COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

HENRY WARD
COMMISSIONER OF HIGHWAYS

February 23, 1961

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

B.2.2.5.
D.1.7.

MEMO TO: D. V. Terrell
Director of Research

The attached, "Performance Report on Application of Wire Mesh Reinforcement to Asphaltic Concrete Pavement Overlays," by R. C. Deen and R. L. Florence, is a follow-up of a report on the same project by E. G. Williams (See Reports of the Highway Materials Research Laboratory, Vol. IX, 1954, beginning on page 157). Mr. Williams noted some difficulty in buckling and deforming of the wire mesh during paving. The material used was wire mesh mats; and, since the placement of this test installation in 1954, continuous rolls of wire mesh placed elsewhere and under some tension have practically eliminated this problem.

In the summary of the performance survey, Table 1, page 8, it is noted that 91% of the cracks have reflected through the control section while 83.4% of the cracks covered with 3-in. x 6-in. mesh have reflected through or cracked near by. For the 4-in. x 4-in. mesh, 47.5% of the cracks have reflected through the overlay.

During the recent Highway Research Board meeting in Washington, D. C., the Maintenance Department Committee on "Salvaging Old Pavements by Resurfacing," sponsored a session. An interesting paper was presented on "Five-Year Field Performance of Reinforced Bituminous Concrete Resurfacing," which discussed the surfacing of two sections of road in Massachusetts. This report has not as yet been released for publication but the following excerpt is quite significant:

> "The road test results after five years under traffic show great variations in the effectiveness of different welded wire fabric styles and configurations."

The Minnesota Department of Highways reported a project, "The Effect of Pavement Breaker Rolling on the Crack Reflectance in Bituminous Overlays." The project described the breaking of slabs into rather short longitudinal sections prior to resurfacing. By this method reflection cracking was practically eliminated in some areas. This appears to be a very economical and reasonable procedure for distributing thermal and deflection meovements more uniformly throughout the slab sections. It may be well for the Department to consider shortening slab lengths prior to resurfacing for control of reflection cracking.

Respectfully submitted,

W. B. Drake
W. B. Drake
Associate Director of Research

WBD:dl
Att.:
cc: Research Committee Members
Bureau of Public Roads (3)

Commonwealth of Kentucky
Department of Highways

PERFORMANCE REPORT

on

APPLICATION OF WIRE MESH REINFORCEMENT TO ASPHALTIC CONCRETE PAVEMENT OVERLAYS

Franklin-Shelby County Project FI 172(12)

by

R. C. Deen
Research Engineer Senior

and

R. L. Florence
Research Engineer Associate

Highway Materials Research Laboratory
Lexington, Kentucky
February, 1961

INTRODUCTION

During the past two decades an increasing mileage of portland cement concrete pavements has been resurfaced with bituminous concrete. This has generally proven to be a satisfactory and economical method of restoring, improving and enhancing the traffic service life of the highways. After a short period, however, cracks often begin to appear over the joints and cracks of the underlying concrete pavement. This condition is commonly referred to as "reflection cracking".

The presence of these reflection cracks are undesirable for a number of reasons. The open crack that develops may permit water to penetrate, often causing raveling of the bituminous overlay as well as the disintegration of the concrete or the softening of the subgrade. The cracks do present an unsightly appearance and may widen and deepen sufficiently to cause a decrease in riding quality as well as an increase in road noise. The maintenance of these cracks also presents special problems.

These cracks develop directly over the joints and cracks in the underlying slabs and there is obviously a connection between the reflection cracks and the joints and cracks in the concrete pavement. It has been found that reflection cracking can be the result of either of two causes, differential vertical movements between adjacent portions of the slabs or the repeated expansion and contraction of the concrete.

Subsealing and mud-jacking have been used successfully to reduce or eliminate reflection cracking due to excessive vertical movements. The techniques for controlling the horizontal movements are not yet understood or perfected. A report from Massachusetts(1)* indicates that most of the reflection cracking observed in that state can be attributed to horizontal movements of the slab. However, a report from California (2) points out cases where the cracking is obviously caused by excessive vertical deflections under heavy traffic. This indicates that the method used to control reflection cracking must be selected on an individual project basis.

There are two approaches to the control of reflection cracking. The first is to attempt to eliminate the formation of the cracks by some new or improved construction technique, and the second is to allow the cracks to form but to minimize their harmful effects by sealing them.

There have been numerous methods proposed and used to control or eliminate the horizontal movements causing cracking. The methods not only must eliminate the undesirable cracking but also should not require special skills or equipment nor increase the cost of the project excessively.

The method used to control the horizontal movements can be listed under three general headings.

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* Numbers in parentheses refer to bibliography in back of report.

Reduction of Slab Movement at Joints

One such method is to fill the expansion joints of the old concrete pavement with incompressible material so that the movement is reduced to an amount which can be tolerated by the bituminous overlay. This process, of course, will cause compression in the slabs with temperature rises and thus there is a danger of blow-ups or compression failures. For this reason not too many consecutive joints should be filled.

Another approach has been to break the slab into small pieces with a maximum dimension of two to four feet. Each small piece induces a small amount of movement which can be tolerated by the bituminous overlay. This technique then distributes the horizontal movement over the length of the pavement rather than allowing it to be concentrated at the expansion joints. This method has the disadvantage, however, of destroying the structural integrity of the concrete slab.

Increase Resistance of Bituminous Overlay to Cracking

Some investigators have suggested that the thickness of the bituminous overlay could be increased to resist reflection cracking. A study in Massachussets (1) indicates that thicknesses up to four inches are not sufficient to prevent reflection cracking.

The Massachusetts study has shown that the ability of typical bituminous concrete mixes to elongate would have to be increased about five times to withstand the stretching imposed by the contraction of slabs in the order of 60 feet long. It has been suggested that additives be incorporated into the bituminous mixture to increase its "stretch-ability".

Distribution of Elongation

Another way of eliminating cracking is to distribute in some manner the elongation imposed at the joints over a much larger area of the resurfacing so that the "stretchability" of the bituminous mix is nowhere exceeded. This can be done by breaking the bond between the concrete slab and the bituminous overlay at the joints so that the two materials may move more or less independently of each other. The use of a unbound granular base course approximately four inches thick over the old concrete before resurfacing has been used successfully in some states and in Europe. The use of this 4-inch thick base course, of course, requires that the final grade be raised significantly and thus may not be desirable in urban areas where curbs, sidewalks and abutting property must be considered. In such cases, sanding, i.e. placement of a thin sand layer over the old concrete, may be used to break the bond between the concrete and the resurfacing. Limited investigations have also been made using about a 3-foot wide metal plate placed on the old concrete over the joints to break the bond.

A number of installations of various types of wire mesh rein-forcement and expanded wire mesh have been made to study the effectiveness of this material in distributing the elongation occurring at the joints. These materials have been placed directly on the old concrete slab as well as between the leveling and resurfacing courses and has been placed continuously over the length of the pavement as well as in short sections over the joints.

TEST INSTALLATION

In the summer of 1954, some 1,000 feet (full pavement width) of wire mesh reinforcement were placed in the resurfacing of US 60 between Frankfort and Shelbyville. At the request of the Division of Construction, personnel from the Research Division observed the experimental features of this project in order to attempt to evaluate:

1. The effectiveness of wire mesh in preventing
   (a) Reflection of cracking of bituminous concrete overlays on cement concrete pavements, and
   (b) Lateral displacement of bituminous concrete overlays when it is subjected to accelerating and decelerating traffic.
2. Methods for incorporating wire mesh reinforcement in bituminous concrete pavement.

A report by E. G. Williams (3) presented comments and obervations on construction procedures and techniques. This present report deals with the field performance of test sections. The observations are presented in the form of strip maps so that rapid comparison can be made between the present condition of the bituminous overlay and that of the cement concrete pavement that was resurfaced.

Location No. 1

This location included 400 feet of wire reinforced overlay and 1300 feet of control pavement. The reinforced section contained 200 feet of wire mesh with 3-in. x 6-in. openings and 200 feet of mesh with 4-in. x 4-in. openings. The wire reinforcement was placed continuously over a leveling course of variable thickness and was then covered by the binder and surface courses totaling 3-1/4 in. in thickness.

Location No. 2

Here short lengths of mesh were placed so that they covered the transverse joints and extended a few feet on either side. The wire was placed directly on the concrete pavement. Some 300 feet of pavement was reinforced at the joints with 3-in. x 6-in. mesh and approximately 1200 feet using 4-in. x 4-in. mesh. The control sections included 8600 feet of pavement.

Location No. 3

This location consisted of 400 feet of reinforced bituminous overlay and 2300 feet of control pavement. Continuous wire mesh was placed directly on the concrete pavement. A pproximately 200 feet of pavement was covered by each of the two types of wire; 1) mesh with 3-in. x 6-in. openings, and 2) 4-in. x 4-in. openings.

PERFORMANCE SURVEY

The strip maps in the Appendix are a pictorial representation of the condition of the cement concrete pavement immediately before resurfacing, and of the bituminous overlay as observed during a performance survey made on November 2, 1960.

Table 1 summarizes the data presented in the strip maps. It will be noted that the use of wire mesh does tend to reduce the reflection of joints and cracks through the bituminous overlay. The reflection of miscellaneous cracks seems to be low (less than 10-15%) both for the control sections and for those sections using the wire mesh. In the case of joints, however, there does seem to be a significant decrease in the number reflected. In the column headed, "Joints Built into PCC Pavement", only the joints existing in the original concrete pavement are considered. For the column headed, "Joints Due to Replacement Patching", the junction between the original concrete pavement and concrete replacement patches are taken into account. It appeared that the original concrete and new concrete lying adjacent to each other performed much as a joint in the original pavement. It is not unreasonable to expect relative movement between the old and the new concrete since there is no method of load transfer built into these patches. These are then considered together with joints in the "Joints Built into PCC Pavement plus Joints Due to Replacement Patching" column.

Table 1. Summary of Performance Survey

Location	New Cracks (feet): Associated with Wire Mesh	New Cracks (feet): Others	Percent of Cracks or Joints Reflected: Random Cracks	Joints built into PCC Pavement	Joints due to Replacement Patching	Joints built into PCC Pavement plus Joints Due to Replacement Cracking	All Joints plus New Cracks Associated with Wire Mesh
1. Control Sections	--	0.0	0.6	100.0	0.0	87.4	87.4
3-in. x 6-in. mesh	22.0	0.0	0.0	50.0	0.0	50.0	83.3
4-in. x 4-in. mesh	0.0	0.0	13.1	50.0	33.3	41.6	41.6
2. Control Sections	--	4.4	4.0	98.0	34.6	94.9	94.9
3-in. x 6-in. mesh	24.2	0.0	0.0	48.4	0.0	48.3	66.7
4-in. x 4-in. mesh	15.4	0.0	6.5	41.5	33.3	41.0	44.2
3. Control Sections	--	5.5	0.0	91.8	46.7	84.3	84.3
3-in. x 6-in. mesh	11.0	0.0	0.0	100.0	0.0	100.0	116.4
4-in. x 4-in. mesh	11.0	3.3	0.0	66.7	0.0	66.7	83.3
Over-all Performance							
Control Sections	--	9.9	2.5	97.0	31.1	91.1	91.1
3-in. x 6-in. mesh	57.2	0.0	0.0	61.8	0.0	61.8	83.4
4-in. x 4-in. mesh	26.4	3.3	7.5	45.5	33.3	27.2	47.5

The investigators, during the visual inspection, noted the presence of several cracks which apparently were new in that they can not be matched with cracks in the original survey of the concrete pavement. Some of these cracks were random and no explanation for their occurrence can be given. However, some were rather straight, transverse cracks that appeared to be a reflection of a joint, except they were not properly located. These cracks occurred only in those areas in which wire mesh was used; most of these cracks occurred in test location 2 where short sections of mesh were used over the joints. On the basis of these observations, it is postulated that these cracks are the reflection of the edge of a sheet of wire mesh. In the column headed, "All Joints Plus New Cracks Associated with Wire Mesh", these cracks are considered along with the joints, etc.

It was noted that the cracks which have developed in the bituminous overlay, in both the control sections and the test sections, have been sealed.

CONCLUSIONS

With respect to the objectives of this investigation, the following conclusions and remarks can be made:

1. The effectiveness of wire mesh in preventing the reflection of cracking (of joints and replacement patches) of bituminous overlay on cement concrete pavements is noted to be

significant. The use of wire mesh with 4-in. x 4-in. openings seems to give better results than that with the 3-in. x 6-in. openings. The performance appears to be more satisfactory when the wire is placed over the leveling course or in short sections over the joints only.

2. The data permits no comments or conclusions with respect to the use of wire mesh in preventing lateral displacement of the bituminous overlay when it is subjected to accelerating and decelerating traffic. The performance of test and control sections showed no indications of a difference in behavior in this respect.

3. The report by E. G. Williams discusses some construction problems and techniques involved in this type of installation. It was particularly pointed out that special provision was necessary to prevent the wire mesh from slipping and from buckling.

BIBLIOGRAPHY

1. Bone, A. J. and Crump, L. W., "Current Practices and Research on Controlling Reflection Cracking," Bulletin 123, HRB, pp. 33-39, 1956.

2. Zube, E., "Wire Mesh Reinforcement in Bituminous Resurfacing," Bulletin 131, HRB, pp. 1-18, 1956.

3. Williams, E. G., "Application of Wire Mesh Reinforcement to Asphaltic Concrete Pavement Overlays," Highway Research Laboratory, Dec. 1954.

4. Bone, A. J., Crump, L. W., and Roggeveen, J. J., "Control of Reflection Cracking in Bituminous Resurfacing over Old Concrete Pavements," Proceedings, HRB, Vol. 33, pp. 345-354, 1954.

5. Crump, L. W. and Bone, A. J., "Condition Surveys of Bituminous Resurfacings over Concrete Pavements," Bulletin 123, HRB, pp. 19-32, 1956.

6. Roberts, S. E., "Cracks in Asphalt Resurfacing Affected by Cracks in Rigid Bases," Proceedings, HRB, Vol. 33, pp. 341-345, 1954.

7. Roggeveen, J. J., and Tons, E., "Progress of Reflection Cracking in Bituminous Concrete Resurfacings," Bulletin 131, HRB, pp. 31-46, 1956.

8. Smith, N. G., "Resume of Results of Welded Wire Fabric in Bituminous Surfaces," ARBA Technical Bulletin No. 215, pp. 10-19, 1956.

9. Solomonson, J. A., "Colorado's Experience in Resurfacing Old Concrete Pavements with Plant-Mix Asphaltic Resurfacing," Papers, Highway Conference, Univ. of Colorado, pp. 41-42, 1952.

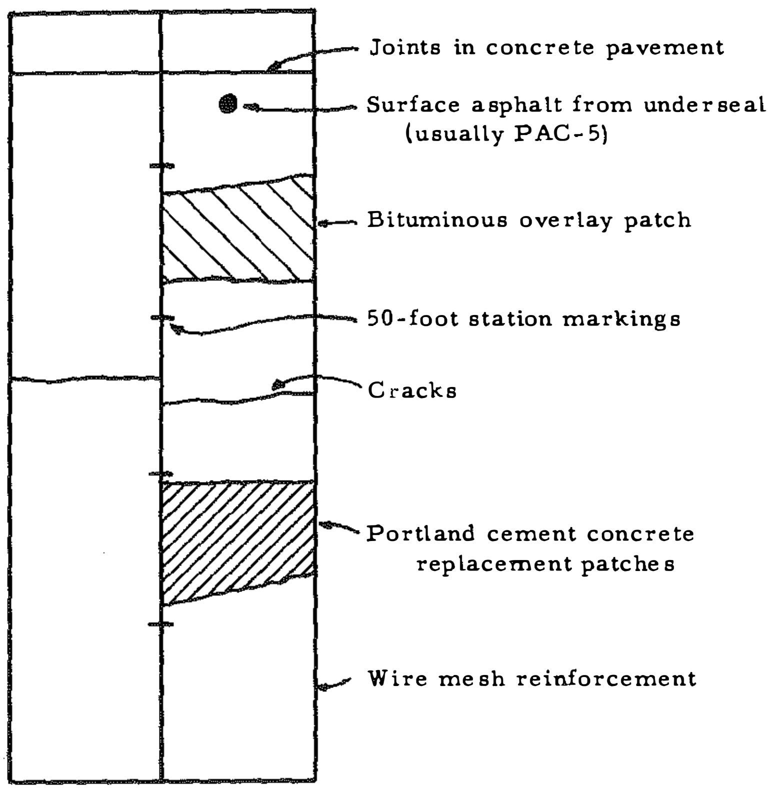
10. Wakefield, Floyd G., "The Practical and Laboratory use of Wire Fabric in Bituminous Resurfacing at Willow Run Airport," ARBA Technical Bulletin No. 215, pp. 1-9, 1956.

11. "A Feild Test of Reinforced Asphalt," Civil Engineering, pp. 38-39, Jan. 1961.

12. "Welded Wire Fabric Reinforcement for Asphaltic Concrete Resurfacing over Concrete Pavement Slabs," Wire Reinforcement Institute, 41 pp., 1954.

APPENDIX

Legend

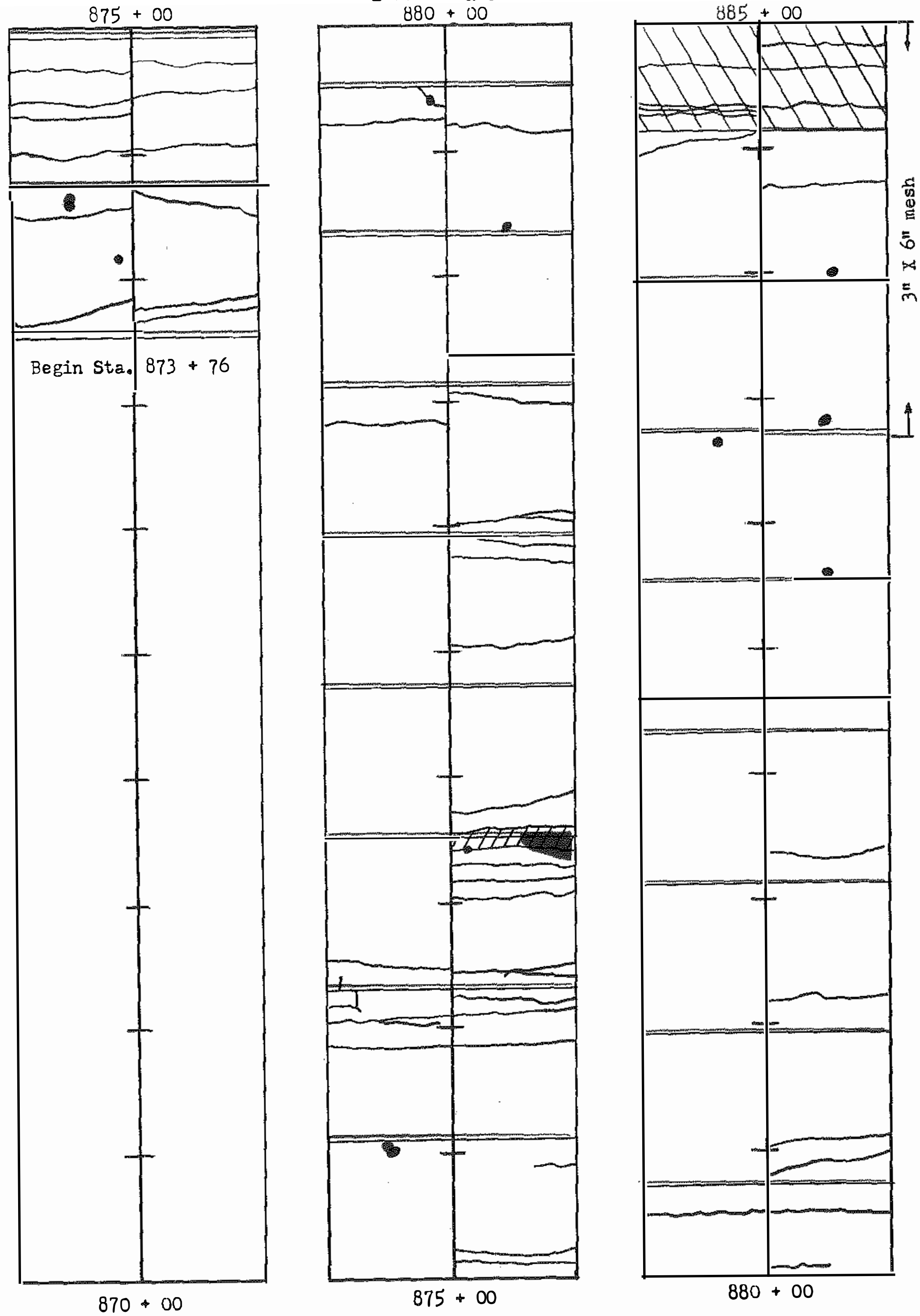


Black - Survey prior to resurfacing (summer, 1954)

Red - Performance survey, October 2, 1960

Wire mesh reinforcement

Location No. 1



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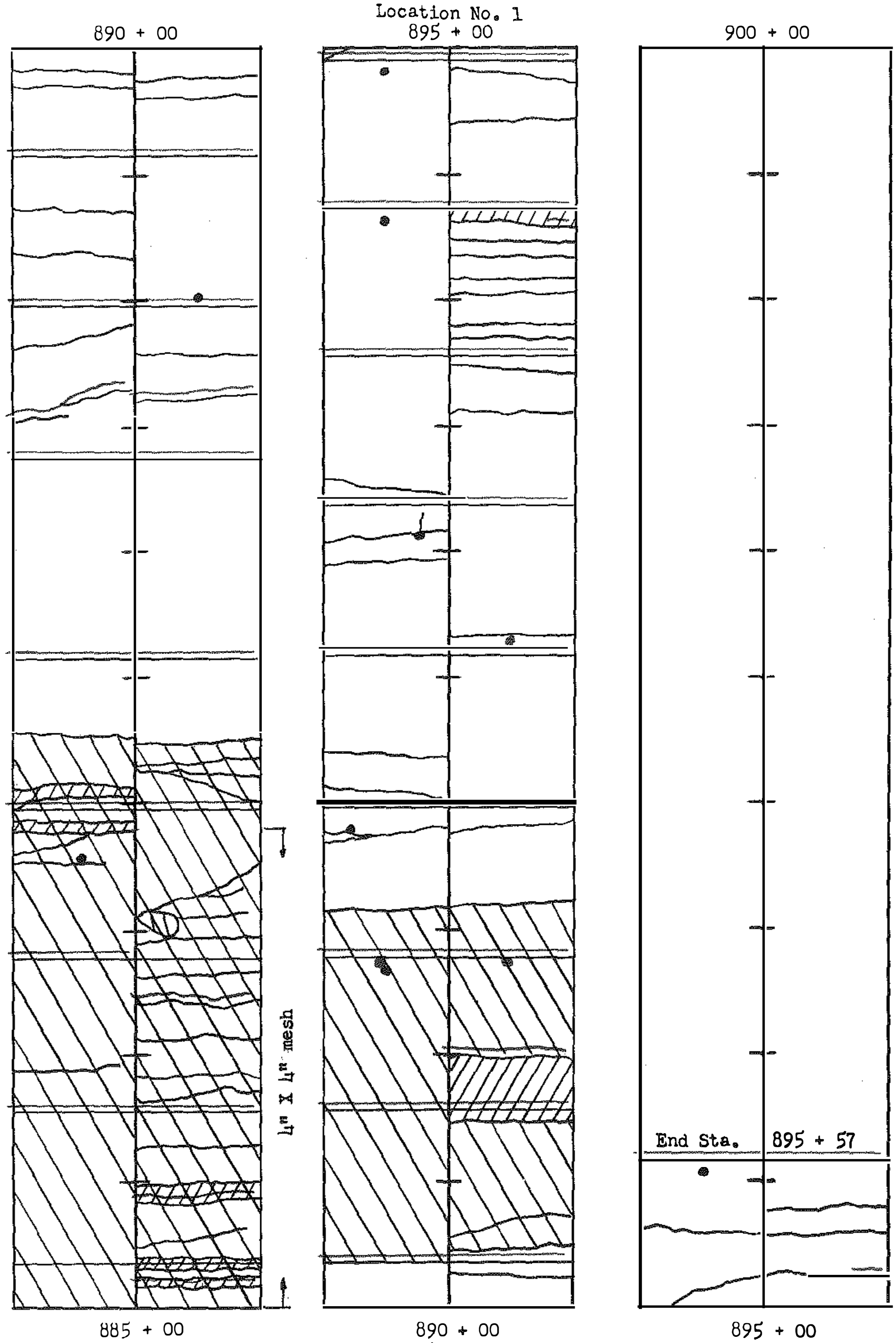

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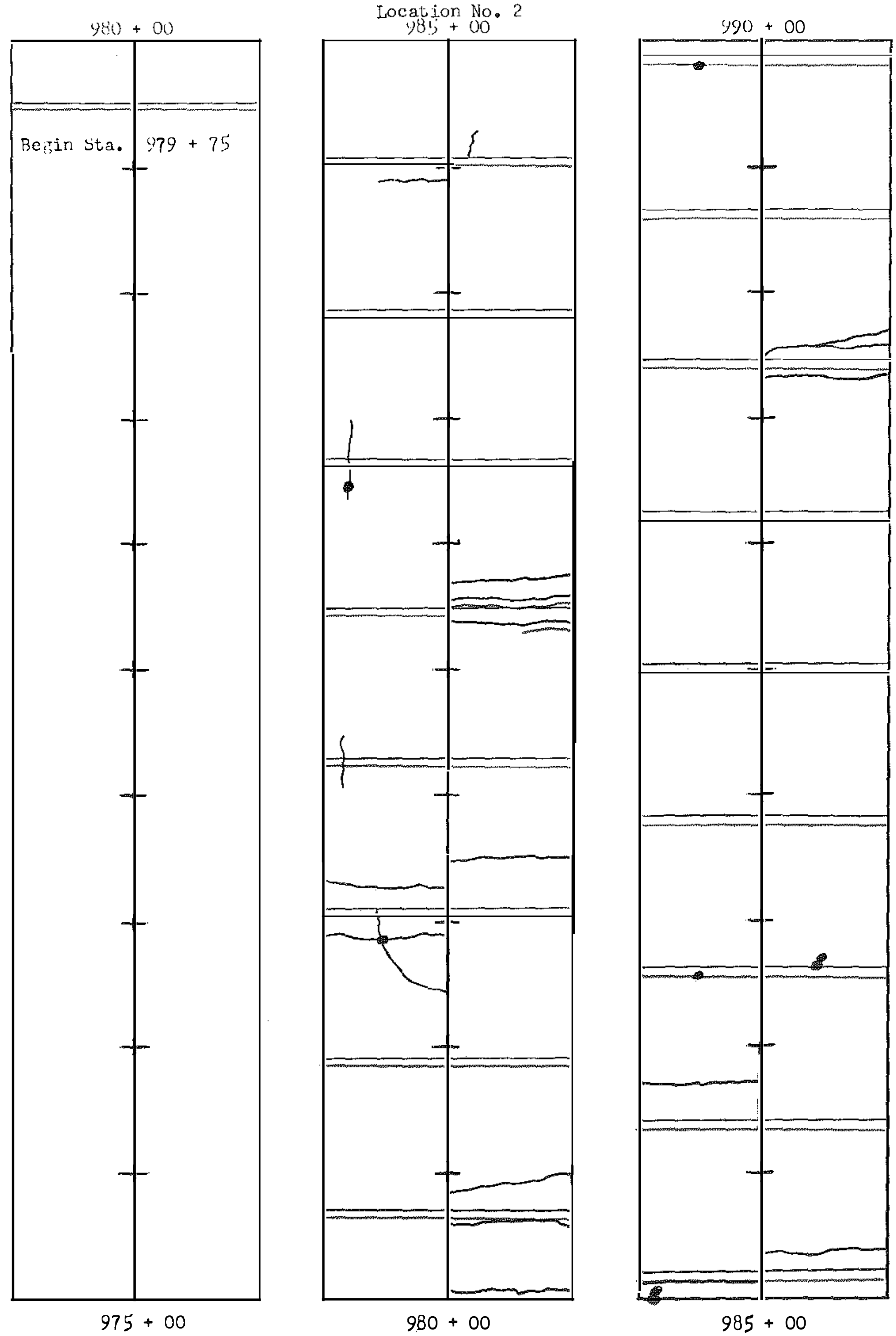

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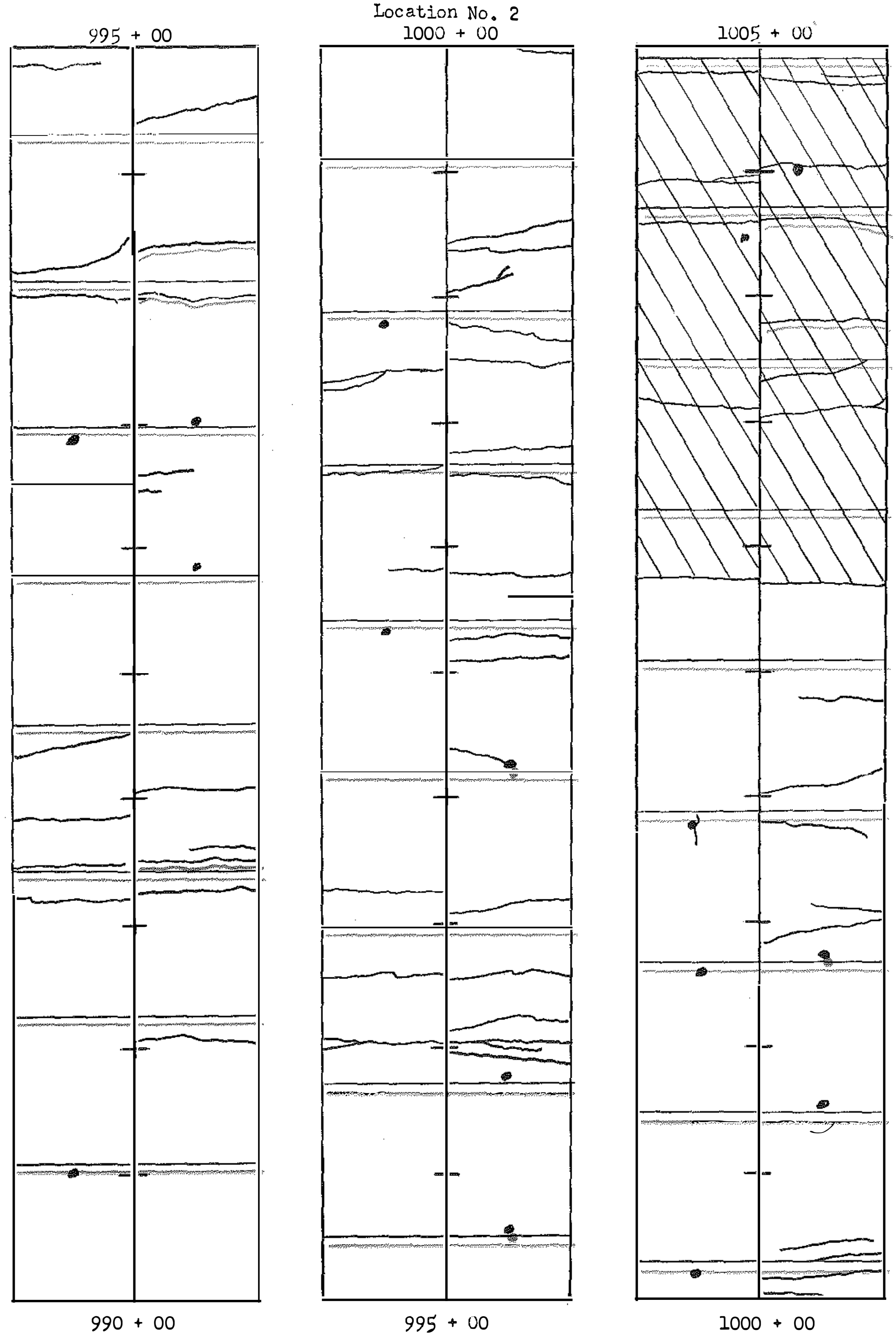

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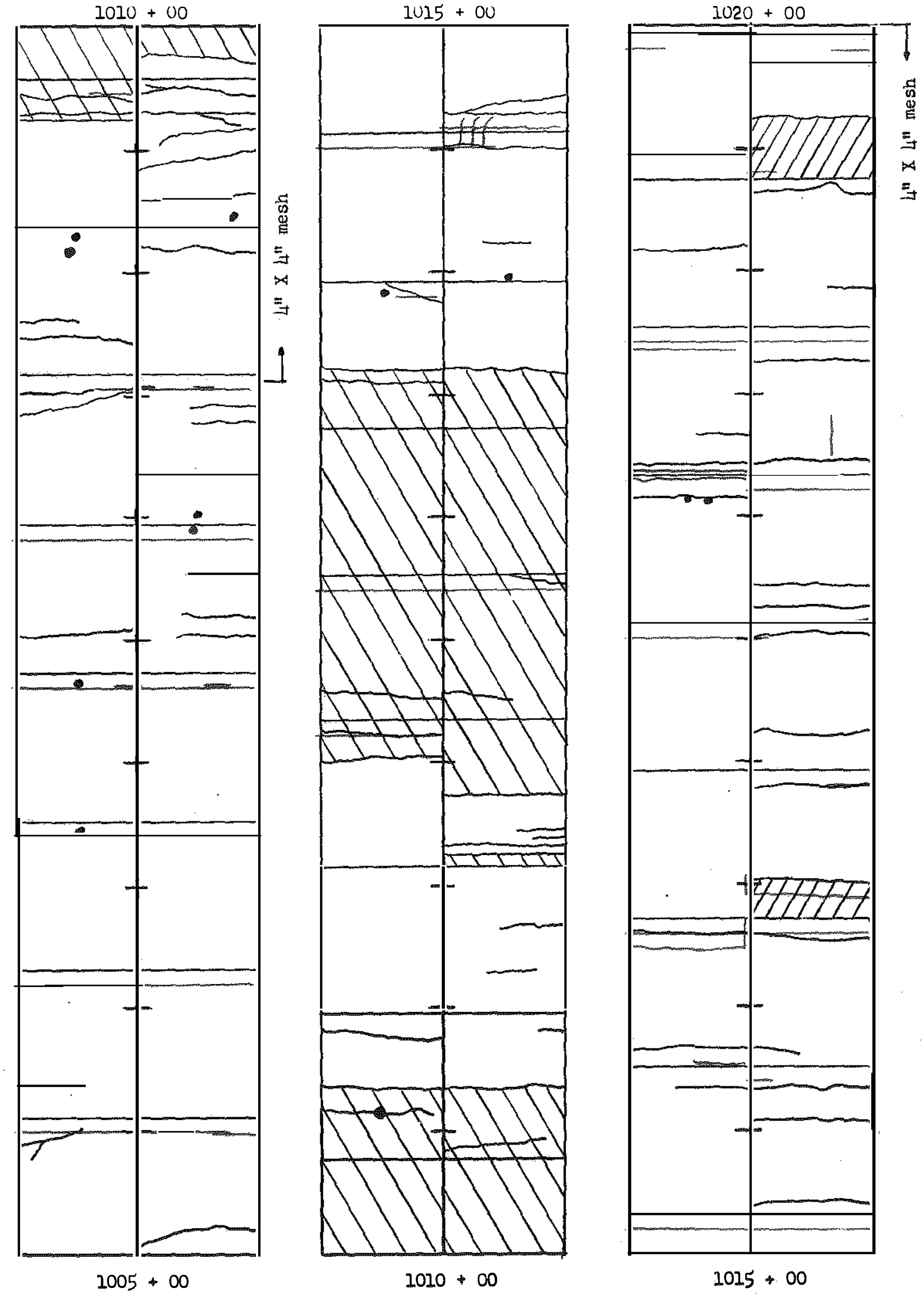

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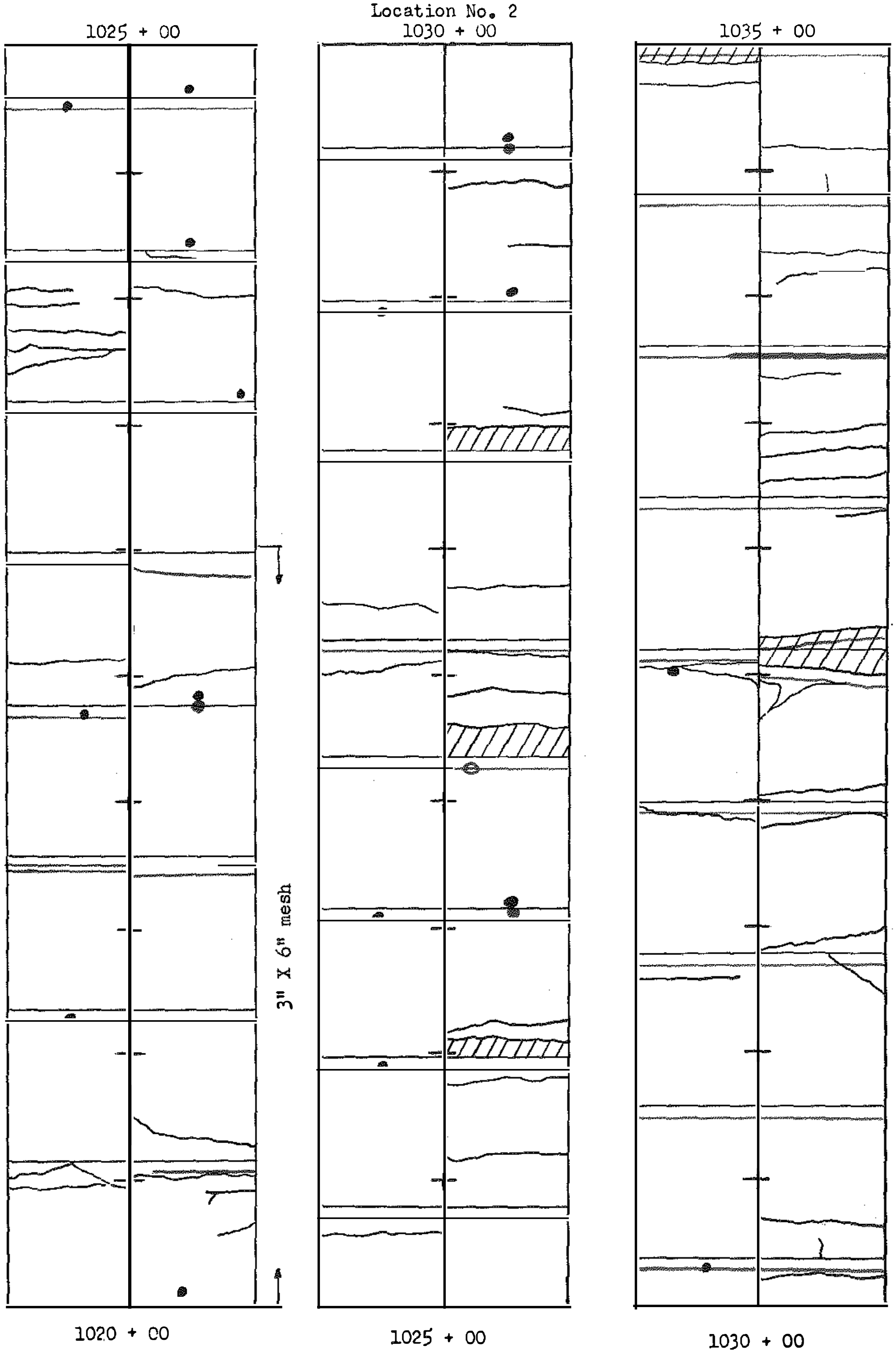

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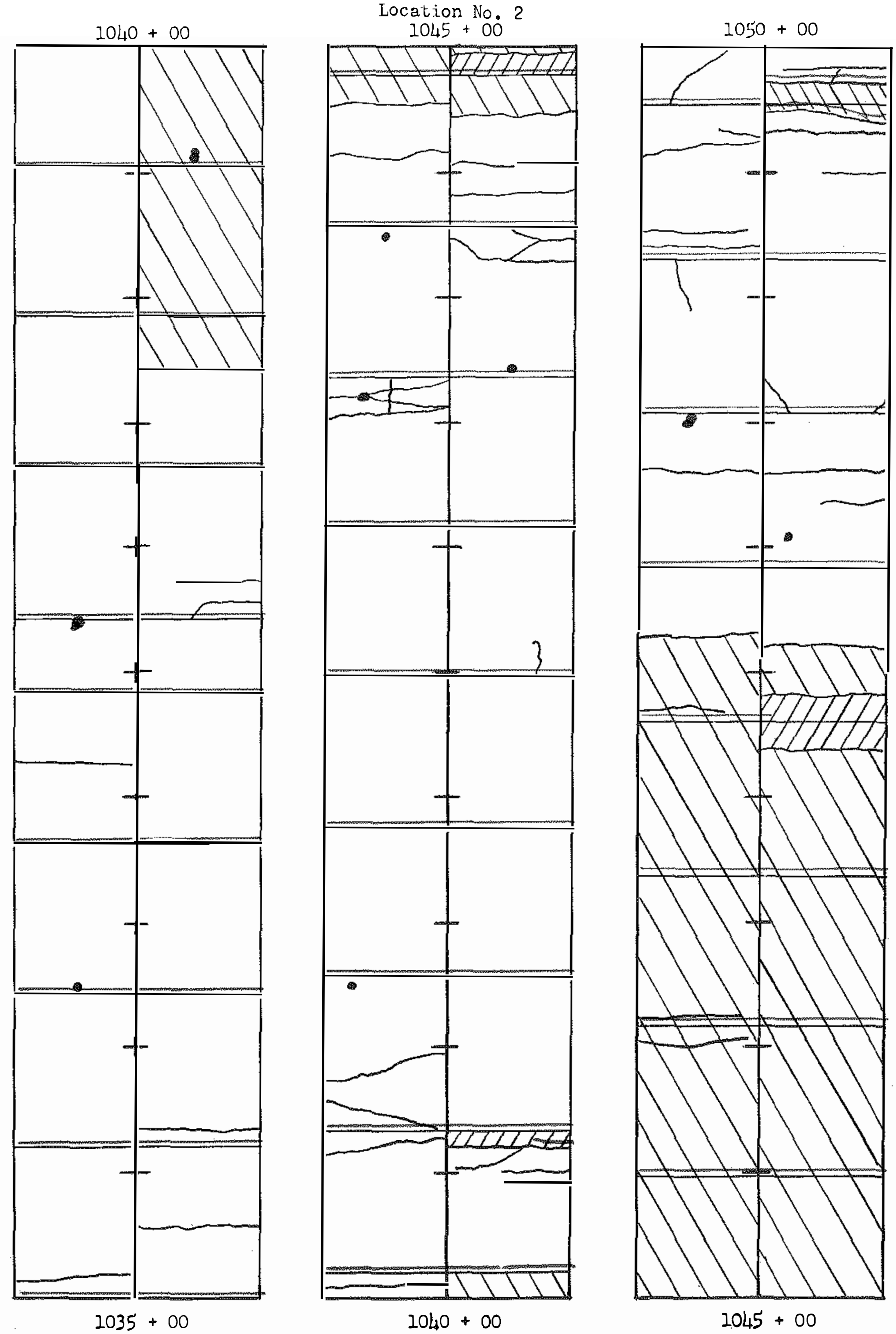

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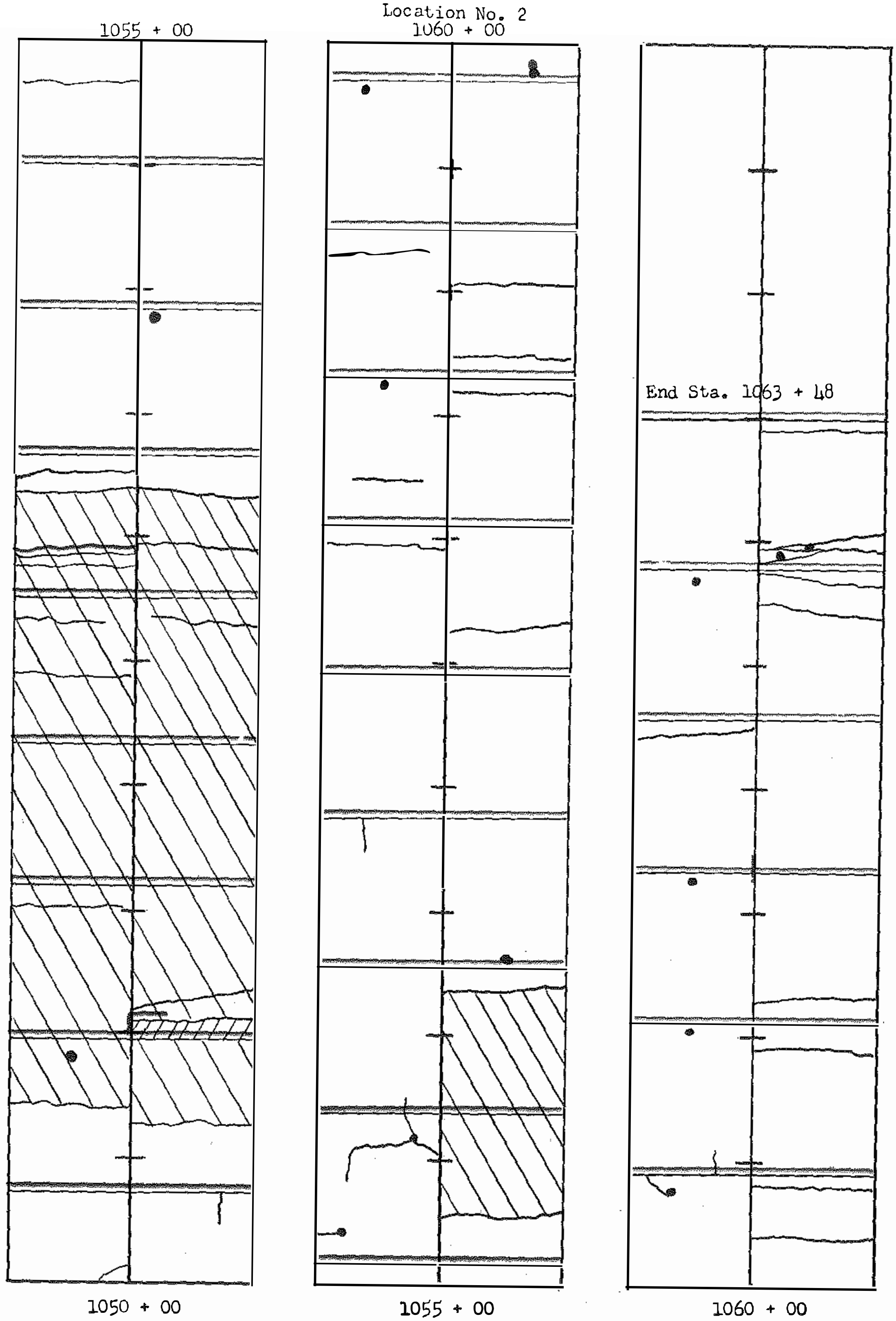

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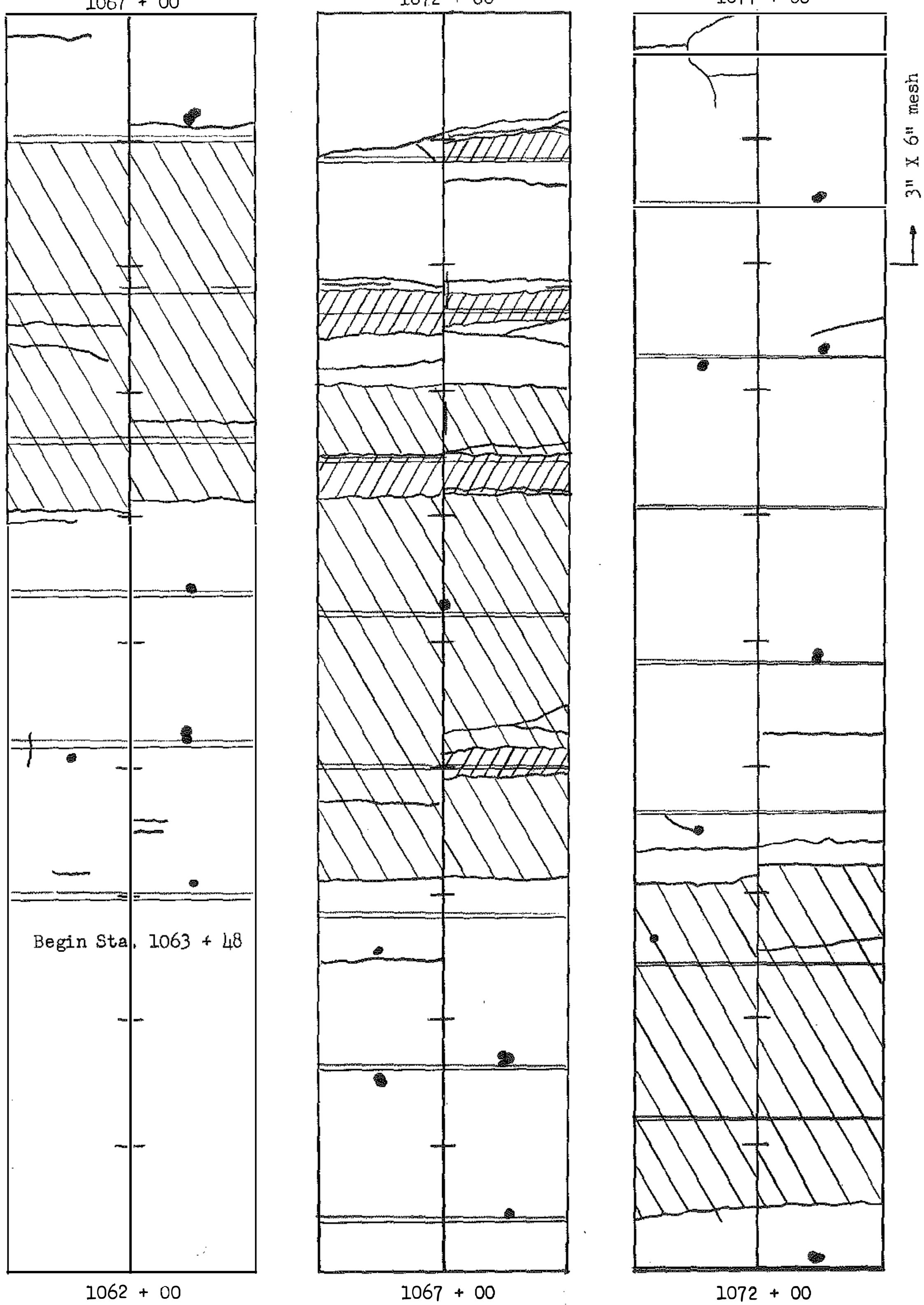

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