GATHRIGHT LAKE PROJECT

LEFT ABUTMENT INVESTIGATION

DOWNHOLE TV SCANNING

COVINGTON, VIRGINIA

10 - 13 AUGUST 1971

DEPARTMENT OF THE ARMY
NORFOLK DISTRICT, CORPS OF ENGINEERS
FORT NORFOLK
803 FRONT STREET
NORFOLK, VIRGINIA 23510

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DOWNHOLE TV SCANNING

1. BACKGROUND. Investigations in October 1970 required to determine the excavation needed for the core trench on the left abutment located cavernous conditions at the top centerline of the dam (Hole 715). The serious nature of these findings necessitated that additional borings be drilled to define the extent of these cavities. Holes 800 through 808 were drilled and reported at a foundation conference with representatives of the Office of the Chief of Engineers, 10 May 1971. Recommendations from that conference included:

a. Extend depth of borings on left abutment

b. Utilize downhole TV camera to study voids

c. If camera inconclusive, drill calyx hole

d. Convene Board of Consultants as soon as possible after additional exploration is complete

2. EQUIPMENT. Two TV cameras were available from the contractor for use. One, a 6" model which was used in the top of hole 1110; and the second, a 3" model which was used in the remainder of the holes. Each camera had a axial downhole head and a radial telephoto head. The cameras were capable of remote focusing and aiming and were equipped with 1200 feet of operating cable. A copy of the IBAK camera brochure is included (Inclosure 2). The support equipment was trailer mounted. The TV equipment was manufactured by IBAK (Industrial - - Kiel), 23 Kiel 14 - Wehdenweg 122, Kiel, Germany. The United States agent for the camera is Bortel Company. The equipment we used was leased from Lauman Company, 100 Lauman Lane, Bethpage, Long Island, New York 11714. Mr. D. P. Lloyd, a partner in Bortel, operated the camera. The mobilization and demobilization for this job were negotiated at $800 lump sum. The rental costs of the logging equipment are presently $450/day while operating and $250/day for standby time. Mr. Lloyd was most cooperative and operated the equipment 1/2 day longer than our contract agreement at no additional cost. The Missouri River Division provided a video tape recorder and playback unit in order to provide a permanent useable record of all of the logging. Mr. Jerry Huie and Mr. Bob Anderson of MRD operated the recording equipment and trained Mr. Bowman, Norfolk District, to operate it. Several 35 mm photos were taken of the monitor screen showing various uses the the camera (Inclosure 3).

3. OBSERVERS. The following is a list of the personnel, and their affiliation, who observed all or part of the downhole TV scanning program.

Paul Fisher	Office, Chief of Engineers
Todd H. Riddle	North Atlantic Division
W. H. Tamm	Norfolk District
George E. Weber	" "
John Bowman	" "
Carl Anderson	" "
John Mitchell	" "
CPT Thomas P. Sandow	" "
George Faglie	" "
Bill Thornton	Mobile District
J. H. Lamar	" "
Dave Childers	" "
Charlie Cox	" "
John Sanford	" "
Bob Anderson	Missouri River Division
Jerry Huie	" " "
Al Depman	Philadelphia District
Jesse Richardson	Southwestern Division
Ken Vanlier	USGS, Tuscaloosa, Alabama

4. STATUS OF EXPLORATION. Borings 805, 807, and 808 were extended in depth. Most 1100 series borings were drilled adjacent to some of the more cavernous borings. Boring 1106 was located 15' E of 807; 1107 was located midway between borings 806 and 808; 1108 is 34' NW of 801; 1109 is about 55' NW of 803; and boring 1110 was drilled beside boring 800. Borings 1100 through 1104 are all scheduled to be drilled 4" in diameter to facilitate the TV camera and are located above state road 605 in order to define conditions further back into the abutment (Location Map - Inclosure 1). Five borings were scanned by the downhole TV camera in the following order:

Boring 1110
Boring 1106
Boring 1107
Boring 1108
Boring 1107 - Repeated at greater depth
Boring 1100
Boring 1110 - Repeated at greater depth

Borings 1107 and 1110 were reworked to allow deeper penetration of the TV camera. Boring 1110 was logged with the 6" camera on the first attempt to 58 feet where it blocked. The second attempt reached 138 feet and into the top of a cavity, but muddy water blocked the view below.

The air hammer-drill used to drill and clean the hole had plastered the walls so that the cavity located at 114 - 119 feet showed only as a widening of the borehole. The larger cavity at 135 - 146 feet was holding muddy water, much higher than it should, probably due to the containment of all of the drill cuttings from below. This is surprising due to the large size of this void. Boring 1107 was logged into the top of the cavity located at 87 feet but was blocked a few feet deeper. The hole was then reamed and re-entered reaching down into the collapsed material of the cave but unable to reach into the second cavity at 151 - 171 feet. An attempt to set 4-inch casing to this depth will be made prior to abandoning this hole. The top of the cavity in hole 1107 was the most spectacular, being open vertically 4 to 5 feet and open at least 20 feet in radius from the hole as judged by the time required to focus the telephoto lens on the radial view camera. Stalactites and the gentle dip of the chamber roof show that some of the solution activity is controlled by bedding. Borings 1106, 1108 and 1100 were scanned and video taped. The tapes will be retained and available for replay.

5. FINDINGS. Some of the electronic equipment was being utilized for the first time for this particular use and much was learned that will be of value in future investigations of this type. Some of the more important findings are:

a. The IBAK camera system is a highly sophisticated, rugged electronic tool with excellent image resolution. It uses a 1" videocon which offers four times as good resolution as NX-TV cameras which use a 1/2" videocon. The lateral camera head with remote focusing allows distances to be computed to a radius greater than 30 feet.

b. Using the axial scanning head, the image is better while retracting from the hole then while entering providing water does not condense on the lens. Water condensed on the lens from highly weeping holes and also while retracting the camera from water. The camera operated well under clear water but muddy water was not penetrable.

c. In order to scan a selected horizon, the hole should be well open or cased to the horizon, washed if clayey, and allowed sufficient time to either drain, or let the colloidal particles settle. The smaller IBAK camera requires a 4-inch diameter casing for clearance.

d. The video recording equipment supplied by Missouri River Division was used in conjunction with the IBAK system for the first time. Some interference was experienced with a cyclic appearance of horizontal black lines across the screen. MRD thought this was due to proximity of the generator but was unable to filter it out in time for this program.

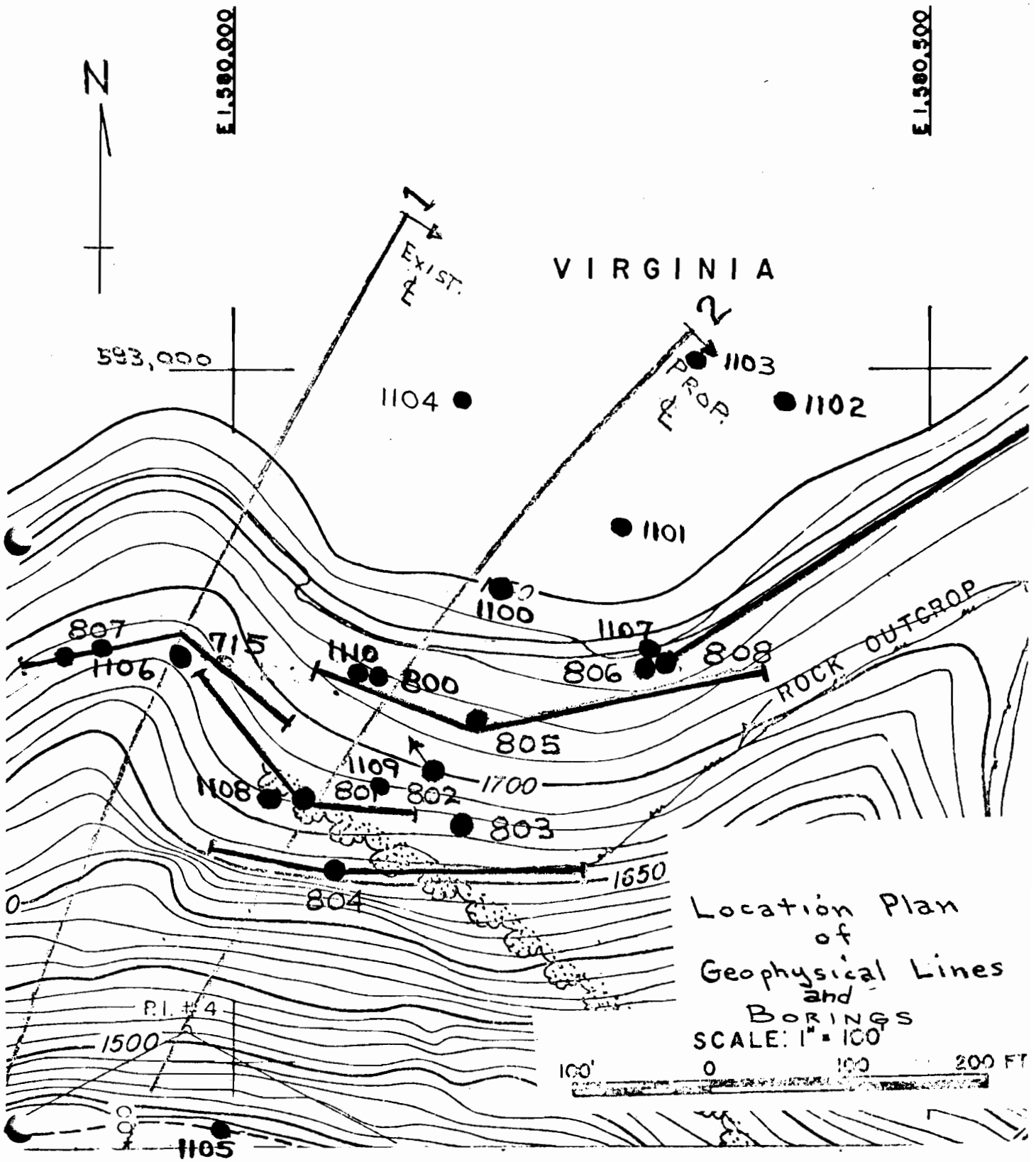
Another problem arose when the video tape was played back on line voltage. The picture rolled and was thus unuseable. Mr. Huie and Mr. Anderson of MRD then decided to return all of the tape and equipment to Omaha, recreate the generator cycles (58-62) and retape the corrected pictures on line voltage. The video equipment tape will then be returned for Norfolk District use.

e. MRD plans to buy the IBAK system this fall and they will add several features to their equipment to further increase the reliability and usefulness of the system. A larger, more stable power source, recorded depths in feet and the video taping equipment are examples. Their equipment will be truck mounted, contain nearly every geophysical downhole logging system available today and will cost $237/day for service.

f. As determined from this program, the total cost of drilling and TV scanning a boring at Gathright is less than 1/8 the cost of a comparative calyx hole.

g. The TV scanning showed the drilling logs to be quite accurate and emphasizes the need for elaborate leakage control measures.

6. RECOMMENDATIONS. The satisfactory operation of this downhole TV system on the first five borings of the left abutment investigation warrants its use on the remainder of the borings. Five borings, 1102, 1103, 1104, 1105, and 1109, remain to be completed and boring 1107 already scanned can easily be prepared for scanning at a greater depth. It is recommended that arrangements be made to use the TV scanning equipment on all of these remaining holes.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Location Plan
of
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and
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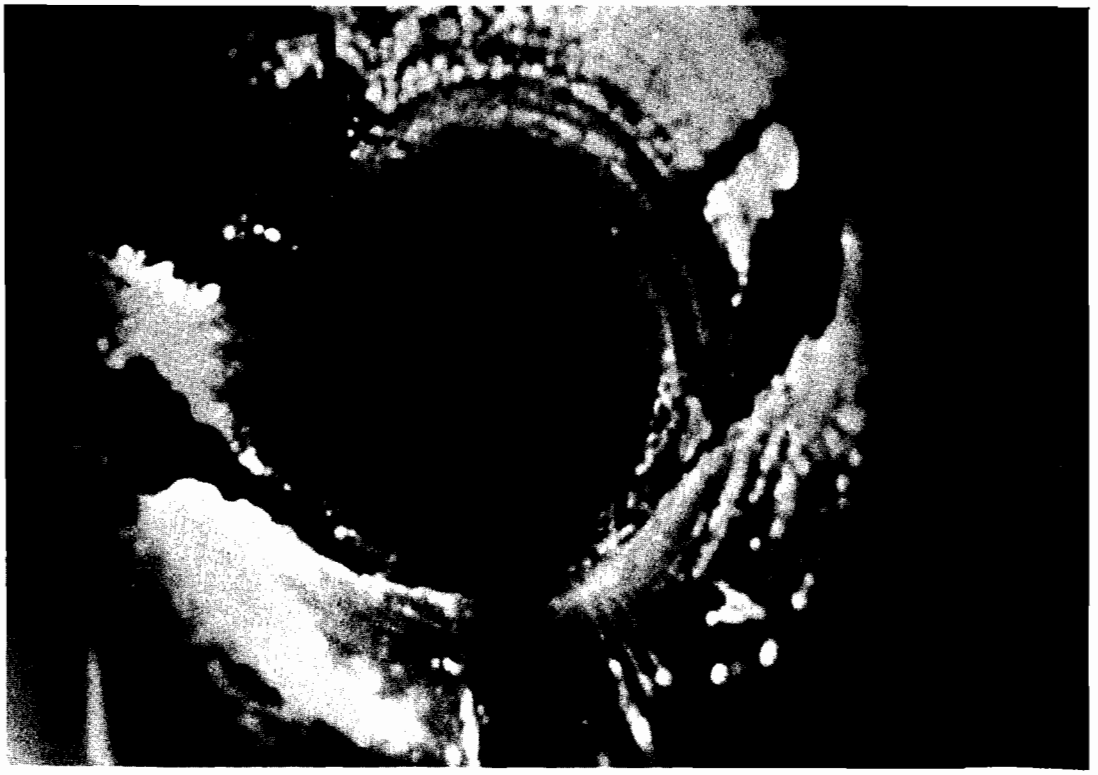
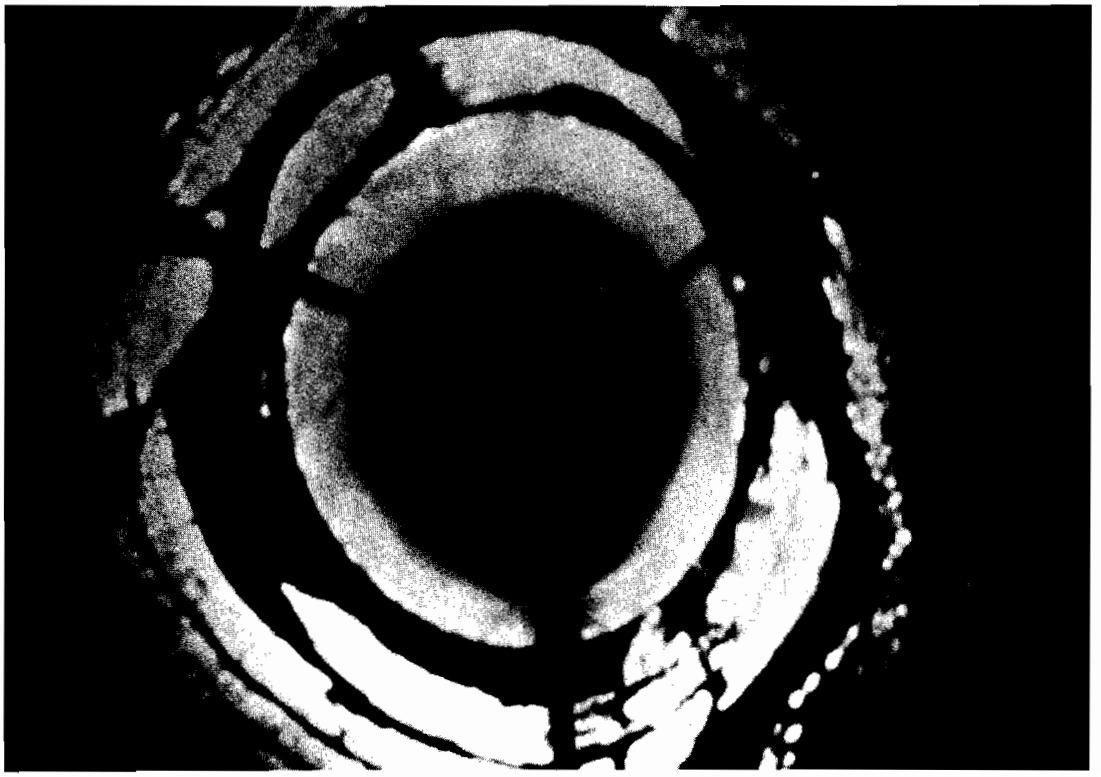
PLATE I

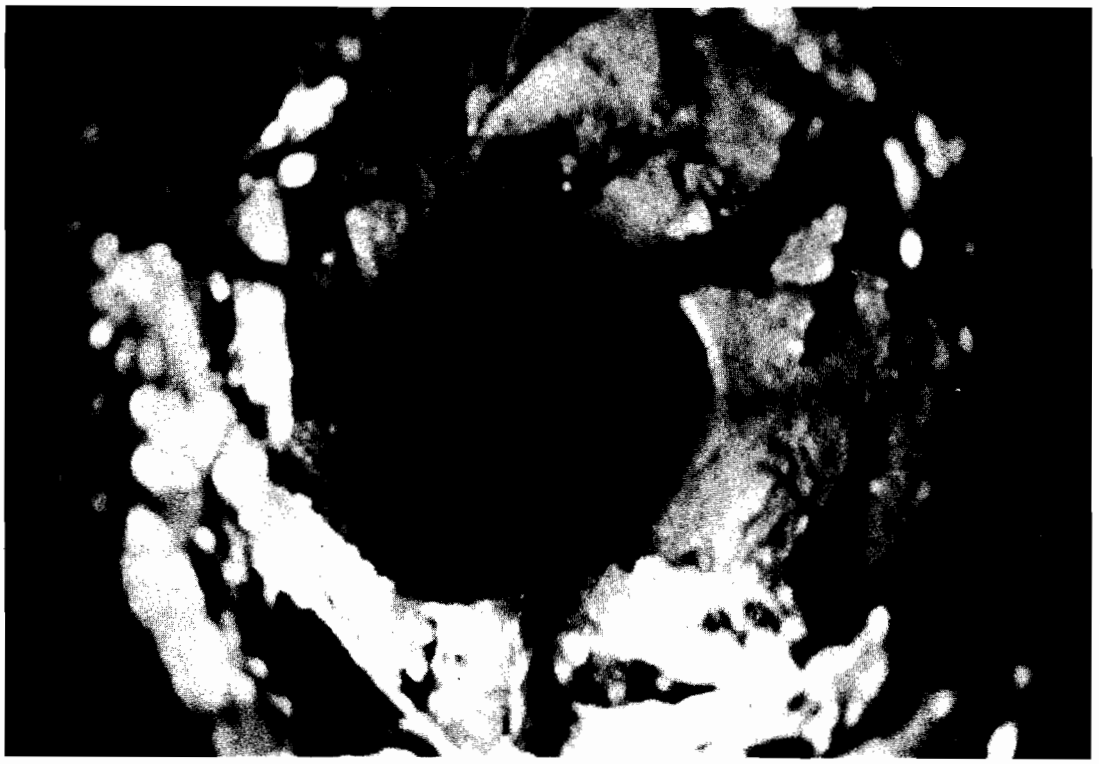


AXIAL VIEW OF TRUE HOLE IN SOUND ROCK SHOWING OPEN JOINT DIPPING 60°

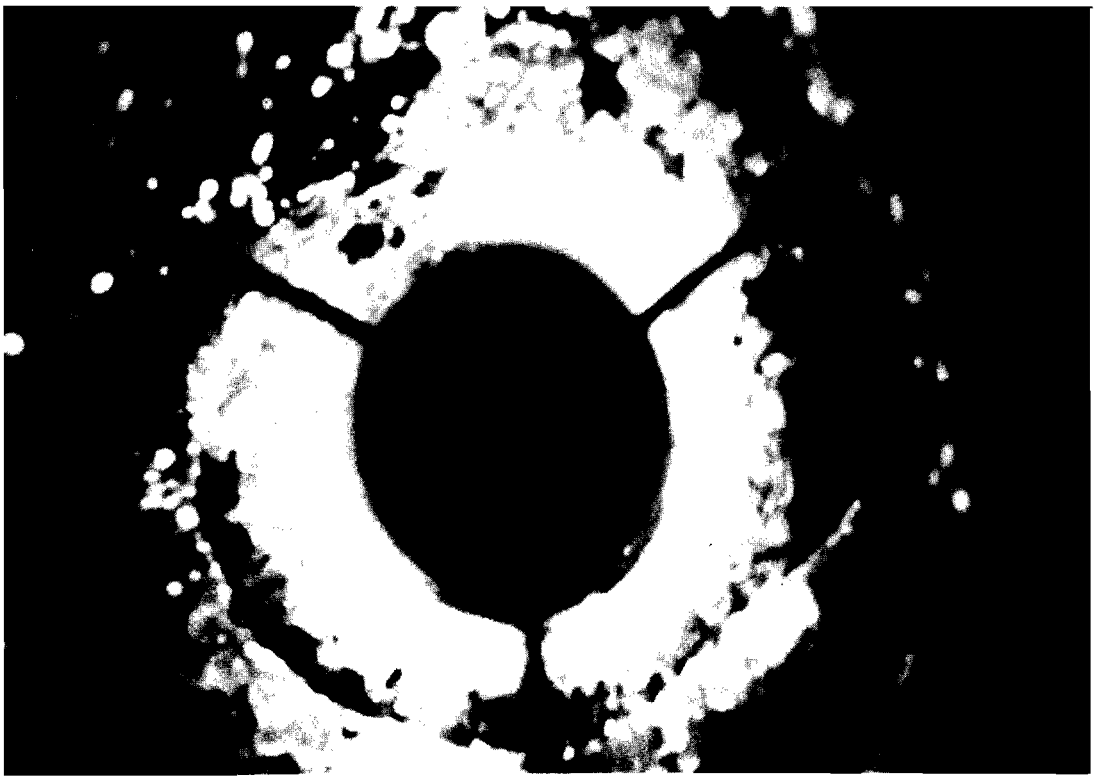
AXIAL VIEW OF CAVERNOUS ROCK



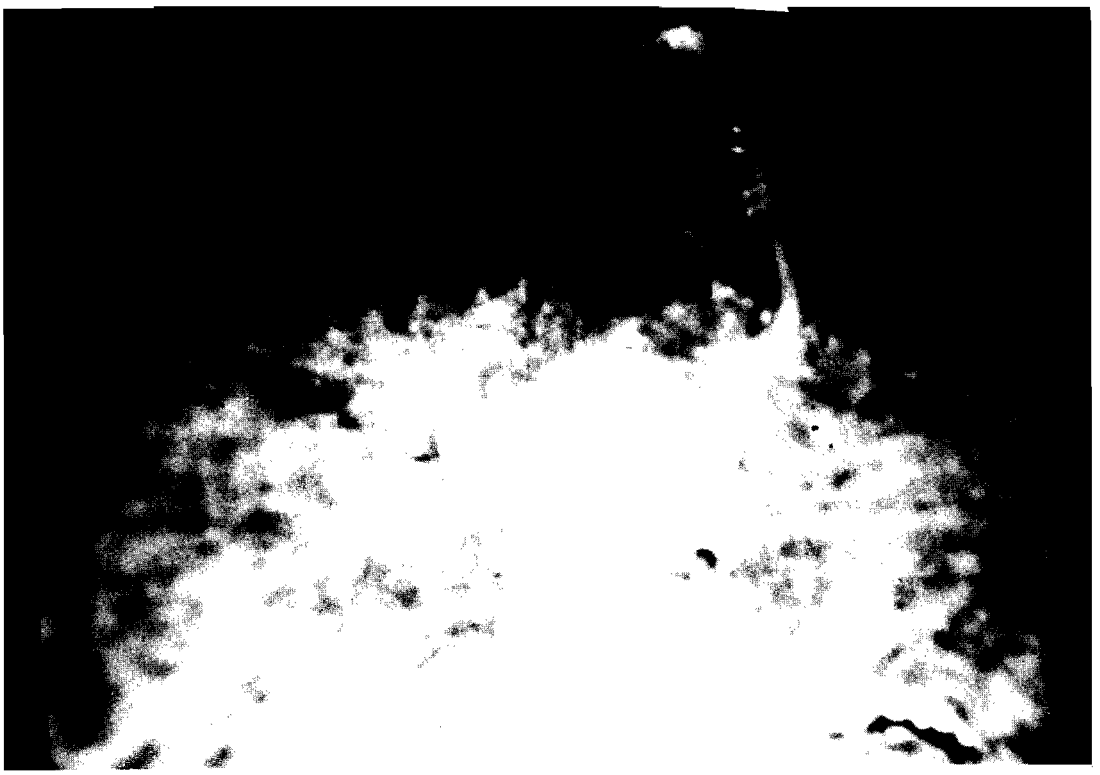
AXIAL VIEW OF HIGHLY JOINTED ROCK (JOINTS OPEN)



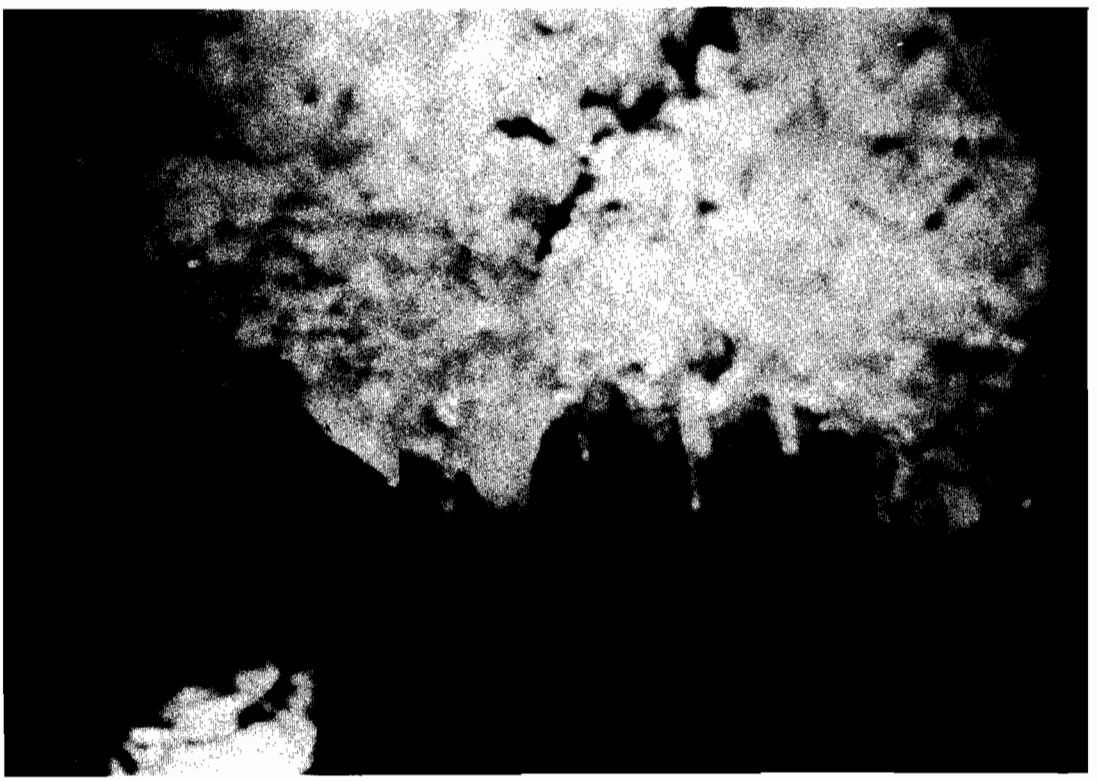
AXIAL VIEW OF CAVERNOUS ROCK



AXIAL VIEW OF MASS OF CALCITE CRYSTALS IN CAVERNOUS ROCK



RADIAL VIEW OF BORING WALL SHOWING INSECT AT 58-FOOT DEPTH

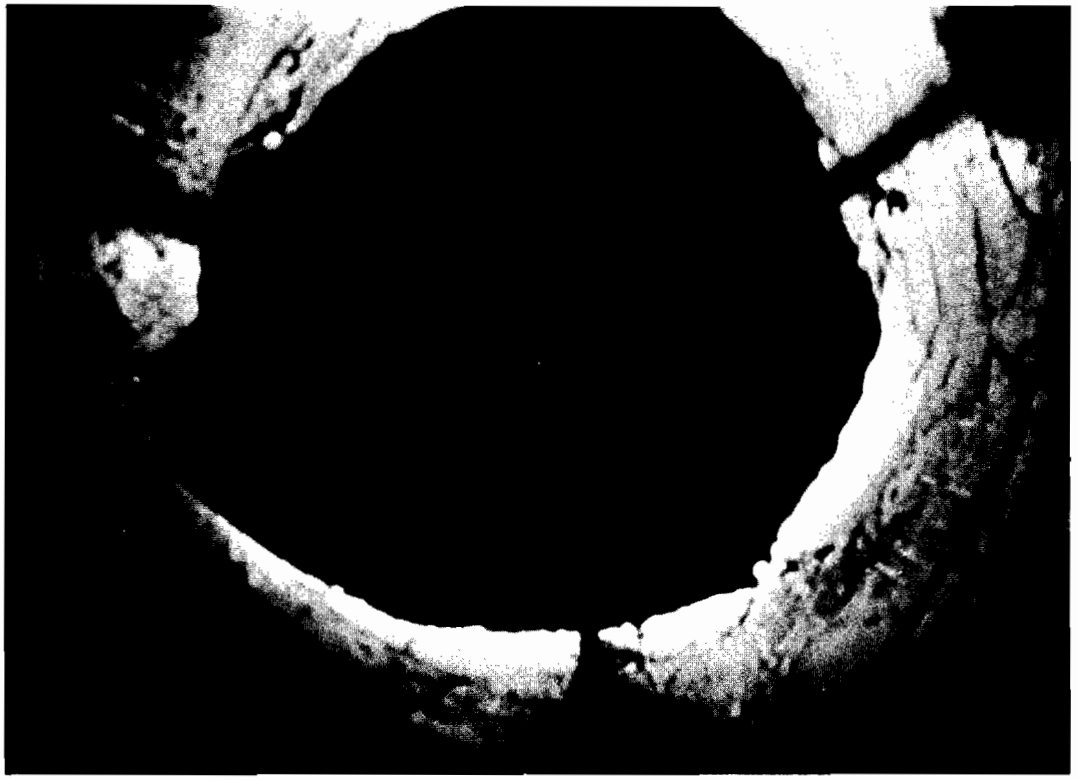


RADIAL VIEW OF STALACTITES ON ROOF OF SMALL CAVITY

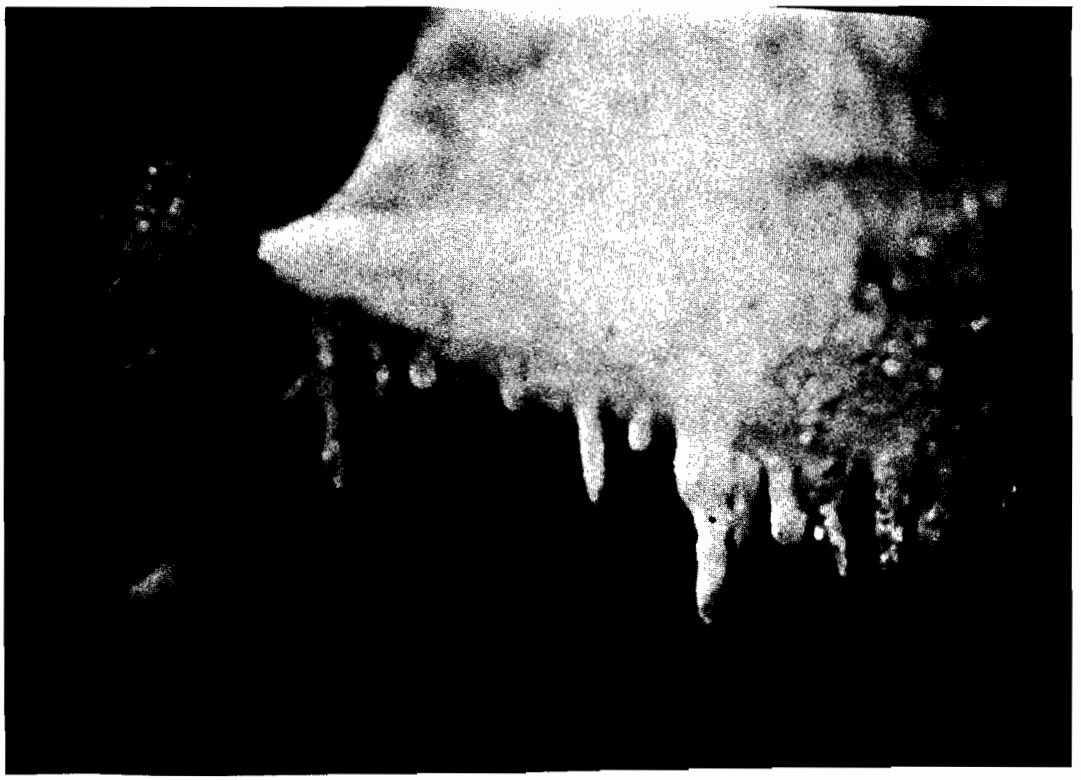
RADIAL VIEW OF COLLAPSE MATERIAL ON FLOOR OF CAVITY SHOWN ABOVE

RADIAL VIEW OF HIGHLY FRACTURED BORING WALL

AXIAL VIEW OF CAVERNOUS ROCK



AXIAL VIEW OF TOP OF 5-FOOT HIGH CAVITY



RADIAL VIEW OF TOP OF CAVITY SHOWN ABOVE

RADIAL VIEW OF PREVIOUS CAVITY (HEIGHT AT BORING 4 TO 5 FEET, RADIUS OF VISIBLE CAVITY 20 FEET)

RADIAL VIEW OF FLOOR OF ABOVE CAVITY SHOWING CLOSE-UP OF COLLAPSE MATERIAL