistened to prevent a water transfer between the saturated mortar and the dehydrated surfaces. Once application occurred, the use of moistened burlap bags and canvas tarpaulins were employed to control the curing rate and to reduce the water loss from the mortar through evaporation. Jobs were covered for a maximum of two days.

References

Cox, G.W.
1976 Laboratory manual of general ecology. William C. Brown Publishers: Iowa

Hunt, C.H.
1972 Geology of soils. W.H. Freeman and Company: San Francisco

Shackley, Myra
1975 Archaeological sediments. John Wiley and Sons: New York

APPENDIX F

Ruins Stabilization at Snake House - Navajo National Monument

Treatment with Methy Methacrylate

by

Dr. William J. Burke

INTRODUCTION

During the week of August 11, 1977, Dr. F.A. Calabrese, Chief of the Midwest Archeological Center, assembled a study team at Mesa Verde National Park to consider recommendations for ruins stabilization and preservation at the Park. During this interval the research at Arizona State University directed toward the preservation of rock art by the in situ polymerization of methyl methacrylate in sandstone was reviewed.

Dr. David Breternitz of the Department of Anthropology at the University of Colorado expressed interest at that time in using this treatment as a possible approach to strengthening the sandstone in certain sections of the Snake House Ruins in the Navajo National Monument so that the weakened sandstone could be remortared without undergoing severe cracking.

In January, 1978, preliminary laboratory tests with methyl methacrylate were carried out on samples of mortar and sandstone from the Snake House Ruins furnished by Dr. Breternitz. It was found that the cohesive strength of the sandstone could be increased several fold with only a modest change in the intensity of the reddish color of the sandstone.

As a result of these studies and further discussions with Dr. Breternitz and Dr. Calabrese, arrangements were made for a field test of the in situ polymerization process on certain carefully selected sections of the Snake House Ruins during the week of May 29, 1978.

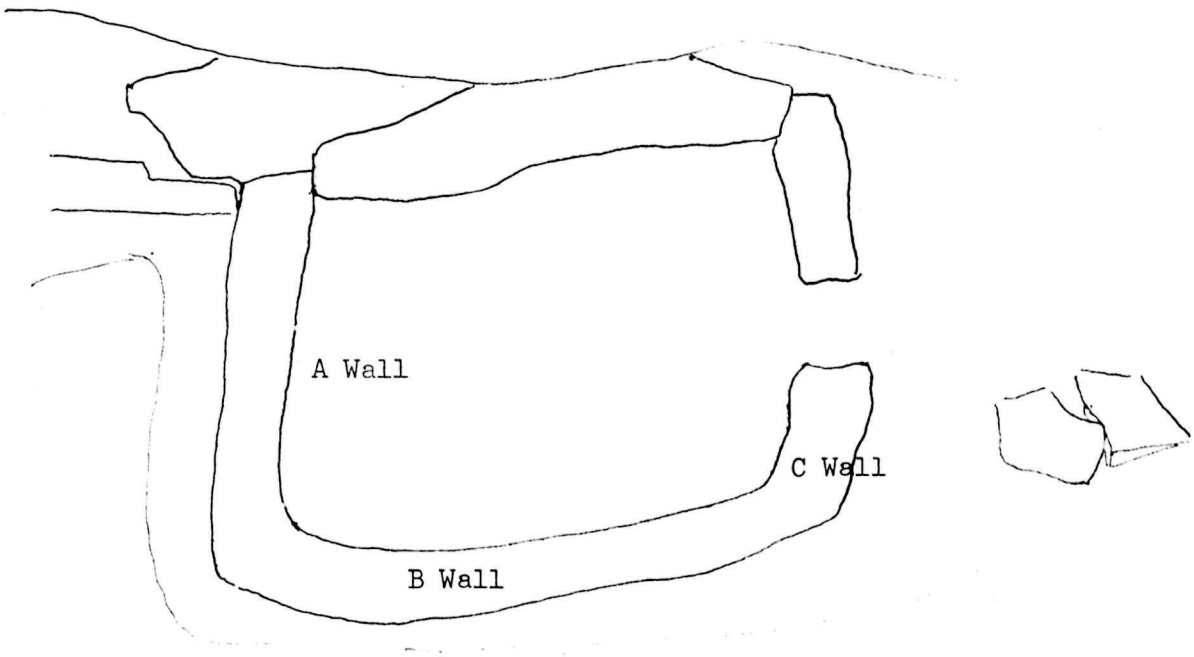
TREATMENT AT SNAKE HOUSE

On May 29, 1978, a team from Arizona State University including Ms. Barbara Ustasiewski, an undergraduate chemistry major, Mr. Richard Bradshaw, a doctoral candidate in chemistry and William J. Burke met Dr. David Breternitz at the Kaibito Trading Post at 2 p.m. (MDT) and proceeded to the base camp of the University of Colorado stabilization field team on the Navajo National Monument.

In addition to Dr. Breternitz, this group included: Ms. Susan Breternitz, Mr. James Firor, Mr. Michael Hilton, Mr. G. Charles Nelson, Ms. Shelly Nelson and Mr. Todd Metzger, undergraduates in the Anthropology program at the University of Colorado; and Professor Enrique Monterroso of the National Museum of Guatemala. Mr. Larry Nordby of the National Park Service joined the group on Tuesday, May 30.

Dr. Breternitz and the Arizona State University team visited the site and observed the stabilization work in progress during the late afternoon on May 29. At that time Dr. Breternitz pointed out specific problem areas and after discussing the various possibilities, it was agreed that the treatment with methyl methacrylate would be limited to Room 3 (see attached drawing) since deterioration of the sandstone in this area was pronounced in certain sections.

On the morning of May 30, with the effective assistance of the Colorado group and Mr. Nordby, 25 gallons of methyl methacrylate and other supplies and equipment were transported from the camp to the ruins site. At 9:40 a.m., the temperature of the outside wall B at a depth of 3 inches was 27°C while the inside of wall B at a comparable depth was 22°C. The Munsell Color reading of the outside of Wall B was 5 YR 5/6 at 9:30 a.m. By 12:40 p.m. the outside of Wall B was 34°C at a depth of 3 inches and



39°C at a depth of about 1 inch while the inside of Wall B, which was in the shade was 32°C at a depth of 3 inches. Unless stated otherwise, the wall temperatures indicated below are at a depth of 2 to 4 inches.

The methyl methacrylate treating solution used in all applications contained 2 per cent of ethylene glycol dimethacrylate and was applied from a galvanized 2 gallon sprinkling can. The first five gallon batch containing 1 percent of Vazo 33W, (2,2-azobis(2,4-dimethyl-4-methoxyvaleronitrile)), as initiator. The treating solution had a temperature of 37°C and a relative viscosity of 1.5 when application to the outside of Wall B of about 1.8 gallons of the treating solution was started at 12:45 p.m. The air temperature at that time was 32°C in the shade. The sandstone absorbed the monomer readily and within a few minutes a second 1.8 gallons at a relative viscosity of 1.8 and 38°C was applied with similar results. Both the

temperature and the viscosity of the remaining treating solution increased rapidly, however, during the application of the last 1.4 gallons. The temperature rose to 44°C and the viscosity was sufficiently high so that the solution toward the end of the application did not penetrate the sandstone appreciably.

In view of this experience the concentration of Vazo 33W was cut to 0.8 percent in all subsequent treating solutions. The first third of the next five gallon batch was applied at 1:00 p.m. before polymerization had started (relative viscosity 1.0) with a view to diluting the high viscosity coat so that it would penetrate the sandstone on the outside of wall B. The second (1.2) and third (1.4) portions of the five gallon batch were applied at the relative viscosities indicated. While much of the high viscosity material on the surface was carried into the sandstone by the use of low viscosity solutions, it was evident that on a number of stones the polymerization had proceeded so far that a coating was deposited on the outside surface.

Application of the third five gallon batch at a temperature of 39°C and a relative viscosity ranging from 1.1 to 1.25 was started at 1:15 p.m. The solution readily penetrated both the outside (35°C) and inside (33°C) of B and C walls and a 14 to 18 inch section of the inside A wall about 3 feet from the room floor. The fourth five gallon batch was applied to the inside of wall B and the narrow strip of inside wall A at 1:30 p.m. at a relative viscosity ranging from 1.3 to 1.45. The fifth five gallon batch was applied at 1:40 p.m. to a vertical section of the outside of wall A about 42 inches wide. The wall was shaded and had a temperature of 28°C at a depth of 3 inches. The treating solution was at 36°C, and had a relative viscosity ranging from 1.1 to 1.8 during the course of treatment which was completed in about ten minutes.

At 2:25 p.m. the outside of wall B had a temperature of 33-34°C at a depth of 3 to 4 inches. The treated portion of the shaded outside portion of wall A had a temperature of 28°C. At 4:00 p.m. qualitative rubbing and fingernail tests indicated that the sandstone had been hardened appreciably. The color of the treated sandstone was noticeably redder than the adjacent untreated stone. The film on several of the rocks in wall B resulting from the application of the last portion of the first five gallon batch resulted in a glossy appearance. In certain areas the film had not set up completely and could be removed with a pen knife. Rubbing the glossy areas with untreated sandstone or with a steel wire brush also reduced the gloss somewhat.

At 9:00 a.m. on May 31, the temperature within the outside of wall B was 21°C while the corresponding shaded inside wall B was 18°C. The temperature increased steadily and by 10:50 a.m., the outside wall was 28°C and the inside wall was 25°C. At 12:45 p.m. the outside of wall B was 37°C and at a depth of 1 inch, and 32°C at a depth of 3 inches. The ambient air temperature in the shade was 32°C. The color of the treated sandstone at this time, while clearly darker than adjacent untreated sandstone, was considerably lighter in color than at 4:00 p.m. the previous day.

In all application on May 31, the methyl methacrylate treating solutions contained 2 percent ethylene glycol dimetharylate and 0.8 percent Vazo 33W. The first five gallons of monomer solution was applied to the outside of B wall during the period 12:55 to 1:03 p.m. The temperature of the treating solution ranged from 36°C to 39°C and the relative viscosity increased from 1.25 to 2.1 during that interval. The second five gallon batch was applied mainly to the inside of B and C walls during the period 1:15 to 1:28 p.m. The temperature of the treating solution increased from 34° to 36°C and the relative viscosity from 1.1 to 1.5

between the initial and final applications.

The third five gallon batch was applied mainly to the inside of wall A with the relatively weak 18 inch horizontal section about 3 feet above the floor receiving a liberal amount of treating solution. The monomer solution relative viscosity ranged from 1.5 to 1.7 and the temperature of the solution was between 36° and 38°C during the application period from 1:40 to 1:50 p.m.

The fourth five gallon batch was applied mainly to the inside and outside of wall A with the middle third being used to treat individual sandstones selected for use in the restoration of sections of the wall, particularly at the intersection of wall A and B adjacent to the base rock. The solution ranged in temperature from 38° to 42°C and the viscosity from 1.2 to 2.8 during the treating period from 2:02 to 2:12 p.m. Although the relative viscosity of the solution at the end of the treatment was relatively high, the liquid penetrated the sandstone readily without depositing any glossy surface film.

Most of the fifth five gallon batch was applied to the shaded outside wall A, which had a temperature of 28°C. The entire wall, including the section treated on May 30, readily absorbed the solution. The last third of the treating solution was applied to the above noted individual rocks which by this time were in the shade. The five gallon batch had initial and final temperatures of 39° to 41°C and the relative viscosity ranged from 1.3 to 1.8 during the application from 2:20 to 2:27 p.m. Again, the treated sandstone had a deeper red coloration than adjacent untreated sandstone. Arrangements were made for Susan Breternitz to follow the color changes with Munsell readings through June 6.

CONCLUSIONS

The application of the treating solution proceeded smoothly and except for a small portion of the first five gallon batch the solution penetrated the sandstone and mortar readily. The temperature range of the wall at the time of the treatment was such as to favor a relatively high conversion of monomer to polymer within the sandstone and mortar.

As anticipated the red-yellow color of the sandstone became more intense with the application of methyl methacrylate but drawing from past laboratory experience with sandstone from the Snake House Ruins, the color can be expected to fade with time. The gloss on certain small areas can also be expected to become less noticeable in the future.

Judging by the qualitative tests made by hand shortly after the treatment, there were definite indications that both the sandstone and mortar had been strenghtened appreciably. The ability of the sandstone to withstand remortaring without cracking will, of course, be the ultimate test of the success of the treatment.

APPENDIX G

Individual stabilization records and photos

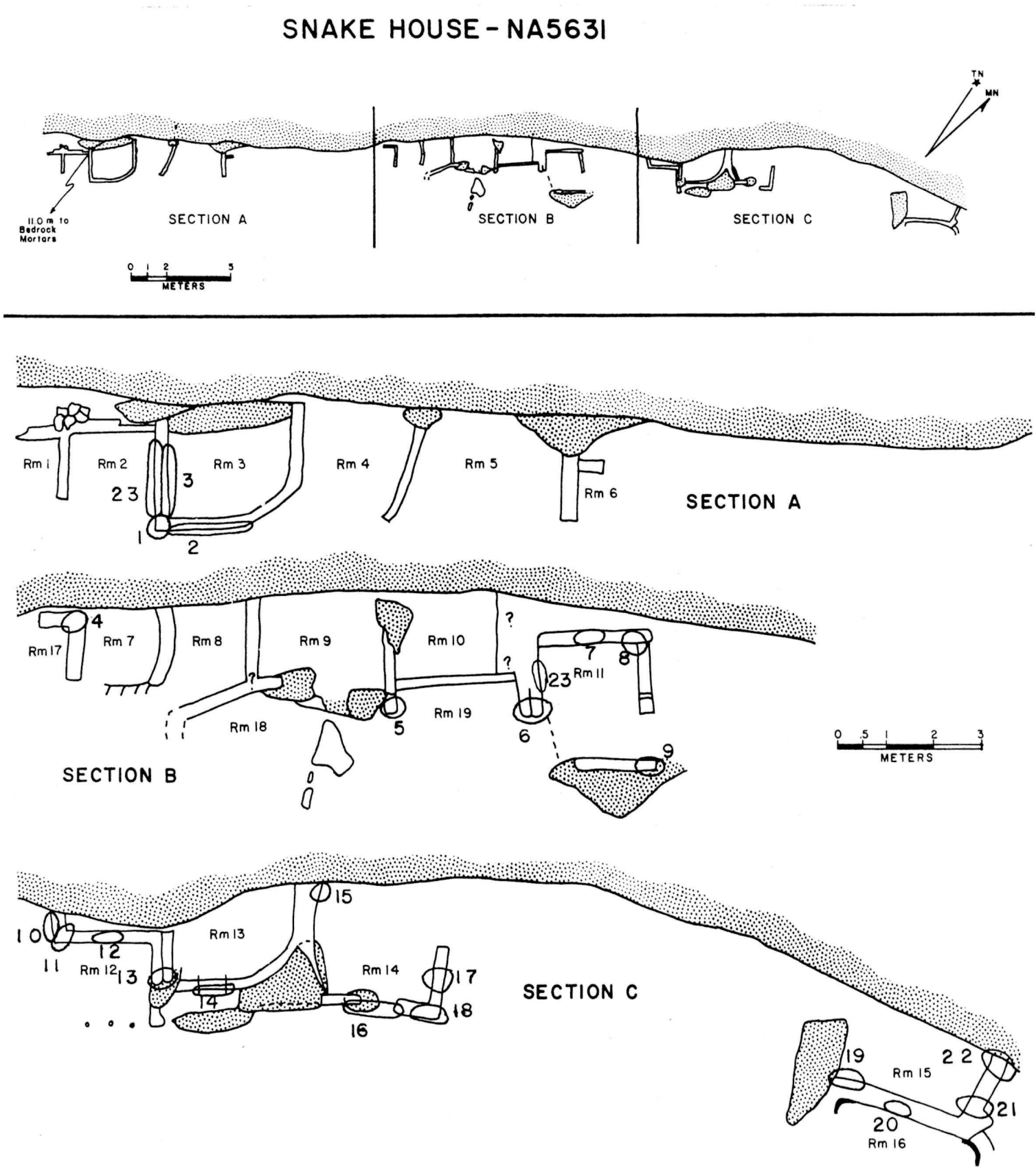


Figure 27. Map of ruin with jobs outlined.

STABILIZATION TASKS - SNAKE HOUSE (NA5631) - August 1977

Job

1. Room 3, So. corner, exterior -- Rebuild base and deep grout exterior to top.
2. Room 3, SE wall, exterior -- Deep grout around beam seats and re-lay exterior stones.
3. Room 3, SW wall, interior -- Grout around beam seats
4. Room 17, No. corner, interior -- Reset stones (low priority)
5. Room 19, SW wall end -- Rebuild end wall from bedrock, deep grout
6. Room 11, SW wall end -- Deep grout
7. Room 11, NW wall -- Re-lay top loose stones
8. Room 11, No. corner, interior -- deep grout
9. Toom 11, NE wall end -- re-lay stones and deep grout
10. Room 12, SW wall, exterior -- fill hole
11. Room 12, SW wall -- re-set capstones
12. Room 12, NW wall -- re-set capstones
13. Room 12, NE wall end -- rebuild lower corner with Room 13
14. Room 13, NE wall, doorway -- re-stone under door and deep grout
15. Room 14, SW wall, interior -- stabilize end of wall at cliff face (low priority)
16. Room 14, NE wall, exterior -- Re-rock under bedrock and base of wall
17. Room 14, NE wall -- re-lay cap rock
18. Room 14, NE wall, exterior, corner -- re-stone and deep grout base
19. Room 15, SE wall, interior, SW½ -- deep grout
20. Room 15, SE wall -- re-set cap rocks
21. Room 15, NE wall -- re-set cap rocks
22. Room 15, NE wall, end -- deep grout at end of wall/cliff face
23. Room 3, SW wall, exterior -- deep grout
24. Room 11, SW wall, interior -- fill wall void

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 3

Job Number 1

Specific Job Location: exterior south corner

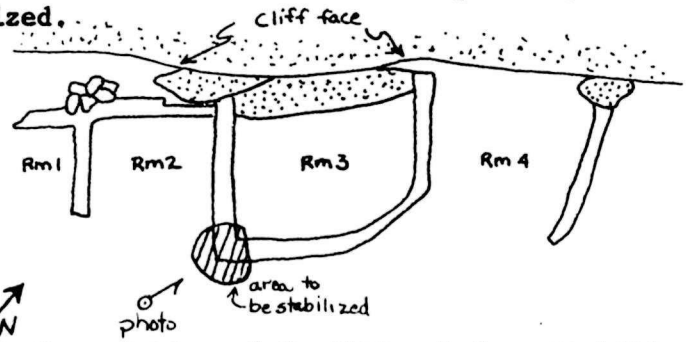
Personnel: TRM, SLBG, DAB, JLF, GCN, MH, WJB, BU, RB, EM, SLN

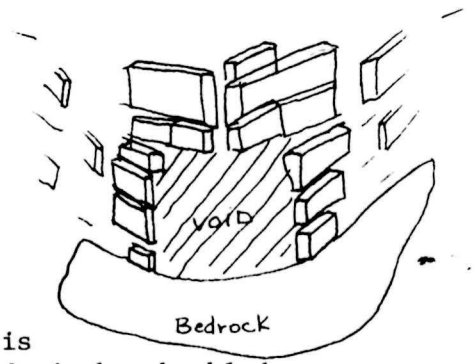
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

The base stones have eroded out of the corner. Mortar is very weathered as is the stone. As the wall has settled, it has buckled and leans toward the south corner. There is extreme pressure on the corner, and several stones have cracked. There is a small amount of bleeding on the interior mortar, and heavy bleeding on the exterior west and south walls.
There appears to be evidence of a second story room, due to clay stains on the back of the cliff line, which are in line with beam sockets on the interior of room 3.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** pack rat nest in corner

Repair or stabilization previous to this work:

A herder has stacked up stones in the original doorway, probably to corral sheep. There is no real stabilization.

Specific stabilization details:

Up to three courses need to be relaid.
The base stones have slipped and fallen. The bedrock under the corner will have to be fitted with a shaped stone and there may even be need to shape a platform on the bedrock, for the reset stones to set on. Minimal grouting is neccesary.

Measurements of wall or area to be stabilized:

Height 45cm **Width** 21 x 25cm **Thickness**

Description of masonry: There is some rock to rock contact, while in some places there is a mortar bed up to 6cm thick. Footing is built on bedrock, and there is a heavy use of chunk spalls. Stones are roughly shaped and spalled. The corner is bound. Stones are approx. 33cm x 4cm to 47cm x 8cm.

Masonry color:

5YR 6/6 Reddish yellow

Structure 3
Job Number 1

Description of mortar: extremely weathered and in poor condition. Mortar is very porous. Spalls that show in the nortar seem to be true.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

All loose materials were removed. Before any coursing began all voids found within the first five courses, from the bottom up, were filled with mortar and 30-40 small to medium true spalls. All surfaces were roughed, using a broom and fingers. Again, before coursing began, contouring of the bedrock was necessary to give a flat foundation for the base stone to sit on. This was completed with a hammer and chisle, making a 16cm wide platform. Two large, one medium, and one small stone were used along with 30 small to medium levelers, 20-30 small to medium true spalls, and 20 small false spalls were used in constructing the corner. The corner was constructed from the bottom up with each successive layer tying in the south and west walls.

Amount of each used in stabilization:
mortar 3¼ bucket **stone** 2L, 1M, 1S **grass** _____ **spalls** 30-40 sm-m True; 20-30 sm-m True; 20 sm False; 30 sm-m Levelers
methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures:

Before treatment:

Stone color: 5YR 6/6 reddish yellow

Stone condition: weathered, crumbly, soft.

Mortar color: 5YR 6/6 reddish yellow

Mortar condition: surface is soft, crumbly. Mortar is in hard chunks and is harder than the stone.

Amount injected:

Into stone: _____

Into mortar: 25 gallons, total for room 3.

Additional stabilization materials that were treated:

Spalls, and small stones

Total amount used, and how	**Total time**	**Total people**

See Appendix F. by Dr. Burke.

Structure 3

Job Number 1

After treatment: See TABLE 6 and FIGURE 17.

Stone color:

Stone condition: very hard, bonds to the mortar. A shiny surface in places.

Mortar color:

Mortar condition: very hard, bonds to the stone well

Concluding Data:

Date started: Methyl Methacrylate: May 30, 1977
Stabilization: June 6, 1977

Date finished: Methyl Methacrylate: May 31, 1977
Stabilization: June 6, 1977

Man Hours: Methyl Methacrylate: 29 hours
Stabilization: 1 hour

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking north and south corner, exterior
Exposure 11, Roll 1
Shade
11/125
May 27, 1977
1:00 pm

Figure 29

After:

University of Colorado, Boulder
TRM,SLN, GCN
Looking north at south corner, exterior
Exposure 6, Roll 3
Shade
5.6/60
June 9, 1977
3:14 pm
Figure 30

Other:

Figure 28.
Room 3, job 1 before stabilization, August, 1977.

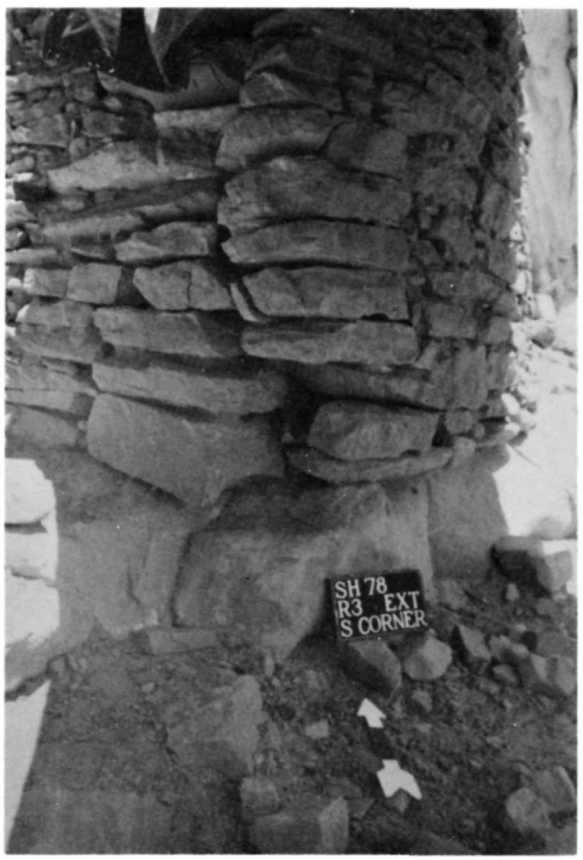


Figure 29.
SHP-78 1-11-13. Room 3, job 1 south exterior of corner before stabilization, May, 1978

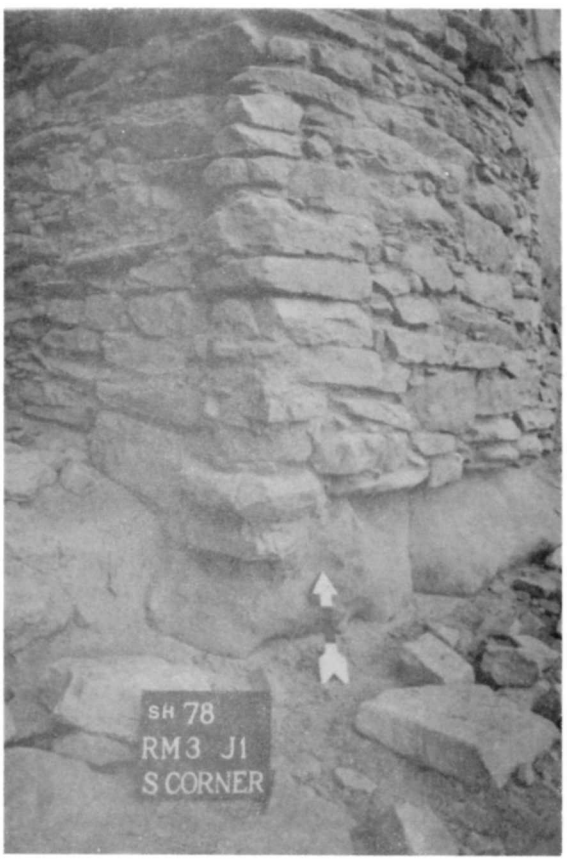


Figure 30.
SHP-78 3-6-31. Room 3, job 1 south exterior corner after stabilization June, 1978

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 3
Job Number 2

Specific Job Location: southeast wall, exterior

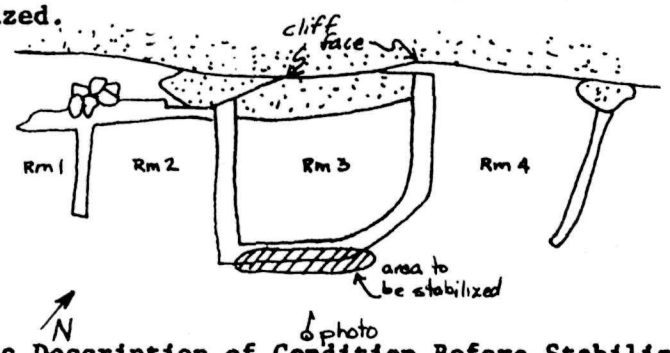
Personnel: TRM, SLBG, DAB, JLF, GCN, SLN, MH, EM, WJB, BU, RB

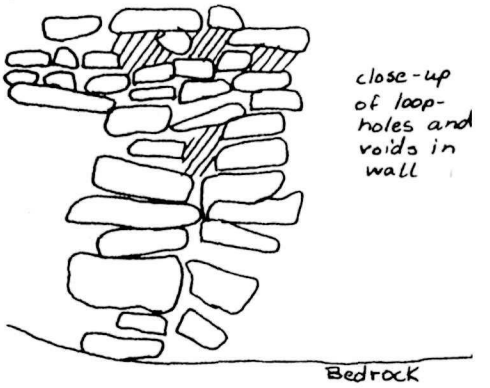
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Weathered. Stone and mortar have pulled apart. The surface is sandy and tends to powder off easily. Several stones have fallen leaving large gaps. The outside areas of the beam seats are also eroded and need repair.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** some rodent damage

Repair or stabilization previous to this work:

None

Specific stabilization details:

It has been determined that the only feasible stabilization method would be Methyl Methacrylate. Beam seats and loose stones need to be deep grouted and relayed. Around the beam seats especially, the mortar is eroded and allowing stones to fall.

Measurements of wall or area to be stabilized:

Height 2.30m **Width** 3.20m **Thickness** 30cm

Description of masonry: At the highest point there are 21 courses. There is a 4-24cm bedding between courses. Wall is built on bedrock and sterile soil. The stones are roughly shaped with some being scabbled. Stones don't generally touch, and there is a heavy use of chinking.

Masonry color: 5YR 6/6 reddish yellow

Structure 3
Job Number 2

Description of mortar: extrememly weathered. Very soft, sandy surface. Chunk chinks of all sizes are exposed in the mortar.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

It was necessary to first clean all vertical and horizontal joints, removing all loose debris. All joints needing repair were wet down and filled with rock and mortar. The mortar was left to dry for a short period of time and then textured. All voids were filled. The degree of filling the joints depended upon intact neighboring aboriginal mortar which in all cases was duplicated. In all, 80-100 small to medium true spalls, 120-150 small to medium false spalls, and 15 small levelers were used. Three stones were relaid on the cap, with six small stones relaid on the exterior south, four small stones added, four small stones relaid on the exterior west, six small stones replaced, two samll stones relaid on the interior south and five small stones relaid on the interior west.

Amount of each used in stabilization:
mortar 2 buckets **stone** 4 new **grass** _____ **spalls** 80-100 sm-m True, 120-150 sm-m False, 15 sm Levelers
methyl methacrylate see below **other** _____

Methyl Methacrylate Figures:

Before treatment:

Stone color: 5YR 6/6 reddish yellow

Stone condition: weathered, crumbly, and soft

Mortar color: 5YR 6/6 reddish yellow

Mortar condition: surface is soft and crumbly, but mortar is in hard chunks.

Amount injected:

Into stone: _____
Into mortar: 25 gallons total for Room 3

Additional stabilization materials that were treated:

Small stones and spalls

Total amount used, and how **Total time** **Total people**

See Appendix F, by Dr. Burke.

Structure 3

Job Number 2

After treatment: see TABLE 6 and FIGURE 17

Stone color:

Stone condition: very hard, with a shiny surface in some places

Mortar color:

Mortar condition: very hard, and bonds well with the stone, shiny in places

Concluding Data:

Date started: Methyl Methacrylate: May 30, 1977
Stabilization: June 6, 1977

Date finished: Methyl Methacrylate: May 31, 1977
Stabilization: June 6, 1977

Man Hours: Methyl Methacrylate: 41 hours
Stabilization: 12 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM,SLBG, DAB
Looking northwest an southeast wall, exterior (two shots)
Exposure 2-3, Roll 1
Shade
8/125, 11/250
May 27, 1977
10;40, 10:45 am
Figure 32, 33

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at southeast wall, exterior (two shots)
Exposure 7-8, Roll 3
Shade
5.6/125, 8/125
June 9, 1977
3:20, 3:25 pm
Figure 34, 35.

Other:

Figure 31.
Room 3, job 2 before stabilization, August, 1977.
Close-up.

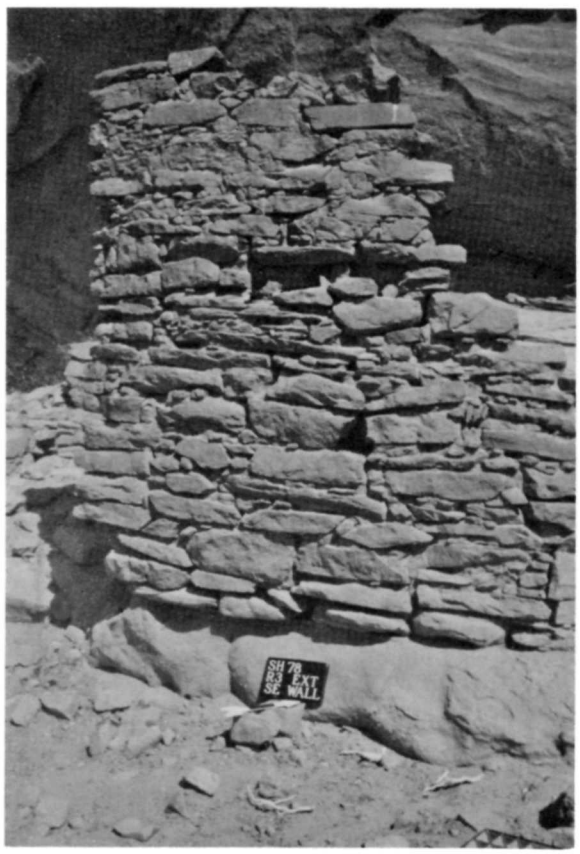


Figure 32.
SHP-78 1-2-4. Room 3, job 2 exterior of southeast wall, before stabilization, May, 1978.

Figure 33.
SHP-78 1-2-5. Room 3, job 2 exterior of southeast wall, before stabilization, May, 1978.

Figure 34.
SHP-78 3-7-32. Room 3, job 2, southeast exterior wall after stabilization, June, 1978.

Figure 35.
SHP-78 3-9-34. Room 3, job 2, southeast exterior wall after stabilization, June, 1978

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 3

Job Number 3

Specific Job Location: interior southwest wall

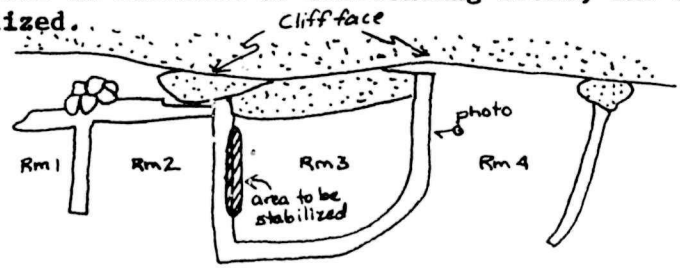
Personnel: TRM, GCN, SLN, SLBG, DAB, JLF, MH, EM, WJB, BU, RB

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

There is heavy erosion above and around the beam seats. Insects have also eroded the mortar leaving a honeycomb effect just above the beam seats. Since there are the remains of a second story above the beam seats, the weight of these stones are putting much strain on the weakened beam seat area.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** insects

Repair or stabilization previous to this work:

None

Specific stabilization details:

Approx. four feet off the ground are a row of beam seats that will need to be grouted and a new mortar bed needs to be worked up. There are no real courses in the area, however, there are 25 pieces of wood that are exposed and need to be grouted back into place.

Measurements of wall or area to be stabilized:

Height 37cm **Width** 77cm **Thickness** 20cm

Description of masonry: no courses in the immediate area. There is mortar and chinking as opposed to stone. Mortar is very sloppy. Spalls are chink type.

Masonry color: 5YR 7/4 Pink

Structure 3
Job Number 3

Description of mortar: There is no real bedding, though there is up to 35cm of mortar in some sections. The mortar is chunky and weathered with a soft flaky surface. Around the beam seats it seems to be a different mortar than in other areas of the ruin, it is a much whiter, more powdery mortar.

Mortar color: 5YR 7/4 Pink

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

Miscellaneous stones were replaced around the beam seats, but, in all cases this was only done to prevent further deterioration. What should be made clear is that no alteration of beam seats occurred other than general grouting. A total of five small stones, along with 10-15 small to medium true spalls were used.

Amount of each used in stabilization:

mortar 1 bucket **stone** 5 small **grass** _____ **spalls** 10-15 sm-m True

methyl methacrylate see below **other** _____

Methyl Methacrylate Figures:

Before treatment:

Stone color: 5YR 7/4 pink

Stone condition: weathered, crumbly, soft

Mortar color: 5YR 7/4 Pink

Mortar condition: surface is soft and crumbly, yet mortar is in hard chunks.

Amount injected:

Into stone: _____

Into mortar: 25 gallons total for Room 3

Additional stabilization materials that were treated:

Small stones and spalls

Total amount used, and how **Total time** **Total people**

See Appendix F, by Dr. Burke.

Structure 3

Job Number 3

After treatment: See TABLE 6 and FIGURE 17

Stone color:

Stone condition: hard, and bonding to mortar

Mortar color:

Mortar condition: hard, and bonding to stone

Concluding Data:

Date started: Methyl Methacrylate: May 30, 1977
Stabilization: June 6, 1977

Date finished: Methyl Methacrylate: May 31, 1977
Stabilization: June 6, 1977

Man Hours: Methyl Methacrylate: 41 hours
Stabilization: 4.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking southwest and southwest wall, interior
Exposure 22, Roll 1
Shade
4/60
May 27, 1977
1:55 pm
Figure 29

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking southwest at southwest wall, interior
Exposure 10, Roll 3
Shade
4/60
June 9, 1977
3:30 pm
Figure 30

Other:

Room 3
Job 3

FEATURES

Functional Name: Beam seats, with remaining wood

Feature Number: 1

Description: The second story beam seats are exposed and still contain wood. Not only are small sticks visible, but there are also several areas with beam impressions. There is heavy erosion and bleeding of mortar.

Location: Interior east and west walls of Room 3

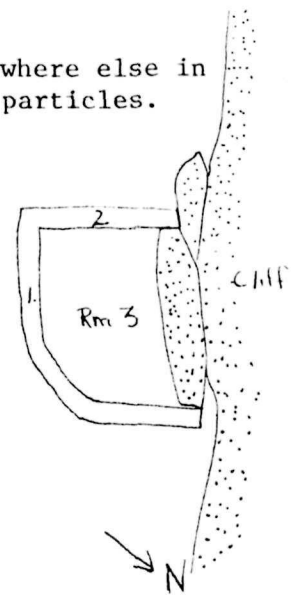
Height: immediate area, 8-16 cm high

Width: immediate area, 1.19m east and 1.73 m west

Thickness: approx. 20cm

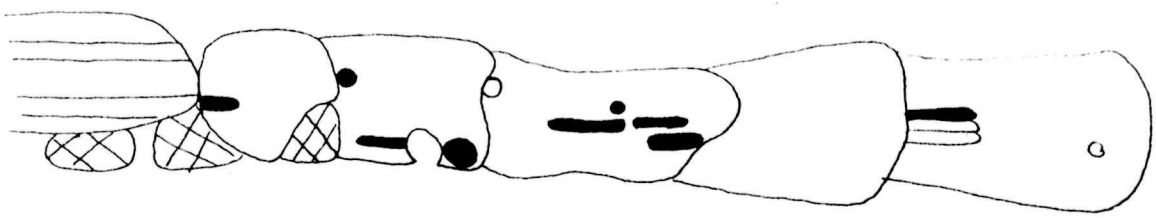
Other: The mortar around these beam seats is different than anywhere else in the ruin. It is very hard, white and contains many different particles. Munsell is 5YR 7/4 Pink, before methyl methacrylate.

SKETCH MAP:

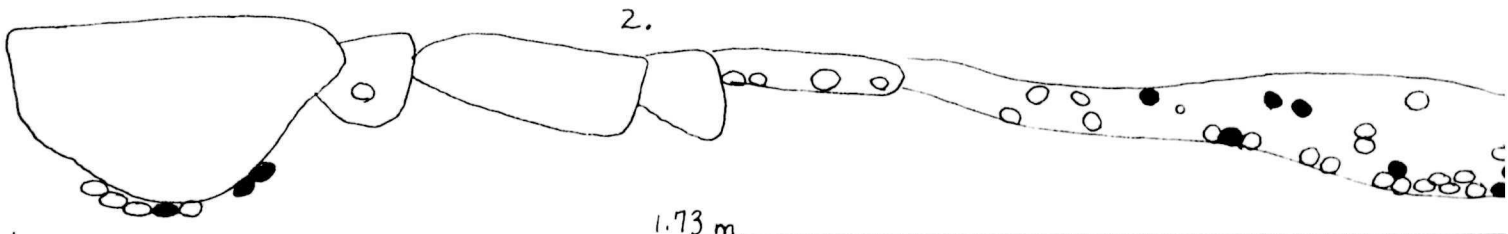


Close up of interior beam seats Room 3

1.



2.



stick impressions
beam post holes
beam post holes with wood in place
exposed wood
stones
adobe sections

Figure 36.
SHP-78 1-22-24. Room 3, job 3, Interior of southwest wall before stabilization, May, 1978.

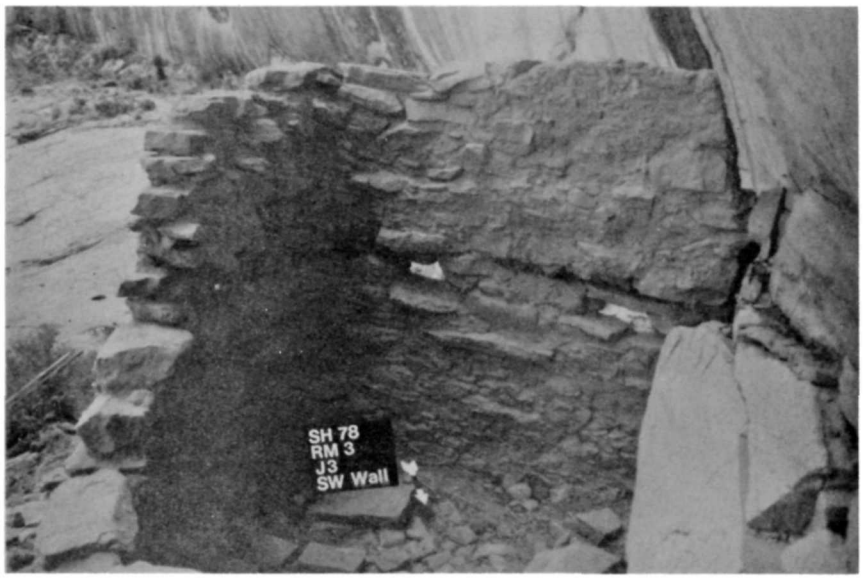


Figure 37.
SHP-78 3-10-35. Room 3, job 3, Interior of southwest wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 17

Job Number 4

Specific Job Location: interior north corner

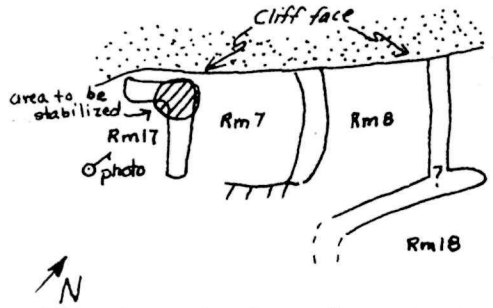
Personnel: EM

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Mortar is cracked and crumbly. Corner has slumped inward and the top course and cap are loose. Only the northeast corner remains of the room, this is slowly pulling away from the cliff and falling inward. No mortar seems to have bled and remains flush with the stones. The room sits on bedrock, and the erosion of this bedrock seems to be the immediate cause of erosion.It is a small back room .

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

The cap and slumping courses need to be reset and realigned. Grouting is also necessary in these same areas.

Measurements of wall or area to be stabilized:

Height 29-80cm **Width** 59cm **Thickness** 30cm

Description of masonry: Stone is shaped and scabbled. Footing seems to be bedrock and sand. The stone is very soft. There are approx. 10 courses. Stones do not touch and there does not seem to be a pattern. There is extensive weathering.

Masonry color: 7.5YR 6/6 reddish yellow

Structure 17
Job Number 4

Description of mortar: Mortar is hard, with a crumbly surface. Chunk chinks 3-7cm thick are obvious. The mortar is porous.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

Two courses, involving two large stones, were reset on the north wall. Ten small false spalls, 10-15 small true spalls, and 10-15 small levelers were all used. The cap rock on the east wall was replaced and a large stone was used to overlap and bond the two walls, connecting tham at the corner. Both interior and exterior grouting was done.

Amount of each used in stabilization:

mortar 2 buckets **stone** 2 large **grass** _____ **spalls** 10 sm False, 10-15 sm True, 10-15 sm Levelers

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: None

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 17

Job Number 4

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31, 1977

Date finished: Stabilization: May 31, 1977

Man Hours: 2 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking north at north corner, interior
Exposure 12, Roll1
Shade
11/125
May 27, 1977
1:05 pm
Figure 39

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking north at north corner, interior
Exposure 4, Roll 3
5.6/125
June 9, 1977
3:00 pm
Figure 40

Other:

Figure 38.
Room 17, job 4, before stabilization, August, 1977.

Figure 39.
SHP-78 1-12-14. Room 17, job 4, interior of north corner before stabilization, May, 1978.

Figure 40.
SHP-78 3-4-29. Room 17, job 4, interior of north corner after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 19

Job Number 5

Specific Job Location: southwest wall end

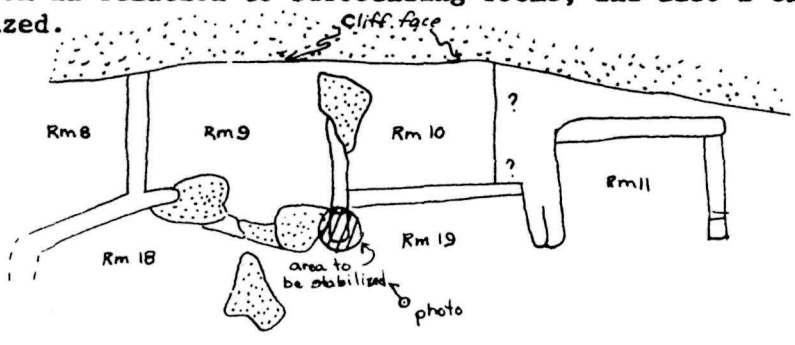
Personnel: EM

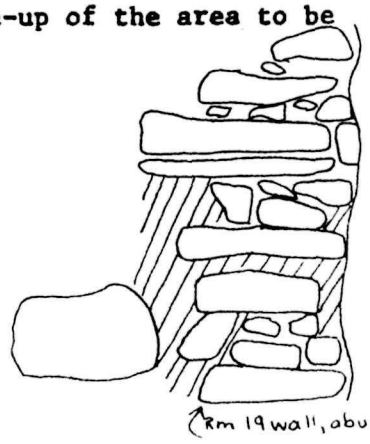
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Top courses are overhung and undercut. Footing and bottom courses are washed out. On the bedrock base there is a grass/jacal layer that is now exposed. Wall is subject to a major water flow. The base of the northeast wall has tumbled and 6-8 courses need to be set in order to supprot the upper courses which remain intact. Deep grouting is also necessary. The wall is so exposed to water wash and the mortar has washed away leaving no support for the large stones

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___ heavy moisture undercutting

Repair or stabilization previous to this work:

None

Specific stabilization details:

Rebuild the end of the wall from the bedrock upwards. Six to eight courses need to be reset and deep grouted.

Measurements of wall or area to be stabilized:

Height 1.47m **Width** 57cm **Thickness** 32cm

Description of masonry: Approx. twelve courses of simple coursing. Heavy chunk chinking. Footing is on bedrock and sterile soil. Rough shaping and spalling to shape the stones. Some weathering. Stones range from 10x5x6cm to 44x30x10cm.

Masonry color: 5YR 6/6 reddish yellow

Structure 19
Job Number 5

Description of mortar: Bed thickness is 4-15cm thick. Mortar is very chunky. Sandy, soft and porous. Mortar bed laps rocks up to 4cm.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

All loose debris was removed and cleaned down to the bedrock. Two large stones served as the base, and were abutted up to the aboriginal wall. The wall was then built up eight random courses to the lowest overhanging stone. The wall was not constructed further. The end of the wall was capped but left unbroken. A total of three large stones, three medium stones, twelve small stones, 30 small leveler spalls, 35-40 small to medium true spalls, and 30-40 small to medium false spalls were used.

The east interior wall of room 9 was also grouted. All loose debris was removed and all holes were patched. A total fo 40 medium false spalls and 30-40 small to medium true spalls were used.

Amount of each used in stabilization:
mortar 5½ buckets **stone** 3L, 3M, 12SM **grass** _____ **spalls** 30m Leveler 65-80sm-m True 30-40 sm-m False 40 m False

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 19

Job Number 5

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization; June 7, 1977

Date finished: Stabilization: June 7,1977

Man Hours: 6 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking west at southwest wall end.
Exposure 9, Roll 1
Sun/shade
8-11/250
May 27
11:20 am
Figure 41

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking west at southwest wall end
Exposure 11, Roll 3
Shade
8/125
June 9, 1977
3:35 pm
Figure 42.

Other:

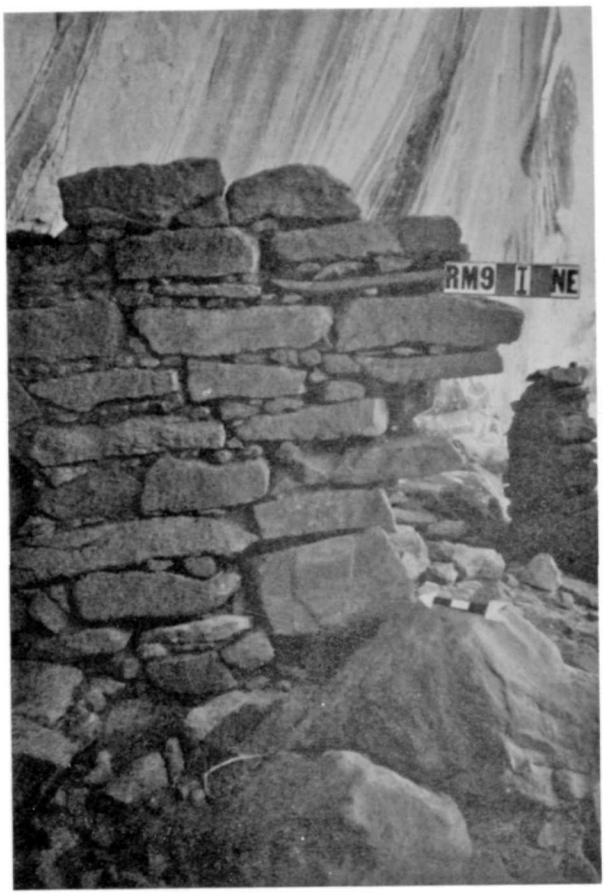


Figure 41.
Room 19, job 5, before stabilization, August, 1977.

Figure 42.
SHP-78 1-9-11. Room 19, job 5, southwest wall end before stabilization, May, 1978.

Figure 43.
SHP-78 3-11-36. Room 19, job 5, southwest wall end after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 11

Job Number 6

Specific Job Location: southwest wall end

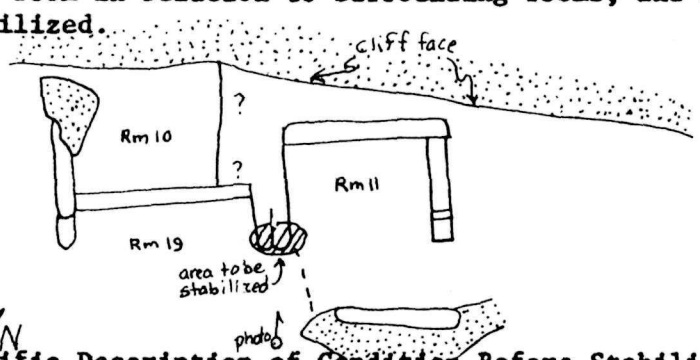
Personnel: SLBG, LVN, DAB

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Mortar is completely washed out from between stones and courses. Stones are quite large and often rest only on chinks or other stones. The wall is leaning inward towards the west. A core is recommended

The west corner is bonded, the north corner is abutted, no other corners are intact.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Deep grout and add a core for support. Mortar is nearly gone and the stones need some sort of support before they all fall out. Extensive grouting and heavy use of true spalls is needed.

Measurements of wall or area to be stabilized:

Height 5.55m **Width** 87cm **Thickness** 56cm

Description of masonry: approx. ten courses remain. Stones are spalled or chunked. Weathering can be seen on the outside rocks. Very crumbly. No pattern in the stone laying, there are the remains of a rubble and mortar core left. Footing is on bedrock and sterile soil. Stone size is approx. 12-35 x 3-12 x 9-20cm

Masonry color: 5YR 7/6 reddish yellow

Structure 11
Job Number 6

Description of mortar: weathered, sandy and soft. The places where it remains it is very messy and thick. Mortar bed is 2-17cm thick. There is up to 4cm of mortar overlap on the stones. Spalls are large thick chunks. Mortar is porous.

Mortar color: 7.5 YR 7/4 pink

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

Larry Nordby began by cleaning down the wall end. Because mortar was not readily available for immediate stabilization, the fragile wall end tumbled as he cleaned the joints. All ten courses were relaid. This consisted of a compond wall with a rubble core. In places, 2-4 stones per course were relaid. A strong footing bed was used. After the bed was set, the stones were reset into their original positions, with the help of drawings and photos. Three new stones were added but only where it was completely necessary. Approx. 20-30 small stones were added to the core, 20-30 small to medium false spalls, and 35 medium true spalls were used in the stabilization. After the relaying was finished, the beds were repointed and antiqued.

Amount of each used in stabilization:
mortar 17 buckets **stone** 3 large **grass** _____ **spalls** 20-30 sm Levelers, 20-30 sm-m False, 35 m True
methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 11

Job Number 6

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31, 1977

Date finished: Stabilization: May 31, 1977

Man Hours: 8.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northwest and southwest wall end
Exposure 8, Roll 1
Sun/shade
8-11/250
May 27, 1977
11:15am
Figure 45

After:

University of Colorado, Boulder
TRM, SLN, GGN
Northwest at southwest wall end
Exposure 3, Roll 3
8/125
June 9, 1977
2:55 pm
Figure 46

Other:

Figure 44.
Room 11, job 6, before stabilization, August, 1977.

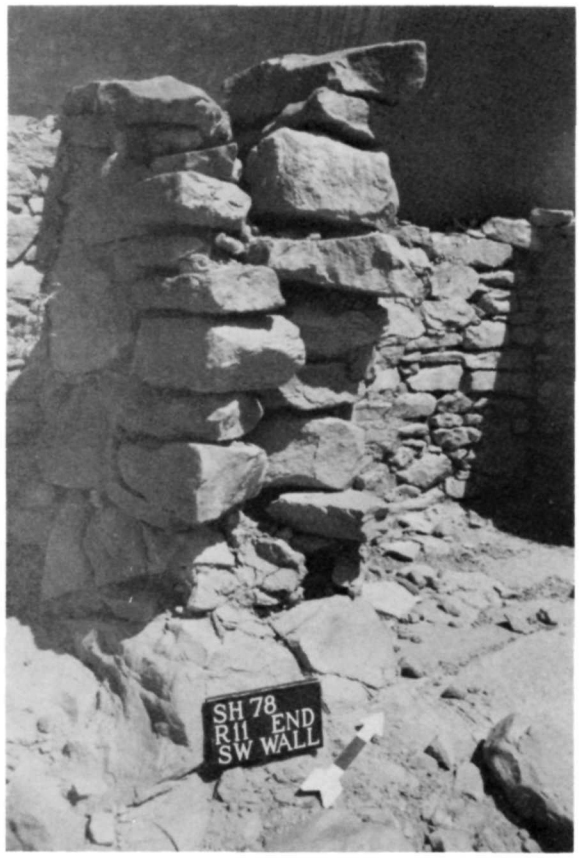


Figure 45.
SHP-78 1-8-10. Room 11, job 6, wall end before stabilization, May, 1978.

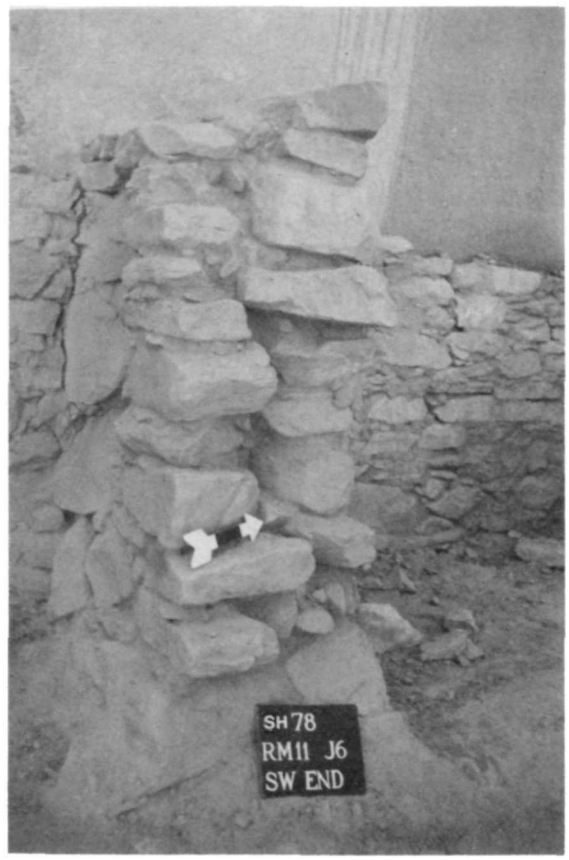


Figure 46.
SHP-78 3-3-28. Room 11, job 6, wall end after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 11

Job Number 7

Specific Job Location: northwest wall, cap stone

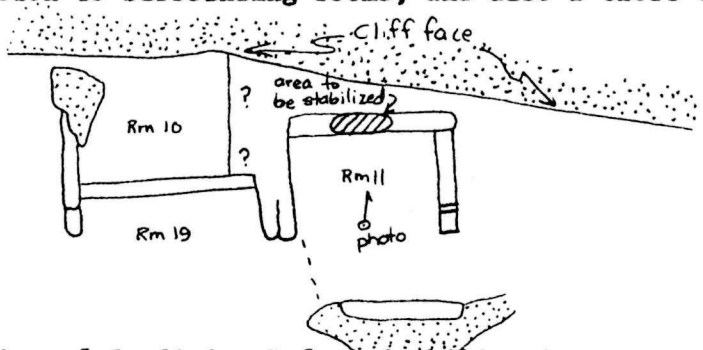
Personnel: EM

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Cap stone is loose and needs to be relaid. Room is in fairly good shape with minimal bleeding at the joints. Mortar bedding is thick and there is heavy use of spalls.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Relay three cap stones and grout the area

Measurements of wall or area to be stabilized:

Height 90cm **Width** 12cm **Thickness** 20cm

Description of masonry: Stone is weathered and brittle. It has been shaped and spalled. There is no pecking. Top stones are quite large. Mortar bed on the cap stones is washed.

Masonry color: 5YR 7/4 Pink

Structure 11
Job Number 7

Description of mortar: Mortar is porous and sandy. Where a mortar bed can be seen it ranges from 5-9cm thick. There is heavy use of chinks

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The three cap stones were grouted into place to assure exact position in there original locations. Six to ten leveler spalls and 5 medium true spalls were used in general grouting.

Amount of each used in stabilization:

mortar 2 buckets **stone**_____ **grass**_____ **spalls** 6-10 m Levelers 5 m False

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 11

Job Number 7

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 29, 1977

Date finished: Stabilization: May 29, 1977

Man Hours: 1 hour

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northwest at northwest wall, interior
Exposure 13, Roll 1
Shade
8/125
May 27, 1977
1:10 pm
Figure 47

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at northwest wall, interior
Exposure 21, Roll 2
5.6/125
June 9, 1977
2:42pm
Figure 48

Other:

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 11
Job Number 8

Specific Job Location: interior north corner

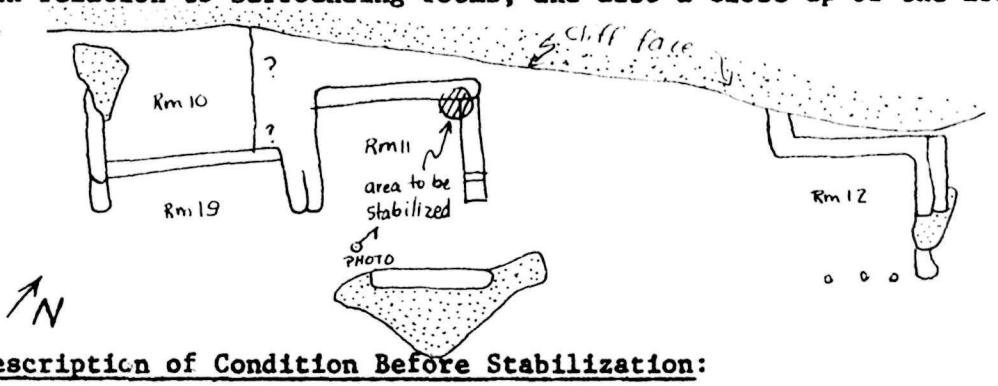
Personnel: EM

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Corner and northwest section of the back wall are very eroded and void of mortar. A drip line seems to be the immediate cause. Stones are leaning towards the center of the room with no mortar support. The base is also eroded and undermined.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___ heavy water damage

Repair or stabilization previous to this work:

None

Specific stabilization details:

Deep grouting and adding of spalls is necessary.

Measurements of wall or area to be stabilized:

Height 4.44m **Width** 85cm **Thickness** 14cm

Description of masonry: twelve to thirteen courses remain. Stones are shaped and scabbled. Weathering is evident. Stones generally don't touch and there is no pattern.

Masonry color: 5YR reddish yellow

Structure 11
Job Number 8

Description of mortar: Mortar is weathered and porous. Many places the mortar bed has eroded out exposing chinking. Bed is 2-12 cm thick

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:
The joints needed to be blended with surrounding areas. This was done by filling all void with mortar and spalls. A total of 15 medium true spalls and 15 medium false spalls were used. The area was roughed and contoured after the joints had dried.

Amount of each used in stabilization:
mortar 3 buckets **stone**_____ **grass**_____ **spalls** 15m True 15 m False
methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 11

Job Number 8

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 29, 1977

Date finished: Stabilization: May 29, 1977

Man Hours: 2 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Northwest at northwest wall, interior
Exposure 13, Roll 1
Shade
8/125
May 27, 1977
1:10pm
Figure 48

After:

University of Colorado, Boulder
TRM, SLN, GCN
Northwest at northwest wall, interior
Exposure 21, Roll 2
Shade
5.6/125
June 9, 1977
Figure 49

Other:

Figure 47.
Room 11, job 7-8,before stabilization, August, 1977.

Figure 48.
SHP-78 1-13-15. Room 11, job 7-8, interior of northwest wall before stabilization, May, 1978

Figure 49.
SHP-78 2-21-33. Room 11, job 7-8, interior of northwest wall after stabilization, June, 1978

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 11

Job Number 9

Specific Job Location: northeast wall end

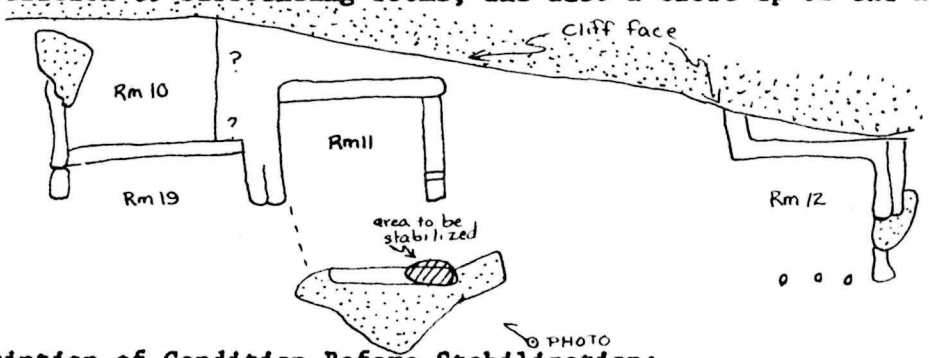
Personnel: SLBG

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Cap stones need to be set. Course below the cap has extremely weathered mortar. Stones and wall itself are falling inward towards the center of the room. The wall is in a direct drip line.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** heavy water damage

Repair or stabilization previous to this work:

None

Specific stabilization details:

Cap needs to be relaid and the the entire wall end needs to be grouted. Spalls and small stones will need to be added and contoured so as to let the water run off of the cap and not settle on the cap stones.

Measurements of wall or area to be stabilized:

Height 1.24m **Width** 80cm **Thickness** 28cm

Description of masonry: Total of nine courses. Footing is bedrock. Stones are roughly shaped and badly weathered. Average stone size is 31-50 x 7-17 x 27-30cm

Masonry color: 5YR 7/4 pink

Structure 11
Job Number 9

Description of mortar: Mortar is very weathered. Drip line can be followed on the mortar. Mortar is brittle and soft with some chunk chinks. Mortar bed is 2-10cm thick

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The top three courses had stones which were loose and several courses needed to be deep grouted due to bleeding of mortar. The section of wall was brushed and cleaned down. After this, a sketch was made and the loose stones were numbered. Three stones were relaid. As the stones soaked in a bucket of water, the entire area was sprayed down. A mortar base was laid and the three stones were reset in place. The interior was deep grouted. Finally the outside was also deep grouted. A total of 10-20 medium true spalls were used to fill voids of space.

Amount of each used in stabilization:

mortar 1 1/3 bucket **stone**_____ **grass**_____ **spalls** 10-20 m True

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 11

Job Number 9

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31, 1977

Date finished: Stabilization: May 31, 1977

Man Hours: 1.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking west at northeast wall end, exterior
Exposure 4, Roll 1
Bright sun
11/125
May 27, 1977
10:55 am
Figure 51

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking west at northeast wall end, exterior
Exposure 20, Roll 2
Shade
8/125
June 9, 1977
2:40 pm
Figure 52

Other:

Figure 50.
Room 11, job 9 before stabilization.

Figure 51.
SHP-78 1-4-6. Room 11, job 9, northeast wall end before stabilization, May, 1978.

Figure 52.
SHP-78 2-20-32. Room 11, job 9, northeast wall end after stabilization, June, 1978.

Ruin Snake House Ruin 1977 **Structure** 12
Job Number 10

Specific Job Location: exterior southwest wall

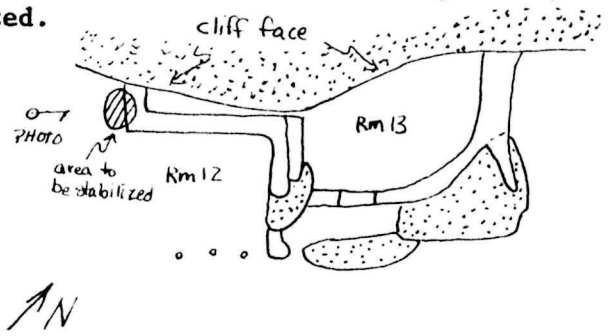
Personnel: TRM

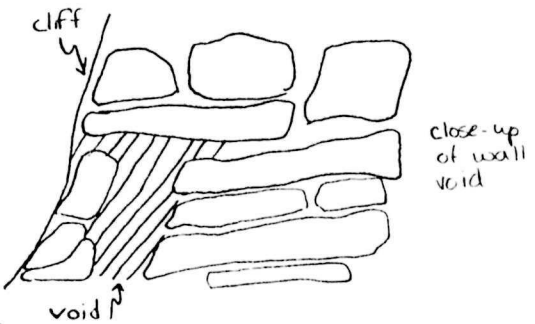
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Base of wall is highly eroded. There are burned remnants and debris pushing on the wall from the inside. It looks as though trash or debris was placed behind the small wall, between the wall and the cliff. With the water erosion the base stones have since fallen out and can no longer hold back the contents behind the wall. The footing is very soft. Mortar has cracked and contain little chinking. Stones need to be added. Hole is 28 x 26cm

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___ fire and rodent damage

Repair or stabilization previous to this work:

None

Specific stabilization details:

Hole void must be filled and the base of the wall grouted . Lowercorner next to the cliff must also be grouted. If possible, some of the debris from behind the wall should be removed to ease the pressure on the wall.

Measurements of wall or area to be stabilized:

Height see above **Width** **Thickness**

Description of masonry: 12 courses, not uniform. Some shaped stone, others only spalled. Base stone is weathered. Footing is soft and wall is simple. Footing is on bedrock and sterile soil. Stone is limestone and sandstone. Stone is cracking in laminations. Average stone size 16-65 x 7-14cm

Masonry color: 5YR 6/4 light reddish brown

Structure 12
Job Number 10

Description of mortar: Mortar is thick and in hard chunks. It is very sandy, course, and porous. It is surface eroded and has a somewhat powdery surface. Chinks are chunk type. Mortar bed is 5-8cm thick

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

In order to repair the hole, an adequate foundation was constructed. This was accomplished by soaking the fill with water, tamping it down with a maul, then placing a medium sized stone, the size of the gap (lenghtwise), on top of this and then tamping it down until it is firmly in place. This served as the foundation for the mortar and coursed stone. Two courses, involving two medium sized stones, were built on top of this. The addition of 4 large true spalls, 20 small true spalls, and 10-15 small to medium false spalls, in, and around all voids left after the coursing, was necessary.

Amount of each used in stabilization:
mortar 1 3/4 bucket **stone**_____ **grass**_____ **spalls** 4 L True, 20 sm True, 10-15 sm-m False
methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 12

Job Number 10

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31, 1977

Date finished: Stabilization: May 31, 1977

Man Hours: 0.75 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM,SLBG,DAB
Looking northeast at southwest wall, exterior
Exposure 5, Roll 1
Shade
8/125
May 27, 1977
11:00 am
Figure 54

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northeast at southwest wall, exterior
Exposure 18, Roll 2
Shade
8/125
June 9, 1977
2:30 pm
Figure 55

Other:

Ruin Snake House Ruin 1977 **Structure** 12

Job Number 11

Specific Job Location: southwest wall, cap

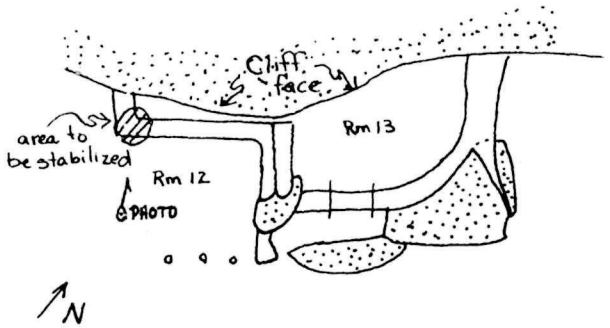
Personnel: TRM

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Top two courses and cap need to be reset. Top courses have pulled away from the body of the wall and are creating a strain. Some mortar has bled out and needs to be regrouted. Room is in back row of rooms

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___ bat excrement

Repair or stabilization previous to this work:

None

Specific stabilization details:

Cap stones need to be rest and area needs to be grouted.

Measurements of wall or area to be stabilized:

Height 61cm **Width** 37cm **Thickness** 41cm

Description of masonry: Masonry in the cap is mainly large blocks of slightly shaped stone. Very little mortar left between the top course and the second course. Stone is weathered

Masonry color: 5YR 7/6 reddish yellow

Structure 12
Job Number 11

Description of mortar: Mortar bed is 2-9 cm thick. It is in chunky sections, is porous and a bit sandy. Few spalls are used in the mortar.

Mortar color: 5YR 7/4 Pink

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

Three cap stones were removed and cleaned of all loose debris. All loose mortar, on the wall, was removed and cleaned down to a level surface. The stones were then reset in their original places. Grouting was done in the immediate area. A total of 10-15 true spalls, and 10-15 false spalls, all small to medium , were used.

Amount of each used in stabilization:

mortar 3/4 bucket **stone**_____ **grass**_____ **spalls** 10-15 sm-m True, 10-15 sm-m False

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 12

Job Number 11

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31,1977

Date finished: Stabilization: May 31, 1977

Man Hours: 0.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northeast at southwest wall, exterior
Exposure 5, Roll 1
Shade
8/125
May 27, 1977
11:00 am
Figure 54

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northeast at southwest wall, exterior
Exposure 18, Roll 2
Shade
8/125
June 9, 1977
2:30 pm
Figure 55

Other:

Figure 53.
Room 12, job 10-11 before stabilization, August, 1977.

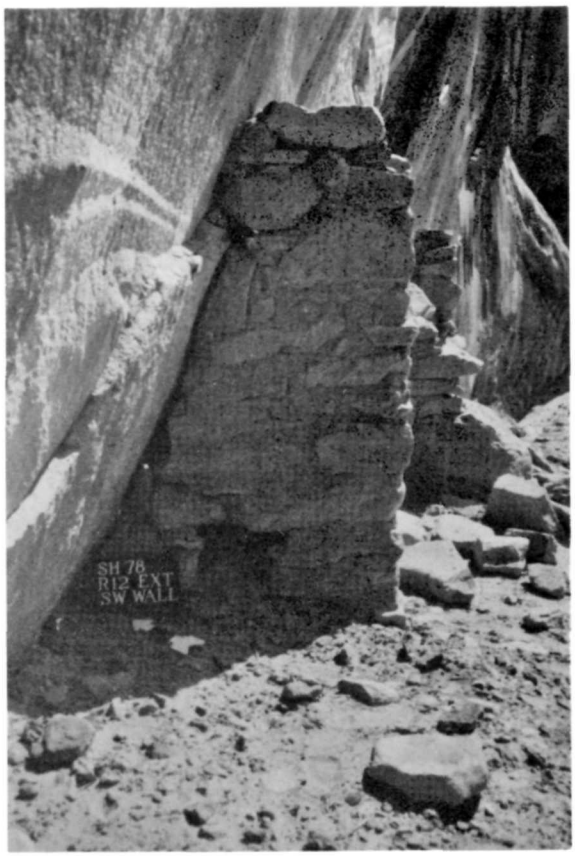


Figure 54.
SHP-78 1-5-7. Room 12, job 10-11, southwest exterior wall before stabilization, May, 1978.

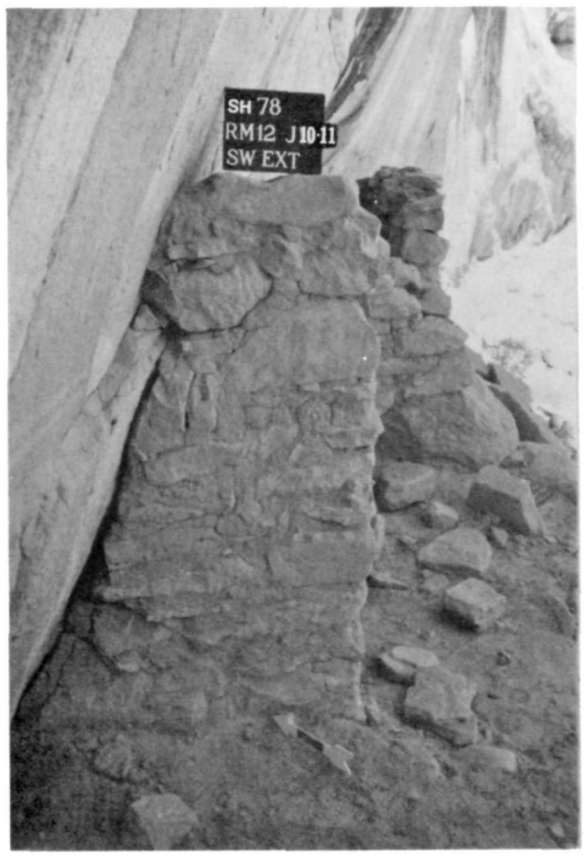


Figure 55.
SHP-78 2-18-30. Room 12, job 10-11, southwest exterior wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 12

Job Number 12

Specific Job Location: Northwest wall, cap

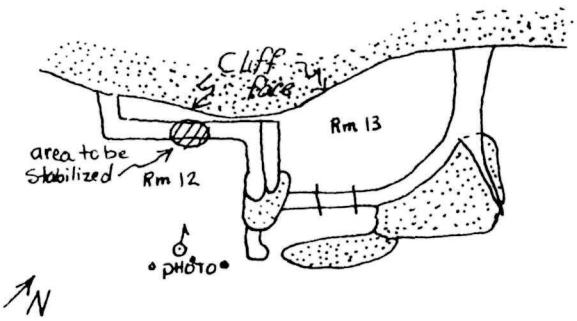
Personnel: EM

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Top two cap stones are loose. Course underneath the cap is also loose. Sections of mortar are also pulling out . Erosion is due to water line and weathering.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Reset cap stones and second course. Remove loosened mortar and grout the area.

Measurements of wall or area to be stabilized:

Height 33cm **Width** 1.17m **Thickness** 24cm

Description of masonry: wall consists of eleven courses, stones are roughly shaped chunks of rock. Stones show signs of weathering.

Masonry color: 5YR 6/6 reddish yellow.

Structure 12
Job Number 12

Description of mortar: sandy and soft, yet it is held in hard chunks. Mortar is porous. Mortar bed is 2-8cm thick.

Mortar color: 5YR 6/4 light reddish brown

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

One stone needed to be set. The stone was soaked, then a base of mortar was laid. The stone was reset in its original place. The area below and to the sides of this stone were grouted with mortar and approximately ten medium true spalls.

Amount of each used in stabilization:

mortar 3 buckets **stone** _____ **grass** _____ **spalls** 10m True

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 12

Job Number 12

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31, 1977

Date finished: Stabilization: May 31, 1977

Man Hours: 1 hour

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northwest at northwest wall
Exposure 15, Roll 1
Shade
8/125
May 27, 1977
1:20pm
Figure 57

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at northwest wall
Exposure 17, Roll 2
Shade
8/125
June 9, 1977
2:25 pm
Figure 58

Other:

Figure 56.
Room 12, job 12 before stabilization, August, 1977.

Figure 57.
SHP-78 1-15-17. Room 12, job 12 northwest wall before stabilization, May, 1978.

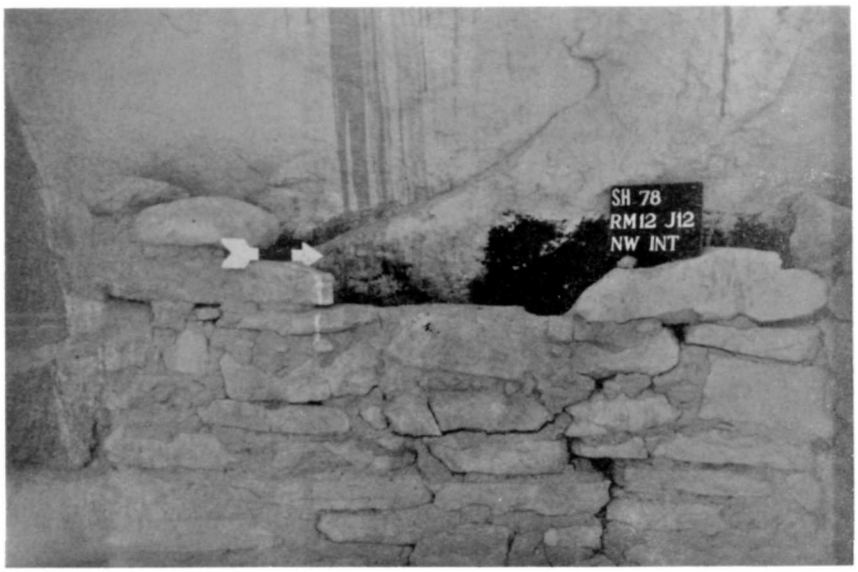


Figure 58.
SHP-78 2-17-29. Room 12, job 12 northwest wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1977 **Structure** 12
Job Number 13

Specific Job Location: northeast wall end.

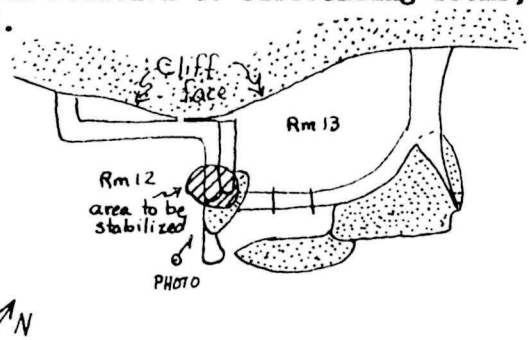
Personnel: TRM

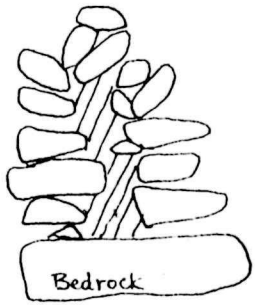
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





close up of wall end to be stabilized

Specific Description of Condition Before Stabilization:

Double wall between Rooms 12 and 13 has slumped and fallen. The footing is bed rock, but it has been undermined and the first course from the ground is very weak. Approx. ten to twenty rocks have slumped and fallen from their original positions.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Need to rebuild the entire lower corner of the double wall. The core needs to be replaced and the footing also needs to be stabilized to prevent further wall fall.

Measurements of wall or area to be stabilized:

Height 90cm **Width** 96 cm **Thickness** 46 cm

Description of masonry: At the corner, six courses remain. Stones are large chunk type, with some shaping. Average stone size is 28-35 x 7-14 x 20-24cm

Masonry color: 5YR 7/4 Pink

Structure 12
Job Number 13

Description of mortar: Mortar bed is 4-11cm thick. It is chunky, very weathered and porous. Surface is powdery.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

All loose stone and mortar was removed to a stable course. One large stone and one medium stone were added to the interior corner of Room 12. Ten small to medium leveler spalls, 20 small to medium false spalls, and ten small to medium true saplls were used. These stones were added to support the over-hanging wall. Two medium stones two courses high were added to fill the gap at the corner at the south exterior of Room 13. The core was then filled with six large true spalls, 2 small stones and 20-30 small to medium true spalls. Four stones were reset in the interior corner of Room 13. Also, 10 true spalls, 5 leveler spalls and six false spalls, all small to medium, were used. All cap surfaces were contoured for drainage.

Amount of each used in stabilization:
mortar 14 buckets **stone** 1L, 3M, 2SM **grass** _____ **spalls** 6L true
20-30sm True
20-30 sm-m True
~~15 sm-m Levelers~~
26 sm-m False
methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 12

Job Number 13

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: June 7, 1977

Date finished: Stabilization: June 7, 1977

Man Hours: 5.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northwest at northeast wall end
Exposure 21, Roll 1
Shade
8/125
May 27, 1977
1:50 pm
Figure 60

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at northeast wall end
Exposure 12, Roll 3
Shade
8/125
June 9, 1977
3:45 pm
Figure 61

Other:

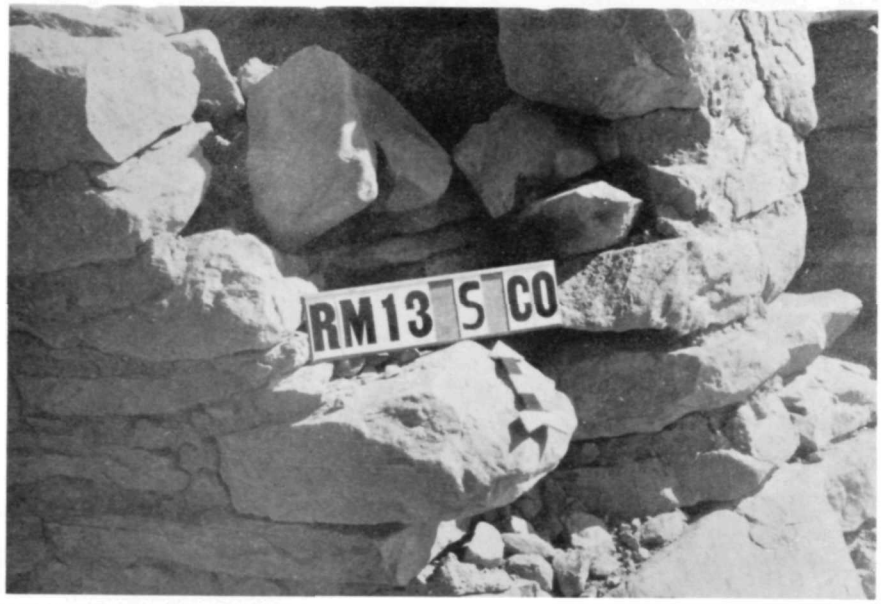


Figure 59.
Room 12, job 13 before stabilization, August 1977.

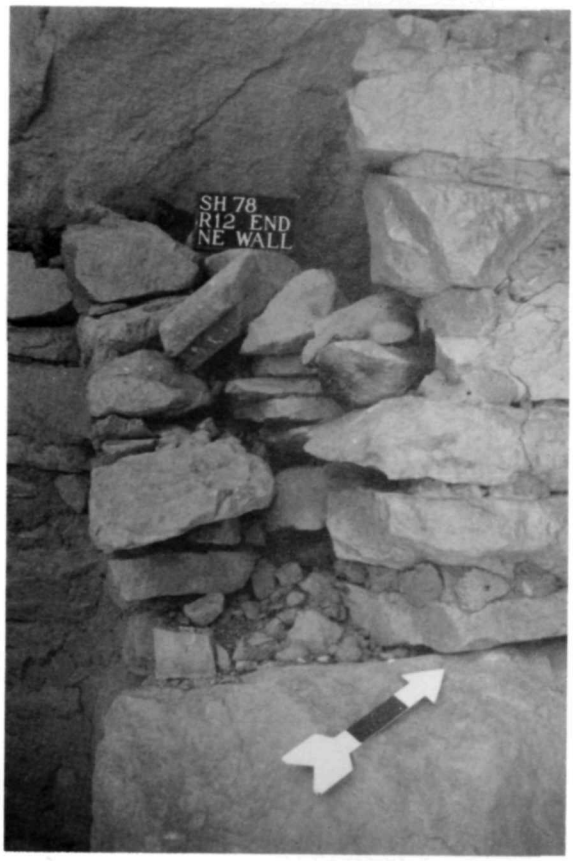


Figure 60.
SHP-78 1-21-23. Room 12, job 13 northeast end wall before stabilization. May, 1978.

Figure 61.
SHP-78 3-12-37. Room 12, job13 northeast end wall after stabilization. June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 13
Job Number 14

Specific Job Location: Northeast wall, doorway.

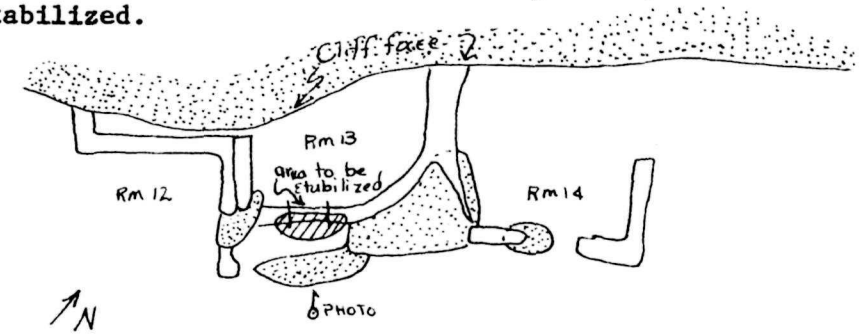
Personnel: TRM

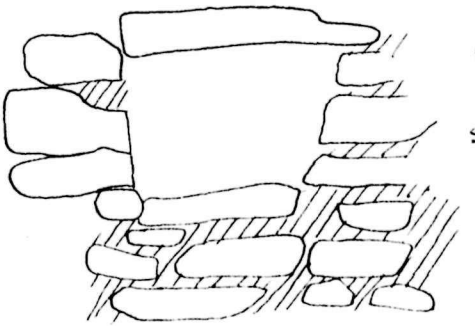
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Stones under the door are separated and loose. Mortar is gone and there is no support for the wall or door lintel stones. The base is also eroded because of water wash from the cave back. The stones are eroded clean of mortar. The lintel of the door is still intact, but the door posts need grouting.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

A few stones need to be replaced and the entire area needs to be relaid and grouted extensively under the door.

Measurements of wall or area to be stabilized:

Height 99cm **Width** 58cm **Thickness** 31cm

Description of masonry: Crudely shaped and scabbled stone of all sizes. The footing is bedrock and sand. There is some slumping in the 5-8 courses of the simple wall. Stones are sandstone and limestone ranging in size 13-65cm x 4-15cm. Stone is cracking with the grain.

Masonry color: 5YR 7/4 pink.

Structure 13
Job Number 14

Description of mortar: Mortar beds are 2-6cm thick being porous and crumbly. Mortar above the doorway is very hard. There is very little chinking in the wall.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

All loose debris was removed. Prior to the addition of the exterior wall all voids in the core, along with portions on the interior were filled. Four small stones, 10 false spalls, 10 leveler spalls and 25 true spalls, were used in repairing the interior, mainly around the base of the doorway and along the east side. Twenty-thirty small to medium true spalls were used in the core. The exterior was completely patched to the base of the doorway. A total of three courses, with 3 large stones, 3 medium stones, 4 small stones, 20 small to medium false spalls, 15-20 small to medium leveler spalls and 10-15 small to medium true spalls were used.

Amount of each used in stabilization:

75-90 sm-m T
30-40 sm-m F
25-30 sm-m L

mortar 10½ buckets **stone** 8S, 3M, 3L **grass** _____ **spalls** _____

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: None

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 13

Job Number 14

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: June 1, 1978

Date finished: Stabilization: June 7, 1978

Man Hours: 4.75 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northwest at northeast doorway, exterior.
Exposure 10, Roll 1
Sun/shade
8-11/250
May 27, 1978
11:25 am
Figure 63

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at northeast doorway, exterior
Exposure 13, Roll 3
Shade
8/125
June 9, 1978
3:50 pm
Figure 64

Other:

Figure 62.
Room 13, job 14 before stabilization, August, 1977.

Figure 63.
SHP-78 1-10-12. Room 13, job 14 northeast exterior wall before stabilization, May, 1978.

Figure 64.
SHP-78 3-13-38. Room 13, job 14 northeast exterior wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 14
Job Number 15

Specific Job Location: interior southwest wall

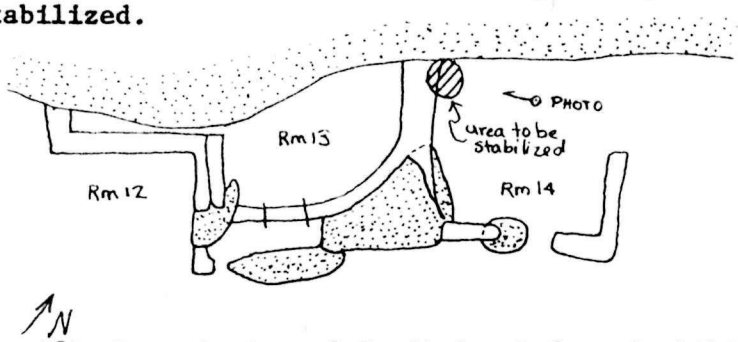
Personnel: EM, SLBG

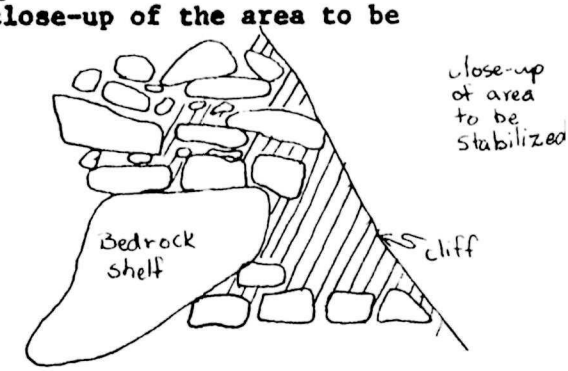
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Small extention wall between Rooms 13 and 14 is suspended in air over a large boulder. The cave back gives some support but the stones have pulled away from the mortar and will soon fall completely out. The wall is slumping both inwardly and down.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Perhaps the only way to support the wall will be to build up underneath the falling stones. This method is not desirable as it contains some surmising on how the wall originally was. It looks as though there were at one time stones under the slumping section but we are not possitive, however support must be given to the falling wall, now.

Measurements of wall or area to be stabilized:

Height 1m **Width** 50cm **Thickness** 35cm

Description of masonry: Masonry is shaped by chunking off spalls or slabbing. Footing is bedrock. There are approximately 8 courses in the simple wall. There is no pattern to the coursing and stones range in condition from good to poor. Stones range in size from 20-39cm x 10-25cm x 8-15cm.

Masonry color: 5YR 7/4 pink

Structure 14
Job Number 15

Description of mortar: Mortar bed is 2-6cm thick and extremely hard. Chunk chinking is evident and the mortar is in large porous sections. The inside is less weathered than the outside mortar.

Mortar color: 5YR 6/4 light reddish brown.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

It was necessary to lay a one stone thick abutted wall, 5-6 courses high to support the slumping section. The base for this build up was hard packed rat excrement and five stones. As soon as the base was well set, one stone at a time was set on the one immediately below it from the base to the cliff overhang. The last stone set supported the loosened sections of the wall. Twenty medium true spalls and 20 medium levelers were used in the stabilization. The mortar joints were repointed as the mortar dried. A total of eight large stones were set as support for the wall. Five stones were used as a beginning base.

Amount of each used in stabilization:

mortar 4 buckets **stone** 8 large **grass** _____ **spalls** 20 m L 20 m T

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 14

Job Number 15

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: June 1, 1978

Date finished: Stabilization: June 1, 1978

Man Hours: 4.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking southwest at southwest wall, interior
Exposure 16, Roll 1
Shade
8/125
May 27, 1978
1:25 pm
Figure 66

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking southwest at southwest wall, interior
Exposure 16, Roll 2
Shade
5.6/60
June 9, 1978
2:15 pm
Figure 67

Other:

Figure 65.
Room 14, job 15 before stabilization, August, 1977.

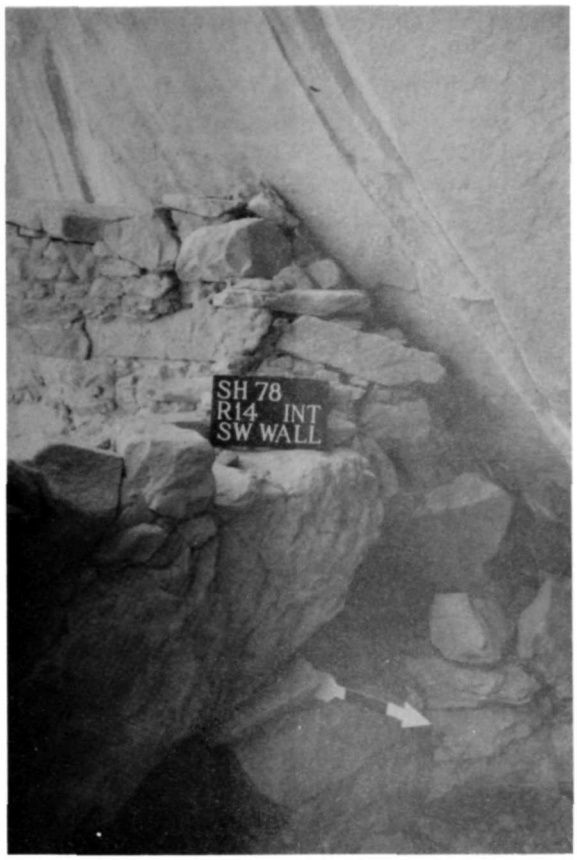


Figure 66.
SHP-78 1-16-18. Room 14, job 15 southwest interior wall before stabilization, May, 1978.

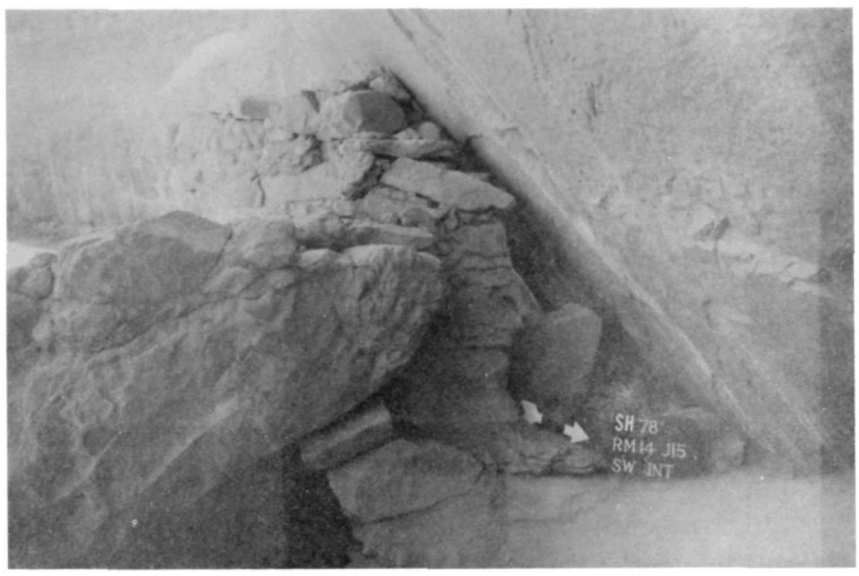


Figure 67.
SHP-78 2-16-28. Room 14, job 15 southwest interior wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 14

Job Number 16

Specific Job Location: Northeast wall

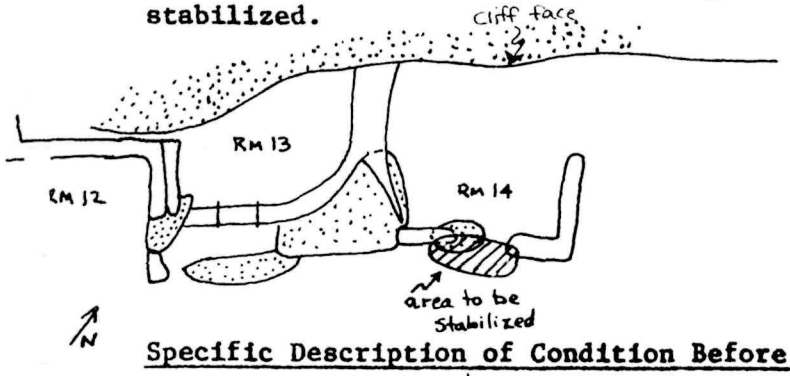
Personnel: SLBG

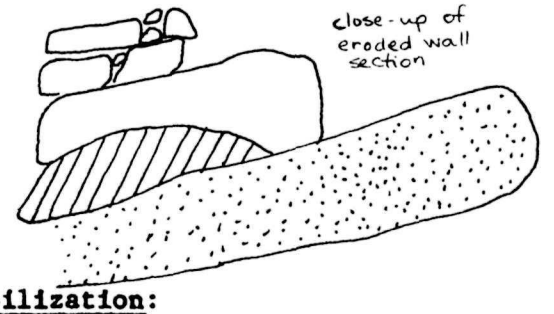
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Photo

The footing and base is completely eroded out. Basal erosion extends back 60 cm into the wall. Rodents have nested in the base and pushed stones and mortar away. The upper sections of the wall will soon fall without any support beneath it.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___ rodent

Repair or stabilization previous to this work:

None

Specific stabilization details:

The base needs to be filled in and deep grouted. The entire hole must firt be cleaned and repaired before the undermining causes the wall to fall. Dry lay may be necessary on the interior.

Measurements of wall or area to be stabilized:

Height 23cm **Width** 53cm **Thickness** 48cm

Description of masonry: No masonry remains in the basal hole. Stones above are roughly shaped large stones of odd shapes. Footing is sloping bedrock.

Masonry color: 5YR 7/4 pink

Structure 14
Job Number 16

Description of mortar: Mortar that remains is hard and chunky. Surface is sandy and porous. Mortar bed, where it still exists, is 2-9cm thick.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The base was first completely cleaned. One large stone was set on the bed rock footing, 2 more large stones were layed over this and 2 medium stones filled the final gap. One and a quarter buckets of mortar and 10-20 medium levelers, 20-30 medium true spalls and 10-15 small false spalls were all used to fill the void. The mortar was repointed at the joints. On the interior of the room a drylay wall was used to hopefully detour moisture from the base in the future.

Amount of each used in stabilization:
10-20 m L
20-30 m T

mortar 1¼ buckets **stone** 3L, 2M **grass** _____ **spalls** 10-15 sm F

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 14

Job Number 16

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: June 1, 1978

Date finished: Stabilization: June 1, 1978

Man Hours: 2.25 hours

Photo Information:

Before:

University of Colorado,Boulder
TRM, SLBG, DAB
Looking northwest at southeast wall, exterior
Exposure 19-20, Roll 1
Shade
8/125
May 27, 1978
1:40-1:45pm
Figure 69

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at southeast wall, exterior
Exposure 14 -15, Roll 3
Shade
8/125
June 9, 1978
4:45- 4:50 pm
Figure 70

Other:

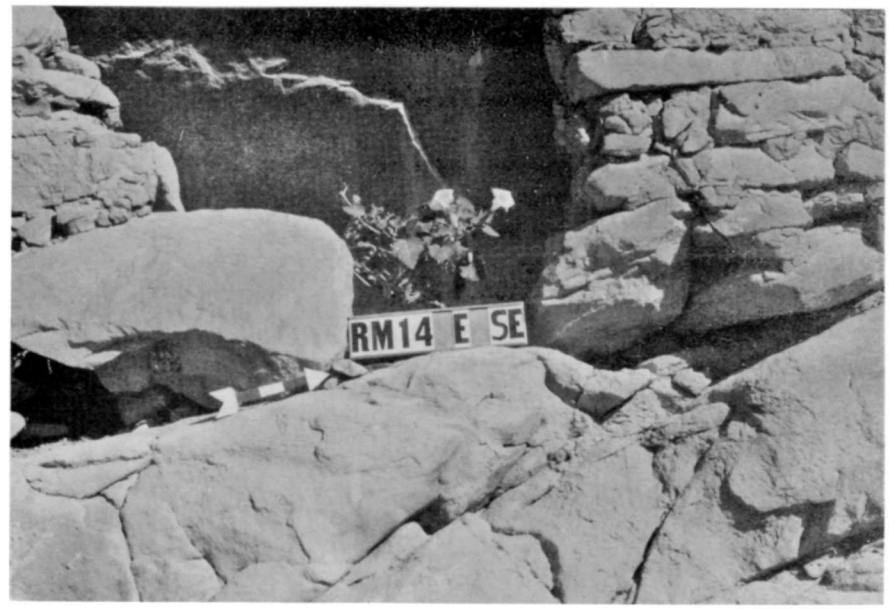


FIgure 68.
Room 14, job 16 before stabilization, August, 1977.

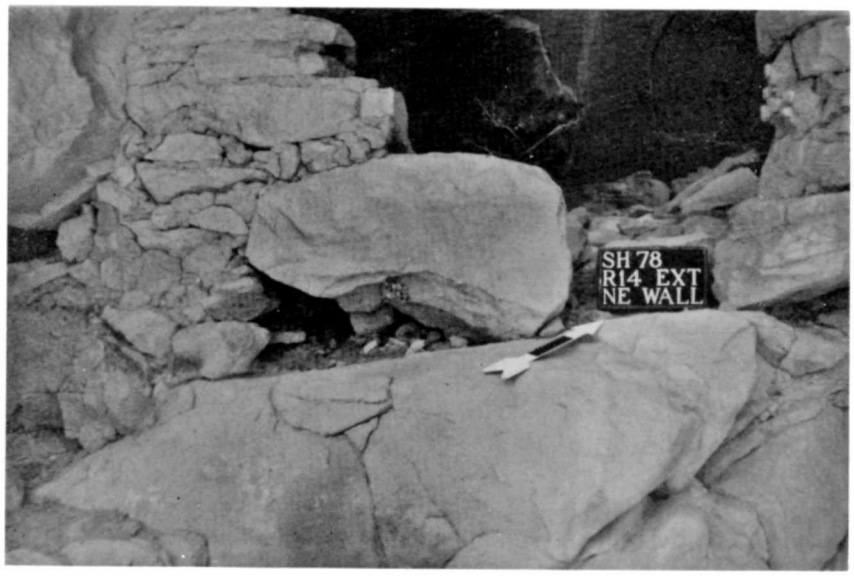


Figure 69.
SHP-78 1-20-22. Room 14, job 16 exterior of northeast wall before stabilization, May, 1978.

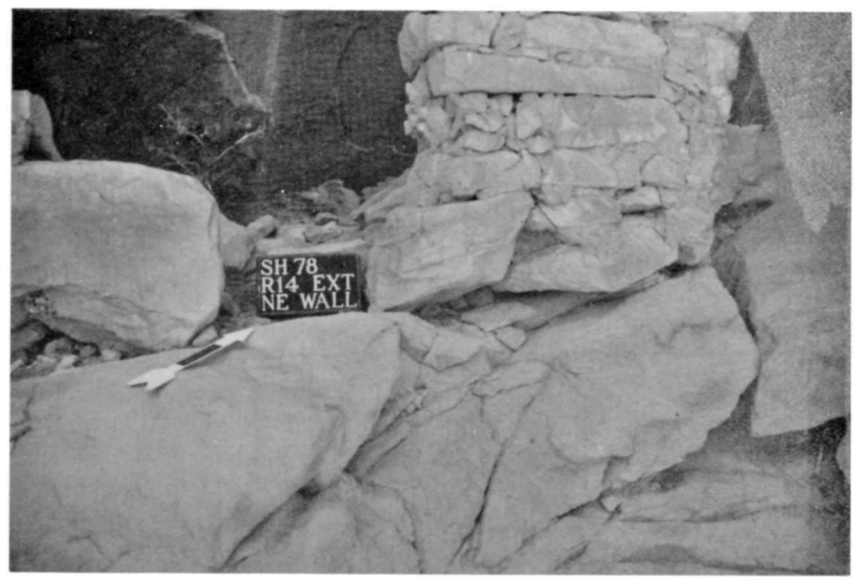


Figure 70.
SHP-78 1-19-21. Room 14, job 16 exterior of northeast wall before stabilization, May, 1978.

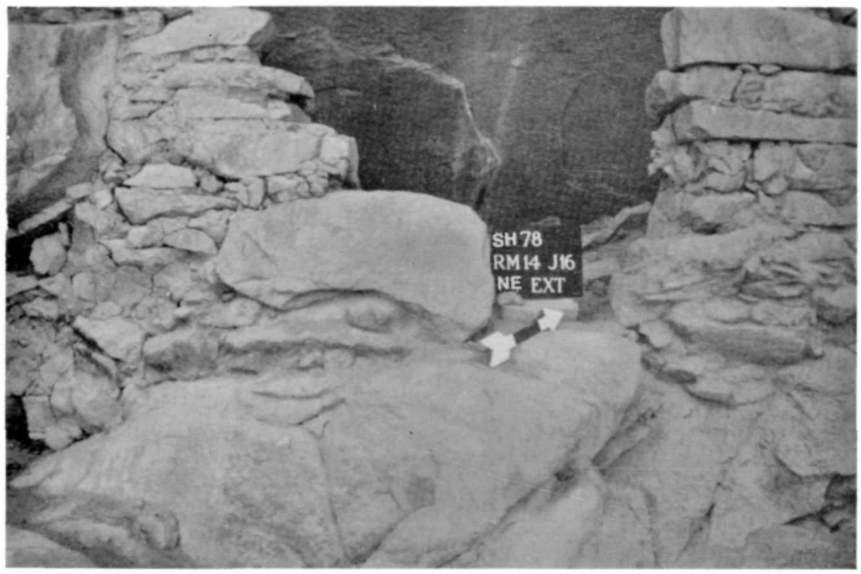


Figure 71.
SHP-78 3-14-39. Room 14, job 16, exterior of northeast wall after stabilization, June, 1978.

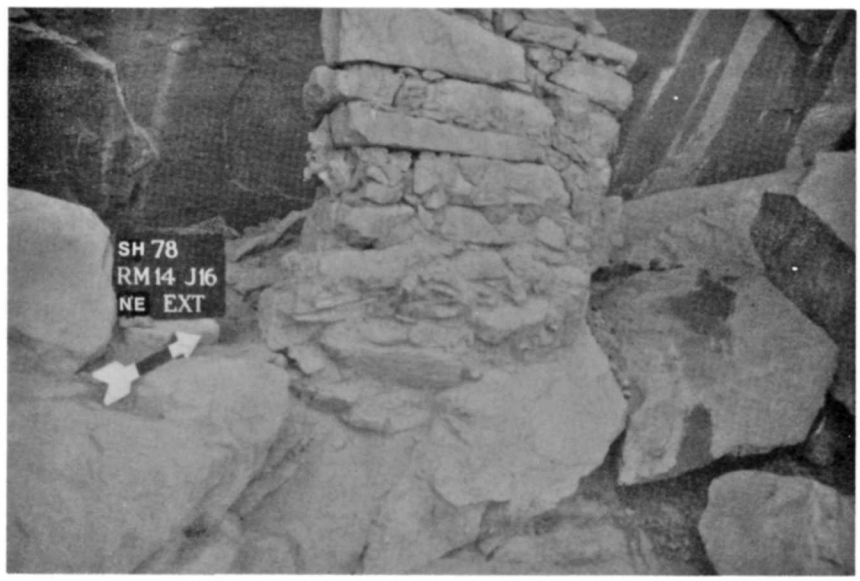


Figure 72.
SHP-78 3-15-40. Room 14, job 16, exterior of northeast wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 14
Job Number 17

Specific Job Location: exterior northeast wall.

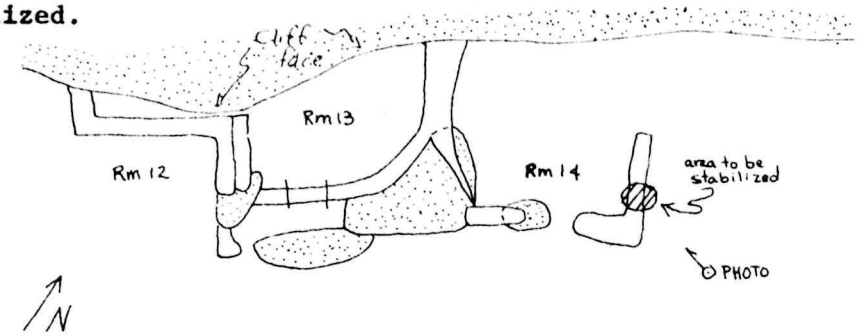
Personnel: SLBG

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Cap stones have come loose and mortar has cracked. The wall is stable, but the cap will fall if it is not reset. The adobe seems to bond better with the stone in this area, than it does in other areas.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Top two courses in the cap need to be reset. Several stones are loose and cracks extend to the lower courses. Grouting and some relaying will retard this erosion.

Measurements of wall or area to be stabilized:

Height 25-45cm **Width** 75cm **Thickness** 35cm

Description of masonry: Stone is chunked and roughly shaped. No stones need to be replaced, just relaid. Footing is bedrock and sand. Approximately 8 courses ramain. Wall is simple with no patterning.

Masonry color: 7.5YR 6/4 light reddish brown.

Structure 14
Job Number 17

Description of mortar: Mortar bed is 5-9cm thick. Mortar is hard and porous. Spalls are thick chunks. Mortar is less weathered than in other areas of the ruin.

Mortar color: 5YR 7/4 pink.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The area was cleaned and brushed. Three cap stones were relaid in place. Four small stones were added in the cap to fill voids. Twelve small to medium spalls were added, they were true spalls, and ten small to medium levelers were also used. The entire area was deep grouted.

Amount of each used in stabilization:

mortar 1 bucket **stone**_____ **grass**_____ **spalls** 10 sm-m L, 12 sm-m T

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 14

Job Number 17

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: June 1, 1978

Date finished: Stabilization: June 1, 1978

Man Hours: 1 hour

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking west at northeast wall, exterior corner.
Exposure 6, Roll 1
Sun
11/250
May 27, 1978
11:05 am
Figure 73

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking west at northeast wall, exterior corner
Exposure 16, Roll 3
Shade
8/125
June 9, 1978
4:55pm
Figure 74

Other:

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 14
Job Number 18

Specific Job Location: exterior northeast corner

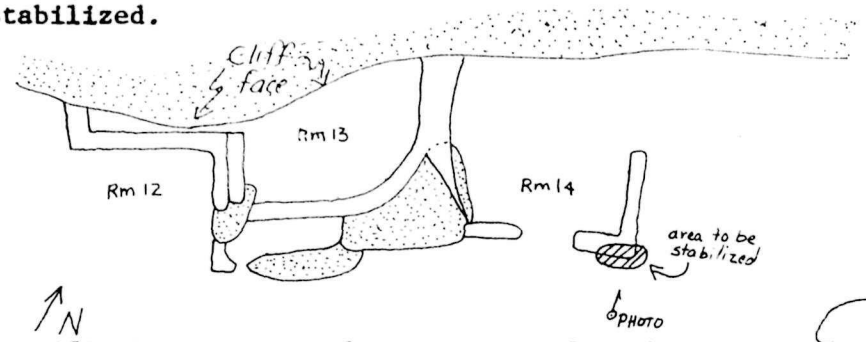
Personnel: TRM

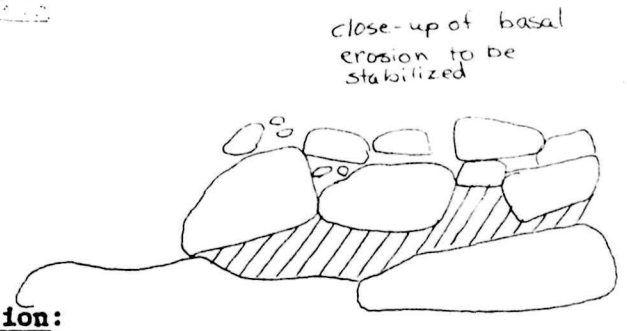
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

The entire base of the wall is eroded. Between the bed rock and the first course there is no mortar remaining, and little stone. The entire area is undermined. The bed rock on which the wall is built is extremely soft and crumbled. A new base needs to be built up.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Restone and deep grout the base. A strong footing course must be laid and braced on the soft eroding sandstone bed rock which is the footing.

Measurements of wall or area to be stabilized:

Height 34cm **Width** 84cm **Thickness** 82cm

Description of masonry: All rock is soft and fragile. Odd sized stones have fallen out of palce. Footing is soft sandstone.

Masonry color: 5YR 7/6 reddish yellow.

Structure 14
Job Number 18

Description of mortar: No mortar bed remains. There is mortar in areas surrounding the area which are hard and contain heavy chinking. This is all we have to go on to match the mortar.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

This involved the removal of all loose debris within the hole, and filling the interior of the wall with dry lay, to prevent fill from spilling into the work area from within the room which was sloped downward towards the exterior south. The bed rock was used as the foundation. Two courses were built on top of this utilizing three and two medium stones consecutively. Three large true spalls randomly placed filled the remaining gap between the new coursing and the wall. A total of 20-30 small to medium true spalls, 10-15 small to medium false spalls, and 10-15 leveler spalls were used. The interior of the wall was left back 15cm to prevent further erosion of the fill within the room. Loose debris was ejected from the wall face, and all gaps were grouted. Fifteen to twenty small to medium spalls were used in the grouting.

Amount of each used in stabilization:
10-15 L
20-30 sm-m T
40-55 sm-m F

mortar 1 5/8 bucket **stone** 5 medium **grass** _____ **spalls** 3 Large T

methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 14

Job Number 18

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: June 1, 1978

Date finished: Stabilization: June 5, 1978

Man Hours: 2 hours and fifteen minutes

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking west at the northeast wall, exterior corner.
Exposure 6, Roll 1
Sun
11/250
May 27, 1978
11:05 am
Figure 73

After:

University of Colorado, Boulder
TRM, SLN,GCN
Looking west at northeast wall, exterior corner.
Exposure 16, Roll 3
Shade 8/125
4:55 pm
June 9, 1978
Figure 74

Other:

Figure 73.
Room 14, job 17-18 close up of northeast wall before stabilization, August, 1977.

Figure 74.
SHP-78 1-6-8. Room 14, job 17-18 northeast exterior wall before stabilization, May, 1978.

Figure 75.
SHP-78 2-15-27. Room 14, job 17-18 northeast exterior wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 15

Job Number 19

Specific Job Location: interior southeast wall.

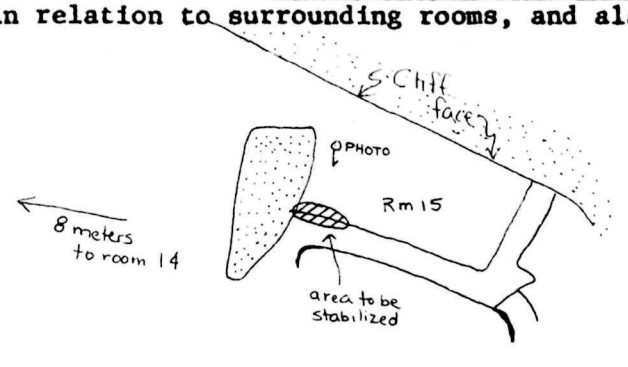
Personnel: TRM

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

The southwest half of the southeast wall needs to be deep grouted. Weathering and possible foot traffic have worn down the wall. The wall is much shorter on the southwest end. Deep grouting is also needed in the core.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

The southwest half of the wall needs to be deep grouted and possibly have a few small stones added for added strength.

Measurements of wall or area to be stabilized:

Height 39cm **Width** 95cm **Thickness** 35cm

Description of masonry: Stone is chunked and shaped and very weathered. The stones generally don't touch. There are approx. 7 courses in the simple wall. The footing is bed rock and sand and sterile fill. Stones range in size 35-40cm x 8-18cm x 10-26.

Masonry color: 5YR 6/4 light reddish brown.

Structure 15
Job Number 14

Description of mortar: Mortar is cracked, sandy and hard. The slightly eroded, porous mortar has some small chinks in it.

Mortar color: 5YR 6/4 light reddish brown.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The job essentially involved grouting a large void within the core of the wall. The gap was filled with successive layers beginning with mortar, which was tamped down followed by 20-30 small to medium true spalls, which in turn were tamped down. A total of 50-60 small to medium true spalls were used. In areas where fingers or sticks were not enough to push the mortar into voids, a grout gun was used. The exterior end was structurally supported in the core area. Two small stones and two large spalls were placed randomly within the core, approx. 15-20 small to medium spalls were used.

Amount of each used in stabilization:

2 1 T
15-20 sm-m T

mortar 2¼ buckets **stone**_____ **grass**_____ **spalls** 50-60 sm-m T

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 15

Job Number 19

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 28, 1978

Date finished: Stabilization: May 31, 1978

Man Hours: 2 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking eastsoutheast at southeast wall, interior.
Exposure 17, Roll 1
Shade
5.6/125
May 27, 1978
1:30 pm
Figure 77

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking eastsoutheast at southeast wall, interior.
Exposure 15, Roll 2
Shade
5.6/60
June 9, 1978
2:00 pm
Figure 78

Other:

Figure 76.
Room 15, job 19 before stabilization, August, 1977.

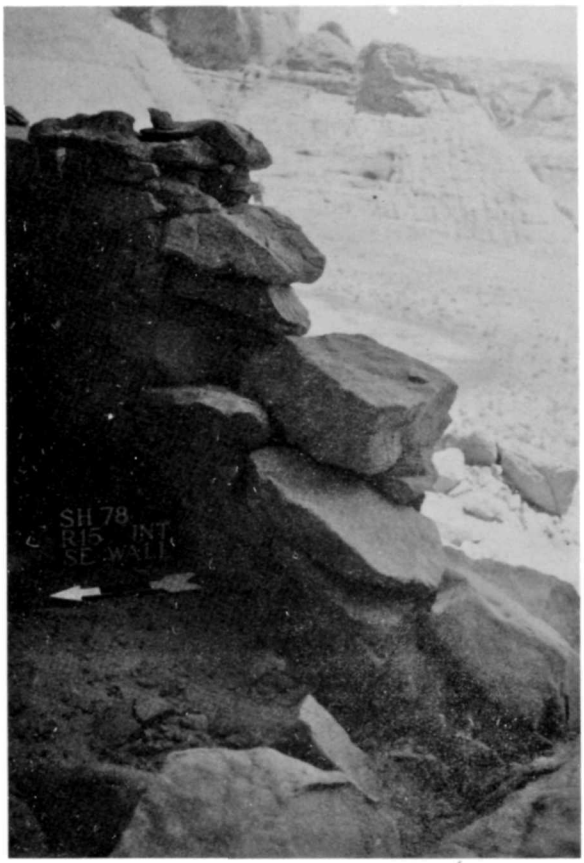


Figure 77.
SHP-78 1-17-19. Room 15, job 19 interior of southeast wall before stabilization, May, 1978.

Figure 78.
SHP-78 2-15-27. Room 15, job 19 interior of southeast wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 15

Job Number 20

Specific Job Location: southeast wall.

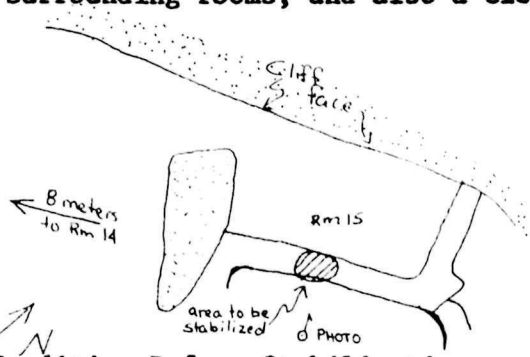
Personnel: SLBG

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Two cap stones are loose and one or two are missing. The wall is in good condition in other respects.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** **other vegetation disturbance** **visitation damage** **vandalism**

Repair or stabilization previous to this work:

None

Specific stabilization details:

Cap stones need to be reset, and the area needs to be grouted. The entire top few courses need to be strengthened with mortar.

Measurements of wall or area to be stabilized: Top two courses

Height **Width** **Thickness**

Description of masonry: Stones are crudely shaped. There has been animal traffic in the room. There is a core in the compound wall. Good shape though slightly eroded.

Masonry color: 5YR light reddish brown.

Structure 15
Job Number 20

Description of mortar: Mortar bed is up to 10cm thick (4-10cm). Mortar is slightly eroded and porous with a fair amount of flat spalls .

Mortar color: 5YR 6/6 reddish brown.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

Three stones in the top two courses were loose. After the area was cleaned, the loose stones were soaked and the entire area sprayed. The three stones were reset in their original positions, and the area under and around the stones were deep grouted. Approx. 10 medium levelers and 10 medium true spalls were used.

Amount of each used in stabilization:

mortar 3/4 bucket **stone**_____ **grass**_____ **spalls** 10 m L 10 m T

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 15

Job Number 20

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 28, 1978

Date finished: Stabilization: May 28, 1978

Man Hours: 1 hour and forty-five minutes.

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northwest at southeast wall, exterior
Exposure 18, Roll 1
Shade
8/125
May 27, 1978
1:35 pm
Figure 80

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northwest at southeast wall, exterior
Exposure 14, Roll 2
Shade
8/125
June 9, 1978
1:50 pm
Figure 81

Other:

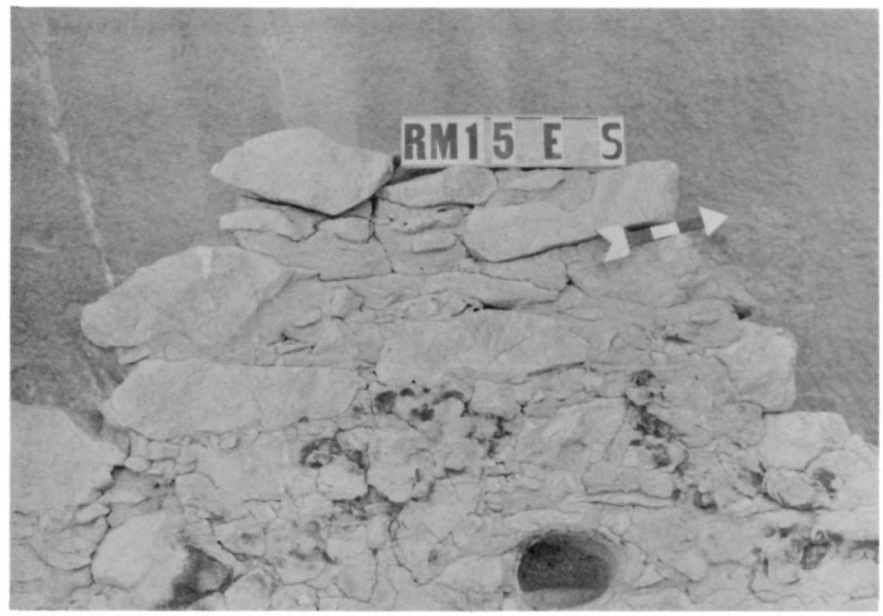


Figure 79.
Room 15, job 20 before stabilization, August, 1977.

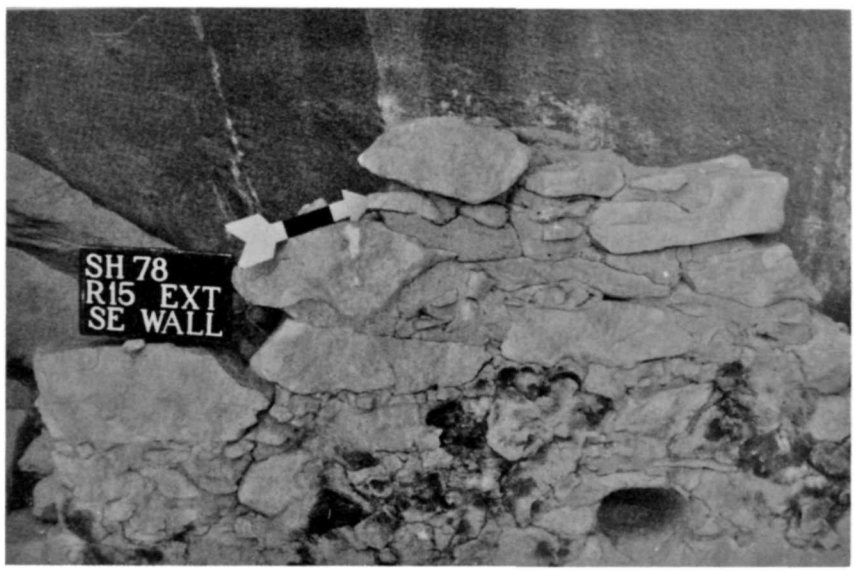


Figure 80.
SHP-78 1-18-20. Room 15, job 20 exterior of southeast wall before stabilization, May, 1978.

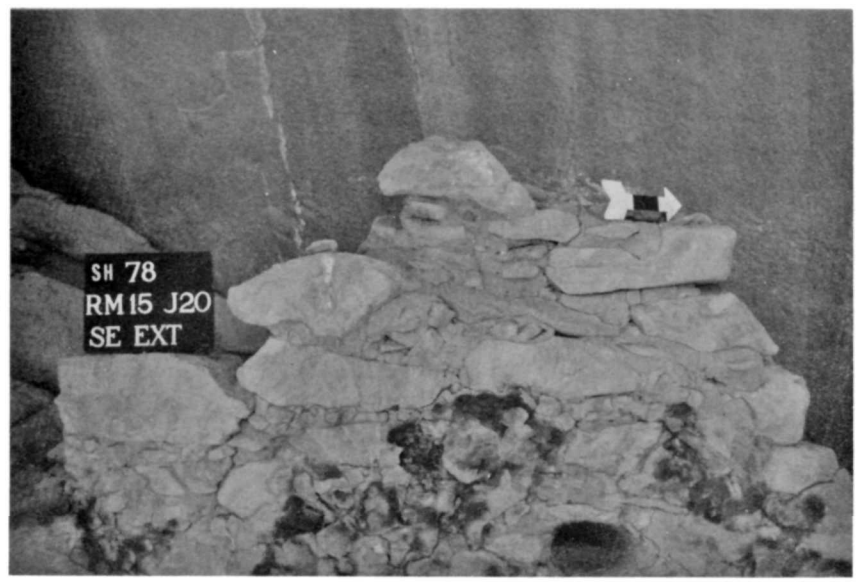


Figure 81.
SHP-78 2-14-26. Room 15, job 20 exterior of southeast wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1987 **Structure** 15

Job Number 21

Specific Job Location: Northeast wall

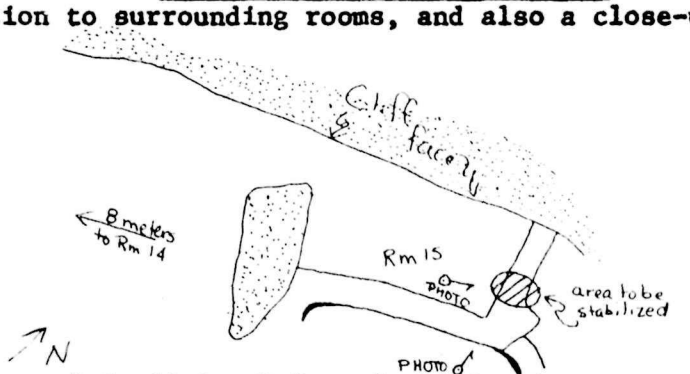
Personnel: TRM

References to Publications and Justification for Job:

Snake House Stabilization Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

The cap and top courses need resetting. Mortar has pulled apart in solid sections, leaving a honeycombed effect. The mortar is very sloppy and this particular section of wall contains many chinks. There is more mortar in the wall construction than there are rocks.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Reset cap rocks and loosened stones beneath the cap. Area grouting.

Measurements of wall or area to be stabilized:

Height 23cm **Width** 1.18m **Thickness** 26cm

Description of masonry:

Stone is very nicely shaped. Pecking and grinding are evident as stone shaping techniques. The footing is built on bedrock. Stone is laid in an overlaying pattern

Masonry color: 5YR 6/4 light reddish brown.

Structure 15
Job Number 21

Description of mortar:
Mortar is in sloppy chunks and is harder than the stone. Small uniform spalls are evident.

Mortar color: 5YR 6/6 reddish yellow

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

Loose stone was torn down two courses involving two medium stones and one small stone. All loose stone and mortar was removed to a level surface. The surface was then swept clean, wetted, and roughed. The three original stones were relaid and one new medium stone was added to the cap. Approx. 25 small to medium true spalls, 15 small levelers, and 15-20 small to medium false spalls were used. The exterior surface was textured immediately upon stone laying, and again upon the final drying of the surface.

Amount of each used in stabilization:
mortar 1¼ bucket **stone**_____ **grass**_____ **spalls** 25 sm-m T, 15 sm-m L, 15-20 sm-m F

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 15

Job Number 21

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 28, 1978

Date finished: Stabilization: May 28, 1978

Man Hours: 4 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM, SLBG, DAB
Looking northeast at northeast wall interior.
Exposure 7, Roll 1
Shade
8/60
May 27, 1978
11:10 am
Figure 83

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northeast at northeast wall, interior
Exposure 13, Roll 2

5.6/125
June 9, 1978
1:45 pm
Figure 84

Other:

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 15

Job Number 22

Specific Job Location: northeast wall end.

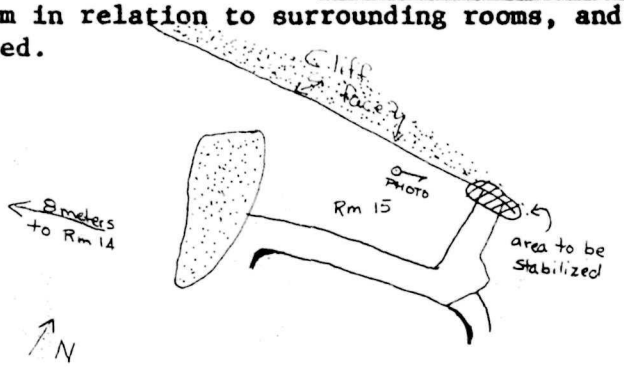
Personnel: TR[M]

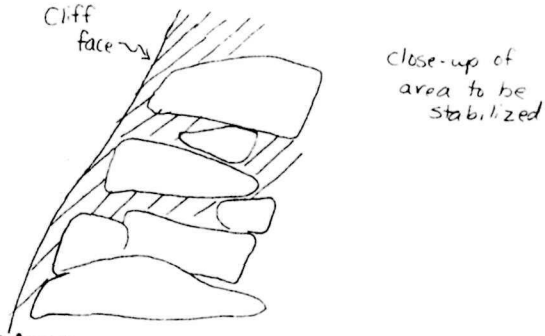
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

Wall has pulled away from the cliff. Two to Six cm of crack have developed up the entire width of the wall. The wall has no support and is buckeling. Drip line is the immediate cause of the erosion, and will continue to wash the mortar out of the joints if the top of the wall is not contoured. The crack is 48cm high, 2-6cm wide, and 25-28 cm thick.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Wall needs to be deep grouted and the crack needs to be filled with stones and mortar so as to reattatch it to the cave back. The wall also needs to be contoured so that in the future the water will run off the wall and not down the joints.

Measurements of wall or area to be stabilized:

Height 48cm **Width** 2-6cm **Thickness** 25-28cm

Description of masonry: Stone is weathered and crumbly. Footing is on bedrock and decomposed sandstone. Because of the presence of a water drip line the stones are very soft and do not hold mortar well. Stones are roughly shaped and of all sizes.

Masonry color: 5YR 6/4 light reddish yellow.

Structure 15
Job Number 22

Description of mortar: Mortar bed is 5-10cm thick, being weathered and chunky. There are small chinks in the mortar. The exterior is much more weathered, but the interior is also weathered.

Mortar color: 5YK 6/6 reddish yellow.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

This stabilization job mainly consisted of grouting a 5cm gap between the bedrock and the cave back. Stone was added in a random fashion involving 6 large spalls, and 25-30 small to medium spalls, all being true. Enough stone and mortar was used to bridge the gap between the wall and the bedrock. The exterior surfaces of both sides of the wall were left back 2.54cm and the top was contoured.

Amount of each used in stabilization:

mortar 3/4 bucket **stone**_____ **grass**_____ **spalls** 6 1 T 25-30 sm-m T

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone:_____

Into mortar:_____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 15

Job Number 22

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 28, 1978

Date finished: Stabilization: May 28, 1978

Man Hours: 2 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM,SLBG, DAB
Looking northeast at northeast wall, interior
Exposure 7, Roll 1
Shade
8/60
May 27, 1978
11:10am
Figure 83

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking northeast at northeast wall, interior
Exposure 12, Roll 2
Shade
5.6/125
June 9, 1978
Late morning
Figure 84

Other:

Figure 82.
Room 15, job 21-22, before stabilization, August, 1977.

Figure 83.
SHP-78 1-7-9. Room 15, job 21-22 northeast wall before stabilization, May, 1978.

Figure 84.
SHP-78 2-13-75. Room 15, job 21-22 northeast wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 3

Job Number 23

Specific Job Location: exterior southwest wall.

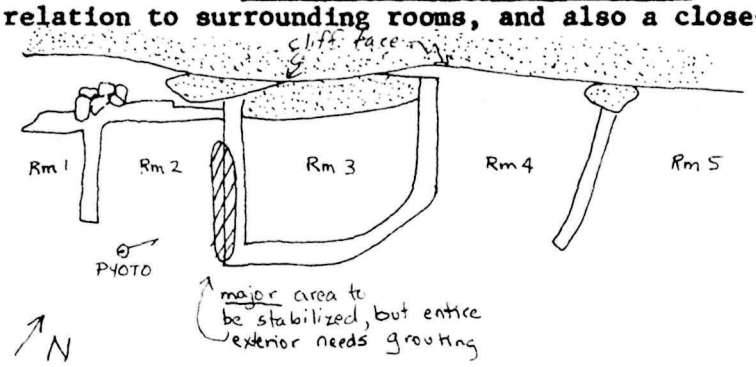
Personnel: GCN, SLN

References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053)

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.



Specific Description of Condition Before Stabilization:

Because stabilization was attempted in August of 1977 and was unsuccessful due to the weathering of the stone and mortar, there are many large areas to be grouted. The wall is heavily chinked with both small and medium sized spalls. Stones may need to be replaced around the beam seats.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

Stabilization was attempted in August 1977, unsuccessfully. See text of report.

Specific stabilization details:

Major grouting and possible filling of some voids with small stones.

Measurements of wall or area to be stabilized: Entire Room

Height ___ **Width** ___ **Thickness** ___

Description of masonry: Courses can be seen inside very faintly due to slopped over mortar, outside courses can be detected. The exterior has approx. 18 courses..Stone is roughly shaped

Masonry color: 5YR 6/6 reddish yellow.

Structure 3

Job Number 23

After treatment: See TABLE 6 and FIGURE 17

Stone color:

Stone condition: very hard, bonds to the mortar. A shiny surface in places

Mortar color:

Mortar condition: very hard, bonds to the stone well.

Concluding Data:

Date started: Methyl Methacrylate: May 30, 1978
Stabilization: June 6, 1978

Date finished: Methyl Methacrylate: May 31, 1978
Stabilization: June 6, 1978

Man Hours: Methyl Methacrylate: 41 hours
Stabilization: 8.5 hours

Photo Information:

Before:

University of Colorado, Boulder
TRM,SLBG, DAB
Looking northeast at southwest wall, exterior.
Exposure 1, Roll 1
Shade
8/125
May 27, 1978
Figure 85

After:

University of Colorado, Boulder
TRM, SLN,GCN
Looking northeast at southwest wall, exterior
Exposure 2, Roll 2
Shade
5.6/250
June 7, 1978
Figure 86

Other:

Structure 3
Job Number 23

Description of mortar: Weathered on the surface but harder than the stone. Chinking is large and samll chunks of stone. Mortar bed is 2-15cm thick and is soft and flaky to the touch.

Mortar color: 5YR 6/6 reddish yellow.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The entire room (interior and exterior) was painted with kneaded mortar at a ratio which made it a thick paste consistancy applicable with 4 inch paint brushes. Walls were dry upon application (including the newly added mortar on stabilization jobs 1, 2, and 3), of the paint and then left to dry for 30 hours. The walls were than lighlt sprayed with water removing the excess paint. Upon drying of the walls, the walls were brushed with brooms, again to remove excess paint.

Amount of each used in stabilization:

mortar 1 ¼ buckets **stone**_____ **grass**_____ **spalls**_____

methyl methacrylate_____ **other**_____

Methyl Methacrylate Figures:

Before treatment:

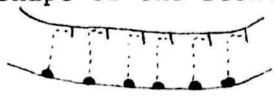
Stone color: 7.5 YR 6/6 reddish yellow

Stone condition: weathered, crumbly, soft

Mortar color: 5YR 6/6 reddish yellow

Mortar condition: surface is soft and crumbly, but mortar is in hard chunks.

On the exterior southeast corner there was a section of wall which would not hold mortar due to the shape of the stone. Six nails were



driven into the void by bending the heads back, and were then webbed with cement wire for support. This held the mortar in place.

Amount injected:

Into stone:

Into mortar: 25 gallons total Room 3

Additional stabilization materials that were treated:

Stones and spalls.

Total amount used, and how **Total time** **Total people**

See Appendix F by Dr. Burke.

Figure 85.
SHP-78 1-1-13. Room 3, job 23 southwest exterior wall before stabilization, May, 1978.

Figure 86.
SHP-78 3-5-30. Room 3, job 23 southwest exterior wall after stabilization, June, 1978.

RUIN STABILIZATION RECORDS

Ruin Snake House Ruin 1978 **Structure** 11

Job Number 24

Specific Job Location: interior southwest wall.

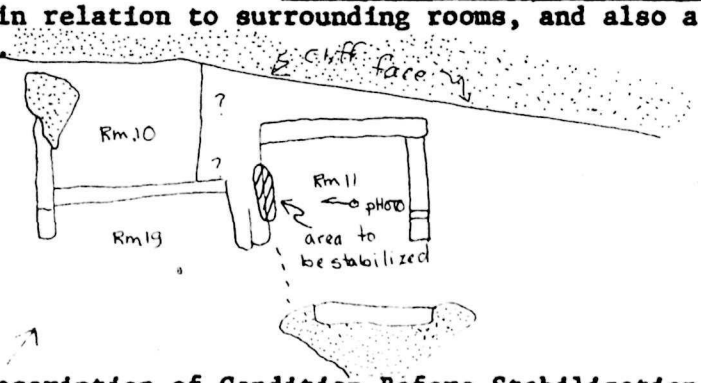
Personnel: EM

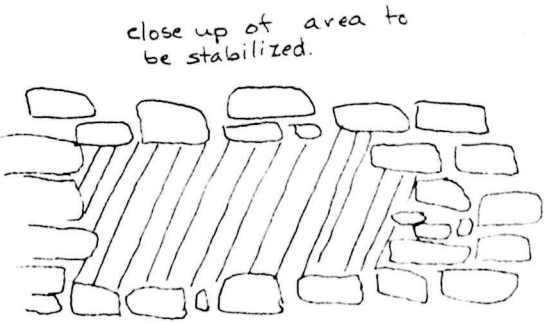
References to Publications and Justification for Job:

Snake House Specifications (contract cx-7-0297-0053).

ARCHITECTURE AND ORIENTATION

draw room in relation to surrounding rooms, and also a close-up of the area to be stabilized.





Specific Description of Condition Before Stabilization:

There is an extensive void in the wall. Not only is it approx. 1m x 1m x 1.5m, but it also extends up into the core. The wall is sturdy but there is still a fair amount of weight over the top of the void.

rain x **snow** x **freeze** x **sun** x **wind** x **root damage** ___ **other vegetation disturbance** ___
visitation damage ___ **vandalism** ___

Repair or stabilization previous to this work:

None

Specific stabilization details:

Build up the core and courses that have fallen out of the now existing void.

Measurements of wall or area to be stabilized:

Height 1m **Width** 1.5m **Thickness** 1m

Description of masonry: Stone around the void is in good condition, roughly shaped and chinked.

Masonry color: Color was never taken.

Structure 11
Job Number 14

Description of mortar:
Mortar is slightly weathered, porous and soft. Mortar bed ranges from 4-8cm thick. There is extensive use of spalls and chinks in the joints.

Mortar color: Color was never taken.

Stabilization methods:

Materials, construction and techniques used to stabilize and accomplish the job:

The hole was cleaned of all loose debris. Dry laid courses were set up to determine the depth of the hole, and amount of core material needed to fill the entire hole. The hole was then patched with 6 large stones, 4 small stones, 40-45small to medium true spalls, and 15-20 small false spalls. Courses were then laid flush with the aboriginal surfaces. Three courses in all were built.

Several stones of all sizes and hundreds of small and medium spalls were used in the core of the void.

Amount of each used in stabilization:
mortar 8 buckets **stone** 6L, 4SM **grass** _____ **spalls** 40-45 sm-m T, 15-20 sm F
methyl methacrylate _____ **other** _____

Methyl Methacrylate Figures: N/A

Before treatment:

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Amount injected:

Into stone: _____

Into mortar: _____

Additional stabilization materials that were treated:

Total amount used, and how **Total time** **Total people**

Structure 11

Job Number 24

After treatment: N/A

Stone color:

Stone condition:

Mortar color:

Mortar condition:

Concluding Data:

Date started: Stabilization: May 31, 1978

Date finished: Stabilization: May 31, 1978

Man Hours: 2.5 hours

Photo Information:

Before:

After:

University of Colorado, Boulder
TRM, SLN, GCN
Looking southwest at southwest wall interior
Exposure 1, Roll 3
Shade
5,6/125
June 9, 1978
2:50 pm
Figure 88

Other:

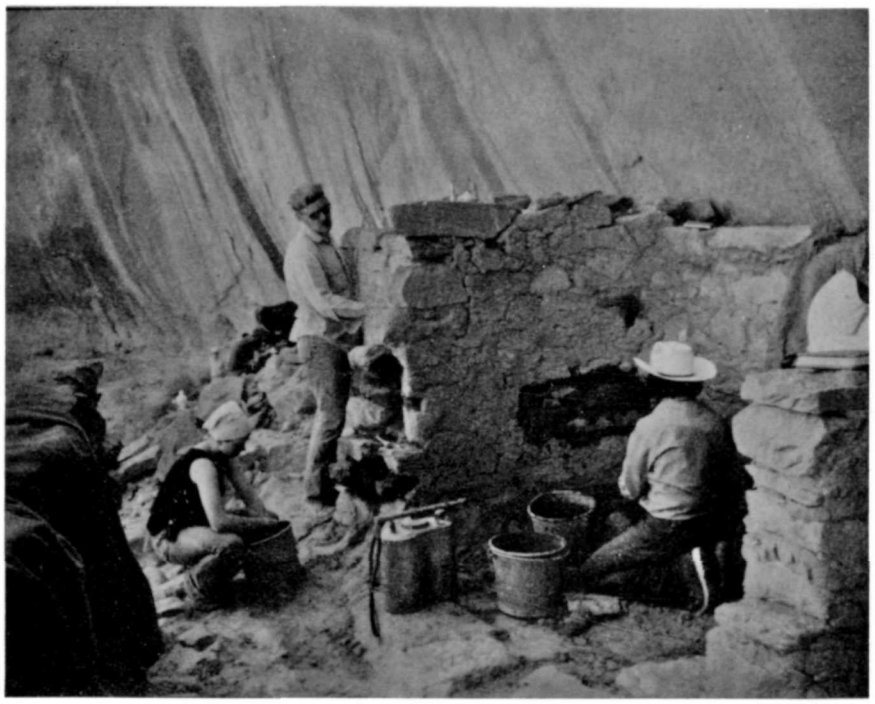


Figure 87.
Room 11, job 24 during stabilization, May 1978.

Figure 88.
SHP-78 3-2-27. Room 11, job 24 southwest interior wall after stabilization, June, 1978.

Figure 89.
SHP-78 2-2-14. Room 3 southwest exterior after total stabilization, 1978.

Figure 90.
SHP-78 2-4-16. Room 3 southeast exterior after total stabilization, 1978.

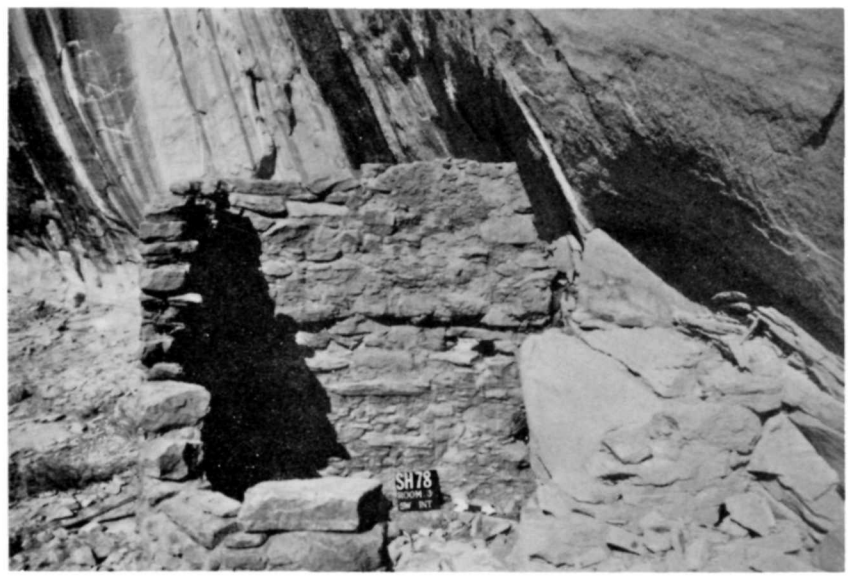


Figure 91.
SHP-78 2-6-18. Room 3 southwest exterior after total stabilization, 1978.

APPENDIX H

Winter Check 1979

Snake House Ruin was checked in March, 1979. The stabilization aesthetically looks good. There is some minor cracking and heavy water wash. Room 14 and 19 both have viable water marks not only on the walls and cave back, but also water lines on the floors of the rooms. It looks as though water has stood in them for long periods of time and basal erosion is beginning. The worst effects on the ruin are weather related erosion factors. Many walls that were not stabilized have had mortar bed wash out since the stabilization was done, Summer 1978. Because of this it is recommended that an extensive regrouting and patching be done after the heavy rains of spring have slowed down.

The methyl methacrylate has bonded extremely well. It seems to have effectively held the mortar and stones in place. There seems to be no unnatural deterioration due to the use of methyl methacrylate, on the stone or the mortar. Room 3 is a fairly uniform color due to mortar washing. There are a few unpainted areas that are the true color of the stone and mortar. These areas match the Munsell Color Chart at 5 YR 5/4 reddish brown. Though there has been change in color from before the methyl methacrylate was applied, until now, the room blends together and with the rest of the ruin quite well. There has been some color change, but as described earlier there is no total uniformity in the ruin anyway. Because of its exposure, the stone and mortar colors differ from room to room to area. Room 3 should now weather in direct response to its exposure, and should be no different than before the methyl methacrylate was applied. The room should be checked twice a year for color change, long-term effects and any changes, but it will continue to blend at a slow, natural speed.

Snake House Ruin, at least at this time, seems to be a positive example of the quality and strength of methyl methacrylate. Any doubts on the legitimacy of methyl methacrylate should be, at least, beginning to fade. Let it here be known that methyl methacrylate can and should be listed among the alternatives in stabilization, for extreme cases of the caliber of Snake House Ruin.

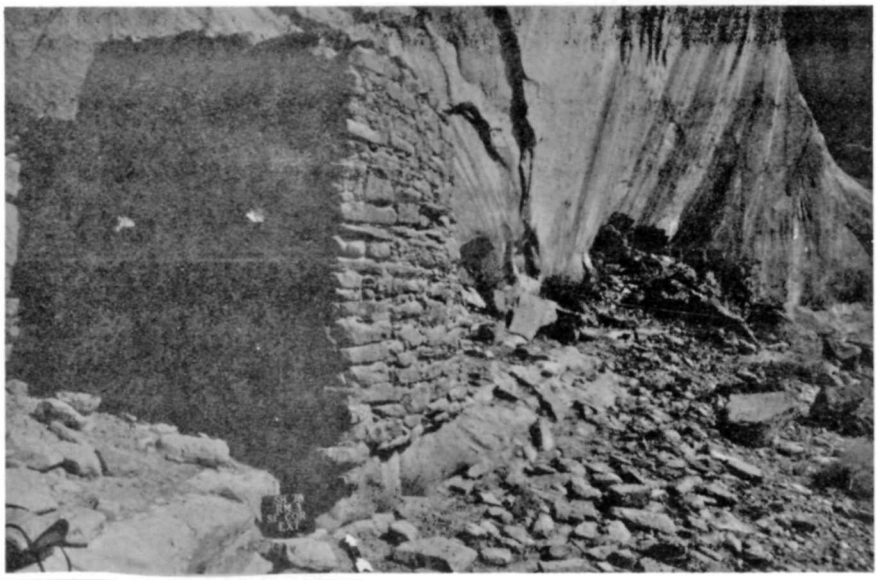


Figure 92.
SHP-78 4-1-3. Winter check Room 3, southeast exterior wall. Note the excellent condition of the stabilization. March 1979.

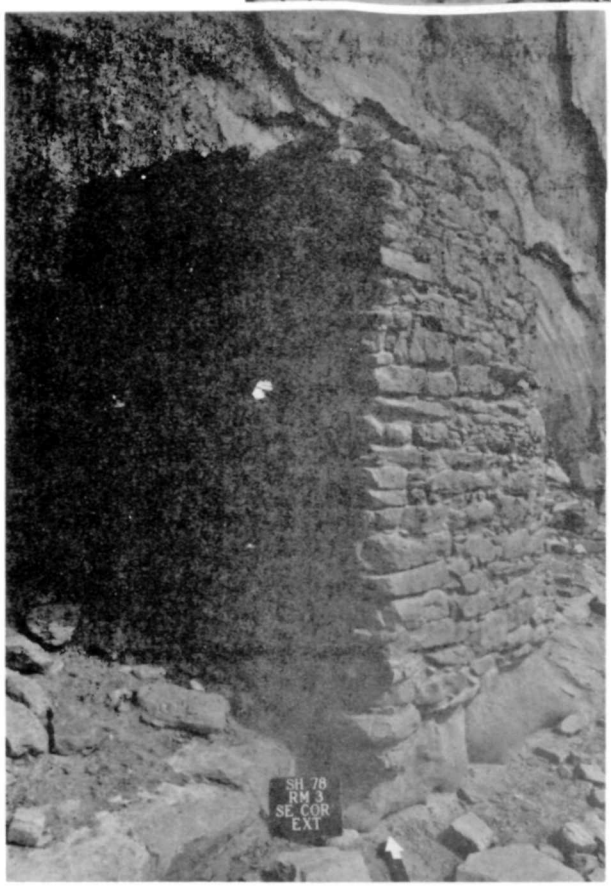


Figure 93.
SHP-78 4-2-4. Winter check Room 3, southeast exterior corner. Note the condition of job 1 stabilization area. March 1979.

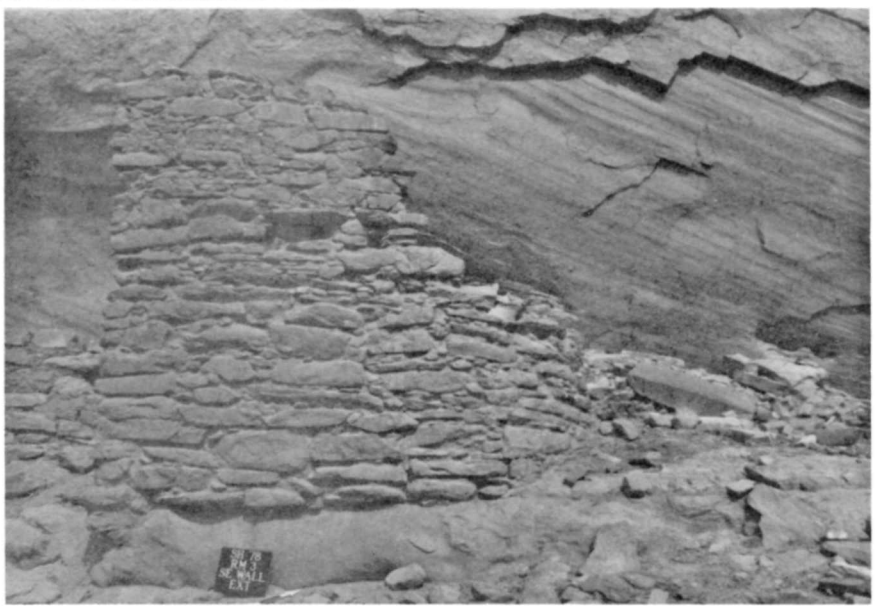


Figure 94.
SHP-78 4-3-5. Winter check Room 3, southeast exterior corner. March, 1979.

Figure 95.
SHP-78 4-4-6. Winter check Room 3, southeast exterior wall. Close-up of painted and methyl methacrylate areas. March 1979.

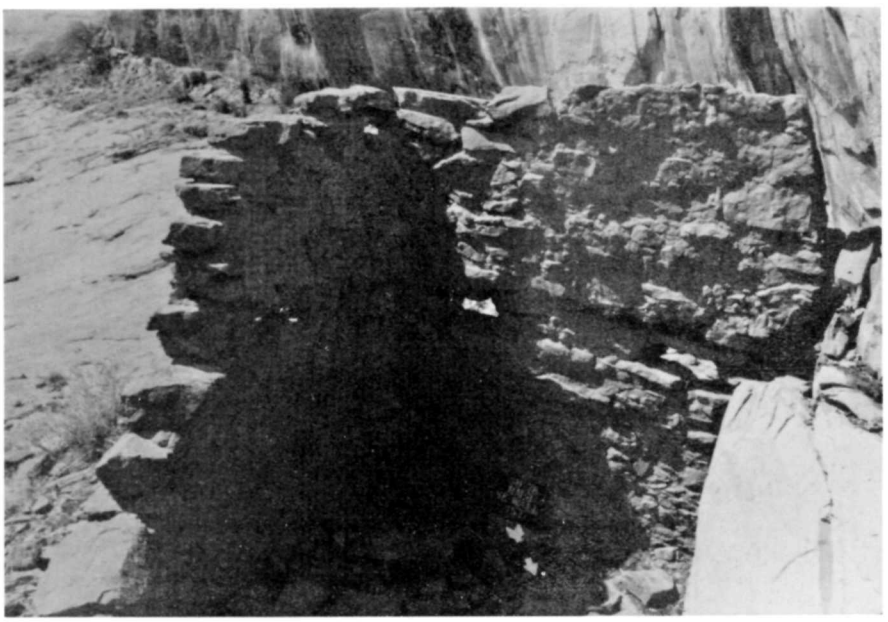


Figure 96.
SHP-78 4-6-8. Winter check Room 3, southeast interior wall. Note position of second story floor beam seats. March 1979.

Figure 97.
SHP-78 4-7-9. Winter check Room 3, southeast interior wall. Close-up of beam seat area. March 1979.

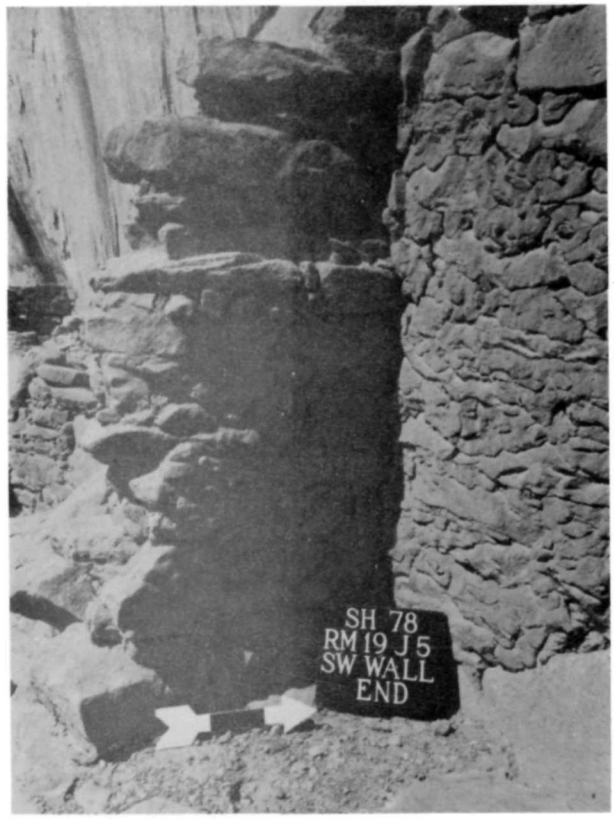


Figure 98.
SHP-78 4-10-14. Winter Check Room 19, job 5; southwest wall end. Note water marking on mortar and stone. March 1979.

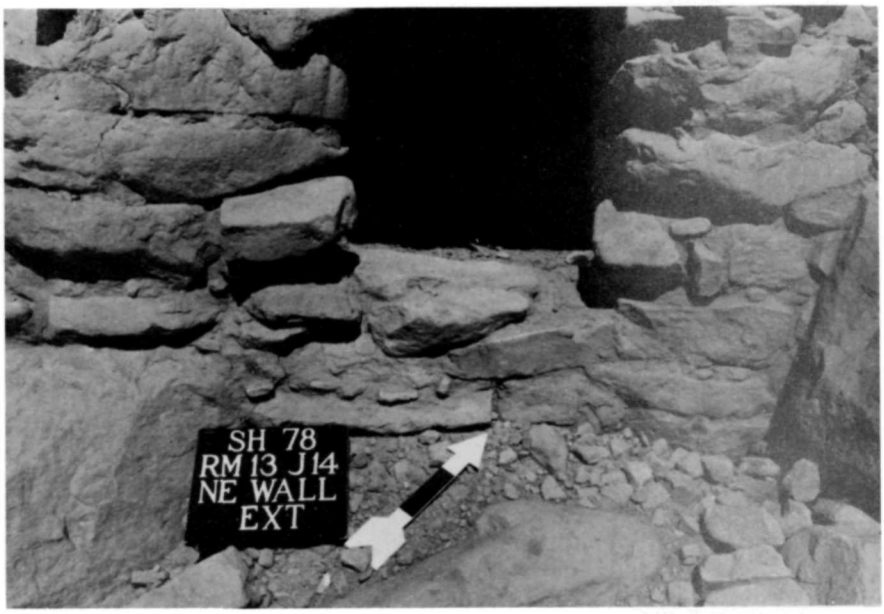


Figure 99.
SHP-78 4-12-14. Winter Check Room 13, job 14; northeast exterior wall. Different soil source used. March 1979.

Figure 100.
SHP-78 4-11-13. Winter Check Room 13, job 14; close-up of soil. March 1979.

Figure 101.
SHP-78 4-8-10. Winter check. Room 14, job 16, northeast exterior wall; close-up of soil mortar. March 1979.

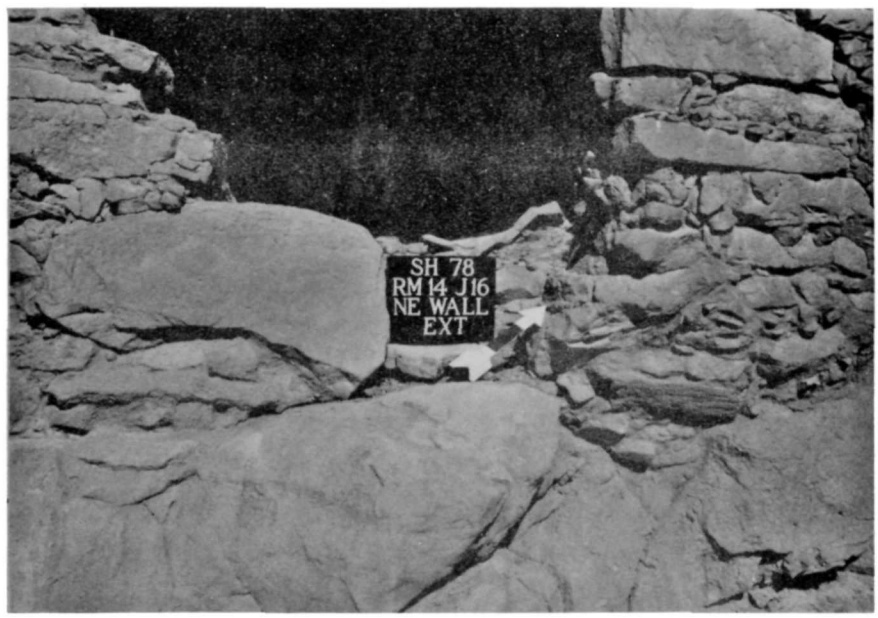


Figure 102.
SHP-78 4-9-11. Winter check. Room 14, job 16, northeast exterior wall. Extreme washing. March 1979.