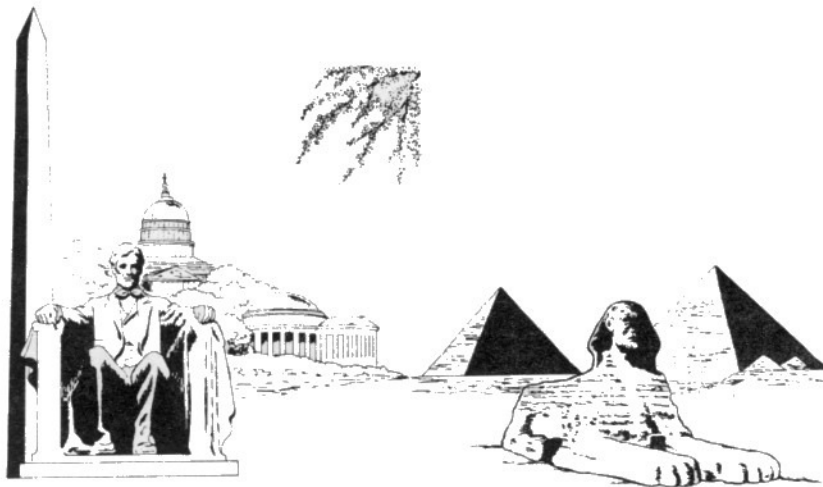


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Ancient and Modern Quarry Techniques

by Dr. David Stewart-Smith, Th.d; M.M.



America's Stonehenge at Mystery Hill:
Monograph Series #1.

Subject: David Stewart-Smith's landmark discovery
of the ancient, stone age, method of shaping stone on
Mystery Hill, which was done **without metal tools** !

2.



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INTRODUCTION

"Ancient and Modern Quarry Techniques" is based on the report of the "Quarry" site by David Stewart-Smith, submitted to the file in September, 1982.

All footnotes were added by the publisher, 1989.

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Ancient and Modern Quarry Techniques

by David Stewart-Smith, Master Mason

The knowledge of ancient stone quarries on the north and west sides of Mystery Hill goes back several years ago to their initial discovery by Osborne Stone and Daniel Leary.^[1] About four years ago^[2] I toured the northern sites and noticed several stones that had been propped up, presumably for ease of handling. Evidence of quarrying can be found for at least a half-mile north of the central site, in varying degrees. The bedrock exposure and several cliffs lend themselves to easy access and ease of quarrying. However, in all sighted instances, I am not aware of the appearance of any drill marks^[3] or other indications of modern or known historic quarrying techniques.

The discovery of one specific stone,^[4] to the west of the north clearance avenue, has answered many questions about the ancient quarrying techniques used. There is also a clear indication, through this particular

footnotes

[1] This "discovery" consisted of curiosity on the part of the people named, concerning certain slabs that looked as if they had been propped upward. There was no research or report on this, however.]

[2] 1978. The report was written in September 1982, and bears the headline: "This preliminary report was first submitted to Dr. Gary Hume, state archaeologist as part of a proposal to register Mystery Hill on the Nation Registry of Historic Sites in August of 1982." Dr. Hume later reneged on his agreement to prepare the National Register application.

[3] Marks made by a steel drill consist of circular holes in stones, or half of such a hole, remaining on the edge of a block which has been split. This is found on modern quarried pieces from the 1700's to today.

[4] Seated on a suspected "propped-stone" slab, at lunch, during the summer of 1982, site guide Mary Creamer reached under the edge and brought out what appeared to be a "flake" (a piece of stone resulting from deliberate tool-making). In spite of it's large size and type (schist, which is too soft to be considered "tool-material" suitable for arrowheads etc.), she realized it was an unusual and important find.

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example, that the techniques employed can be identified and related to not only the peripheral astronomical stones, but also to the central site, itself, where are found the stone chambers.

The specific example, of ancient stone quarrying and dressing, is a stone about 13 feet in length, 5 feet in breadth, and 12 inches in depth, which has been moved from it's place in the bedrock, about 10 inches. The stone is a native schist which contains a good amount of mica and feldspar in it's composition. The stone weighs approximately 4 tons. After moving the stone from bedrock, the quarrymen levered the face of the stone up about 9 inches and propped it, underneath, with a rectangular block of native granite. The engineering involved here consisted of moving the stone about 10 inches along a horizontal plane, from the bedrock, and then levering the face vertically, about 9 inches, sloping the stone back toward it's original place in the bedrock, and then propping the face. Levering would probably have been used to move the stone away from the bedrock, using the bedrock ledge as a stationary fulcrum.

At this stage, dressing the ashlar commenced by striking off a large disk of stone from the underside of the face, creating one, large, initial, concoidal flake, which lies under the stone. The face being narrowed in depth, in this manner, was then worked by striking off smaller flakes. It is apparent that the masons wished to create not only a pointed shape to the stone, but also to sharpen and refine the edge of the face. The smaller dressing-flakes^[5] are in evidence under the raised-face of the stone, lying on top of the large initial flake.

In addition to the face being worked, the base was cut using a natural fissure in the rock. The residual block, from the base, has been moved away about 6 inches and turned over, so that the natural face of the stone is now the exposed top.

CONCLUSIONS: The quarrying and dressing of the stone was carried out using **percussion** techniques. The

[5] Chips of stone resulting from deliberate action, not erosion.

[6] Hewing means "cutting" although, except for stone wedges and chisels, is not like modern cuts made with metal edges; Dressing refers to any method that shapes the stone, whether by striking, cutting, grinding, or polishing. Percussion-dressing refers specifically to striking.

5.

movement and positioning of the stone demonstrates a working knowledge of the fulcrum and lever. This form of dressing and hewing^[6] is in evidence throughout the site. The peripheral stones^[7] are shaped in this manner and several of the roof slabs and uprights^[8] within the central site have also been quarried and shaped in this manner. The technique is consistent with indigenous stone working techniques used on handtools, and is unique by comparison with colonial quarrying techniques where feather and wedge^[9], and bolsters^[10] would have been used, marking the stones with characteristic drill marks or bolster marks. This work appears to have been executed with stone tools rather than metal tools.

End of preliminary report.

[For those who desire the excavation report, in full, it is carried in footnote size as Appendix C of this booklet.]

Conclusion from the full Excavation Report:

Adding only briefly to what was written in my preliminary report, the excavation of the ashlar confirmed that no known historic or colonial quarrying and dressing evidence could be found.

The work appears to have been carried out solely with stone tools. Some possible tools were extracted during the excavation: these being stones which displayed softer surfaces than the characteristic sharp flakes. It

[7] The many standing and fallen stones on the perimeter around the central or main site. See appendix A for more on these.

[8] Uprights in this case means wall-stones, erected with a long-axis as base, showing a horizontal profile longer than it's height; however, there are two free-standing stones in the central site that act as doorway pillars, which are set on a base narrower than their height, and are reminiscent of the perimeter standing stones.

[9] Feather and wedge, or Plug and Feather, are tools used to split stones. The wedge, or plug, is a tapered chisel-like piece placed into a position between two flat, thin pieces called feathers, in the series of holes drilled or chiselled into a stone. The plugs are tapped between the feathers, building up lateral stress, until the stone splits. One set is on display in the America's Stonehenge lodge.

[10] A name for a flat, tapering, spade-shaped chisel used up until the early 1800's (and concurrently with the steel drill in the 1700's) to make initial holes in stones, which could then be split. A number of these "V-shaped" marks are noted in the central site. See footnote 9.

6.

appeared that some handily-shaped flakes may have been used during the dressing and hewing, for grinding and percussion. No colonial or historic artifacts or interference was noticed during the excavation. No marks of metal implements were noticed.

Another stonemason, Joseph Auciello, and I excavated the squares described [in Appendix C] and our overwhelming impression was that metal tools would have been used if we were dealing with European or colonial quarrying and hewing during the last 1000 years.^[11] Of course, this does not preclude the possibility that a colonial or European might not have worked the stone with stone implements.

However, the hewing and dressing, in this example, evidenced a certain expertise with the implements used. The selection of the type of stone to be dressed was specific. The propping methods used on the stone demonstrate an expert familiarity with the quarrying techniques and an exacting determination in the dressing and shaping of the ashlar. Several other examples of dressed stone have been noticed on the hill, and whoever worked this stone showed a confirmed knowledge of quarrying, dressing, and hewing with percussion and passive techniques. The work here is not random or haphazard, nor is it the work of someone "making do" with stone implements. The work was carried out by an expert with stone tools.

As with the architecture on the hill (which required sophisticated planning and engineering), the quarrying and dressing techniques follow an order. The excavation revealed the method involved with this type of stone masonry. This method can be explained in four stages.

1. Work bedrock to create^[12] fissure and break stone away from bedrock. Cut footing from north end of stone.

2. Lever under face of stone or use dry wooden wedges (west), prop stone up with block.

3. Strike off large disks from stone, shim deep to

[11] Since the use of Bronze and Iron tools on European monuments, as at Stonehenge in England, leaving clearly visible metal-tool marks, has been used for over 2,500 years in the megalithic region, one might safely extend the minimum time to that date.

[12] Or exploit an existing fissure.

underside, create basic shape with large dressings.

4. Refine shape by dressing off smaller flakes, creating a uniform line to the front face.

NOTE: The development of the fissures may have taken place over a period of time^[13] to allow passive techniques to work, but the removal of the ashlar from the bedrock and the dressing is probably the work of two days for a three-man crew.

Quarrying and Hewing Techniques^[14]

No tradesperson in the field makes more work than necessary for himself or herself. Stones to be quarried would be selected where the bedrock had been broken or fissured by frost and vegetation.

In this particular instance, the bedrock was probably fissured. The native schist can be scored or pocked with stone tools. Several deep pocks were noted along the east seam of the quarried stone. These artificial depressions would presumably run along the course of a natural fissure. They would collect water, which would freeze, and in the spring collect seeds which would sprout in the depression, their roots seeking water in the fissure. The artificial pocking would succeed in weakening the stone sufficiently for quarrying within an annual cycle.

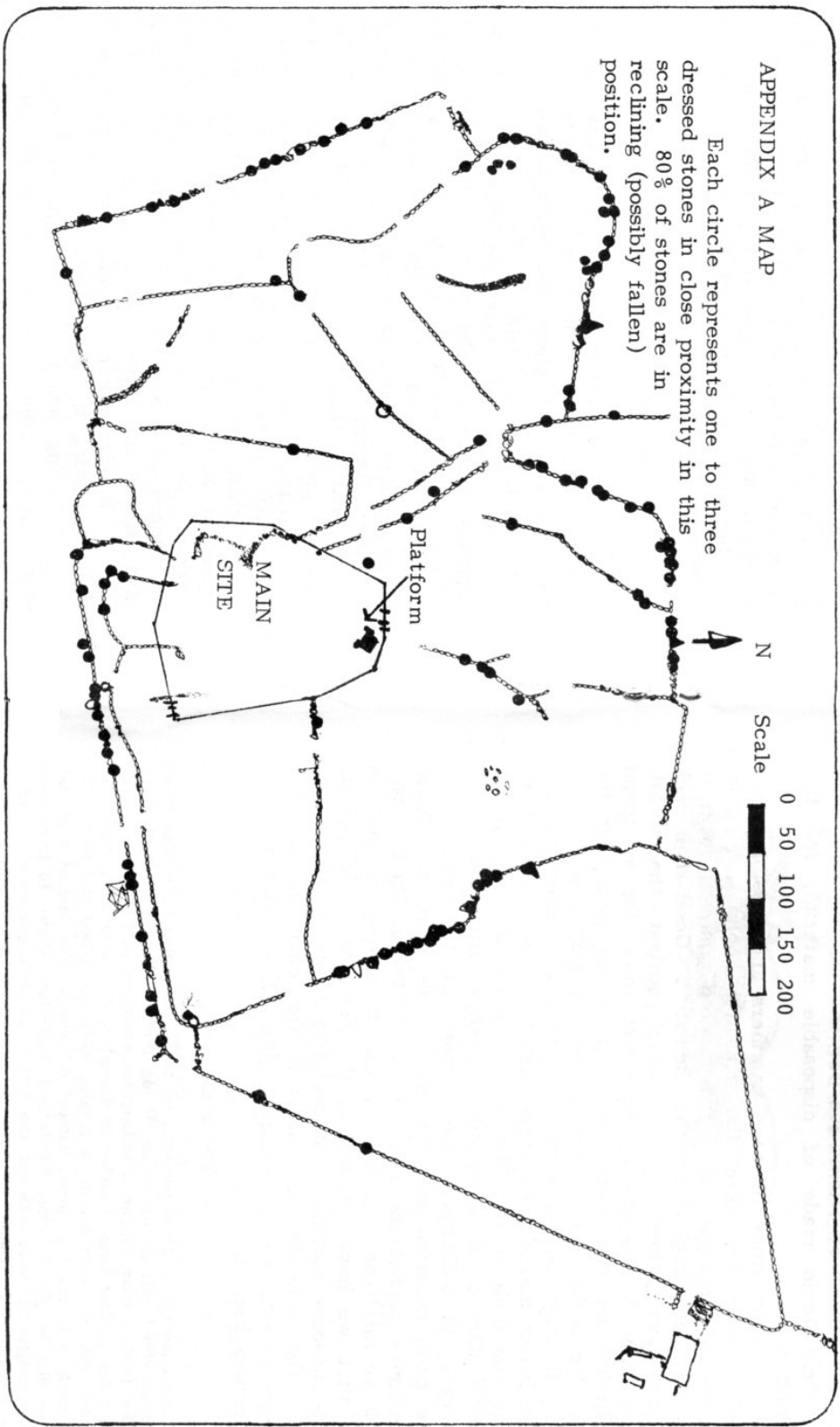
Schist, being a soft metamorphic rock, lies in layers or strata, so any horizontal plane could be easily worked. In this case the plane was a foot deep. Shims or wedges of wood could be driven into the horizontal plane where the stone was to be separated from the bedrock. Wooden wedges would swell, when soaked with water, assisting the separation.

Levering was used along the east seam to pry the stone away from its vertical plane in the bedrock. Levering was also used to elevate the face of the stone after which it was propped and shimmed.

During a workshop on the quarrying techniques, we found a 15 foot oak lever to be very effective, three

[13] Subsequent estimates might allow for one to five years of passive technique prior to final disinterment and dressing. However, any number of blocks could be in progress over the hilltop during such a period.

[14] Ancient techniques, including percussion-dressing. Not to be confused with "modern" "quarrying".



people being able to maneuver a 1½-ton stone^[15] We found what could have been fulcrum stones to the east and west faces of the stone, well in proximity to the quarrying. Again, knowledge of the lever and fulcrum is implicit in this example.

The large, initial, dressing flakes were probably struck off using a large "throwing hammer" weighing about 70 or 80 pounds, which was thrown from behind the face to strike off flakes. It is possible that a hafted adze was used, but the necessary weight (over 25 lbs.)

10.

would make this tool very unwieldy. The frequency of breakage of tools, as well, would render the hafted tool a constant source of frustration for the mason. We favor hand-held tools made of disposable material, for this technique.

A good stock of hand hammers and possibly stone chisels would complete the mason's toolkit. Again, because of breakage, we have favored common rock; in this case, anything harder than schist^[16]. Good river rock or an even-grained granite would outlast the schist. Presumably the masons had effective tools, for we found no broken hammer stones or throwing hammers near the site. We broke several tools during our workshop.

It must be stressed again that the quarrying and selection of material indicates that the masons knew their stone and their tools. The entire ancient site at Mystery Hill^[17] indicates an admirable expertise with stone, from quarrying to building. Several stones in the central site have been quarried and dressed in this manner. These techniques cannot be described as European (in the last 1000 years^[18]) or colonial. I am, therefore, inclined to say that we have witnessed the remains of indigenous stone masonry techniques unique^[19] to Mystery Hill.

The selection of material for quarrying demonstrates an intimate knowledge of the hill and its geology; indigenous indeed.

The End

[15] Subsequently, in other projects, up to 2½-ton stones have been lifted and maneuvered entirely by means of log levers. During the restoration of the Double-Solar, Upper Chamber, for example, David Stewart-Smith used a log 12 feet long, 8 inches in diameter, as a lever; two men stood to each side to apply levers as breaks, while he raised and moved the wall using only the log, alone, without difficulty. The largest roof slab on the site weighs 11 tons; the largest wall-stone known to have been moved weighs 21 tons. Except the latter, which might require double crew, all of the stones of the site (averaging 4-6 tons) could be emplaced by a crew not exceeding four people.

[16] The workshop piece, which was quartz/quartzite/feldspar, high in mineral content that is, was worked using granite and quartzite hammers.

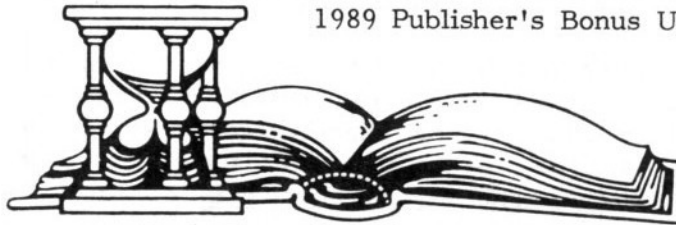
[17] This does not include those areas of known or discovered alteration in modern times, which evidences drastic differences in style and quality.

[18] Subsequent observation of similar sites indicates that of the 350 on file, up to 20% show similar style: i.e. percussion-dressing. It is not found anywhere else in the world. Also see footnote 11, above.

[19] See footnote 18.

WHAT THE NH STATE ARCHAEOLOGIST THINKS:

1989 Publisher's Bonus Update



Dr. Gary Hume, who's specialty is **lithics** (stone tools, their types, creation and usage), has been N.H. State Archaeologist, and head of the state's historic preservation office. He was the supervisor for three projects on Mystery Hill, of which the "Quarry" dig was the third. As suspected, the use of percussion dressing was confirmed in this project. Dr. Hume examined this work and concurred. Shortly afterward he was interviewed by James S. Upton, who was writing for The New Hampshire Times. The April 25, 1983 issue (pp. 20-21) carried the article including the interview: "The bulk of the stones at Mystery Hill were quarried by hand, using stone tools. "The marks are unmistakable," says Gary Hume, archaeologist for the state historic preservation office."

A few years later, Dr. Hume was interviewed on the local PBS program "New Hampshire Crossroads", on which he admitted the possibility of some great age to the site. He speculated that something akin to an American Indian "vision quest" site might be one use for the pre-colonial portion. In 1989, he approved for federal matching funding purposes, the hours of an excavator on the most recent project undertaken.

The conclusion is that Gary Hume is convinced of the percussion dressing technique discovered, agrees that this indicates stone tool use in ancient quarrying at the site, feels that a portion of the site is of prehistoric origin, and approves of the legitimacy of certain projects that have been undertaken to investigate it.

While he does not approve of all such projects on Mystery Hill (neither has the publisher), nor does he accept any current theory or dating as definitive, his attitude concerning the legitimacy of the site and of particular researchers, including David Stewart-Smith's quarry-technique research, is encouraging.

12. PERCUSSION DRESSING
Appendix A : VISUAL SURVEY

by W. E. J. Hinton Jr.

Shortly after the "Quarry" project ended, I made a walking visual survey of the outer perimeter walls with David Stewart-Smith. As he examined each stone over about 300 lbs (a little less than 2 cubic feet), I recorded the location on the general reference map of the site. The map is reproduced here with a black circle next to the wall at the location of a piece that shows sufficient dressing to be reasonably sure of identification as worked stone.

The map shows only a few of the 150 worked stones discovered in the perimeter that day. Subsequently, the number has increased to about 200, giving the site about 300 dressed stones. Except in the perimeter walls, about 80% of structurally-used pieces show no dressing marks at all, however. A formal survey is planned.

[See "Appendix A Map" in centerfold.]

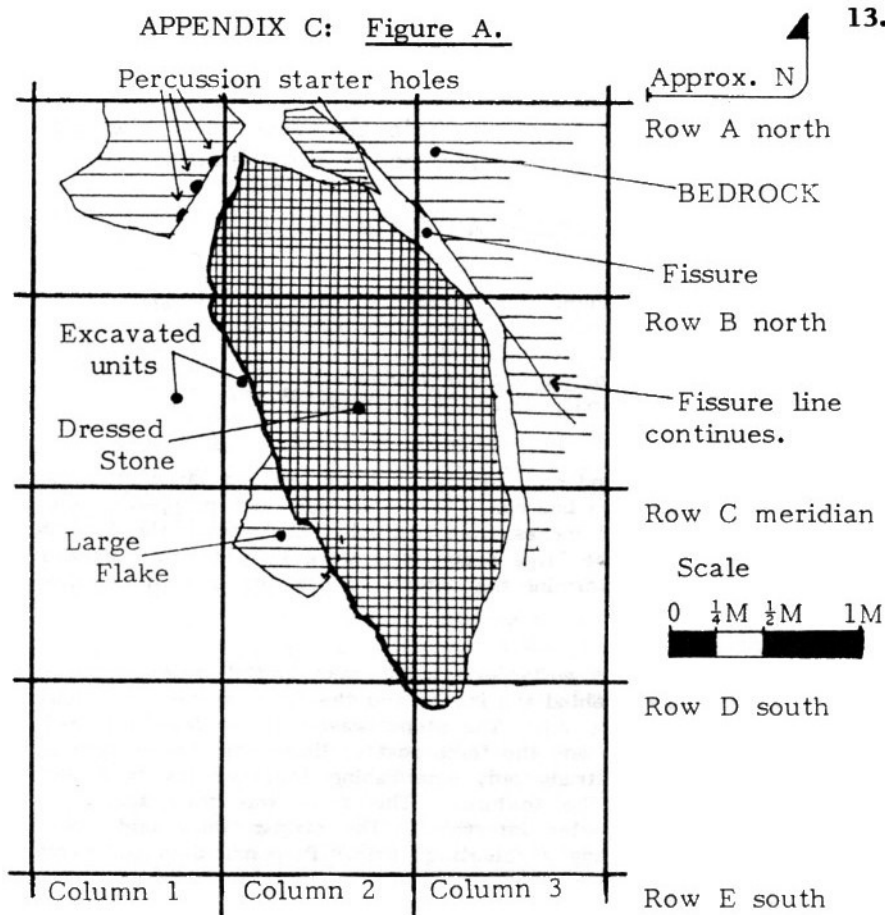
Appendix B : PERCUSSION DRESSING
WORKSHOP

by W. E. J. Hinton Jr.

During the "Quarry" project, a short workshop was held. An unworked block near the site was chosen, and a demonstration of propping and percussion dressing followed. David Stewart-Smith, with Jamie Eichholz and Mary Creamer (shown in two of the few photographs submitted to the file; see footnote 21) propped the piece, in order to raise and expose the edge chosen for dressing. Duane Eichholz photographed this.

The dressing stage was mainly performed in one session, which delayed slightly to 2 o'clock, by this writer's watch. David Stewart-Smith, Joseph Auciello, Jamie Eichholz, and Gus Colburn took turns raising the available 40-80 pound throwing-hammer stones, to detach initial large flakes from the face, followed by cobble-sized hammerstones used by Mr. Stewart-Smith, Jamie Eichholz, and this writer, for retouch work.

Throwing the larger hammers, followed by recovery and lifting for another strike, averaged about 8 seconds



per blow. Each blow tended to produce a number of splinters and dust; an average of 1 to 1½ dozen blows was needed to detach each large flake, including one to three dozen secondary flakes. These mineral pieces were smaller and more chunky than would be expected of the schist, and thus produced a greater number of smaller secondary flakes per successful blow.

Retouch produced a shallow reversed-"s" curve of about 30 inches length, and 10 inches across the width. The process ended at 2:16.

The shape and area chosen were unplanned at the time. As a result, subsequent workshops where blows were attempted in order to remove the prominent nose, failed; but during a further session, the nose dropped off. This indicates, both, that the amount of time necessary to such work is relatively limited, but that well planned engineering would be required in order to obtain the final

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shape desired. One can hardly do other than concur with the report conclusion that such final blocking and dressing is the work of 2 days or less per crew per block, once passive techniques have sufficiently weakened the slab's place in the bedrock to allow ready detachment.

Appendix C : EXCAVATION REPORT

Supervisor: Dr.Gary Hume; New Hampshire state Archaeologist
Project director and Excavator: David Stewart-Smith; Master Mason
Site Director: James C. Eichholz[20]
Assistant Excavator: Joseph Auciello; Mason
Assistant and Photographer: Duane W. Eichholz[21]

Method

The task in hand was to map and excavate a large stone which had been quarried from bedrock. The stone had been propped up elevating the face about 12 inches from bedrock. Underneath the face many dressing flakes and one large prop stone were left in situ. Excavation was conducted to determine the extent of dressing and the method of propping.

Grid

A 3 meter by 5 meter grid would take in the entire stone itself, the bedrock incision behind the stone, and the flake scatter in front of the stone. [See Figure A]. The stone was quarried from the bedrock along the eastern wall and the flake scatter lies along the western side.

The grid was strung out, establishing four corners 3x 5 meters, oriented entirely to the feature. The form was then squared with crossing strings at meter intervals. The strings were laid over the entire feature, producing a "floating" grid. Perpendiculars and parallels were checked for accuracy within the grid. [See figure for unit identification system used.]

Levels

A copious photographic record was taken throughout the excavation to illustrate the stages. Three arbitrary levels were set: surface, exposed dressing flakes, and exposed bedrock and the prop-stone. These levels were selected as representative stages where the most information could be gathered.

Throughout the excavation we stayed within the bounds of the grid, and exposed Square 2B-north for the third level as that square

Footnotes

[20] Jamie Eichholz, guide at the site and son of Duane Eichholz, was director of an excavation project that year, but was otherwise not "site director", nor involved with this project except as a volunteer.

[21] Duane Eichholz was site Director of Research from Spring 1982 through March 1983. He also took the oft-mentioned "copious photographic record". Except for up to 3 prints each of not more than half a dozen pictures, Mr. Eichholz did not deposit prints, slides or negatives of the work with either the site or David Stewart-Smith, even after the latter's repeated requests for same. This matter remains unresolved at this date.

contains the prop-stones.

Squares and Levels

Square 1B north, Level 1.

This square takes in the beginning of the deepest overhang of the dressed stone. On the surface level in the middle of the square a large amount of flake scatter was noticed. The western wall of the square gave way to a hard-packed covering of duff and root material lower than the level of the flakes. In the northwest and southwest aliquots of the square, two isolated arrangements of stone were noticed in the hard-packed duff. These later proved to be flakes which had been used as rubbing tools. Their grain and features had been softened in comparison with other dressing flakes. The mound of flakes "peaked" in the middle of the northeast and southeast aliquots, approximately 70 cm from the western wall of the square.

Several larger flakes were visible in this area lying beneath smaller flakes of stone, demonstrating that larger flakes were struck off first in shaping the stone. Any loose duff and leaves were cleared, exposing the flakes.

Square 1B north, Level 2.

Work began at this level by cleaning the stones with small trowels and brushes. A decision was made that flakes carried away by a 4-inch light-bristle brush during cleaning would be counted later. This left intact flakes starting at 3 cm. A good deal of root material had veiled the contours of the flake mound. The veil was clipped and cleared away. The stones were then brushed with a light bristle brush; loosened earth and root material was cleared away by whisk broom and small trowel.

It was found useful to apply pressure on a stone when clipping roots around and underneath it. This effectively leaves the flake intact and creates a pillar for the stone. The flakes of the mound were pillar-ed and cleared in this manner exposing the full contour of the dressing-flake mound.

In the southeast aliquot of the square a pile of much smaller flakes was noticed. The flakes averaged about 2 cm by 1 cm. As this area was not protected by the rock overhang, it is possible that the small flakes were the result of weathering.

About 60 small flakes were counted from brushing off this level.

Square 1B north, Level 3.

Basically, Level 3 represents the exposure of bedrock along the western wall of the square. Directly underneath the overhang of the ashlar we encountered stones in place, lying on the bedrock. These stones appeared to have been placed to support the prop-stone found in Square 2B north. It was decided to leave these stones intact. After clearing around the stones, it was noticed that the "stones" could have been one stone originally: about 70 cm in length and 30 cm in width. The eastern side of the stone supports the propping stone in Square 2B north.

Square 2B north, Level 3.

Most of square 2B-north consists of features directly underneath the dressed stone. Most notably, there was found a concoidal disk with

16.

striking platform, about 28 cm by 18 cm, which had been placed under the overhang. The wide end (with striking platform) was jammed deep into the overhang, presumably as a safety-prop. This disk would have had to have been dressed off the face and then placed under the overhang. It had all the qualities of a safety shim.

The prop-stone is an angular block which supports the dressed stone, roughly at it's midriff. It rests on three shims which stand on the stone described in square 1B-north, level 3.

The prop-stone and it's shims were brushed and replaced, leaving the whole support method of the stone intact. We decided that, structurally, the propping of the stone must be left intact.

Overview of Squares and levels.

Any flakes which had been removed were placed outside the squares and arranged into three rough size groupings. There were literally hundreds of flakes in the refuse. No "artifacts" were discovered in the sifting other than small dressing flakes which are artifacts in themselves, so to speak. A copious photographic record was kept and two maps drawn of level 1 and level 2.

Time, unfortunately, played a part in the amount of control maintained during the excavation. Threat of interference with the feature was very real, so the excavation was as expedient as possible, using pre-historic excavation techniques and copious photographs rather than mapping in the features which time would not allow. However, I am satisfied that enough information was extracted to draw major conclusions about methods of quarrying and dressing. Two more squares remain totally intact should we need to go back to this site with more time and control. These two squares are 1C-meridian and 2C-meridian.

[Conclusion appears in main text, see page 5]

DAVID STEWART-SMITH holds a Doctors degree in Theology, and passed as a Master Stone Mason while in Scotland. He has restored a number of sites including a Scottish 17th century farm complex in Midlothian; Craignish Castle, Argyllshire; a 17th century ferry house; and as consultant engineer on Armaddy Castle, at Lorne, and for **Her Majesty's Commission on Ancient Monuments** for Craignish Sculptured Stones, Craignish, Argyll, Scotland. Returning to the U.S. in 1978, he has worked as consultant for the **Society for the Preservation of New England Antiquities**, the **Historic Preservation Society** of Newport, Rhode Island, and for the **New England Antiquities Research Association**. He has done restoration at Mystery Hill since 1978, and has been company site Director of Restoration from 1979 to the present, in addition to other credits too long to list here. He lives with his wife in a late 1700's farmhouse in New Hampshire.