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Dames & Moore Job No. 10500-014-14
Salt Lake City, Utah

February 14, 1983

ADDENDUM REPORT

DETAILED SEEPAGE INVESTIGATION OF
MILL WASTE DISPOSAL ALTERNATIVES
WEST GAS HILLS, WYOMING

FOR

FEDERAL AMERICAN PARTNERS

Dames & Moore

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February 14, 1983

Federal American Partners
Gas Hills - Star Route
Riverton, WY 82501

Attention: Mr. Niles Andrus,
General Manager

Gentlemen:

This letter transmits three (3) copies of our "Addendum Report, Detailed Seepage Investigation of Mill Waste Disposal, West Gas Hills, Wyoming, For Federal American Partners."

This addendum report presents additional mathematical modelling results for sub-grade disposal Alternative IV as requested by the Wyoming Department of Environmental Quality. The requests concern time extensions to mathematical modelling analyses performed previously and sensitivity analyses of several key input parameters to the model.

It has been our pleasure to assist you on this additional investigation. Please contact us if further discussion or clarification is required.

Very truly yours,

DAMES & MOORE

Larry T. Murdock
Partner

Devraj Sharma, Manager
Advanced Technology Center

LTM/DS/pc

Attachments

TABLE OF CONTENTS

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INTRODUCTION

This brief report presents a set of additional mathematical modelling results for sub-grade disposal Alternative IV of the uranium mill tailings disposal planned by Federal American Partners (FAP) at their West Gas Hills, Wyoming facility. Previous work concerning disposal alternatives was undertaken by Dames & Moore (1981). The present study is an extension of some of that work.

The additional work was undertaken to fulfill a request by the Wyoming Department of Environmental Quality (WDEQ). This request was made in a letter from WDEQ to FAP dated November 24, 1982. The scope of work was clarified in discussions between representatives of FAP, Dames & Moore and WDEQ at the latter's offices on January 24, 1983. These discussions were followed up by a letter from Dames & Moore to WDEQ on January 27, 1983 which outlined the work scope. Confirmation of the agreed scope of additional investigations was received from the WDEQ in a letter dated February 2, 1983.

SCOPE

The scope of our additional modelling is:

1. To extend the time frame of the model results from 25 years to 250 years,
2. To evaluate the sensitivity of the model results to changes in hydraulic conductivity of the lower Wind River sandstone and to changes in assumed distribution coefficient (Kd),
3. To model a "realistic worst case" condition for the 250-year period,
4. To provide opinions regarding the affects of the Sagebrush Fault on northerly migration of tailings effluent,
5. To provide information on the use and verification of the TARGET model.

The additional modelling has been performed for Alternative IV disposal (below-grade, below the water table disposal) as described in our earlier study (Dames & Moore, 1981). The results are presented on Figures 1 through 37.

The results typically contain contours of piezometric head in steps of five feet; plotted numbers are heads above the 6,000-foot baseline elevation. The results also present contours of pH, ranging from pH=7 (the "neutral boundary), down in steps of 0.5.

The results as presented are "snapshots" of pH concentration and piezometric head at specific time instants over a period of approximately 250 years, with active disposal being from 0 to 5 years.

TIME EXTENSION

In order to extend the time frame the investigation employed parameters governing flow and transport of pH from the disposal area which are identical to those adopted during the earlier study. The only change was that the calculations were extended from 25 years to 250 years to model flow over an extended period of time. It should be noted that this case, using these original values (Kd=1.3, Hc*=10^{-5} cm/sec*), represents, in our opinion, the most realistic prediction of flow and contaminant migration. Piezometric heads for this case are presented on Figures 1 through 6 and pH levels are presented on Figures 13 through 18.

The "outer" contour of pH for all cases is for pH=7.0. This contour usually has a jagged form, caused by the plotting package only; the plotter is

*Kd = Distribution Coefficient
Hc = Hydraulic Conductivity

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attempting to interpolate over a very shallow gradient of pH, and is simply a numerical effect in this package. The contours tend to follow cell faces in the finite difference mesh. As the pH gradient increases, interpolation is numerically simpler, and smoother contours are generated.

The results of the time extension indicate that a total "equilibrium" or premining condition is not totally reached even after 250 years. However, as can be seen on Figure 6, the piezometric heads are very close to expected post-mining conditions after 250 years and little, if any, mounding of water is evident in the tailings.

SENSITIVITY TO CHANGES IN HYDRAULIC CONDUCTIVITY

As requested by the DEQ, the saturated hydraulic conductivity, (permeability) of the lower Wind River sandstone was increased ten fold from $1x10^{-5}$ cm/sec to $1x10^{-4}$ cm/sec. This represents, in our opinion, an overly conservative "worst case" value for average permeability of the entire sandstone unit. Piezometric heads for this case are presented on Figures 7 through 12; pH values are presented on Figures 19 through 24.

As expected, heads within the tailings are dissipated more rapidly with the higher permeability around the pit. pH also migrates northward more rapidly and after 250 years the most acidic value to reach the Sagebrush Fault is a pH of 4.05 as compared to a maximum pH of 6.84 for the original 10^{-5} cm/sec permeability.

SENSITIVITY TO DISTRIBUTION COEFFICIENT

The DEQ requested that the distribution coefficient (Kd) be lowered to 0 to evaluate the program sensitivity to no chemical retardation.

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This represents an extremely conservative upper bound for migration of pH because of the neutralization capacity of the natural rock materials. The results for Kd=0 are presented on Figures 31 through 36. They show that the lowest pH value to reach the Sagebrush Fault at 250 years is 2.51 and that the pH=6 contour reaches the fault in approximately 18 years.

REALISTIC WORST CASE

To simulate a "realistic worst case" condition we reduced the Kd to 0.65, or one-half of the original value. A hydraulic conductivity of $1x10^{-5}$ cm/sec was assumed. The resulting pH contours for these conditions are shown for various time periods on Figures 25 through 30. For this case the results predict a low pH value of 5.87 at the fault after 250 years and approximately 213 years would be required for th pH=6.0 contour to reach the fault.

SUMMARY OF RESULTS

The results of the modelling studies are summarized in Tables 1 through 5. Table 1 lists the parameters which were varied. Tables 2 and 3 show which Figure numbers present results for piezometric head and pH, respectively, for various combinations of Kd and permeability changes. Some interpretation of the results are presented in Tables 4 and 5. Table 4 shows the peak value of pH which arrives at the fault after the 250 year period for each parameter study. Table 5 shows the time predicted for a pH value of 6.0 to reach the fault.

SAGEBRUSH FAULT

The east-west trending Sagebrush Fault lies approximately 1,100 feet north of the center of the proposed subgrade disposal area. It is a normal fault

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with an estimated 50-foot to 100-foot displacement. The downthrown side is on the north and the fault dips at approximately 54 degrees to the north.

As mentioned in our earlier report, the fault zone, where exposed by mining operations, is "pencil thin" and has little or no gauge material. On this basis it is not expected that the fault is a significant barrier to ground water. Because the north side of the fault is downthrown, the upper Wind River materials may be in contact with the lower Wind River at the fault. Since the upper unit is generally more permeable than the lower unit the fault may act as a "water fall" in the vicinity of the fault. Water level readings tend to confirm this since they have relatively low gradients in the vicinity of the pit, drop relatively steeply as they cross the fault, then flatten again north of the fault.

It is our opinion that the fault will have little overall effect on northward migration. Although gradients are steeper in the immediate vicinity of the fault, gradients and permeabilities to the north (downgradient) are very similar to those on the south upgradient.

MODEL INFORMATION

The mathematical model called TARGET employed for the present investigations was developed, tested, validated, calibrated, and applied by Dames & Moore to a number of projects. TARGET denoting Transient Analyser or Reacting Ground Water flow and Effluent Transport is a proprietary model. It is based upon a novel integrated finite-difference method of solving the partial differential equations which govern ground water flow and chemical species transport. The method of solution is an extremely efficient one, is numerically stable at all flow speeds and has provided accurate and reliable results at a minimum of computational effort. Furthermore, it takes simultaneous account of flow and mass transport.

A computer program which embodies TARGET in two-dimensional form was employed for present purposes. This program is identical to that employed in the earlier study (Dames & Moore, 1981), where it was calibrated. Methematical details as embodied in this program were provided in the earlier report. The model has been successfully employed in over 40 other projects. Attachment 1 presents a selected list of relevant projects. In addition, a list of recent publications which describe novel applications of TARGET is also included in Attachment 2.

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REFERENCES

Dames & Moore, 1981, Report "Detailed Seepage Investigation of Pile Waste Alternatives, West Gas Hills, Wyoming", Volume 1, January 16

_____, 1983, Communication, from Dr. Devraj Sharma (Dames & Moore) to Mr. Ed Frances (WDEQ), January 27.

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TABLE 1

PARAMETER VALUES
USED IN
SENSITIVITY EVALUATION

Hydraulic Conductivity	1) 1×10^{-5} cm/sec (original value)
	2) 1×10^{-4} cm/sec
Distribution Coefficient (Kd)	1) 1.30 ml/gm (original value)
	2) 0.65 ml/gm (realistic worst case)
	3) 0.00 ml/gm (worst case)

TABLE 2

FIGURE NUMBERS FOR PIEZOMETRIC HEAD

Hydraulic Conductivity (cm/sec)	Kd (ml/gm)		
	0.0	0.65	1.30
1×10^{-5}	Figures 1 through 6	Figures 1 through 6 (realistic worst case)	Figures 1 through 6 (original case)
1×10^{-4}	---	---	Figures 7 through 12

TABLE 3

FIGURE NUMBERS FOR pH DISTRIBUTION

Hydraulic Conductivity (cm/sec)	Kd (ml/gm)		
	0.0	0.65	1.30
1×10^{-5}	Figures 31 through 36	Figures 25 through 30 (realistic worst case)	Figures 13 through 18 (original case)
1×10^{-4}	---	---	Figures 19 through 24

TABLE 4

LOWEST pH (MAXIMUM ACIDITY) TO REACH THE FAULT AT 250 YEARS

Hydraulic Conductivity (cm/sec)	Kd (ml/gm) 0.0	0.65	1.30
1×10^{-5}	pH 2.51	pH 5.87 (realistic worst case)	pH 6.84 (original case)
1×10^{-4}	---	---	pH 4.05

TABLE 5

TIME TAKEN FOR pH 6.0 TO REACH THE FAULT

Hydraulic Conductivity (cm/sec)	Kd (ml/gm) 0.0	0.65	1.30
1×10^{-5}	18 years	213 years (realistic worst case)	>250 years (original case)
1×10^{-4}	---	---	88 years

BRIEF DESCRIPTIONS OF RECENT GROUND WATER MODELLING PROJECTS

Approximate Date	Owner	Project	Location
Winter, 1978	Alumina Partners of Jamaica	Estimation of ground water pollution resulting from red mud disposal in an open pit.	St. Elizabeth, Jamaica
Spring, 1979	Confidential Client	Modelling of the impacts upon ground water quality of the below-water table disposal of mine wastes.	Texas
Spring, 1979	Utility Fuels, Inc.	Evaluation of the effectiveness of various dewatering schemes in three interconnected aquifers.	Jenkins Project Uranium Mine, Wyoming
Summer, 1979	TUGCO	Analyses of the impact upon ground water quality of the postulated accidental rupture of a holding tank.	—
Fall, 1979	Nuclear Regulatory	Review and evaluation of models for the transport of radionuclides through shallow land burial grounds by means of surface and ground water.	--
Winter, 1980	Confidential Client	Analyses of various containment schemes for the exclusion and clean-up of contaminated ground water.	--
Spring, 1980	Exxon/Crandon	Modelling of the transport of reacting chemicals from a simulated tailings pond, both in the unsaturated and saturated ground water zones.	Crandon, Wisconsin
Summer, 1980	U.S.S. Agri-Chemical	Analyses of steady-state ground water seepage through several gypsum tailings dam designs.	Florida

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BRIEF DESCRIPTIONS OF RECENT GROUND WATER MODELLING PROJECTS (Continued)

Approximate Date	Owner	Project	Location
Summer, 1980	Exxon	Analysis of the water inflow rates and final water levels to be expected in and around an abandoned open-pit uranium mine.	Wyoming
Summer, 1980	Cyprus Minerals	Analyses of various dewatering options for an open-pit mine in a confined leaky aquifer.	Freemont County, Colorado
Fall, 1980	Federal Partners of America	Analysis of the transient seepage flow and chemical species transport through saturated and unsaturated soil adjacent to a uranium tailings pond and evaporation pond, for various disposal and liner design options.	Wyoming
Winter, 1980	Exxon Research & Engineering	Assessment of state-of-the-art in uranium tailings management, including disposal alternatives, seepage potential, and effectiveness of seepage control measures.	Not applicable
Spring, 1981	Unknown	Analysis of ground water seepage and chemical transport from uranium tailings disposal trenches into the adjoining unsaturated soil.	Southwest United States
Spring, 1981	Rossing Uranium	Developement of data management programs for the analyses of ground water and geochemical monitoring programs.	Namibia, Africa
Spring, 1981	Estech General Chemicals	Prediction of the rates at which a phosphate strip would be dewatered by means of two different gravity drain systems.	Florida

BRIEF DESCRIPTIONS OF RECENT GROUND WATER MODELLING PROJECTS (Continued)

Approximate Date	Owner	Project	Location
Spring, 1981	International Coal Refining Co.	Mathematical modelling of the transport of various chemical species from the metal sludge landfill at the Solvent-Refined Coal-1 Demonstration Plant. The transport of arsenic and selenium through saturated and unsaturated soils toward the Green River was predicted for various liner and leachate collection options.	Newman, Kentucky
Summer, 1981	Confidential Client	Analysis of the transport of reacting chemical species in the ground water resulting from miscellaneous spills and leakages into and above a shallow aquifer.	Colorado
Summer, 1981	Exxon/Troup	Application of models to assess the effectiveness of proposed dewatering and depressurization schemes for two aquifers adjacent to a large open-pit mine.	Texas
Fall, 1981	Electric Power Research Institute	D&M was subcontracted by Acurex Corporation to undertake part of a NO_x control technology assessment. The work involved modelling the migration of contaminants through the ground water from lined and unlined ash and sludge ponds, and modelling the contamination of surface water which results from overflow of ash settling ponds.	Nationwide

BRIEF DESCRIPTIONS OF RECENT GROUND WATER MODELLING PROJECTS (Concluded)

Approximate Date	Owner	Project	Location
Spring, 1982	Confidential Client	Impact assessment of laterite ore tailings disposal operations on the ground water quality and flow patterns. The transport of heavy metals through the variably-saturated underlying soil and rock, to the unconfined fractured rock aquifer below, and from this aquifer to nearby rivers was predicted.	United States
Summer, 1982	Debra Project	Evaluation, through mathematical modelling analyses, of various irrigation schemes for the disposal of secondary-treated sewage. Both saturated and unsaturated modelling analyses were carried out in order to determine optimum application rates.	Florida
Summer, 1982	Department of Energy/ Sandia Laboratories	Mathematical modelling investigation of the effectiveness of various encapsulation schemes for a large, abandoned tailings pile near Salt Lake City. Several ground water seepage mitigation measures were analyzed, and the migration and attenuation of radium-226 was predicted in each case.	Salt Lake City, Utah
Summer, 1982	ALCOA - Australia	Analysis of ground-water contamination from an alumina red mud holding pond. This study was concerned with the flow of a high density fluid from the pond and with its subsequent mixing with the ground water. True density coupling was accounted for.	Western Australia

BRIEF DESCRIPTIONS OF RECENT GROUND-WATER MODELLING PROJECTS (Continued)

Approximate Date	Owner	Project	Location
Fall, 1982	Peabody Coal Company	Assessment of impacts of withdrawing large quantities of water (3000-3600 gpm for 35 years) from a 5400 square mile ground-water basin. Evapotranspiration, leakage from an overlying aquifer, municipal and mine pumpage, discharge into springs and streams, and recharge onto outcrops from snowmelt and rainfall were considered. Drawdowns on a regional scale, as well as drawdowns at individual wells, were analyzed.	Western United States
Winter, 1982	Confidential Client	Analysis of transport by the ground water of a volatile organic chemical. The chemical was accidently spilled on the ground surface. Clean-up procedures will be recommended as a result of the on-going modelling and field studies.	Eastern United States
Winter, 1982	Brevard County/ Stottler-Stagg Associates	An investigation was carried out to determine the optimum design, capacity and water-quality impacts of a set of proposed percolation ponds. The first phase of calculations included predicting the interaction of the pond geometries and operating scenarios. Secondly, water-quality predictions were undertaken for the optimum design and various anticipated loading rates, over a period of	Merit Island, Florida

ATTACHMENT 2

ADVANCED TECHNOLOGY CENTER
LIST OF RECENT PUBLICATIONS

1. +Asgian, M.I. (1977)
"The Analytic Solutions of Two Ground Water Flow Problems." M.S. Thesis, University of Minnesota, Minneapolis, August.

2. Asgian, M.I. (1977)
"Line Sources." Internal report - Department of Civil and Mineral Engineering, University of Minnesota, Minneapolis. Prepared under Contract DAC-77-C-0040, U.S. Army Corps of Engineers, Nashville District, October.

3. Asgian, M.I., (1980)
"Earthquake Source Modelling - A Review." Dames & Moore ATG Technical note TN-LN-50.

4. Asgian, M.I., D. Dirmikis, and G. Hocking (1978)
A Mathematical Model for Transient Heat Conduction." Dames & Moore Technical Note TN-LN-20. 5.

5. Asgian, M.I. and P. Mandelbaum (1979)
"Displacement Discontinuity Method for Stress Analyses of Underground Excavations." Dames & Moore ATG Technical Note TN-LN-53.

6. Avery, A.F., S.D. Lympany (1975)
"Target Accuracies and Sensitivity Studies in the Assessment of Data Requirements for Practical Shield Design."

7. Evans, J.W., S.D. Lympany (1982)
"An Improved Mathematical Model for Melt Flow in Induction Furnaces and Comparison with Experimental Data." Submitted to Metallurgical Transactions, May 1982.

8. Evans, J.W., S.D. Lympany, and D. Sharma (1981)
"A Mathematical Model of the Hall-Heroult Cell and Calculations for Some Improved Cell Designs." Presented 2nd Work Congress Chemical Engineering, Montreal, Canada, October 4-9.

9. Evans, J.W., Y. Zundelevich, and D.Sharma (1981)
"A Mathematical Model for Prediction of Currents, Magnetic Fields, Melt Velocities, Melt Topography and Current Efficiency in Hall-Heroult Cells." Published in Metallurgical Transactions Bulletin.

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"Magnetic Fields, Current Densities, Melt Velocities and Current Efficiencies in Hall-Heroult Cells - Computations and Comparisons with Measurements." Report LBL-8519, Lawrence Berkeley Laboratory, University of California, Berkeley, California, 25 pp.

+Dames & Moore authors are underlined.

September 1982

11. Hamilton, J.L. (1978)
"Computer Runs Using Trust: A Computer Program Modelling Saturated-Unsaturated Flow in Deformable Porous Media." Dames & Moore ATG Technical Note TN-DN-15.

12. Hamilton, J.L. and O.I. Oztunali (1980)
"Comparative Evaluation of Radionuclide Transport Models." Inter-Agency Workshop on Modelling and Low-Level Waste-Management, Denver, Colorado, December 1-4.

13. Hamilton, J.L. and D. Sharma (1978)
"A User's Guide to Trust: A Computer Program Modelling Saturated-Unsaturated Flow in Deformable Porous Media." Dames & Moore ATG Technical Note TN-DN-16.

14. Hopkirk, R., S.D. Lympany, J. Marti (1980)
"Three Dimensional Numerical Predictions of Impact Effects." BNES Symposium, March 12, 1980. Published by the Institute of Civil Engineers.

15. Hopkirk, R.J., D. Sharma, and P-J. Pralong (1979)
"Coupled Convective and Conductive Heat Transfer in the Analysis of Hot Dry Rock Geothermal Systems." Paper presented at Conference of Numerical Analyses of Thermal Problems, Swansea, Wales, July 2-6, 39 pp. Also Chapter 13 in "Numerical Methods in Heat Transfer" published by John Wiley (1981).

16. Kappus, U. and D. Sharma (1982)
"Water Conservation Opportunities in Spent Shale Management." Presented ASCE Special Conference on Water and Energy, Fort Collins, Colorado, June 27.

17. Lympany, S.D., (1974)
"The Calculation of Neutron Leakage Spectra and Some Group Flux Sensitivities in a 40 cm Diameter Iron Sphere with a Cf 252 Source in the Centre." UKAEA internal publication.

18. Lympany, S.D., J.W. Evans (1982)
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"Contribution to the Exercise on Sensitivity Studies for the NEA Theoretical Fast Reactor Benchmark." Shielding Conference, Vienna Oct. 11-16, 1976.

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"Computer Modelling of Jointed Rock Masses." Prepared for Defense Nuclear Agency, Washington, D.C., Technical Report N-78-4.

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"Calculation of the Secondary Flow of the Second Kind through a Fully Elliptic Procedure." 1981 AFOSR-HTTM-STANFORD Conference on Complex Turbulent Flows, Stanford, California, September 14-20.

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"Ground Motion in the Epicentral Region of the May 6, 1978 Friuli Earthquake in North Italy." Proceedings of the Seventh World Conference on Earthquake Engineering, Istanbul, Turkey, September.

24. Pralong, P-J., D. Sharma, and R.J. Hopkirk (1981)
"Predictions of Heat Distributions from a Fire in a Complex Building." Presented at the International Conference on Numerical Methods in Thermal Problems, Venice, Italy, July 7-10.

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26. Robl, R.F., W. Haupin, and Sharma, D. (1977)
"Current Efficiency in Hall-Heroult Aluminum Smelters Including Hydrodynamic Parameters." Presented at TMS-AIME Annual Conference, Atlanta, March.

27. Sinclair, T.J.E., M.I. Asgian, and R.D. Boyd (1979)
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"Applications of an Efficient Computational Procedure for the Prediction of Momentum, Heat and Mass Transfers in Variably Saturated Porous Media." Invited paper, Impact of Richards Equation: AGU Semi-centennial Session, San Francisco, California, December 7-11.

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"Fluid Dynamics and Mass Transfer in Variably-Saturated Porous Media: Formulation and Application of a Mathematical Model." Invited paper, presented Symposium Unsaturated Flow and Mass Transport, Battelle-NRC, Seattle, Washington, March 23-24.

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32. Sharma, D. and J.L. Hamilton (1978) "A Numerical Procedure for Solving the Three-Dimensional Diffusion/Conduction Equation in Solid Media." Dames & Moore ATG Technical Note TN-LN-7.

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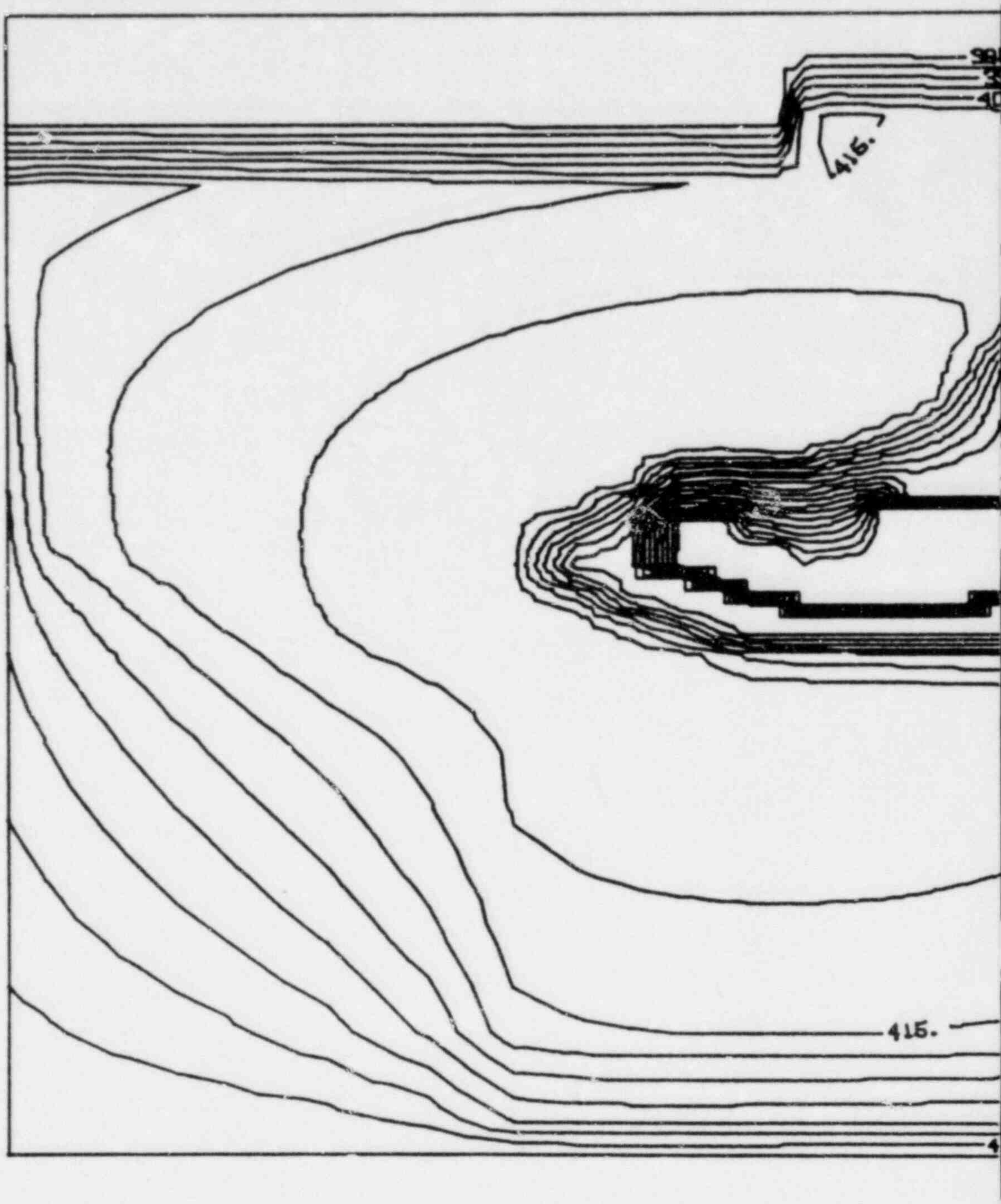

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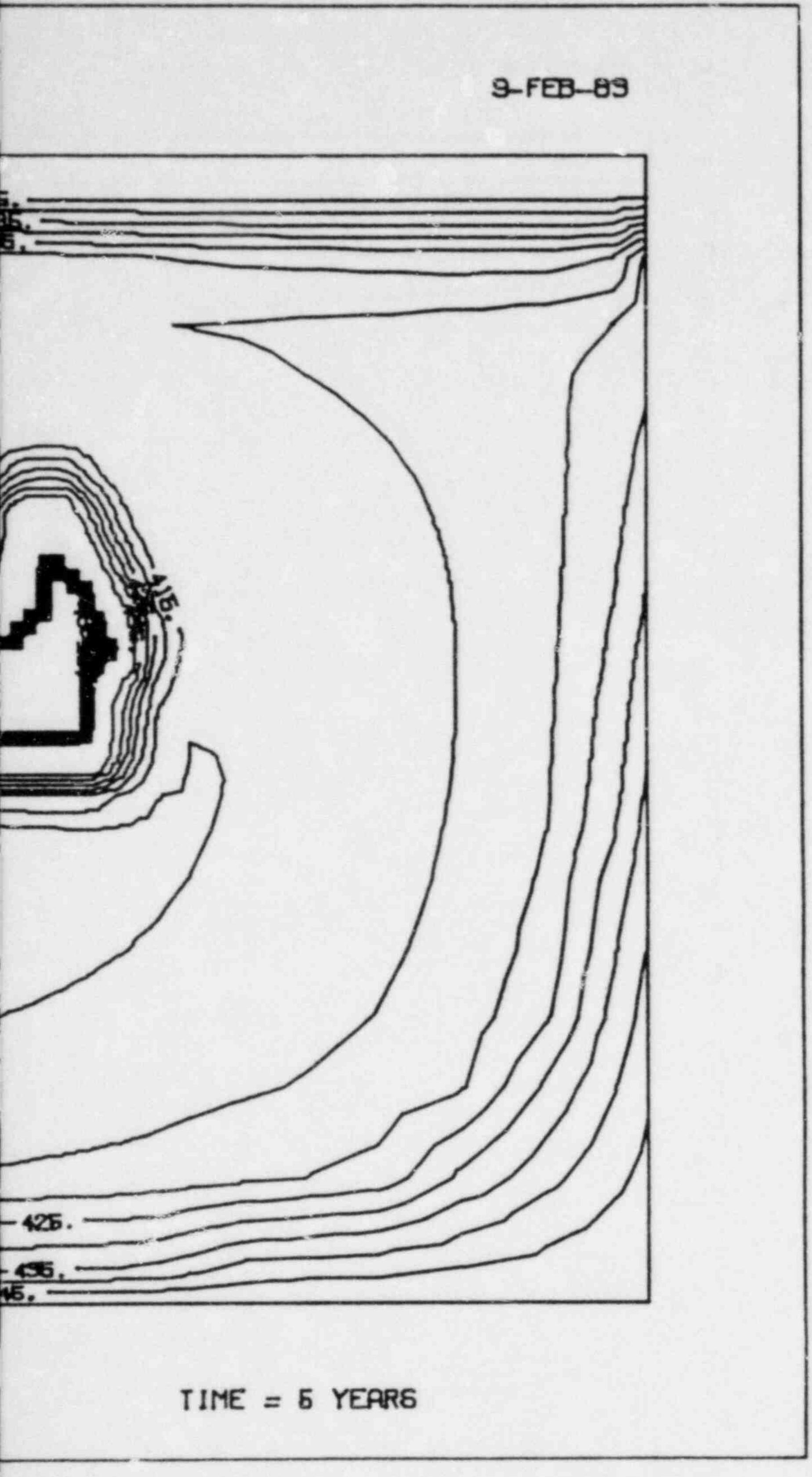

PIEZOMETRIC HEAD

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FIGURE 1

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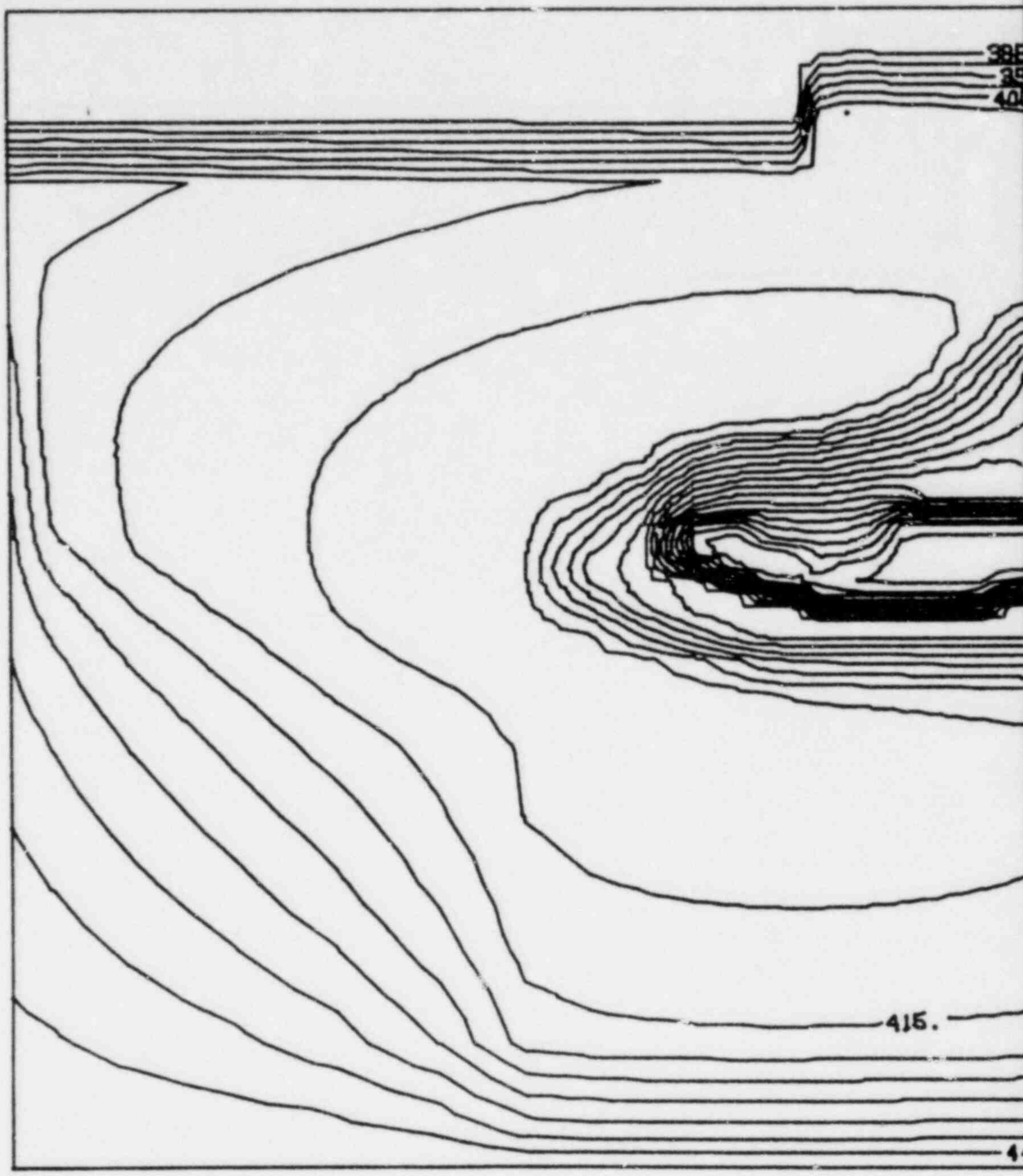

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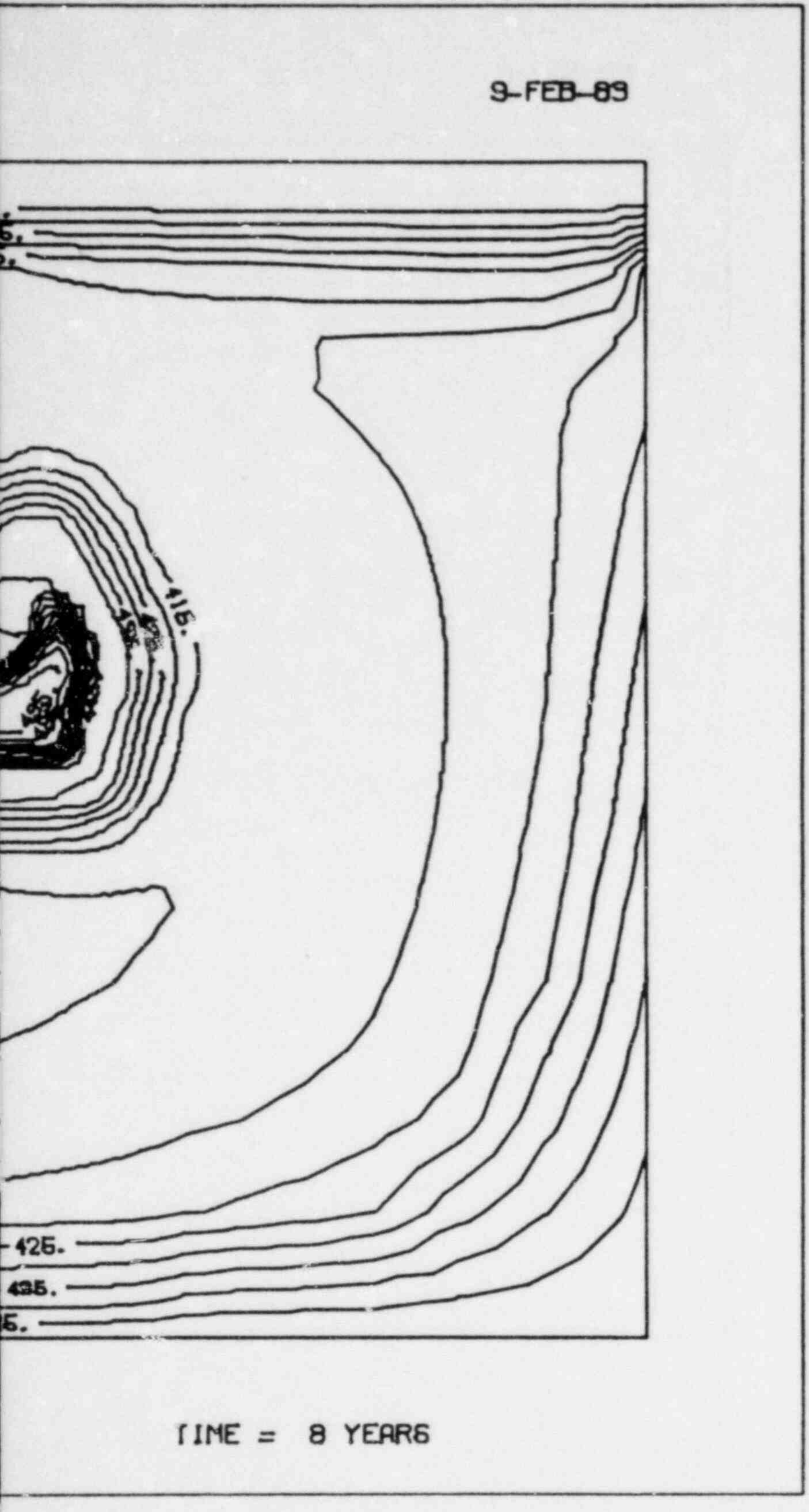

PIEZOMETRIC HEAD

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FIGURE 2

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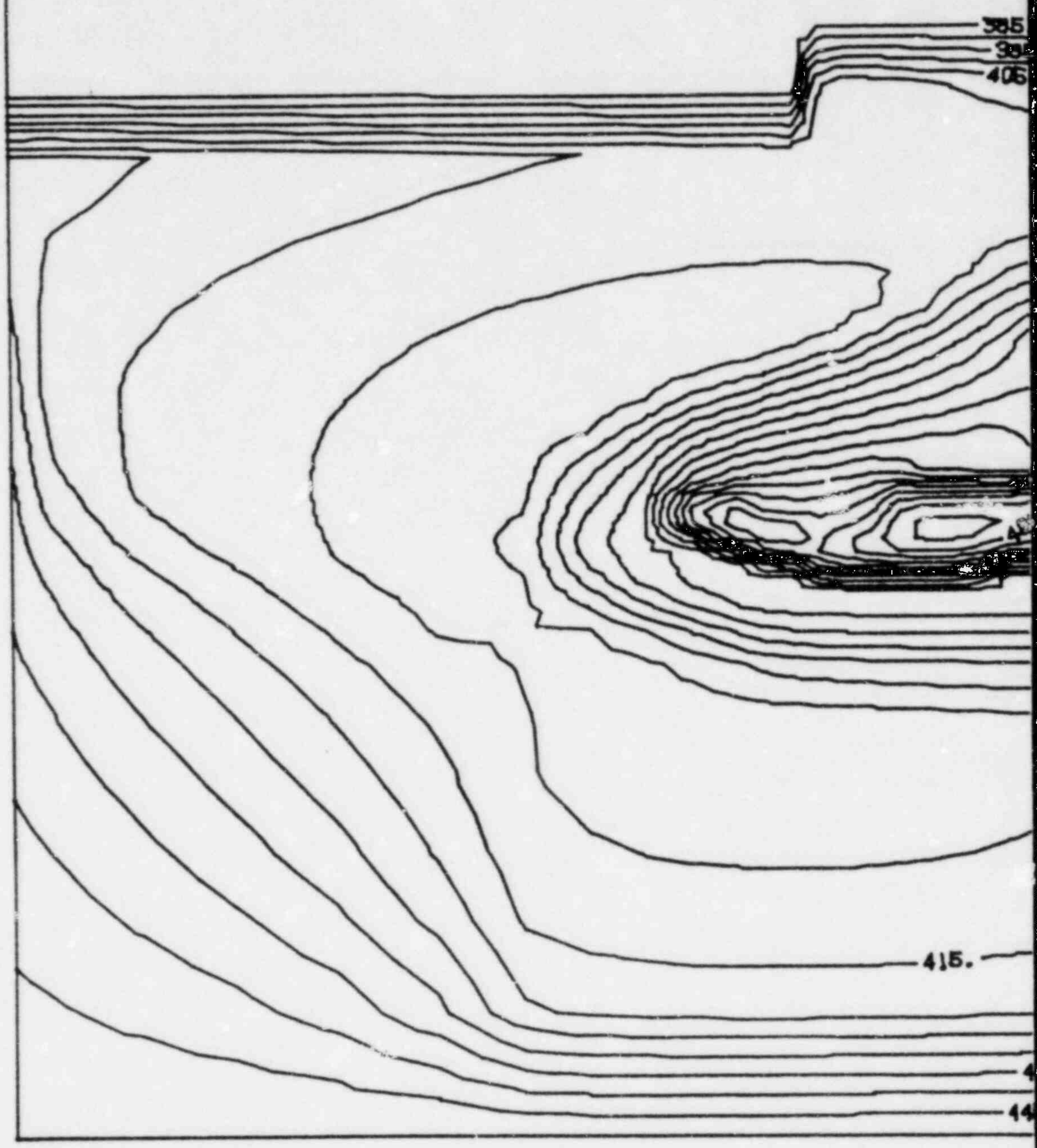

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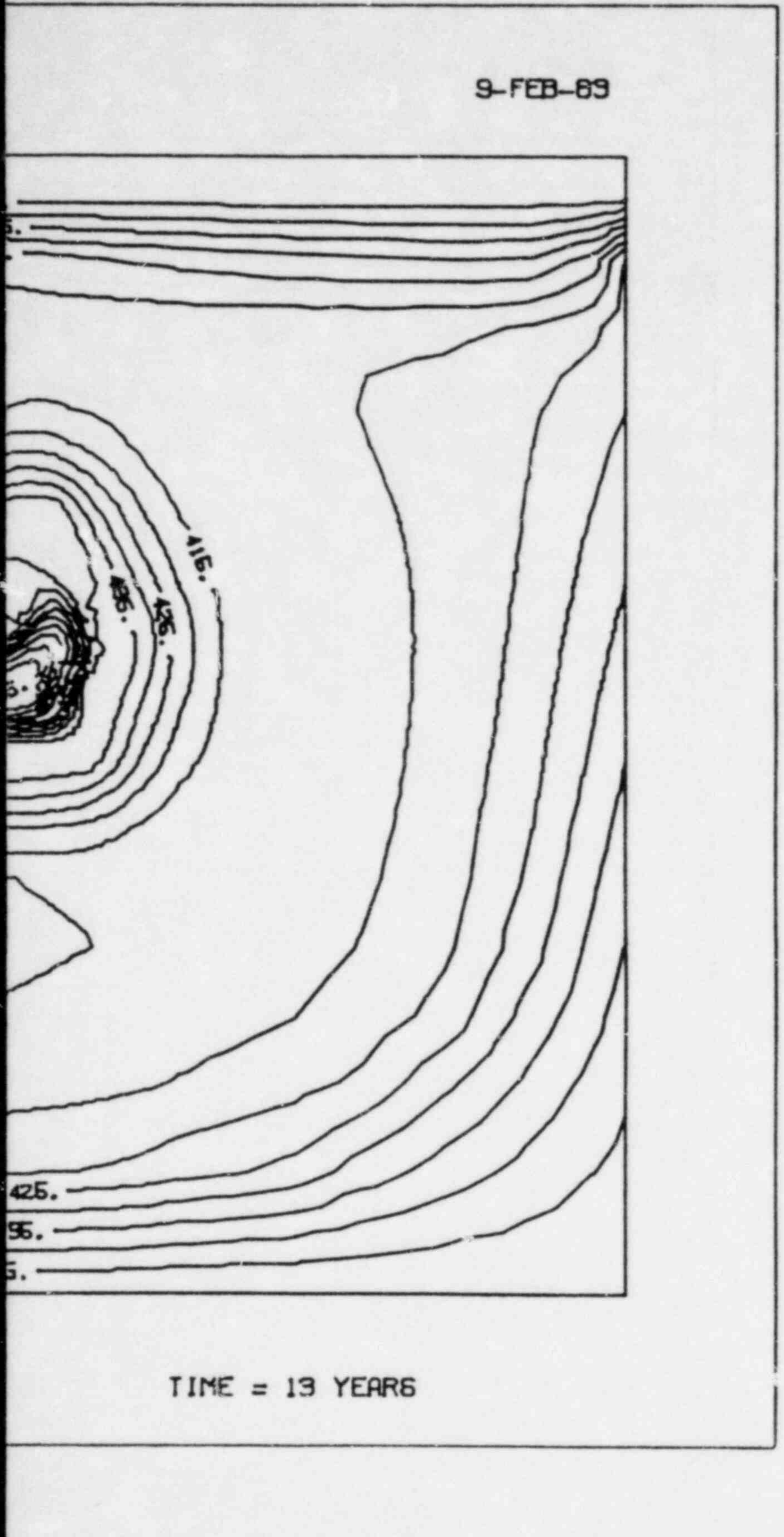

PIEZOMETRIC HEAD

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FIGURE 3

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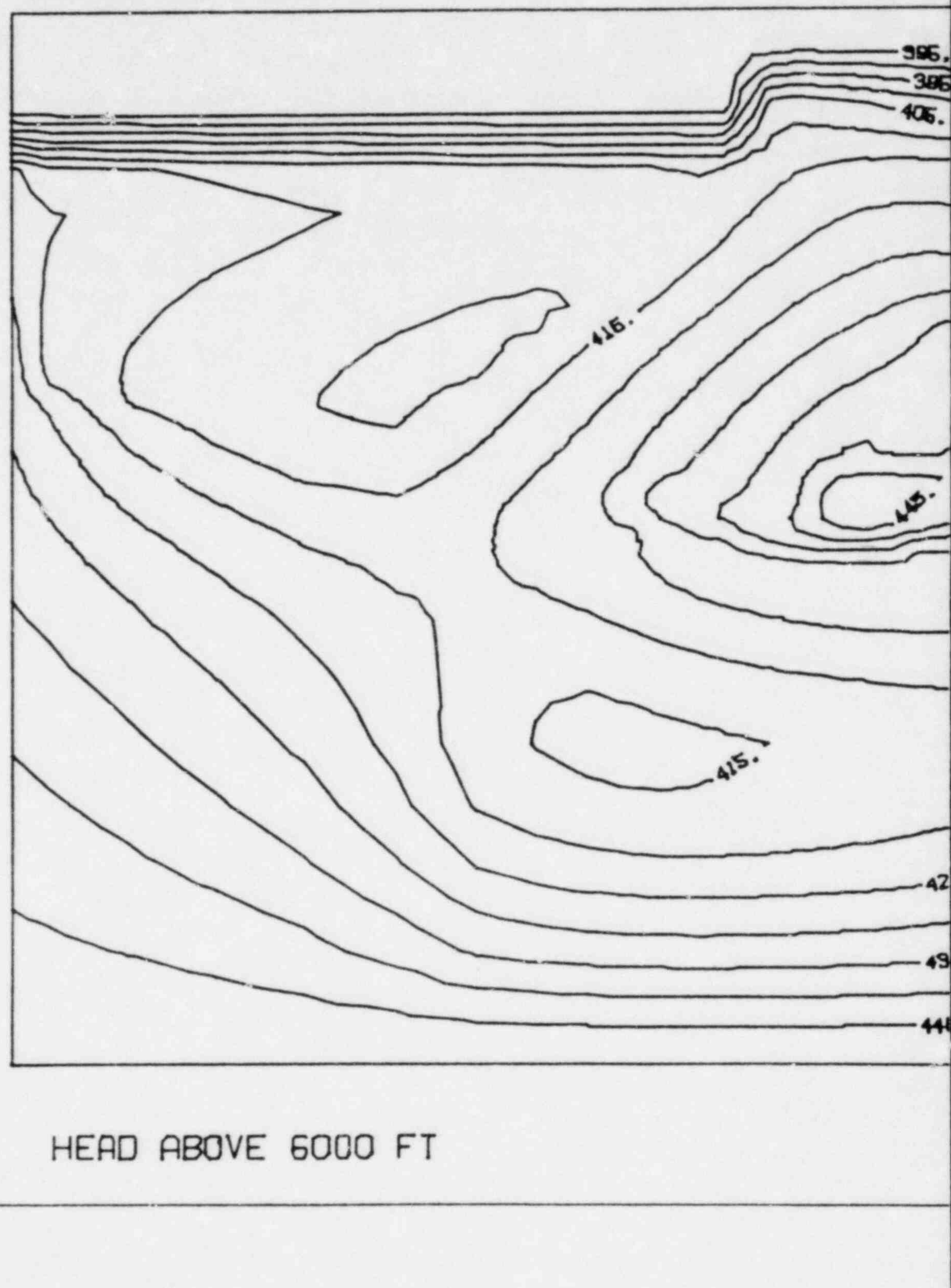

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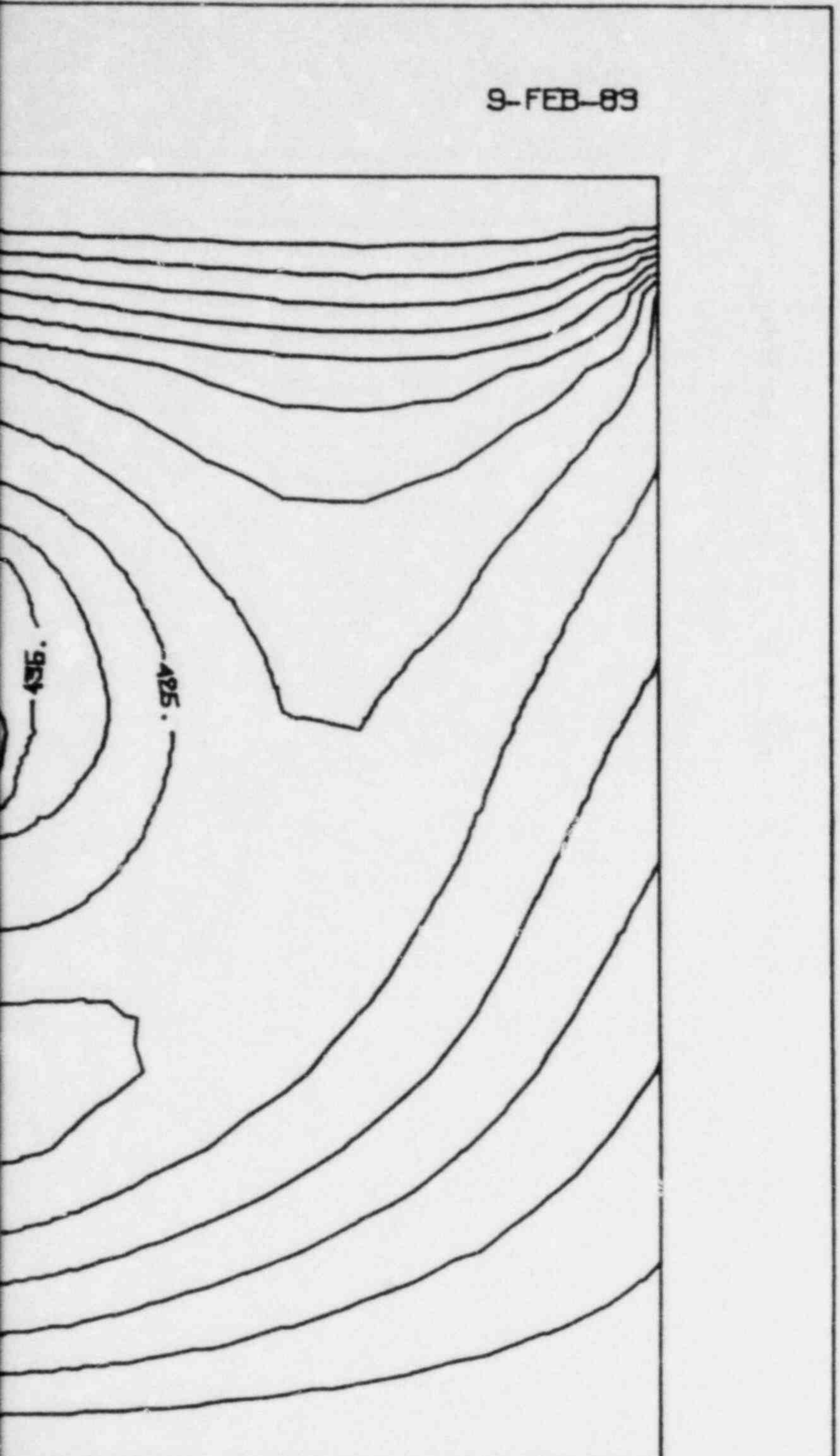

PIEZOMETRIC HEAD

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FIGURE 4

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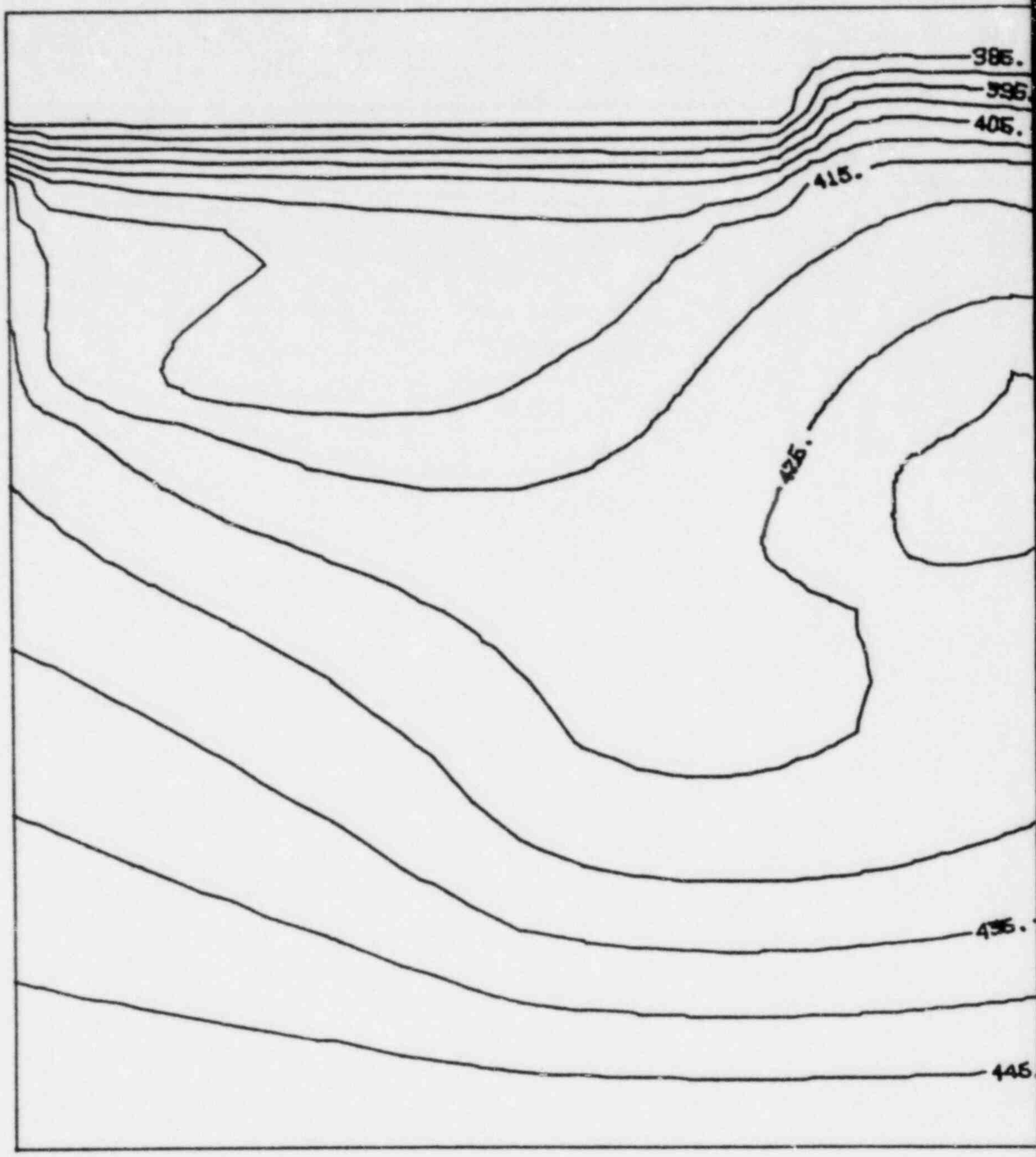
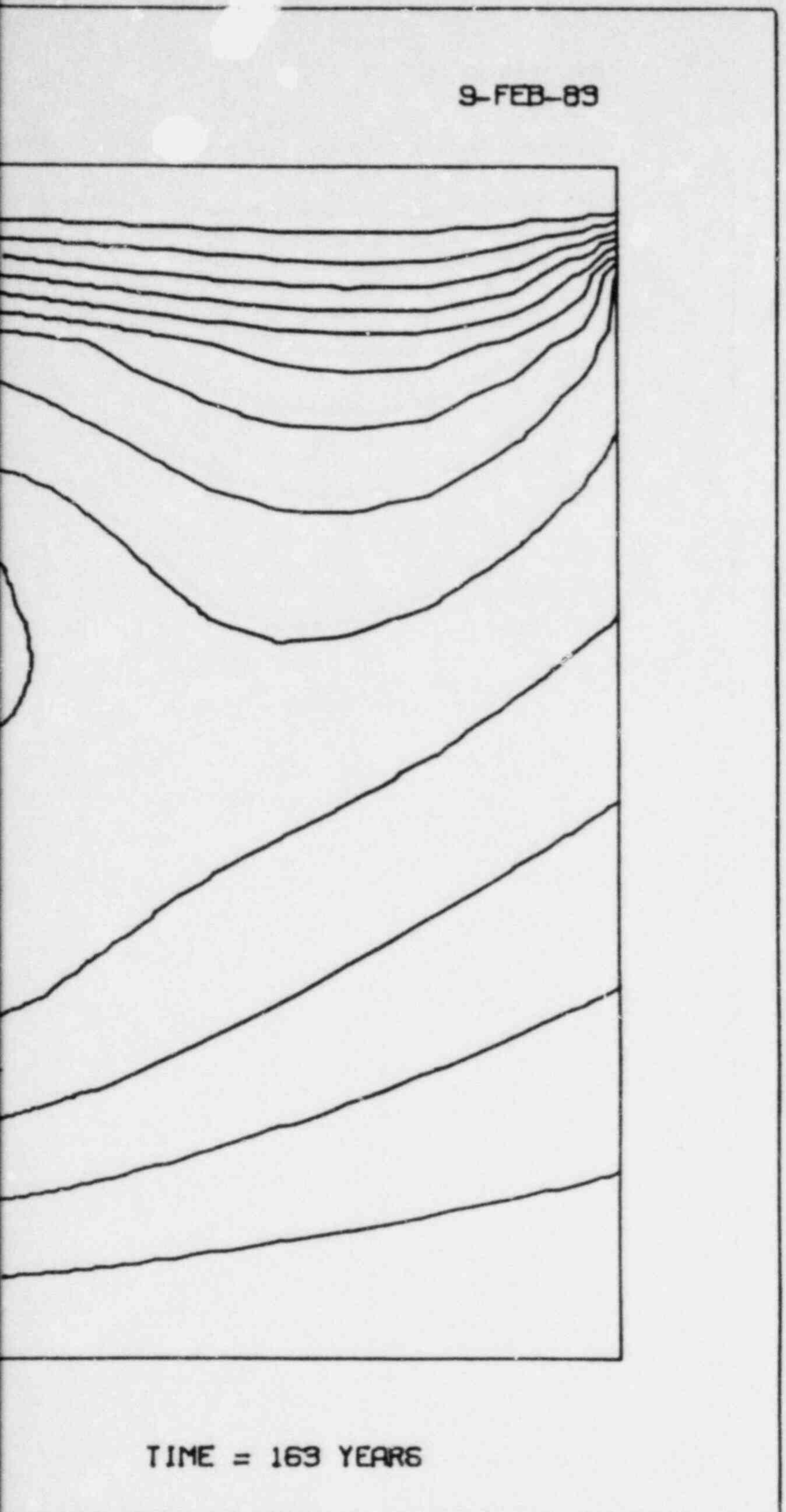


HEAD ABOVE 6000 FT

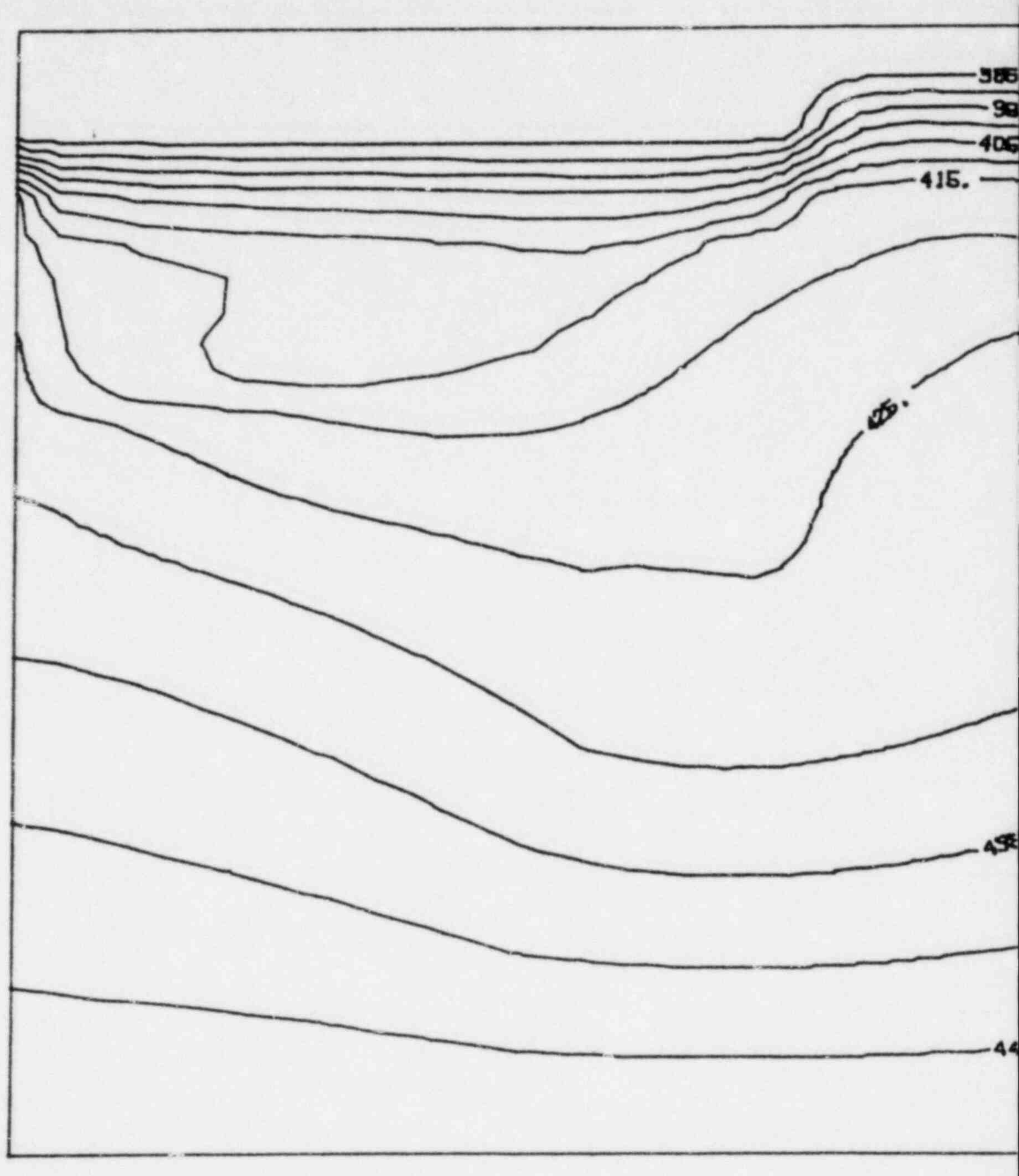


PIEZOMETRIC HEAD

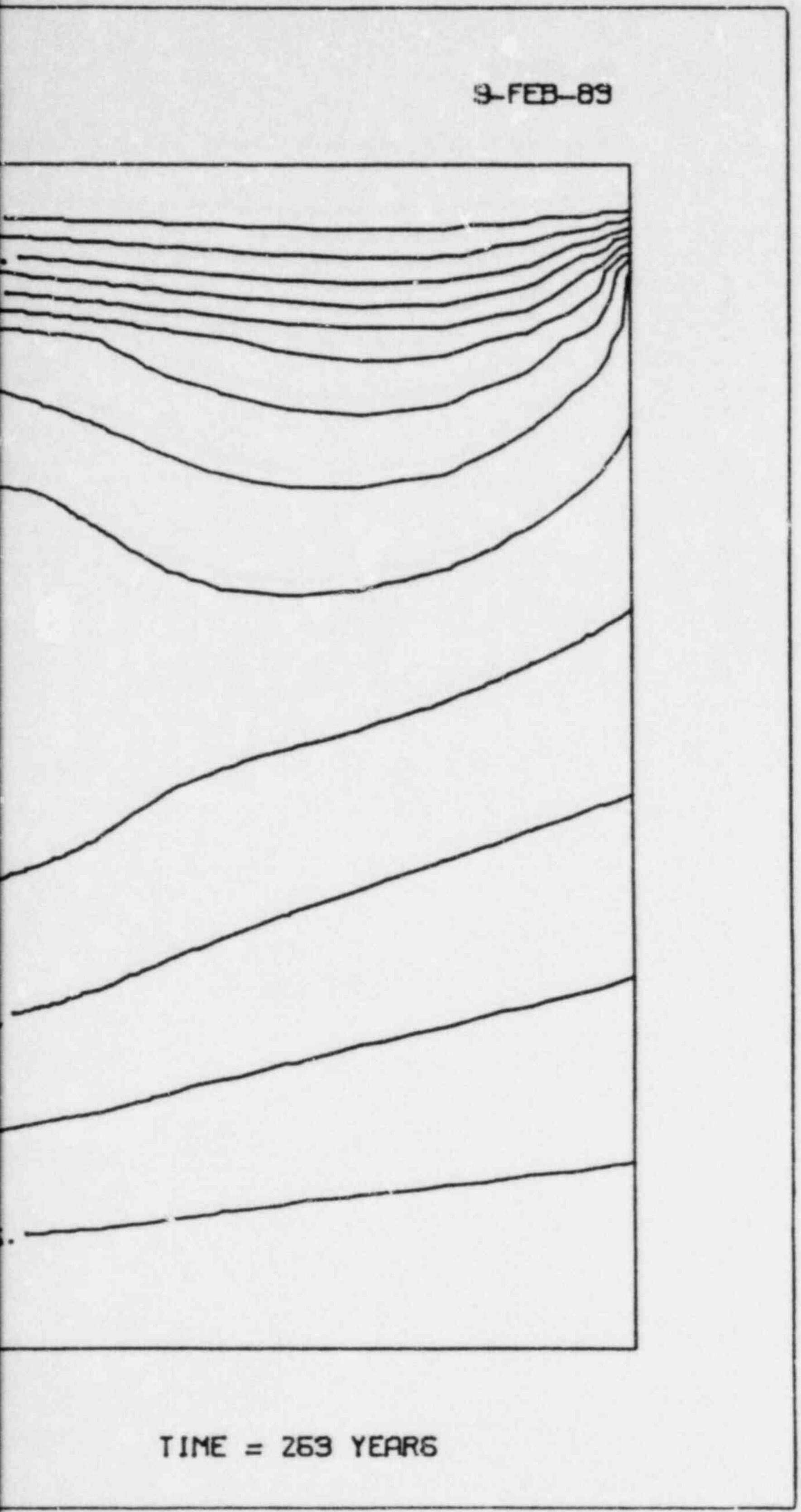
DAMES & MOORE

FIGURE 5

CONTOUR INTERVAL = 5.



HEAD ABOVE 6000 FT

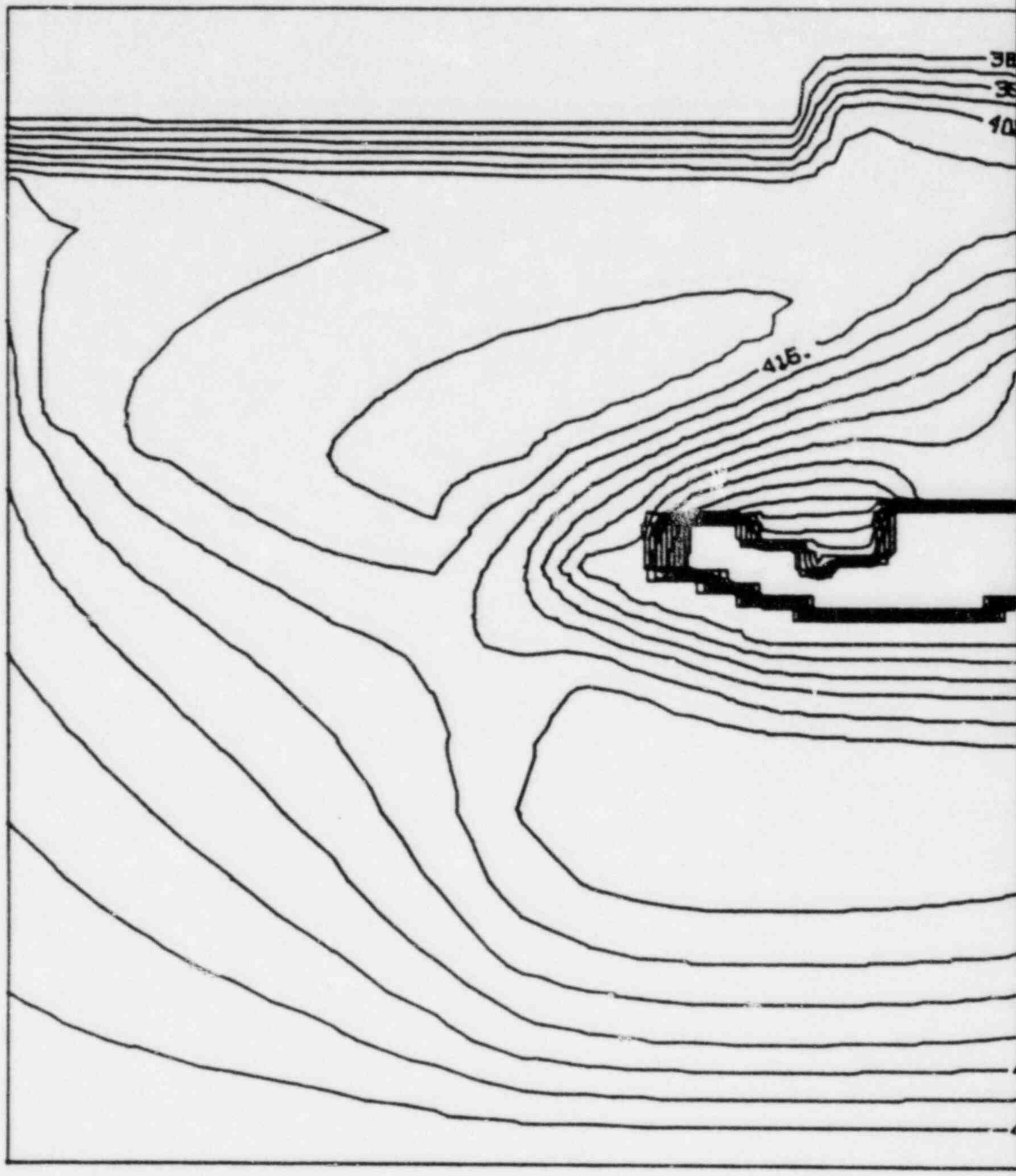


PIEZOMETRIC HEAD

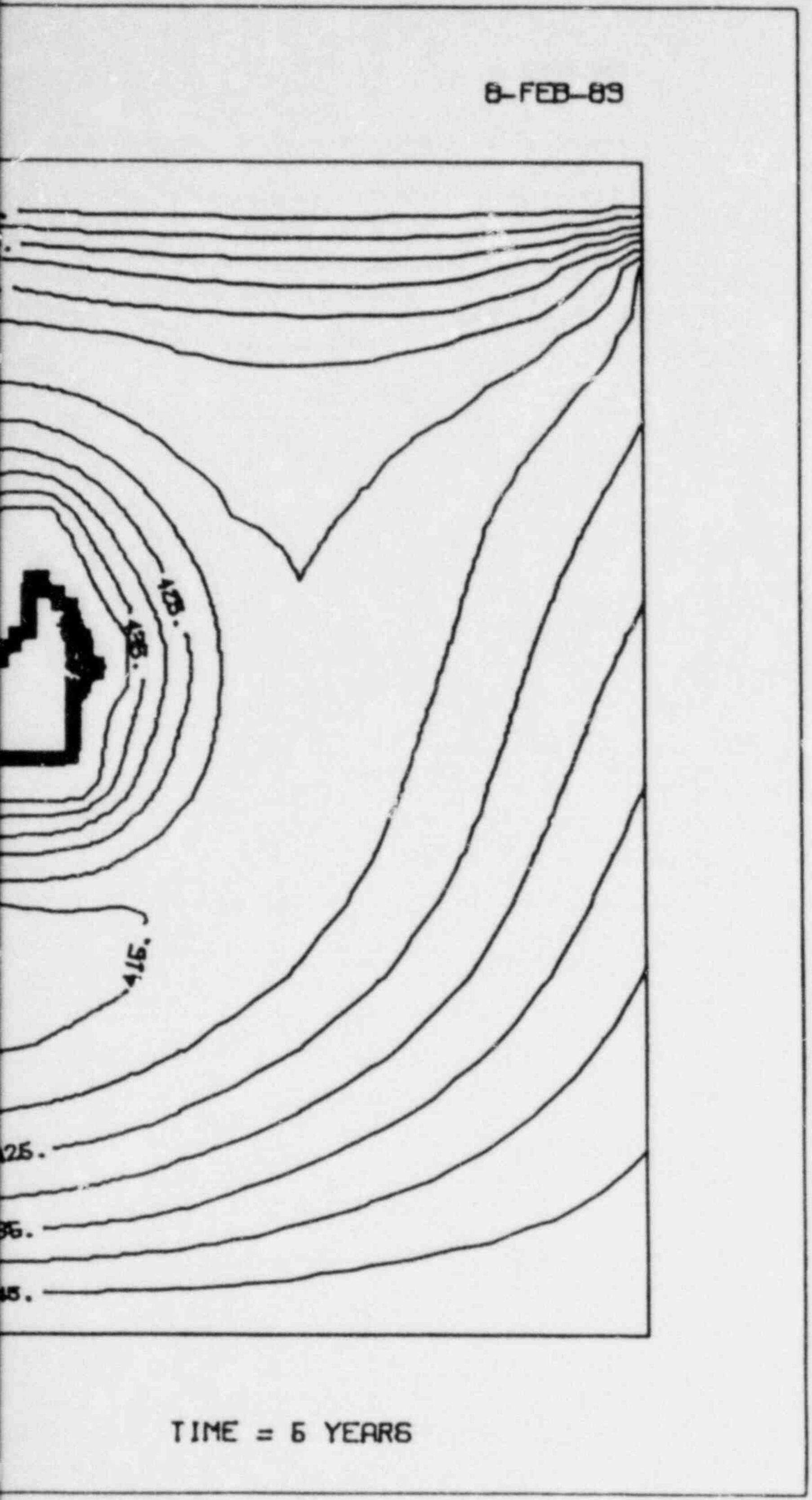
DAMES & MOORE

FIGURE 6

CONTOUR INTERVAL = 5.

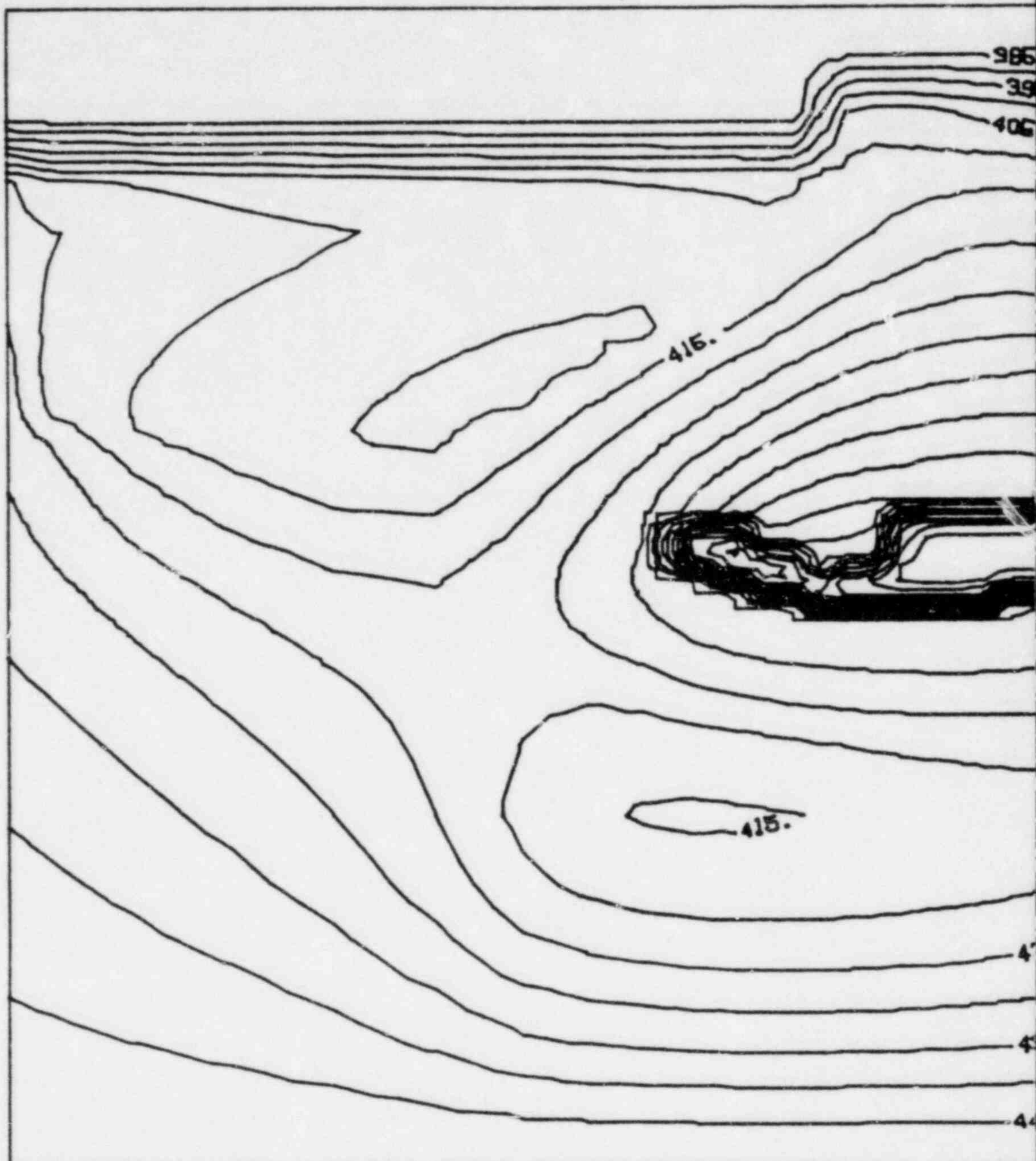


HEAD ABOVE 6000 FT

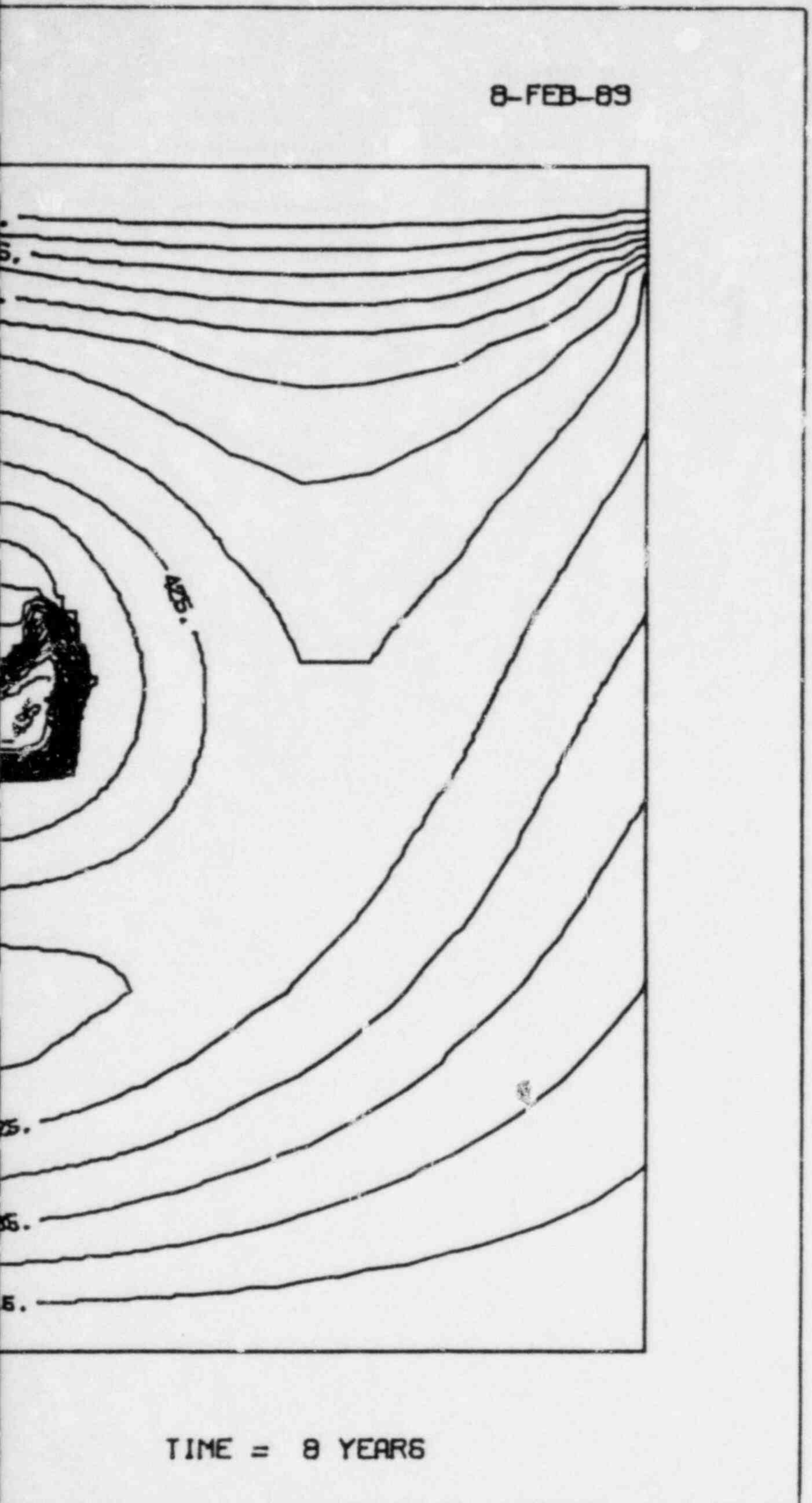


PIEZOMETRIC HEAD

CONTOUR INTERVAL = 5.



HEAD ABOVE 6000 FT

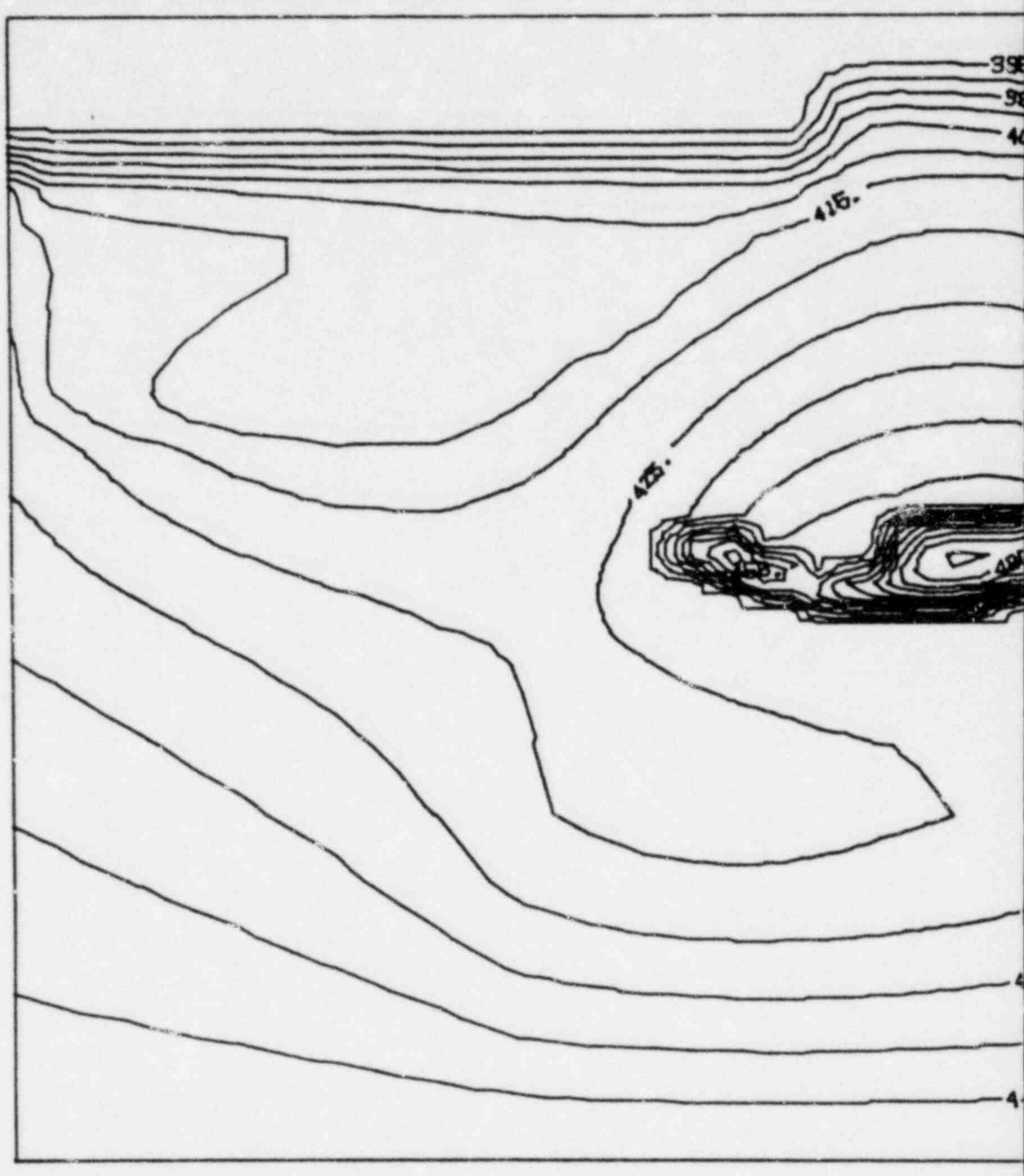


HEAD FOR
HIGH CONDUCTIVITY

DAMES & MOORE

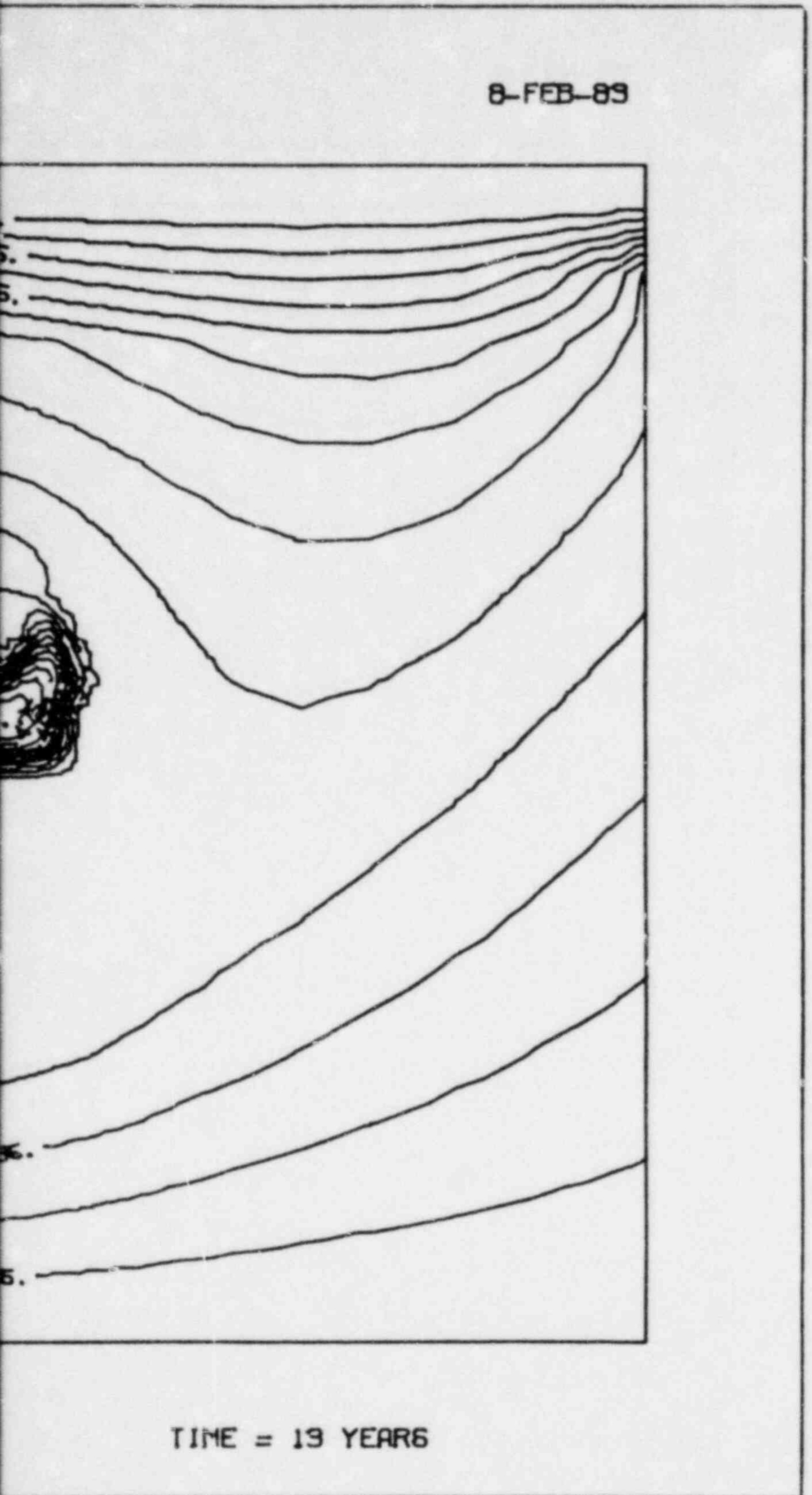
FIGURE 6

CONTOUR INTERVAL = 5.



HEAD ABOVE 6000 FT

466 . 12 (4-64)

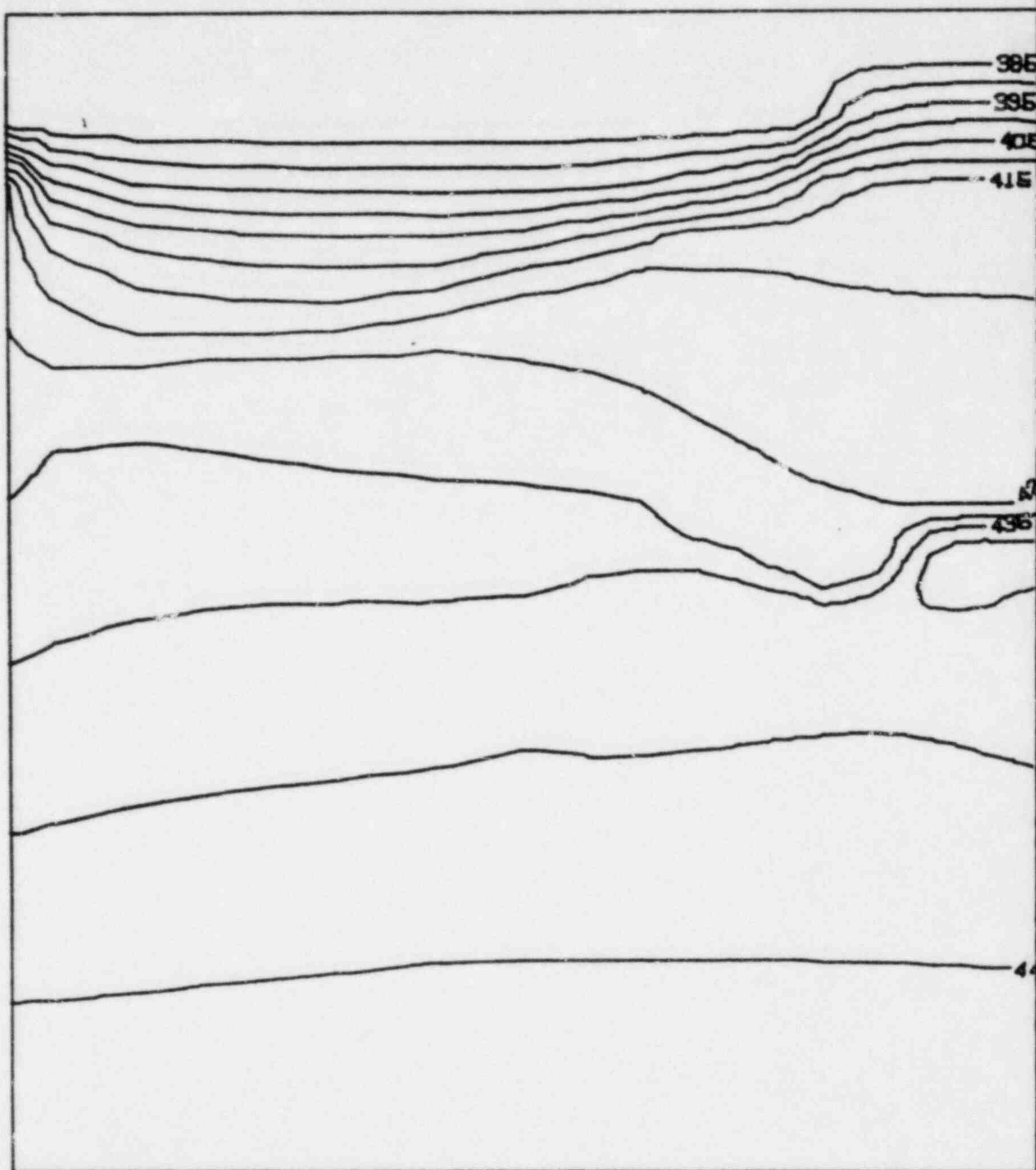


HEAD FOR
HIGH CONDUCTIVITY

DAMES & MOORE

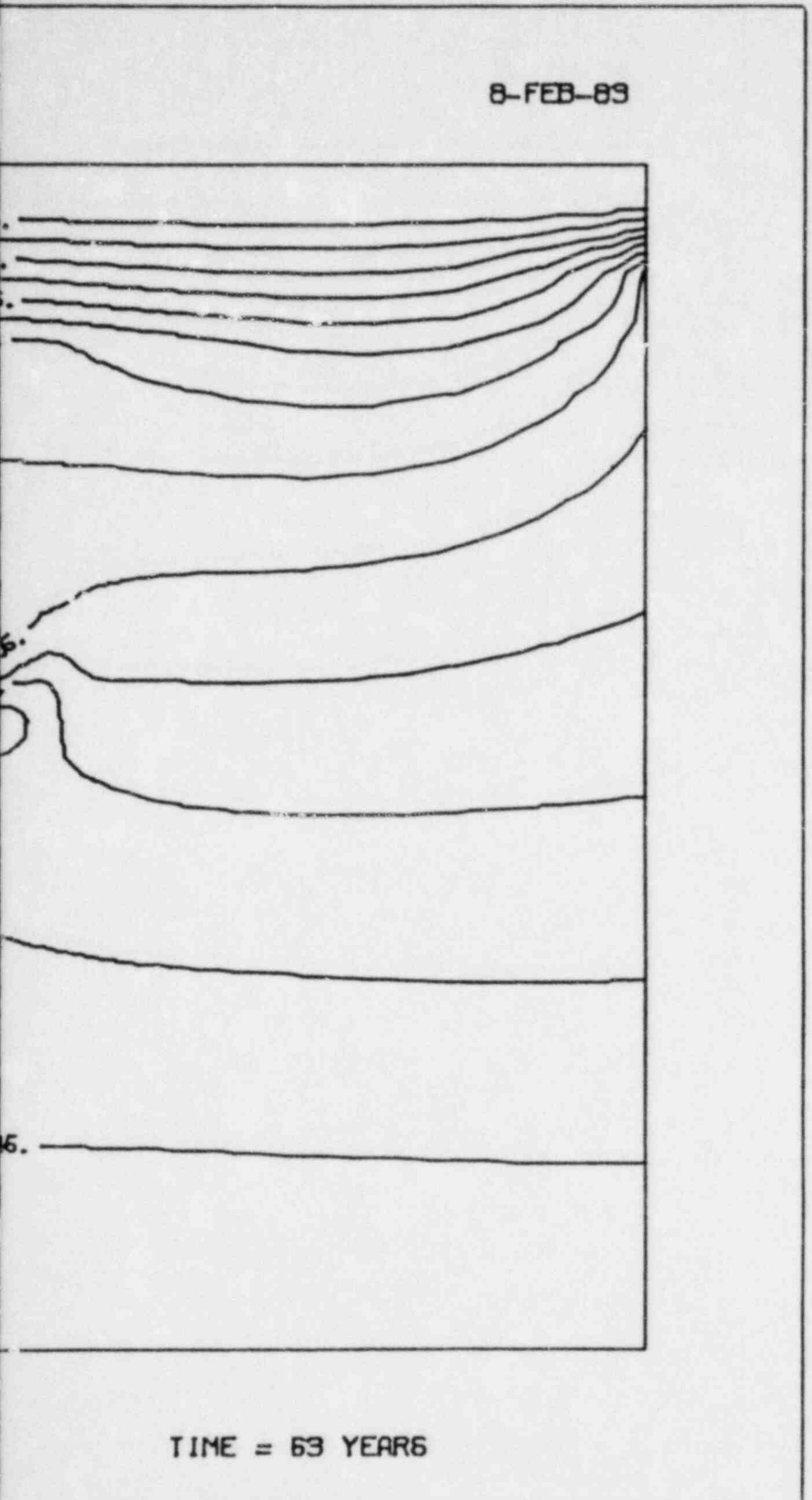
FIGURE 9

CONTOUR INTERVAL = 5.



HEAD ABOVE 6000 FT

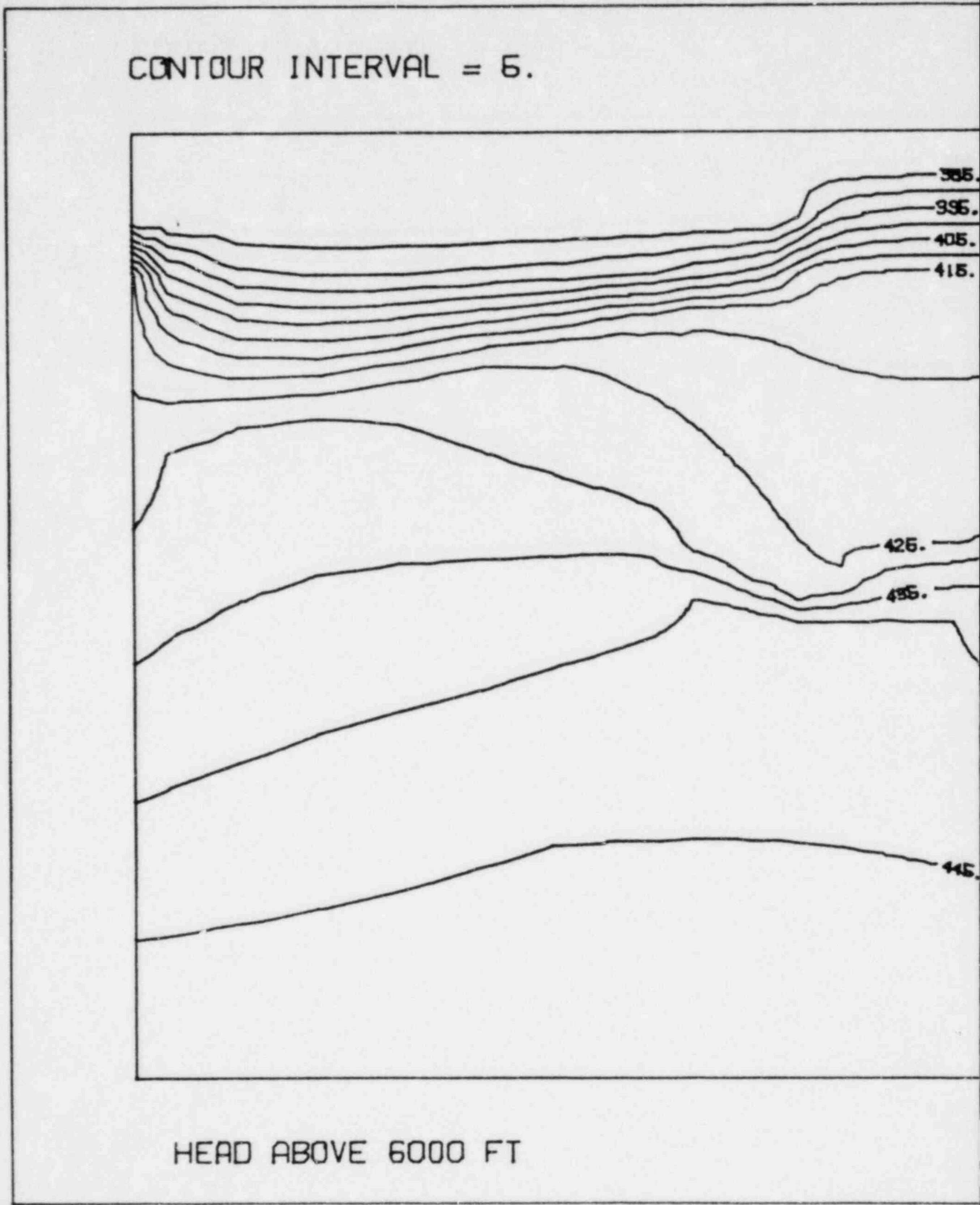
466 12 (4-64)

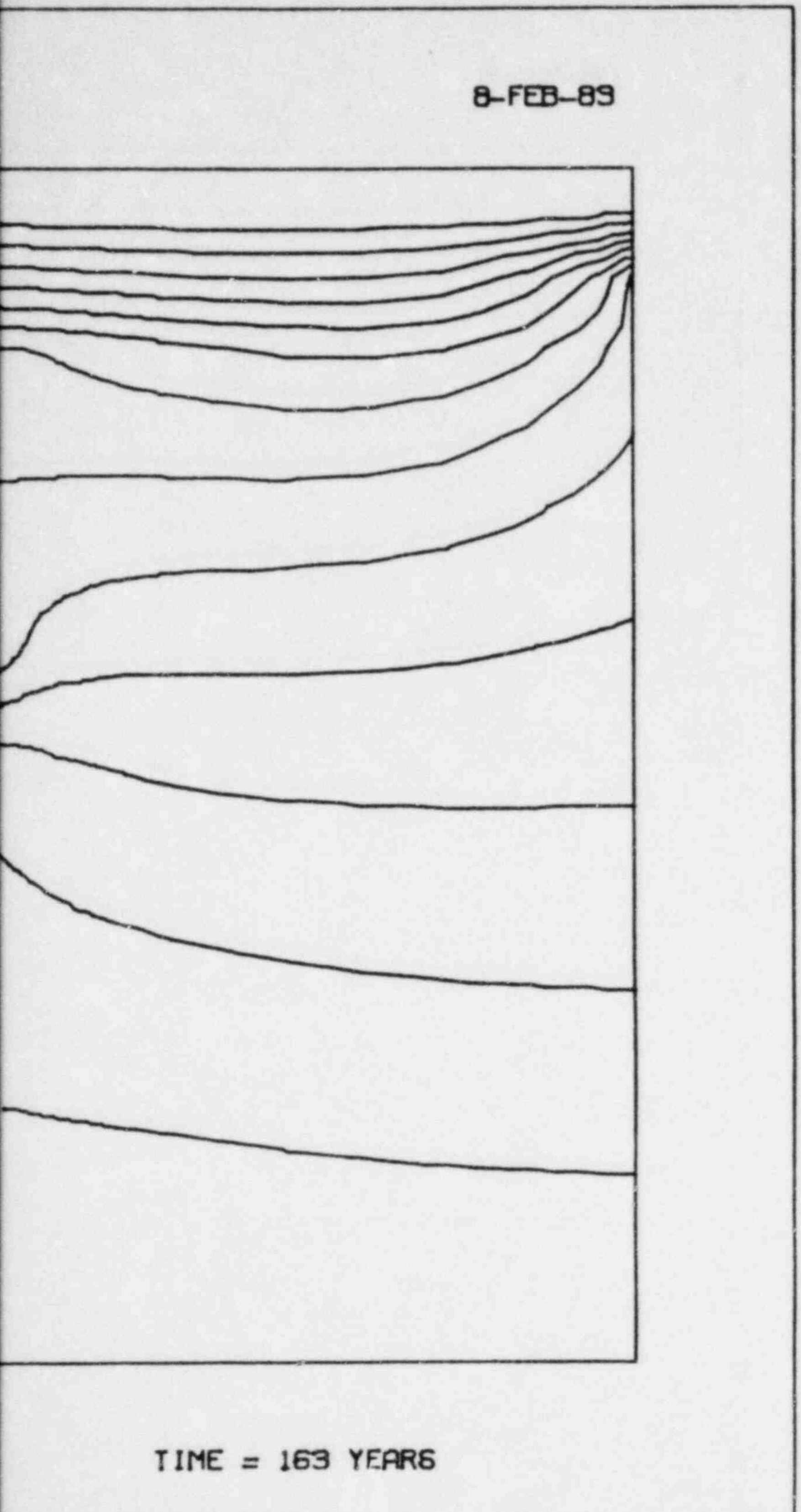


HEAD FOR
HIGH CONDUCTIVITY

DAMES & MOORE

FIGURE 10


CONTOUR INTERVAL = 5.
385.
395.
405.
415.
425.
435.
445.
HEAD ABOVE 6000 FT

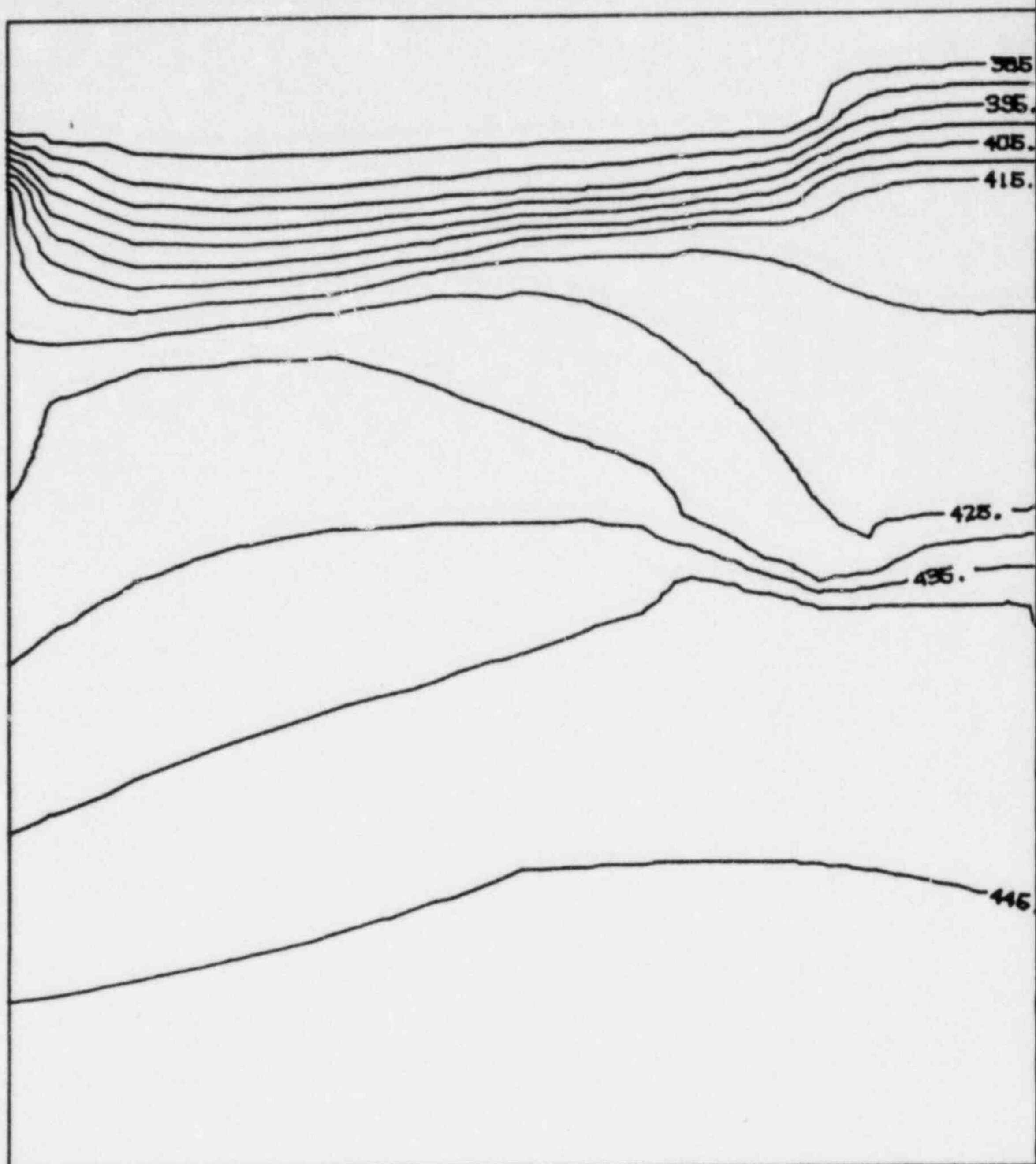


HEAD FOR
HIGH CONDUCTIVITY

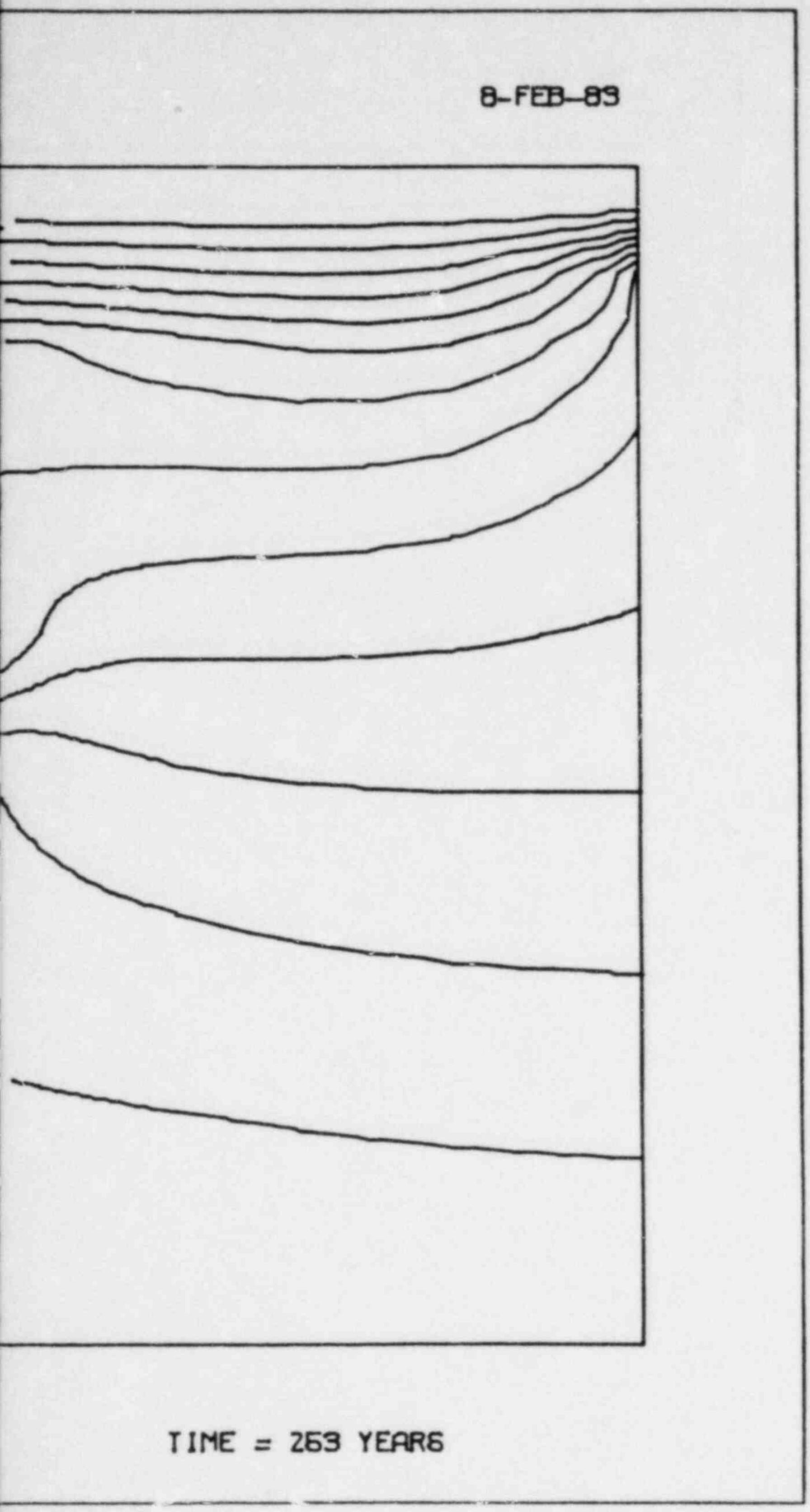
DAMES & MOORE

FIGURE 11

CONTOUR INTERVAL = 5.



HEAD ABOVE 6000 FT

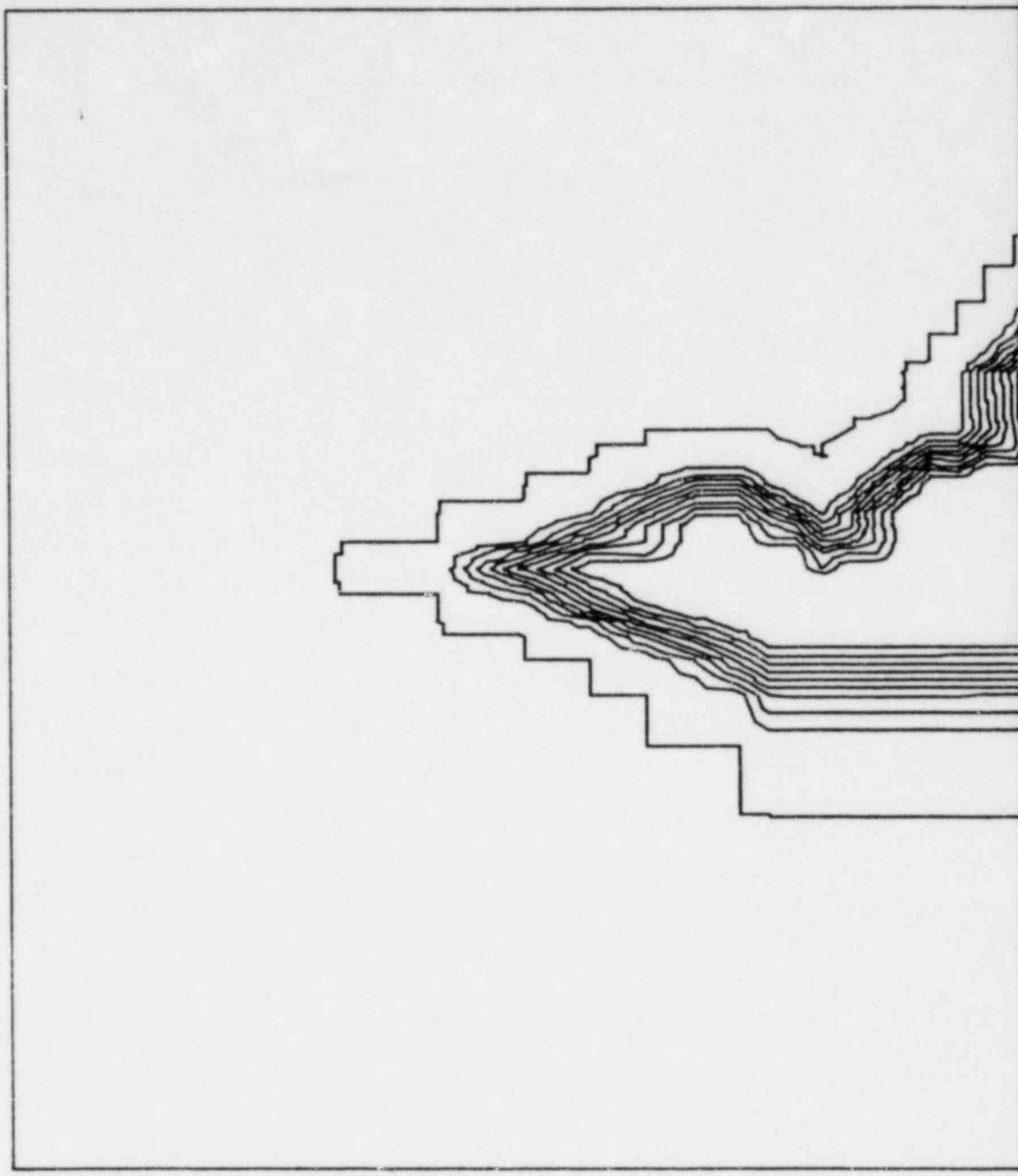


HEAD FOR
HIGH CONDUCTIVITY

DAMES & MOORE

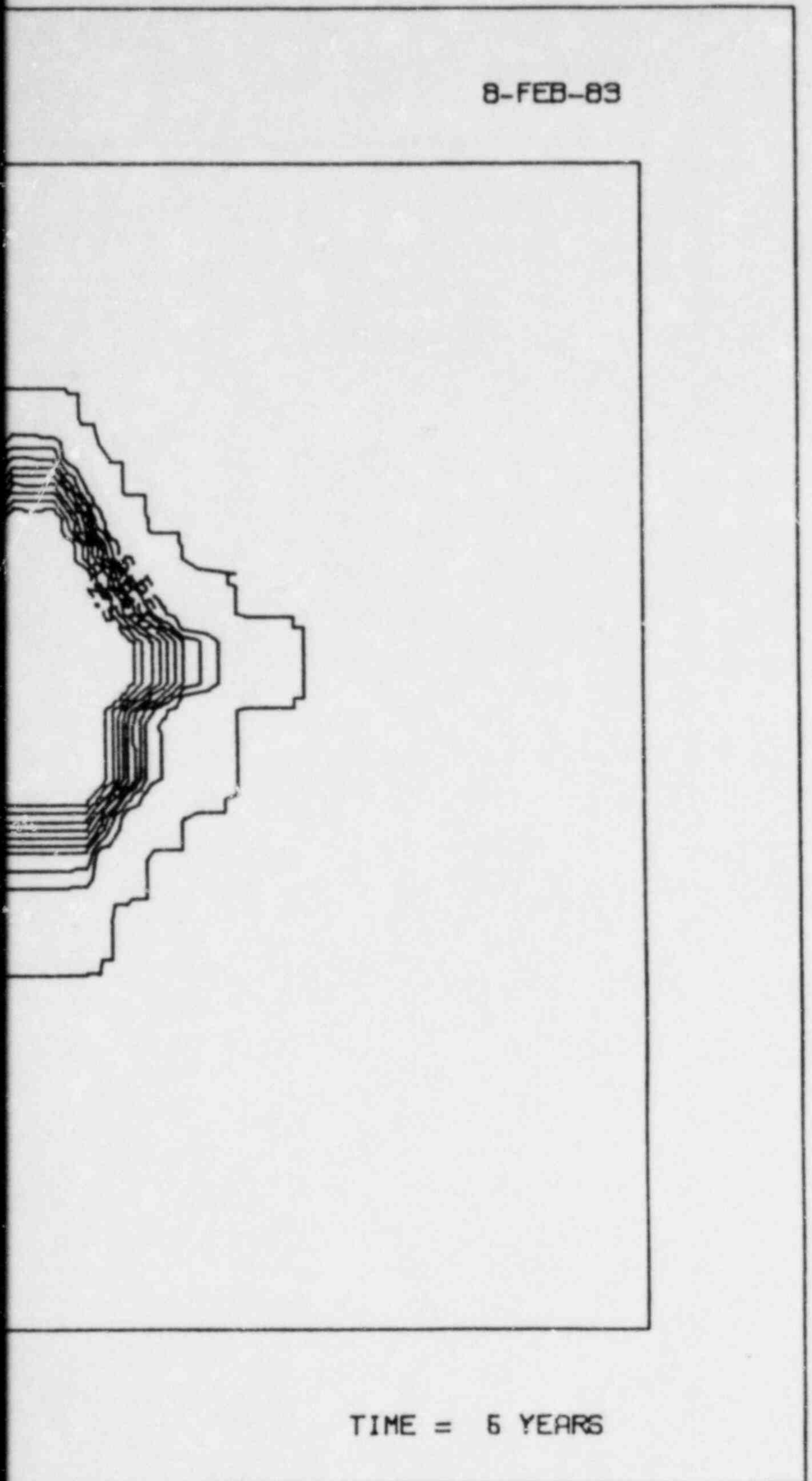
FIGURE 12

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 1.3 ML/GM

466.12 (4-64)

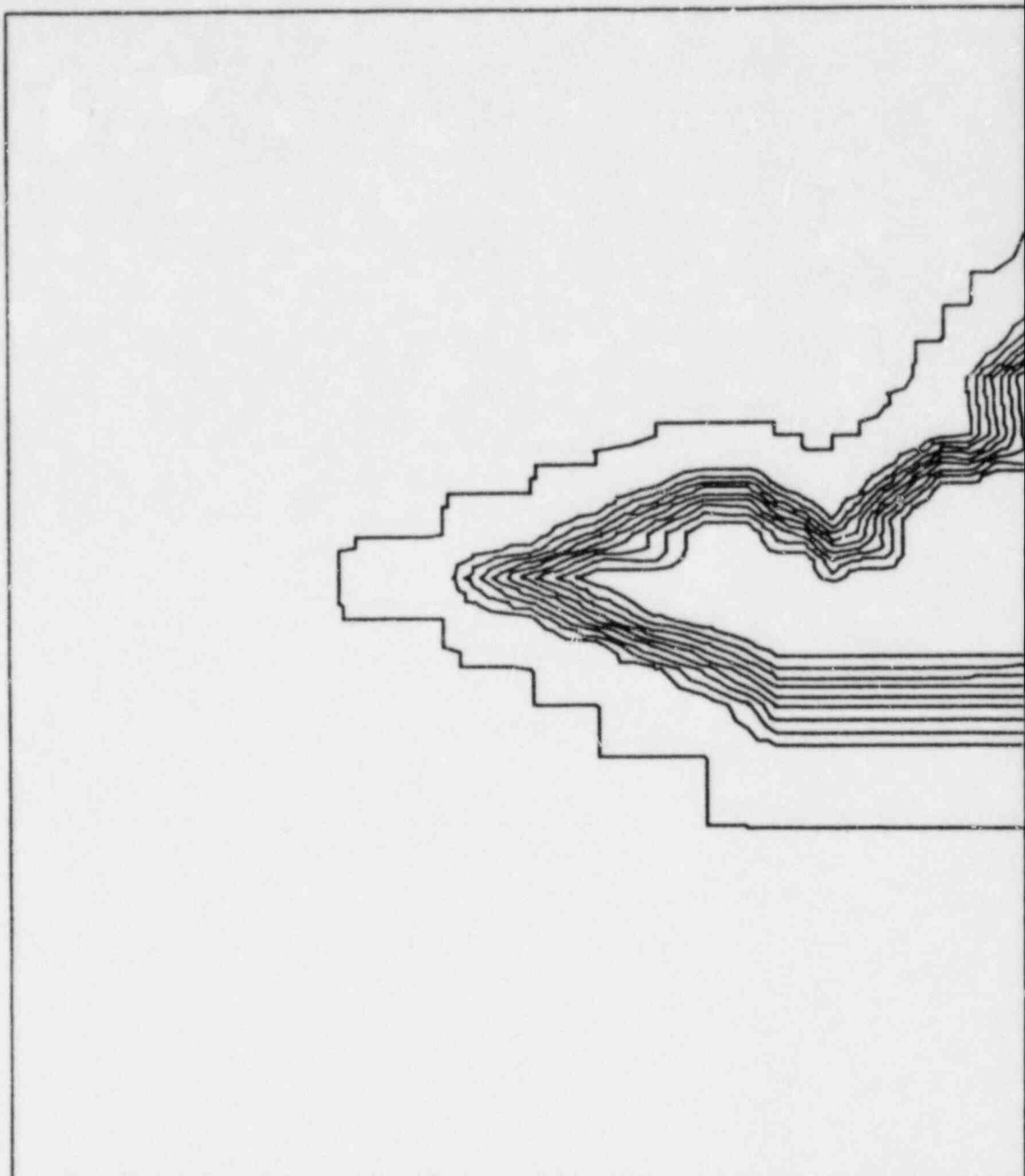


PH LEVELS

DAMES & MOORE

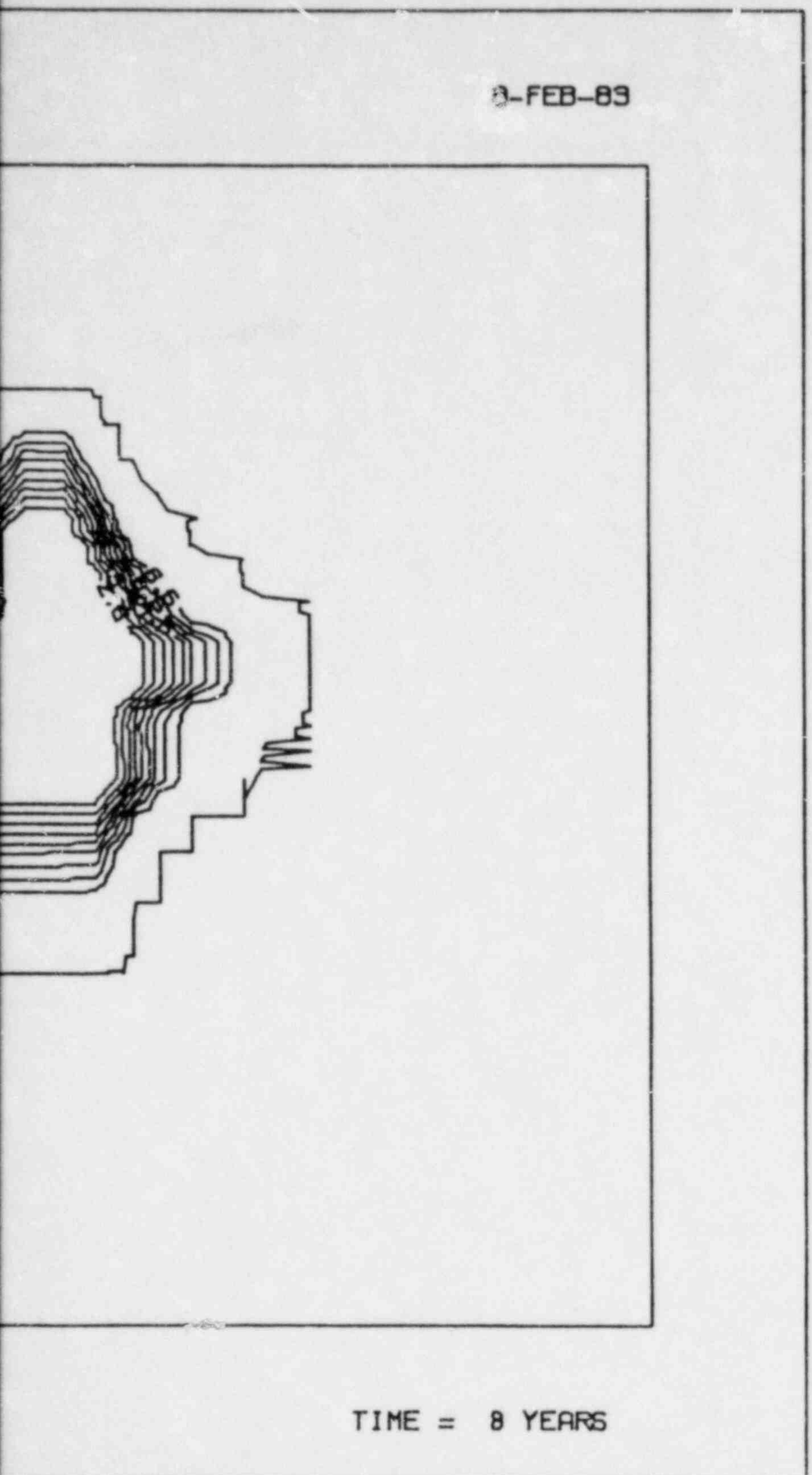
FIGURE 13

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 1.3 ML/GM

466.12 (4-64)

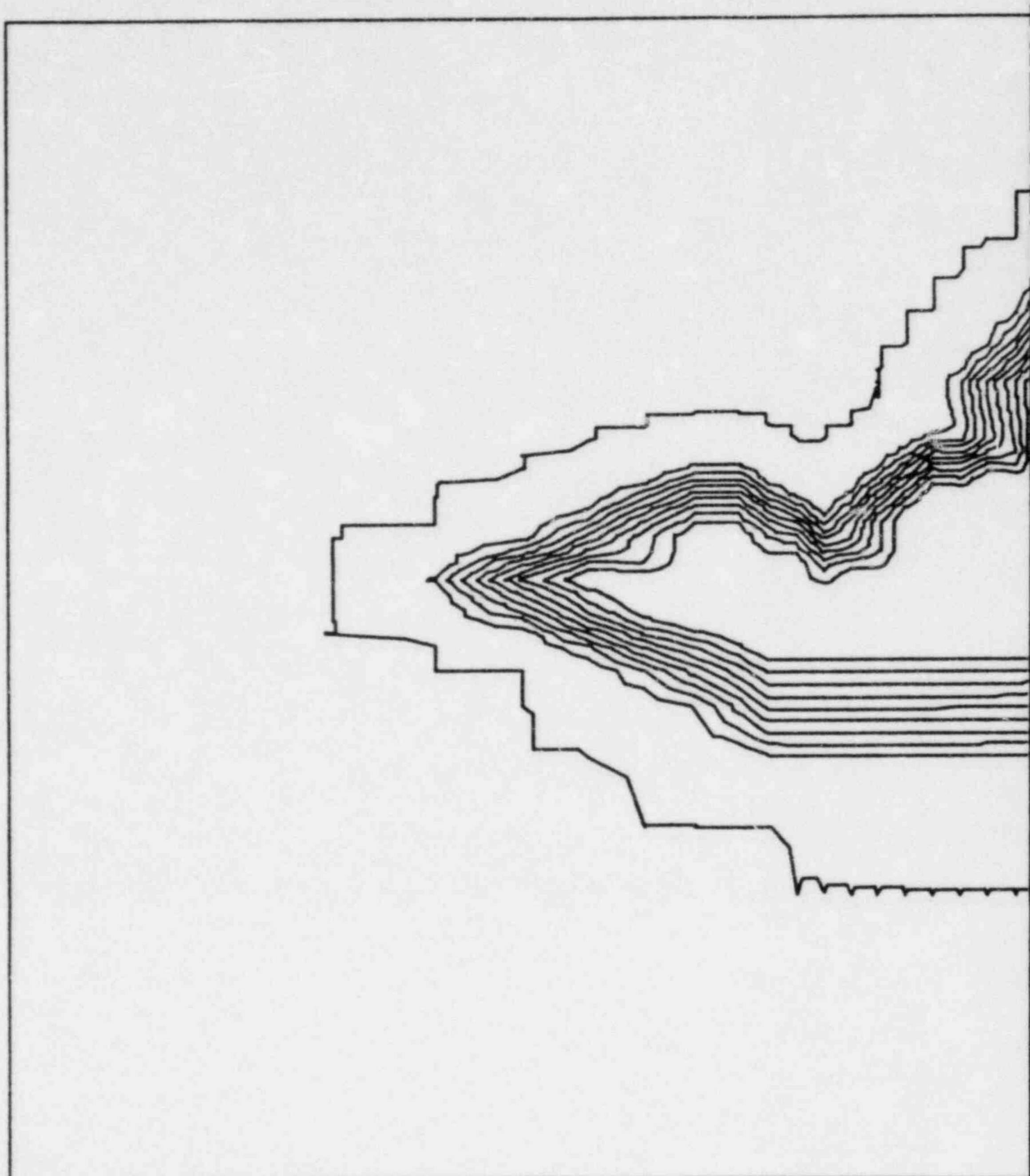


PH LEVELS

DAMES & MOORE

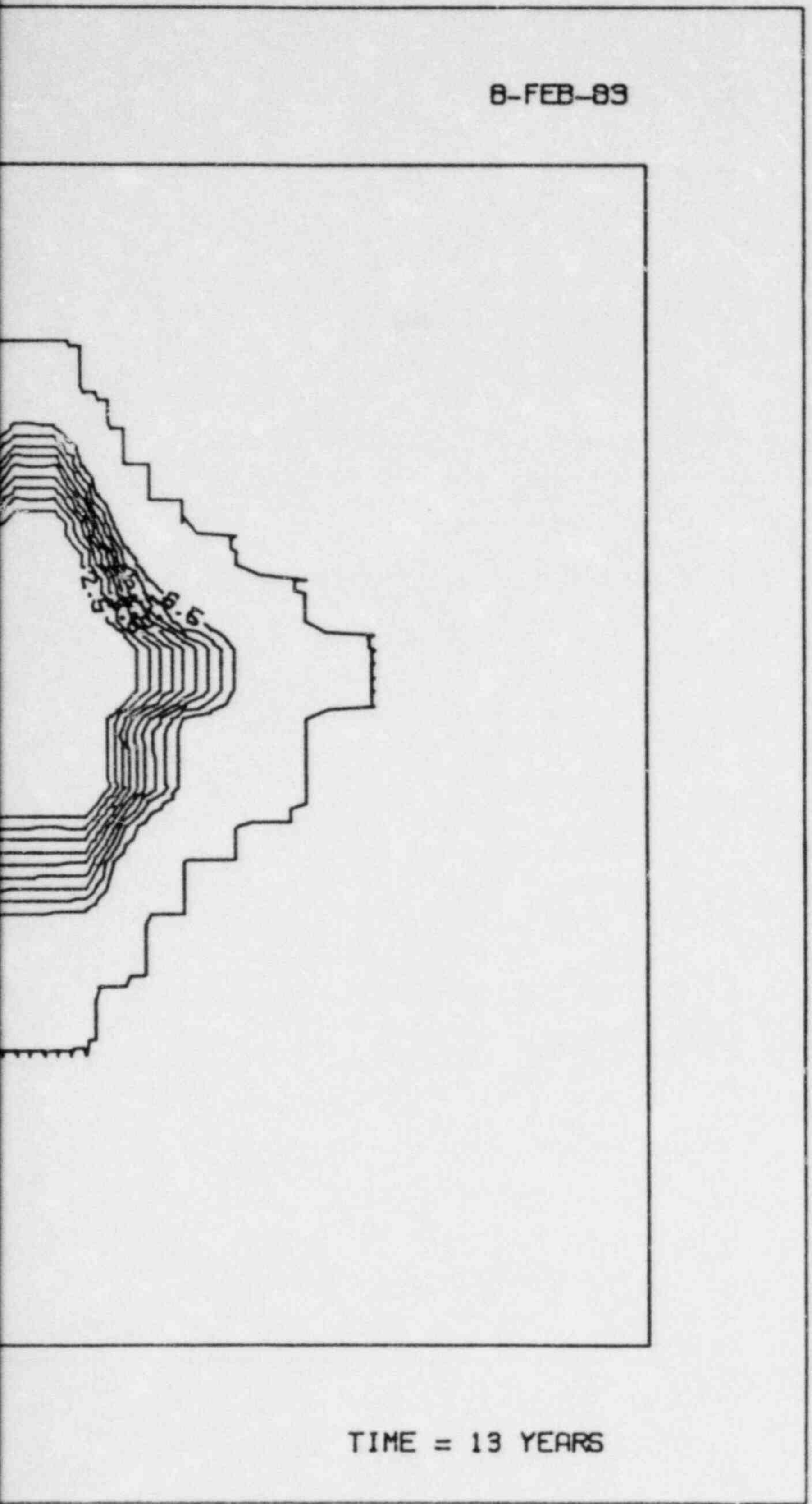
FIGURE 14

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 1.3 ML/GM

466.12 (4-64)

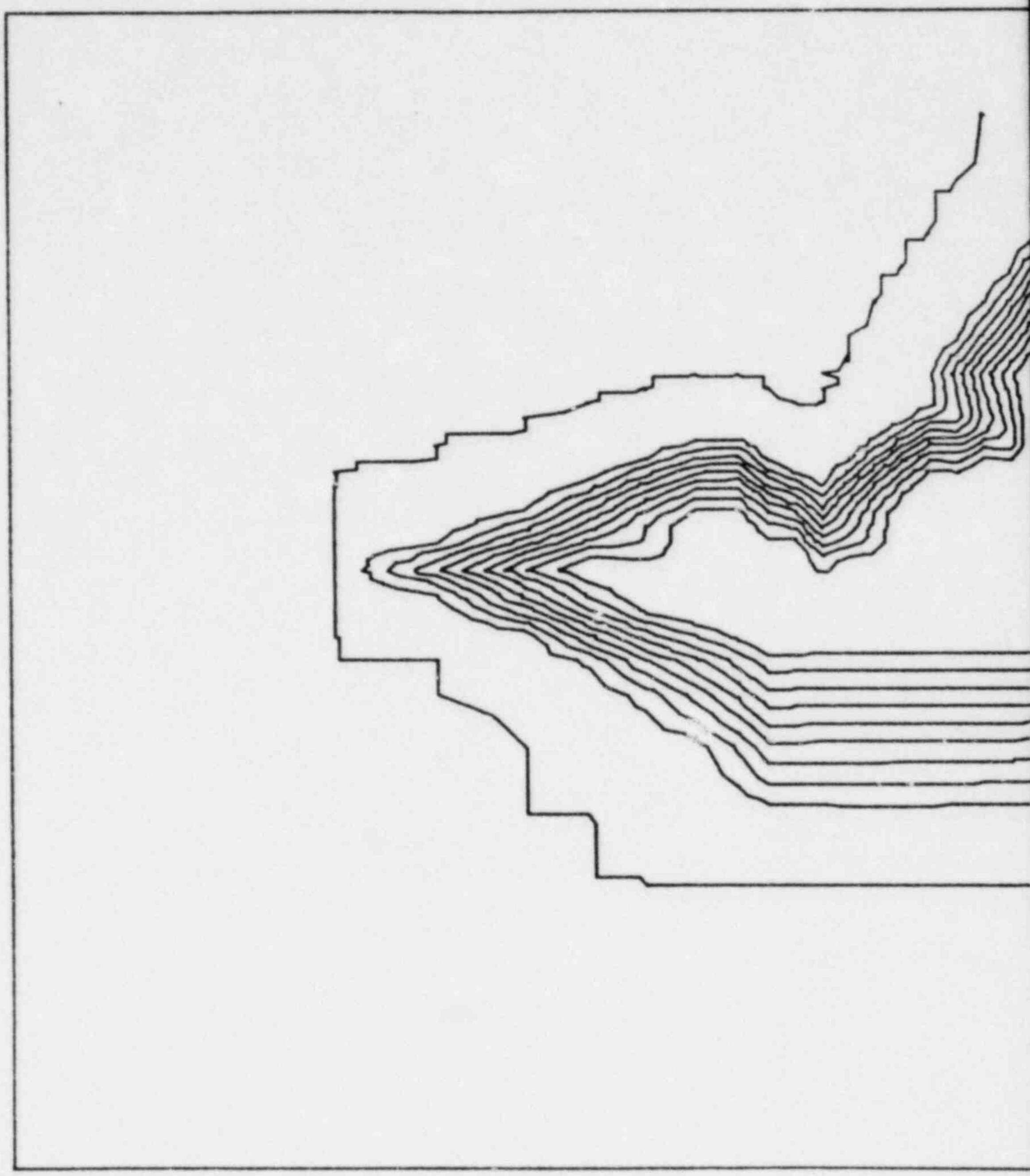


PH LEVELS

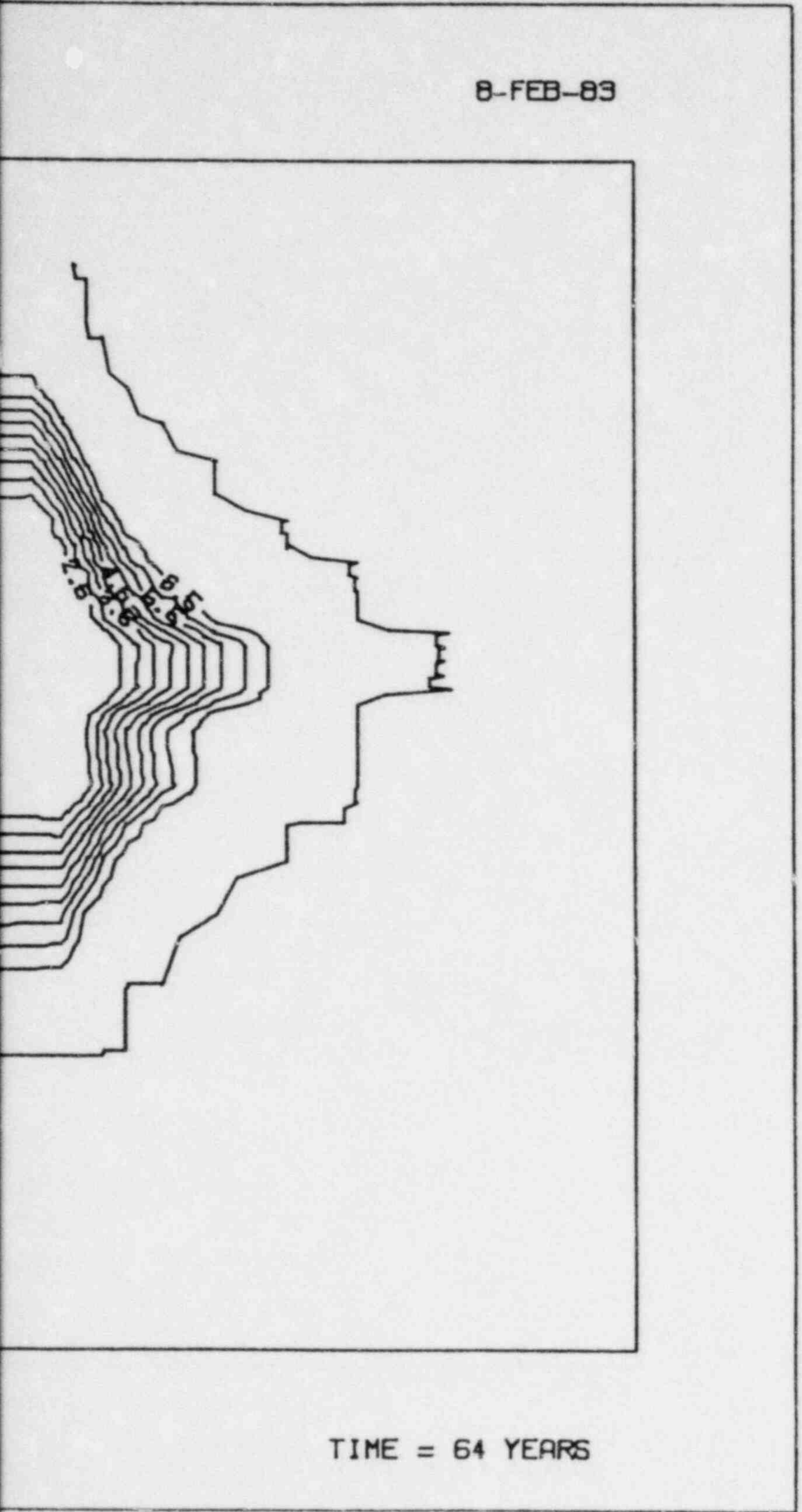
DAMES & MOORE

FIGURE 15

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 1.3 ML/GM

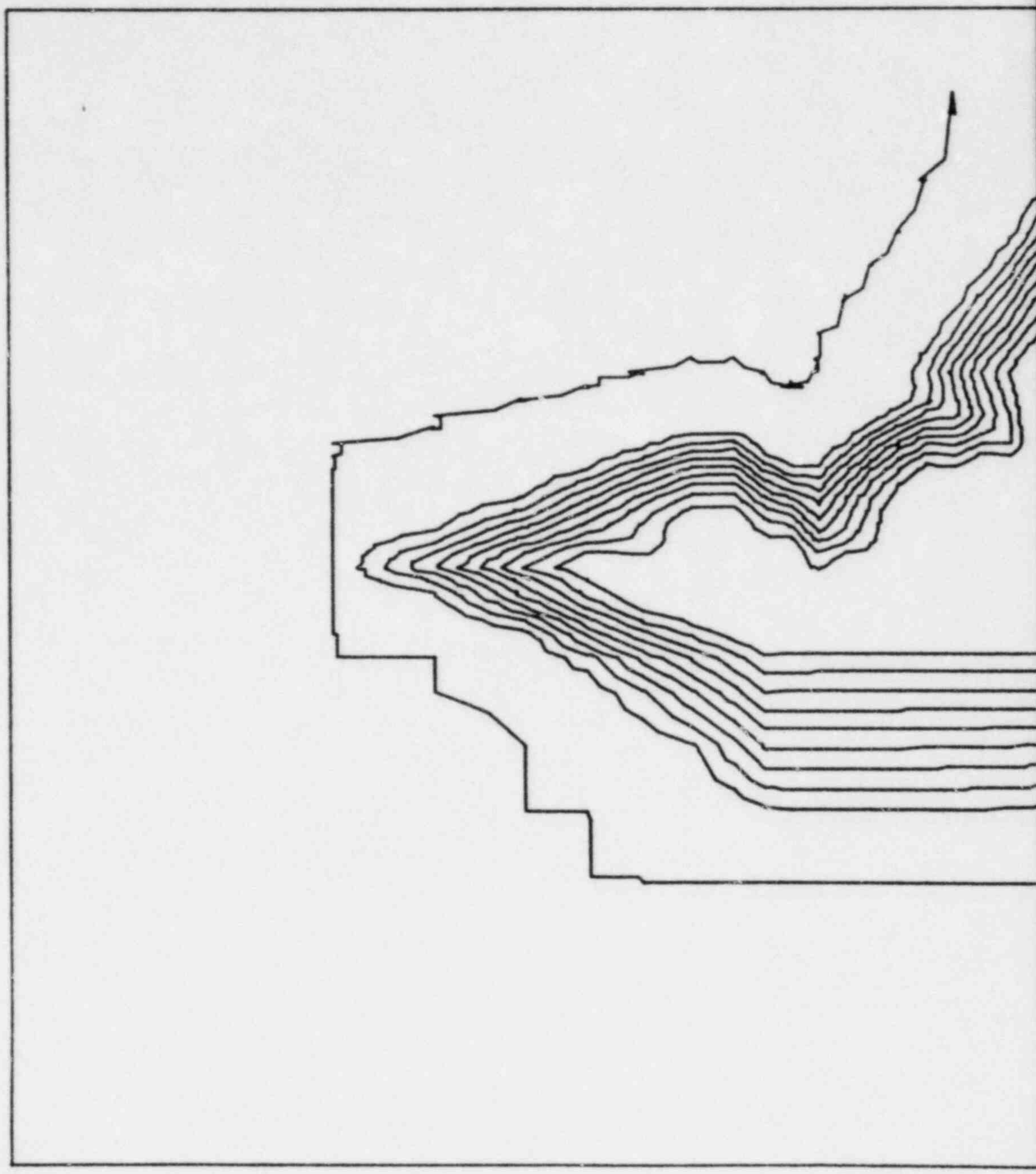


PH LEVELS

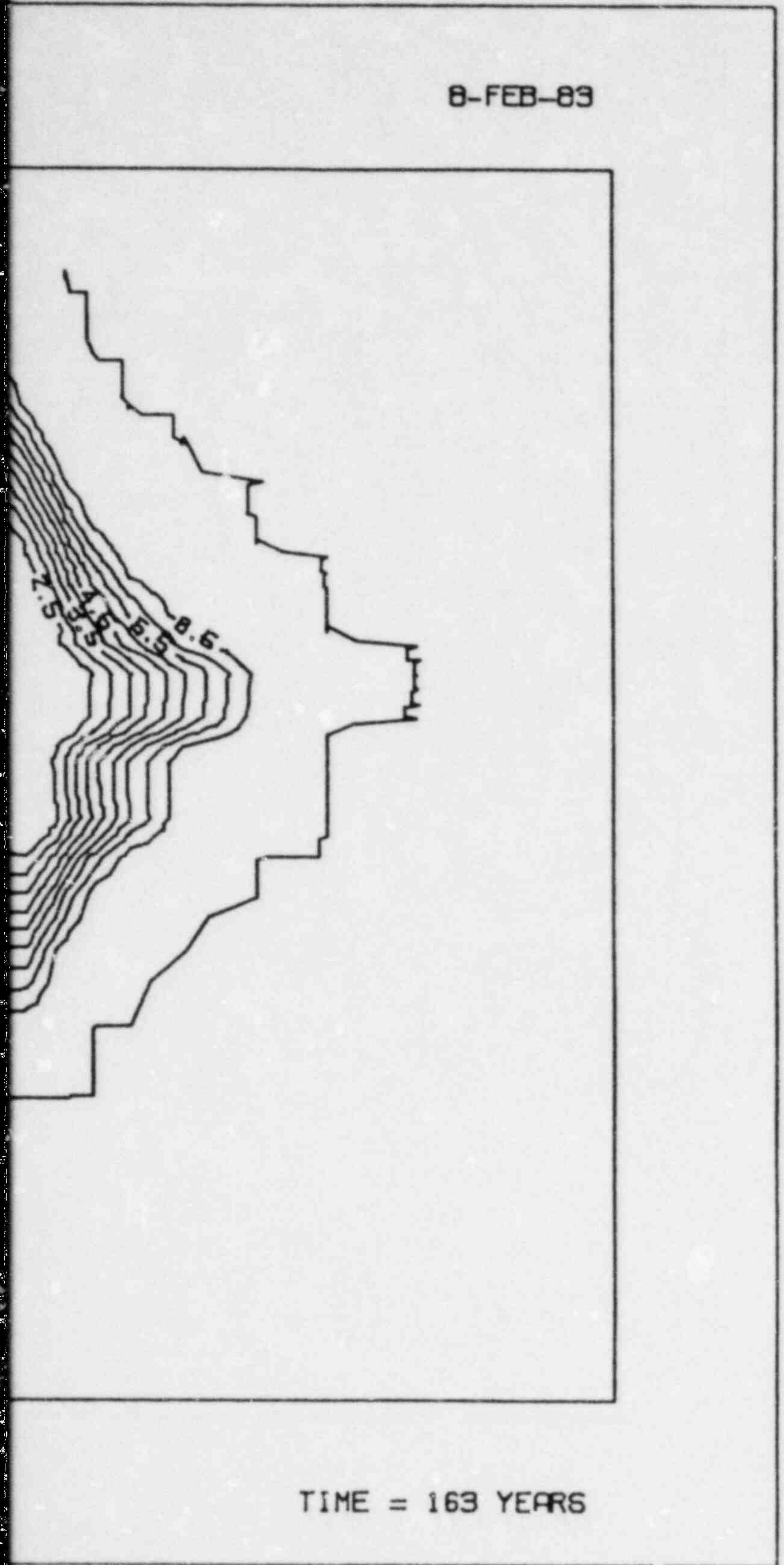
DAMES & MOORE

FIGURE 15

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 1.3 ML/GM

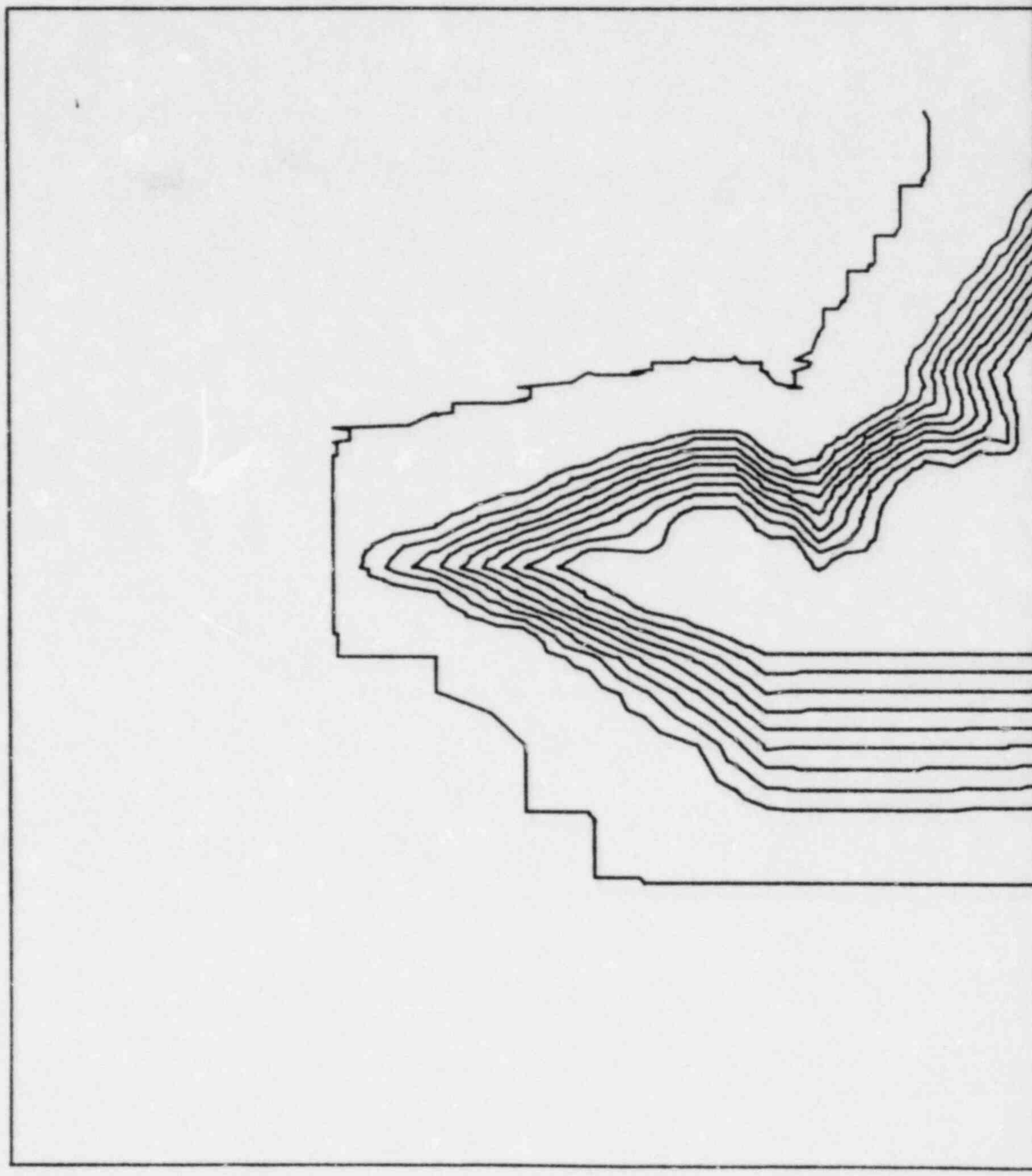


PH LEVELS

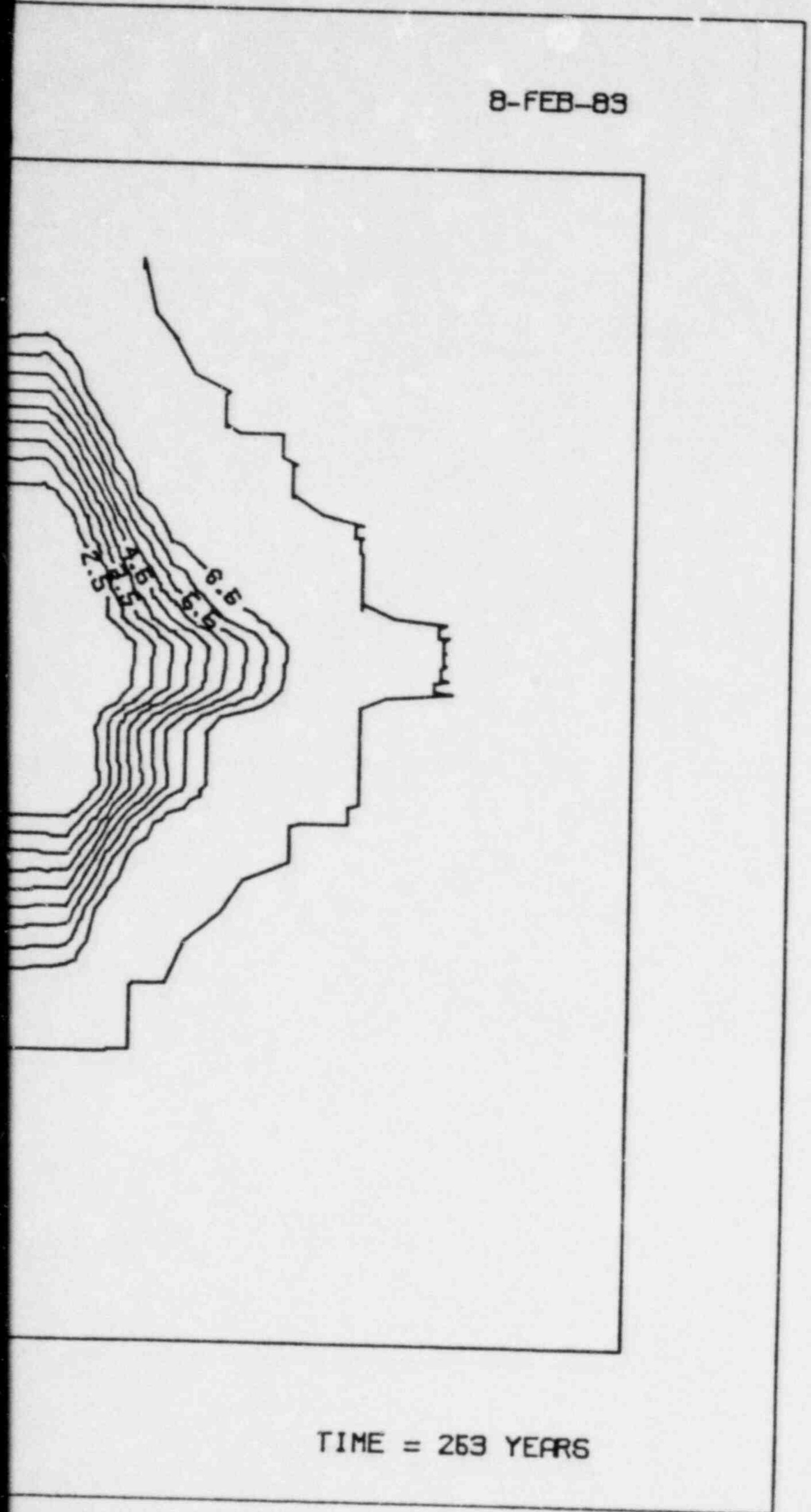
DAMES & MOORE

FIGURE 17

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 1.3 ML/GM

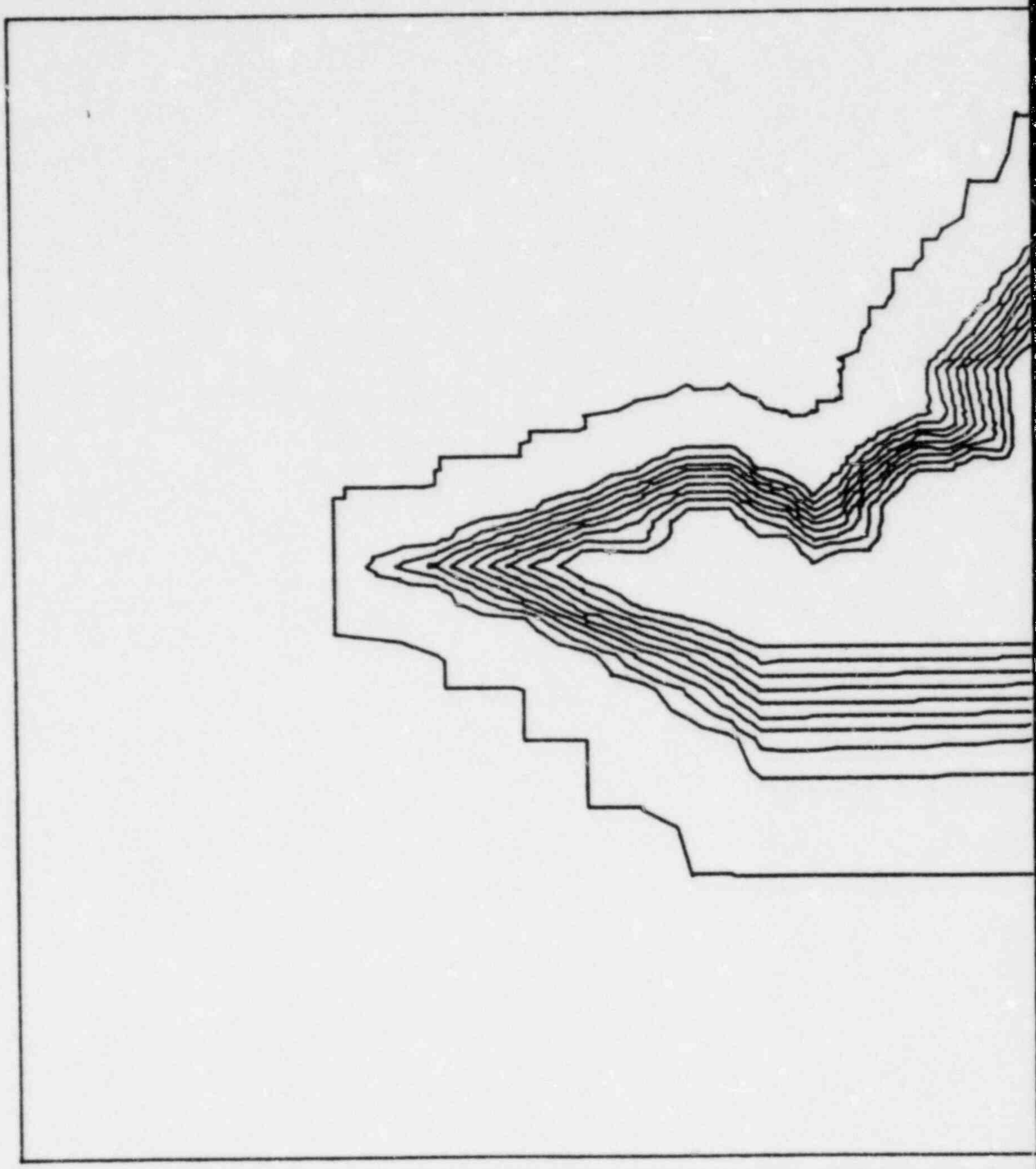


PH LEVELS

DAMES & MOORE

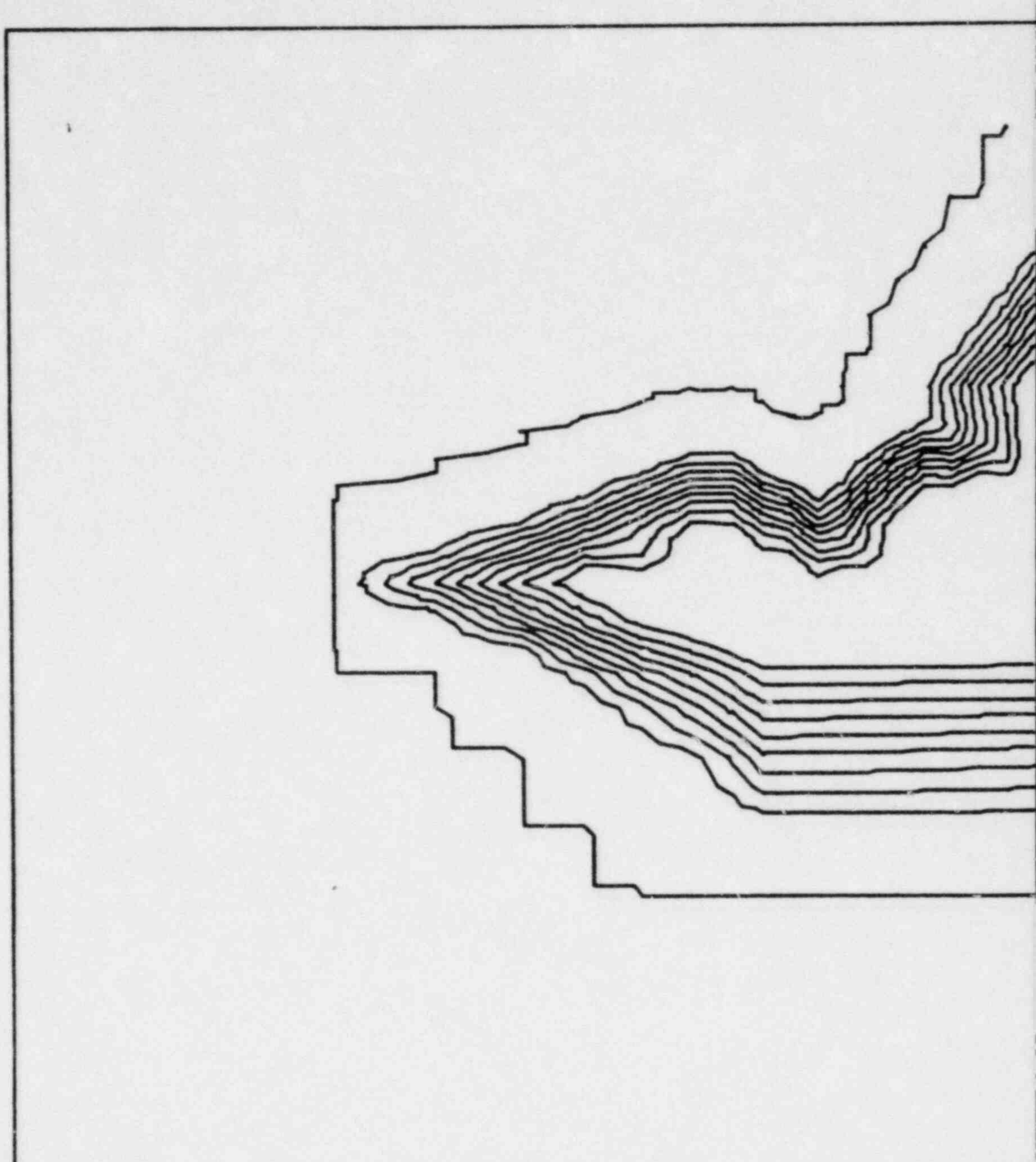
FIGURE 16

CONTOUR INTERVAL = 0.5



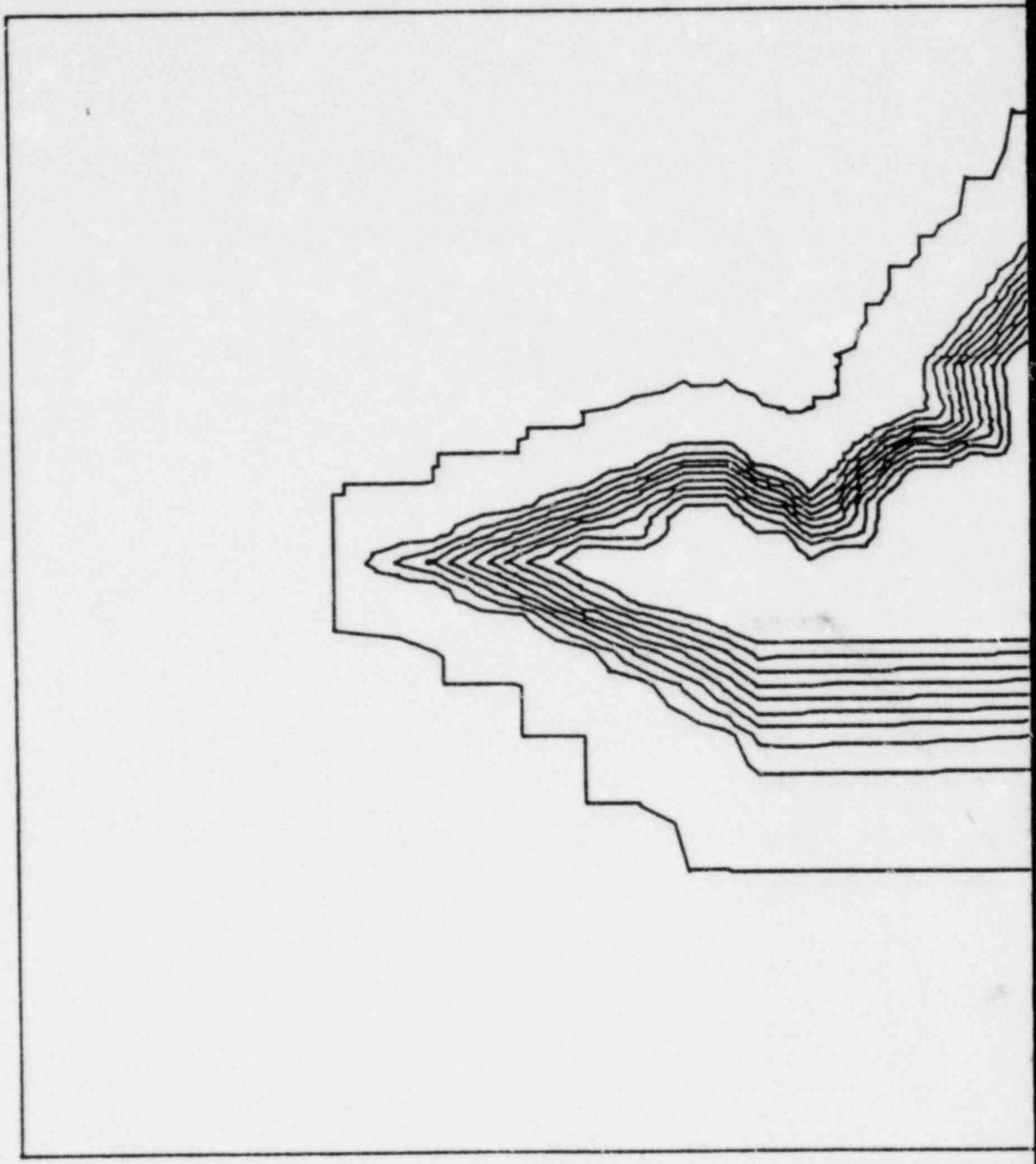
ALTERNATE IV - HIGH CONDUCTIVITY

CONTOUR INTERVAL = 0.5



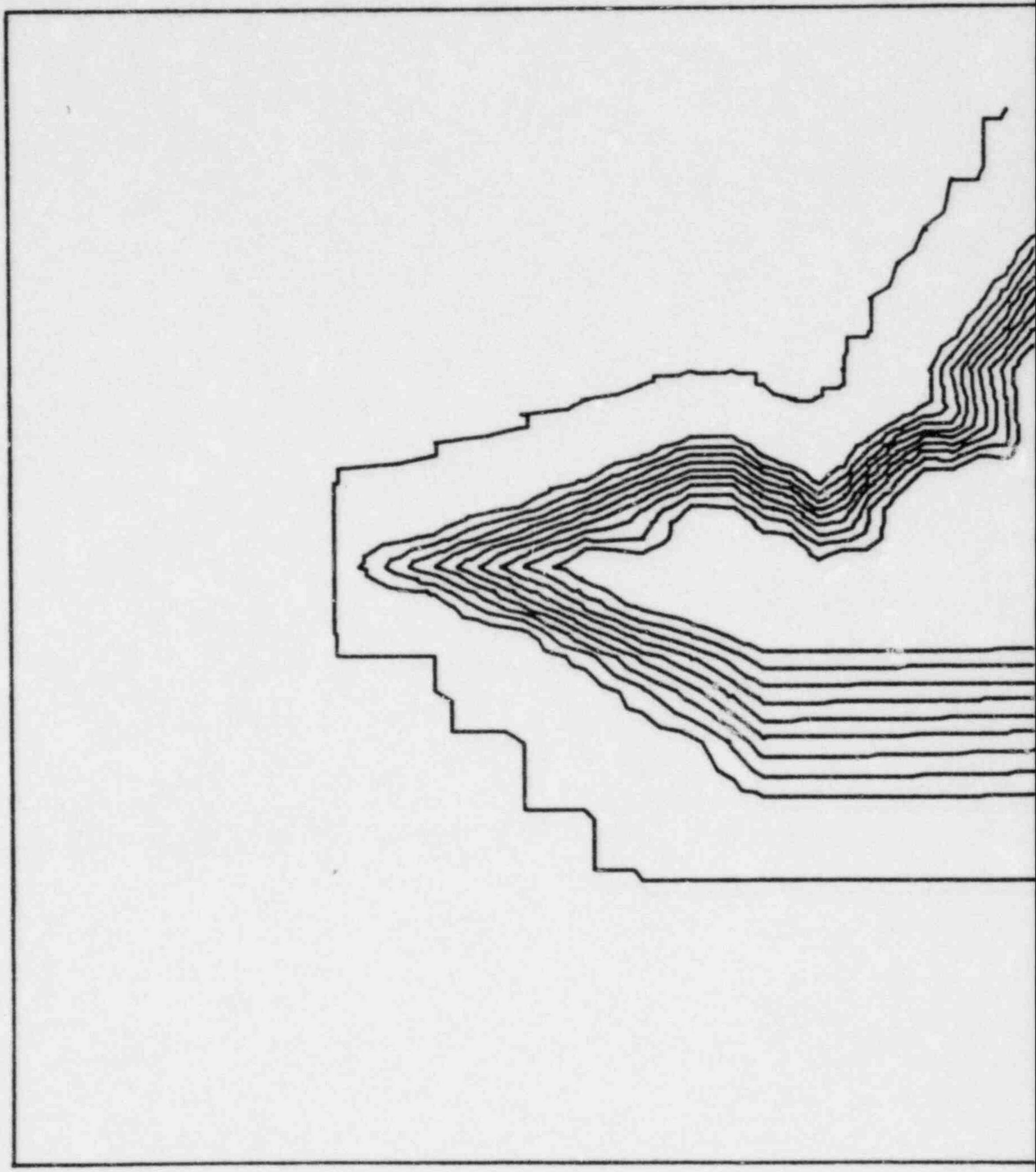
ALTERNATE IV - HIGH CONDUCTIVITY

CONTOUR INTERVAL = 0.5

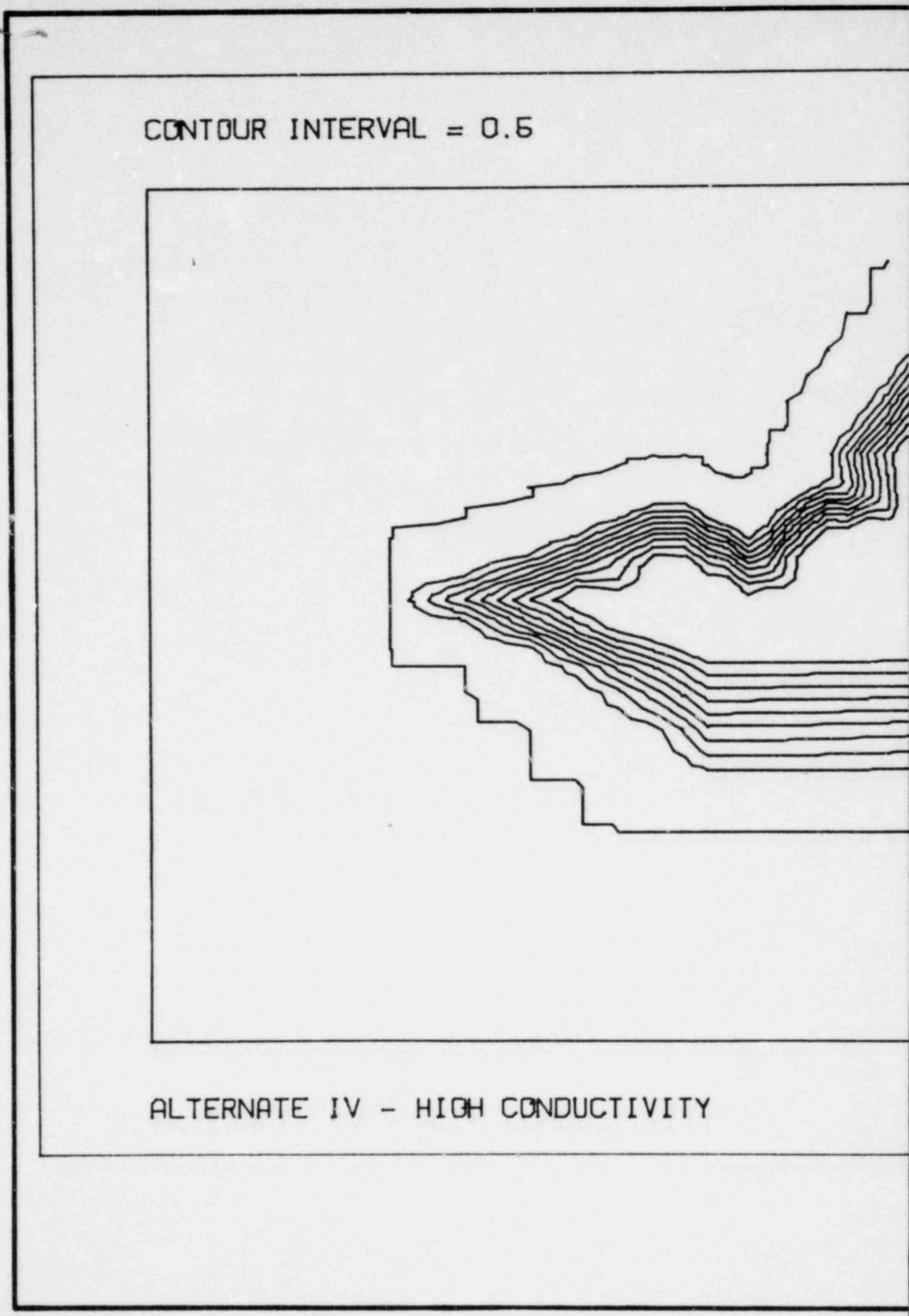


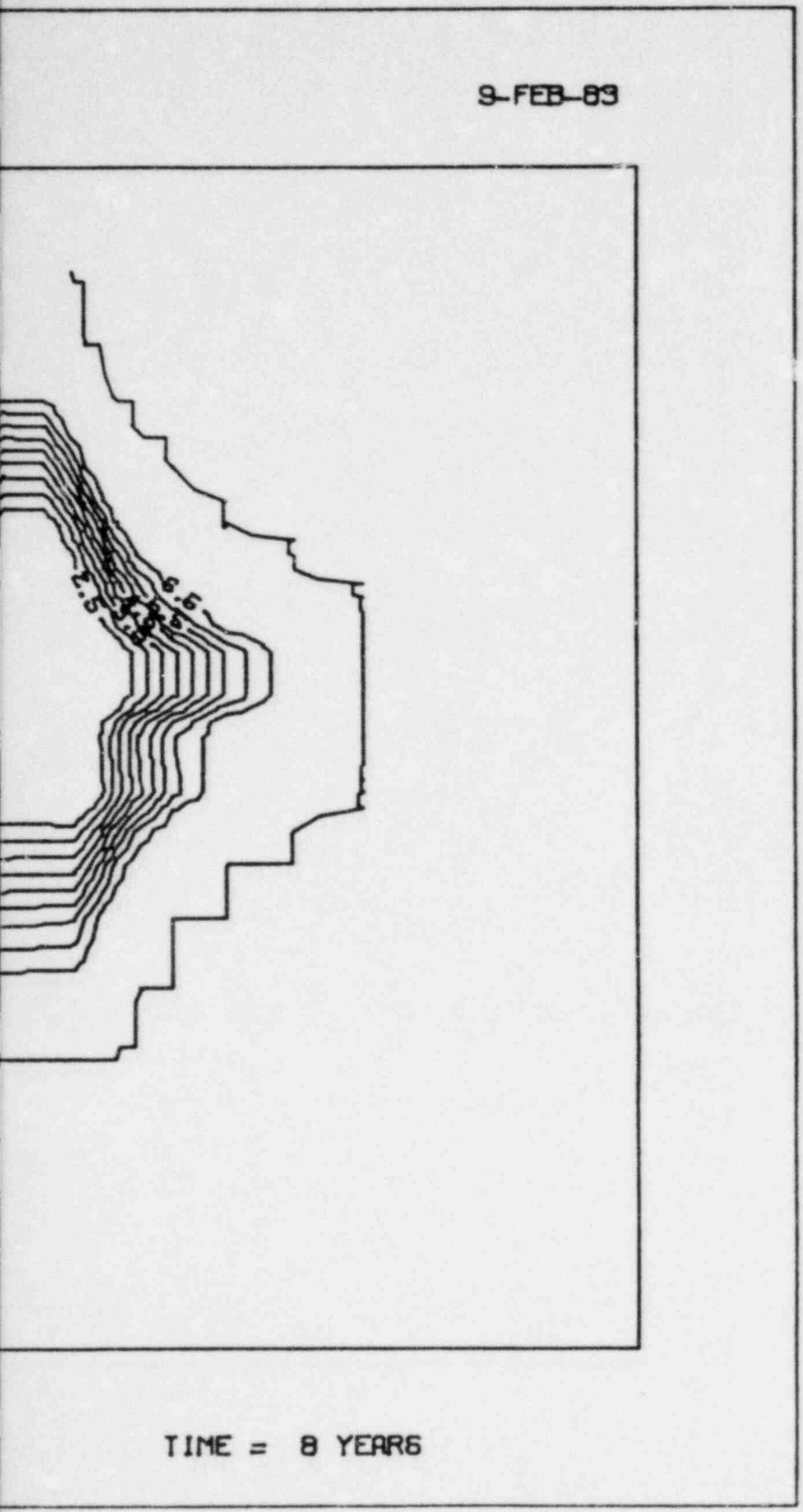
ALTERNATE IV - HIGH CONDUCTIVITY

CONTOUR INTERVAL = 0.5



ALTERNATE IV - HIGH CONDUCTIVITY


CONTOUR INTERVAL = 0.5
ALTERNATE IV - HIGH CONDUCTIVITY

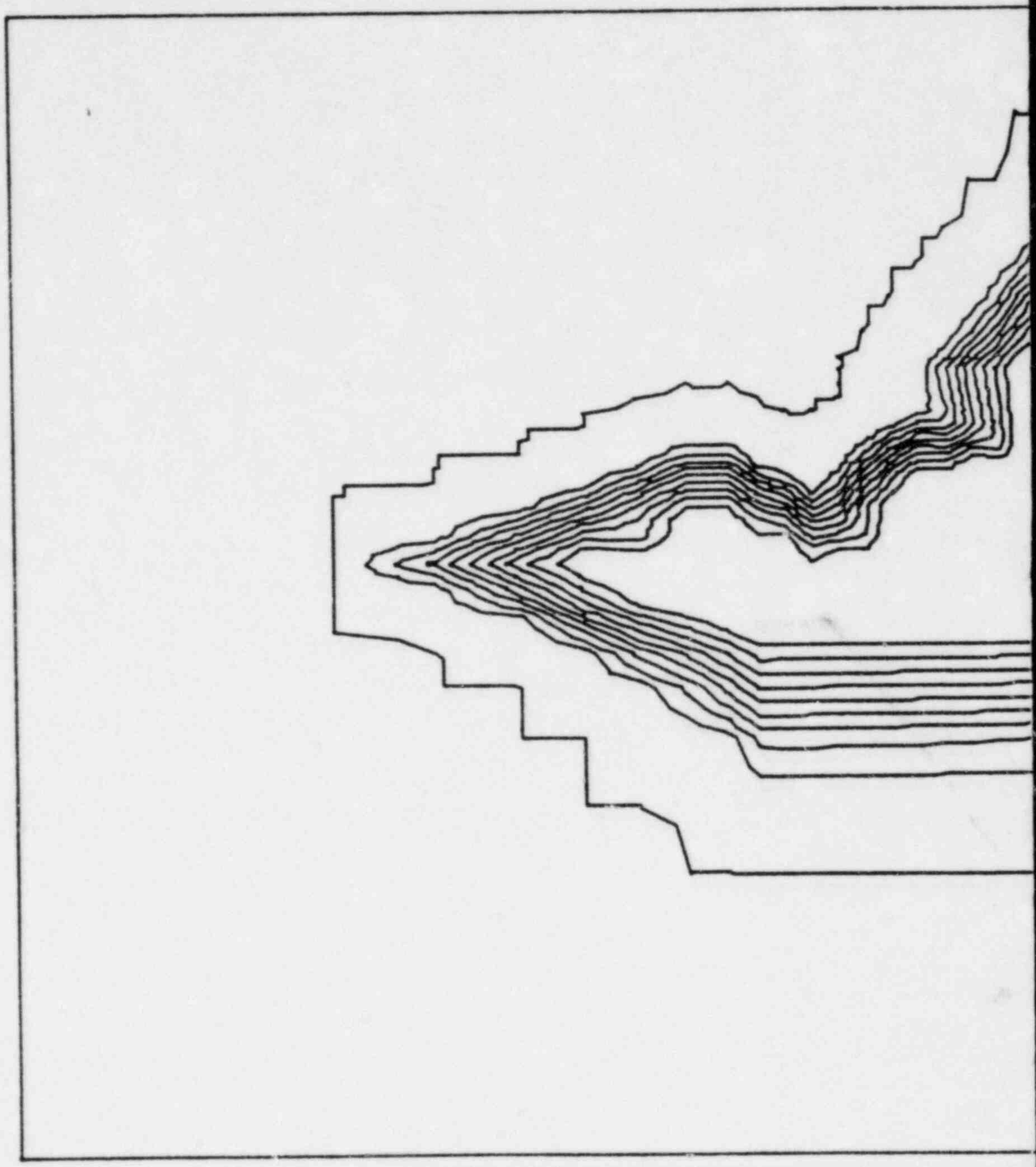


PH LEVELS

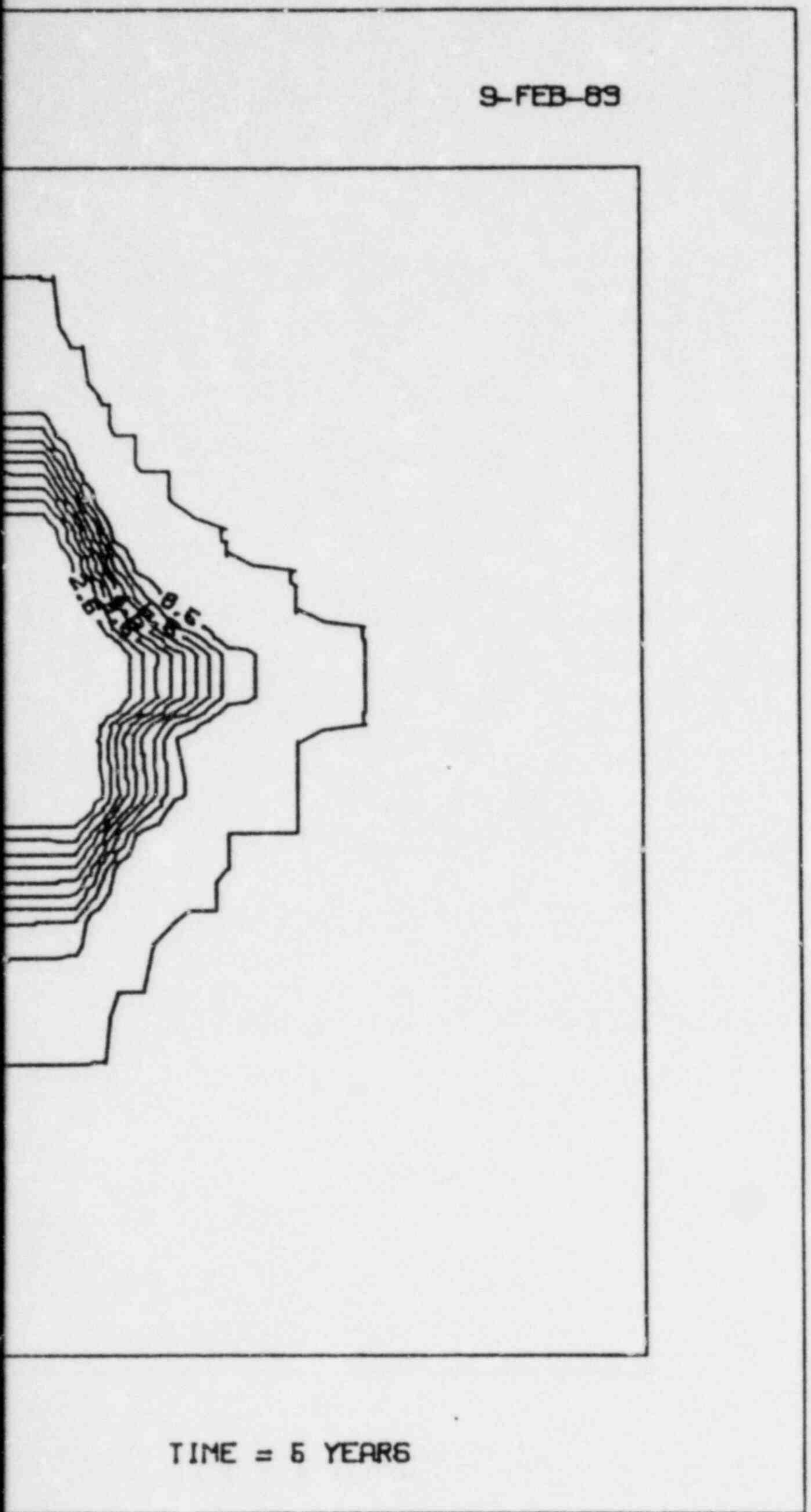
DAMES & MOORE

FIGURE 20

CONTOUR INTERVAL = 0.5



ALTERNATE IV - HIGH CONDUCTIVITY

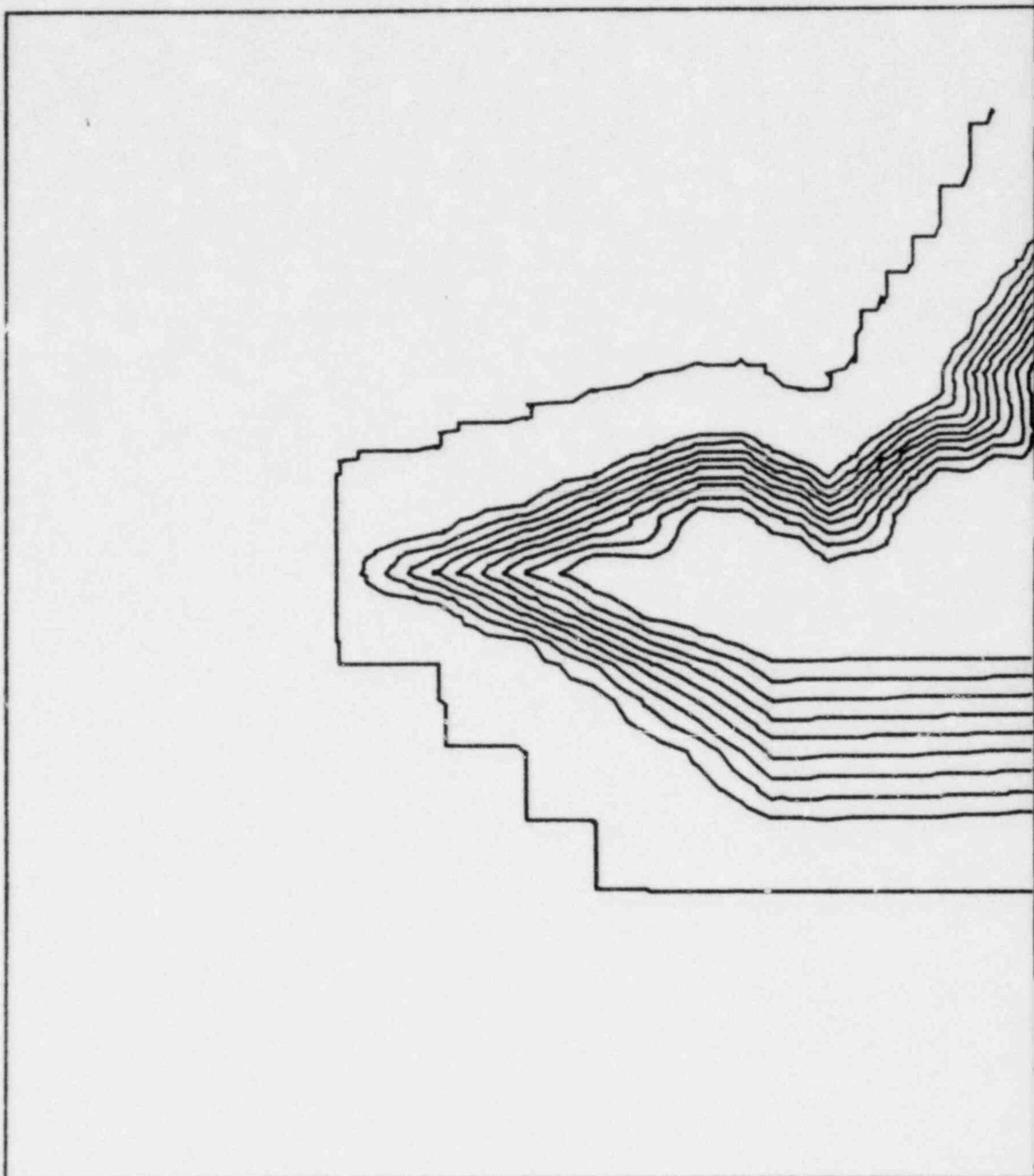


PH LEVELS

DAMES & MOORE

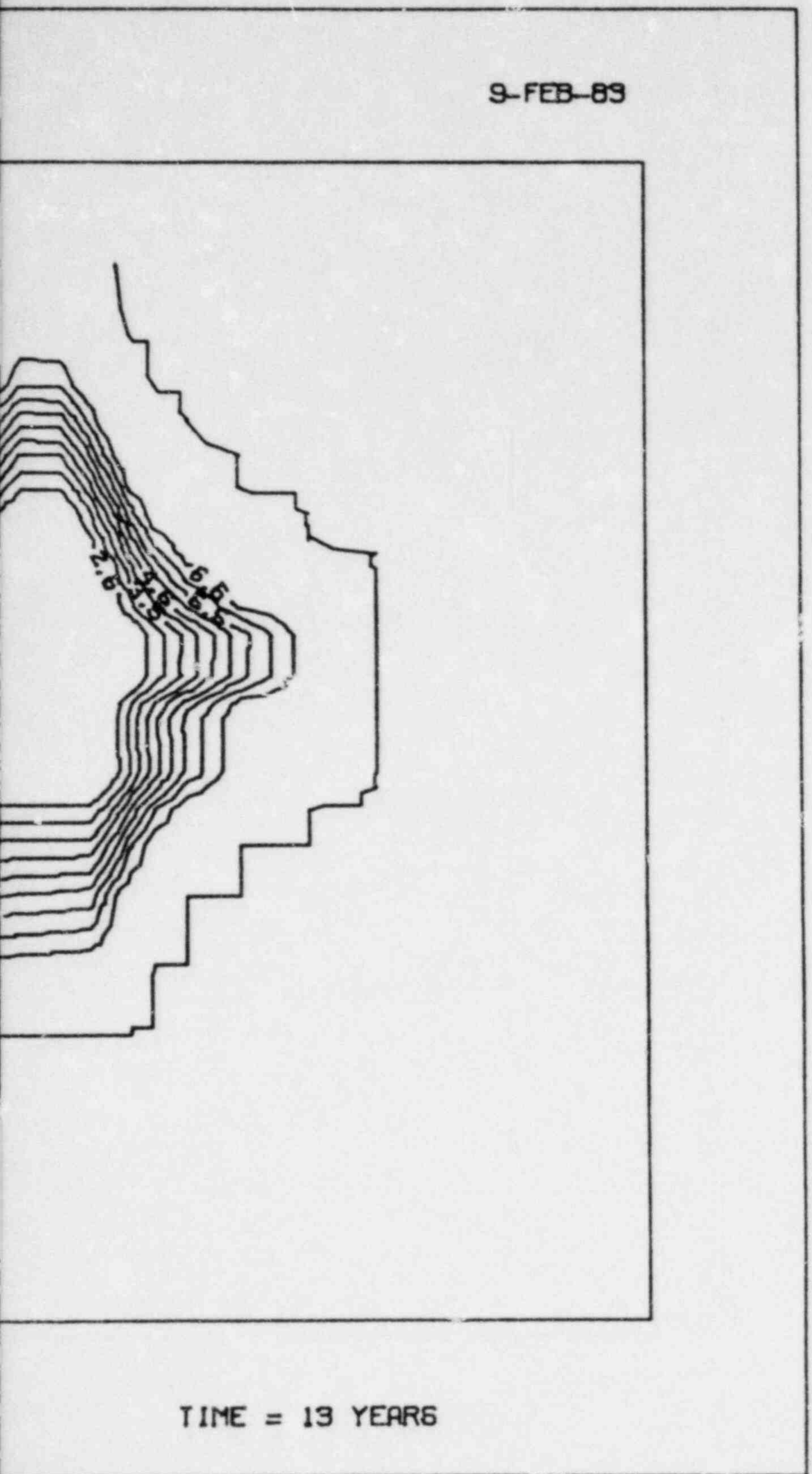
FIGURE 19

CONTOUR INTERVAL = 0.5



ALTERNATE IV - HIGH CONDUCTIVITY

466.12 (4-64)



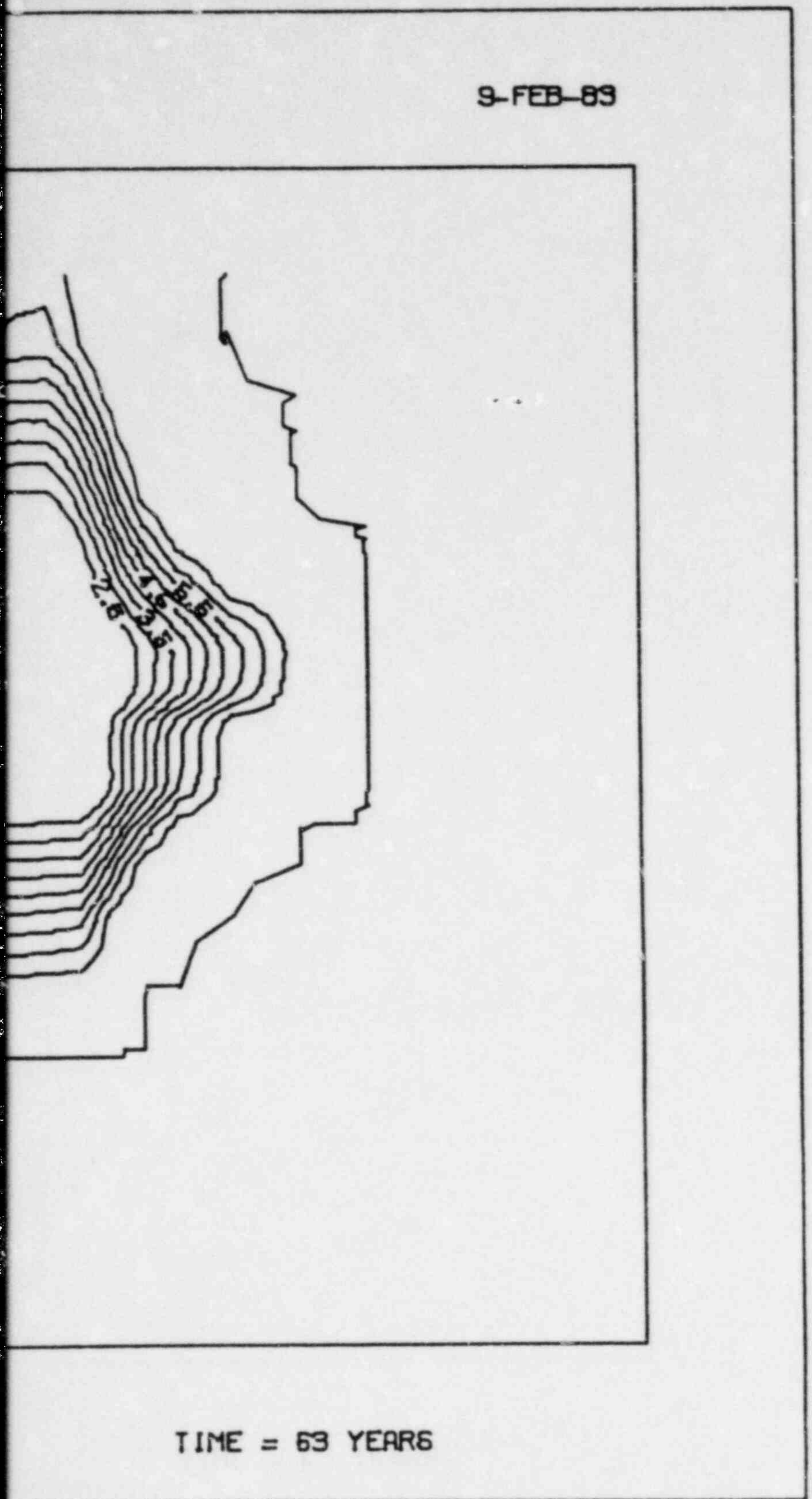
PH LEVELS

DAMES & MOORE

FIGURE 21

CONTOUR INTERVAL = 0.6

ALTERNATE IV - HIGH CONDUCTIVITY

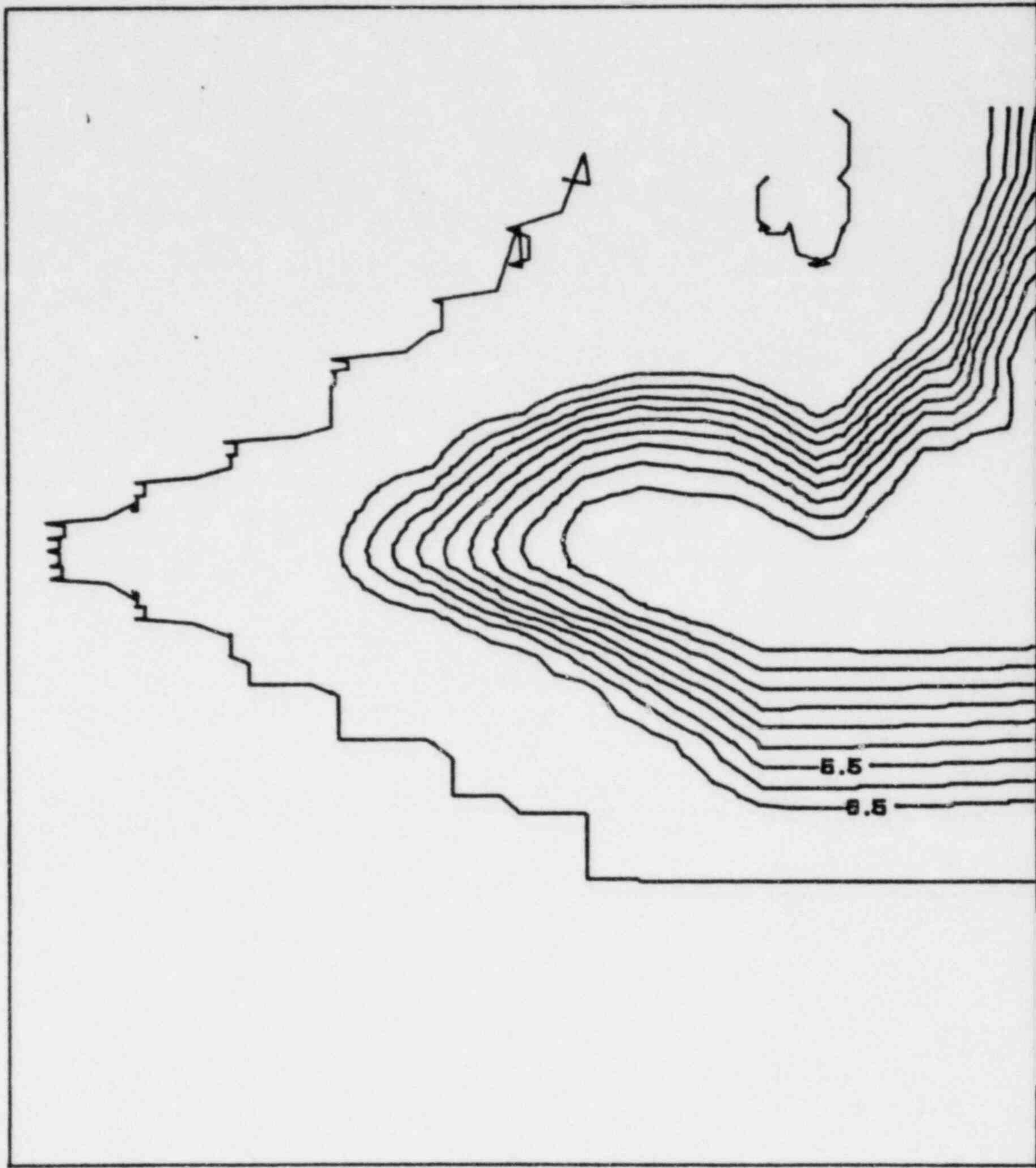


PH LEVELS

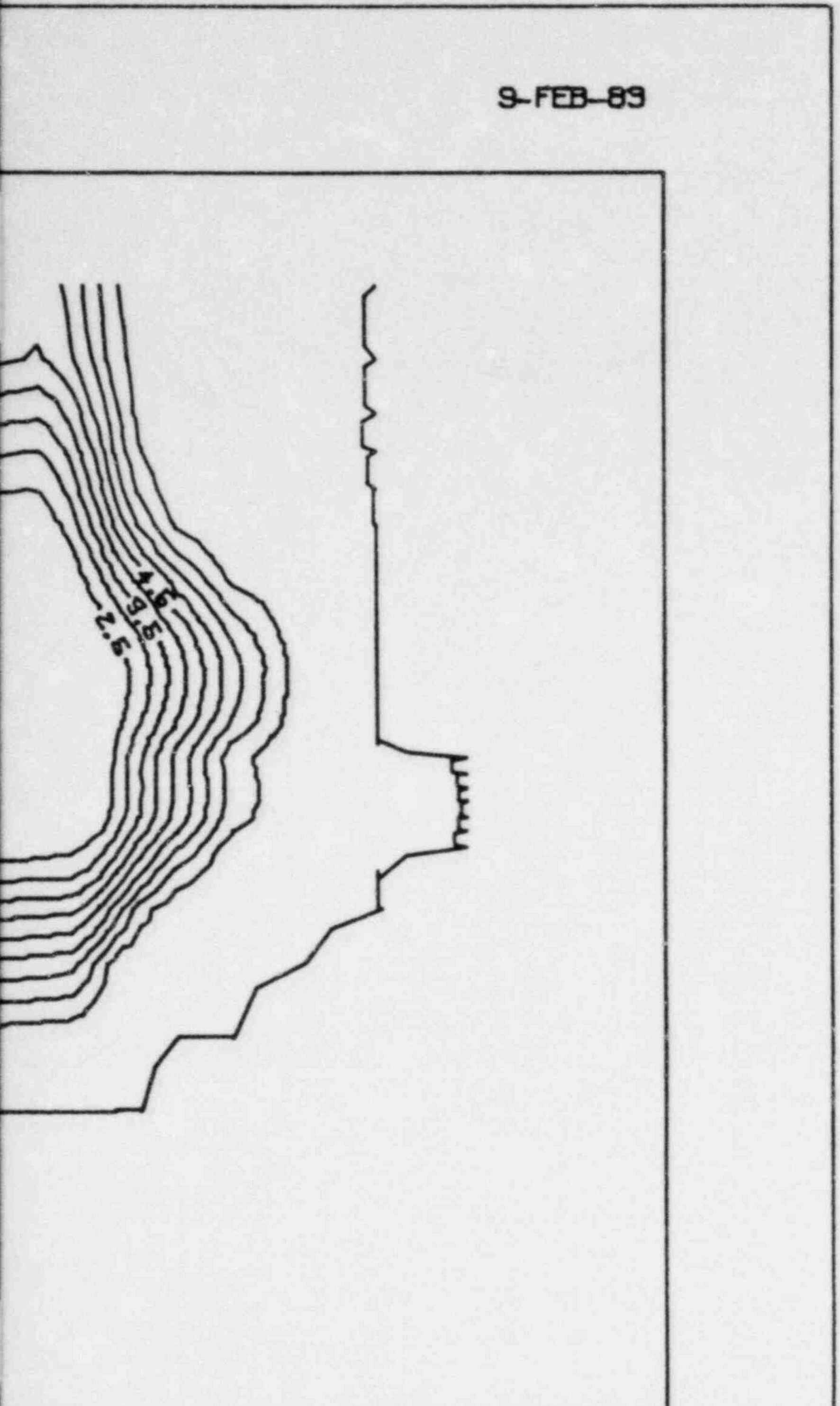
DAMES & MOORE

FIGURE 22

CONTOUR INTERVAL = 0.5



ALTERNATE IV - HIGH CONDUCTIVITY

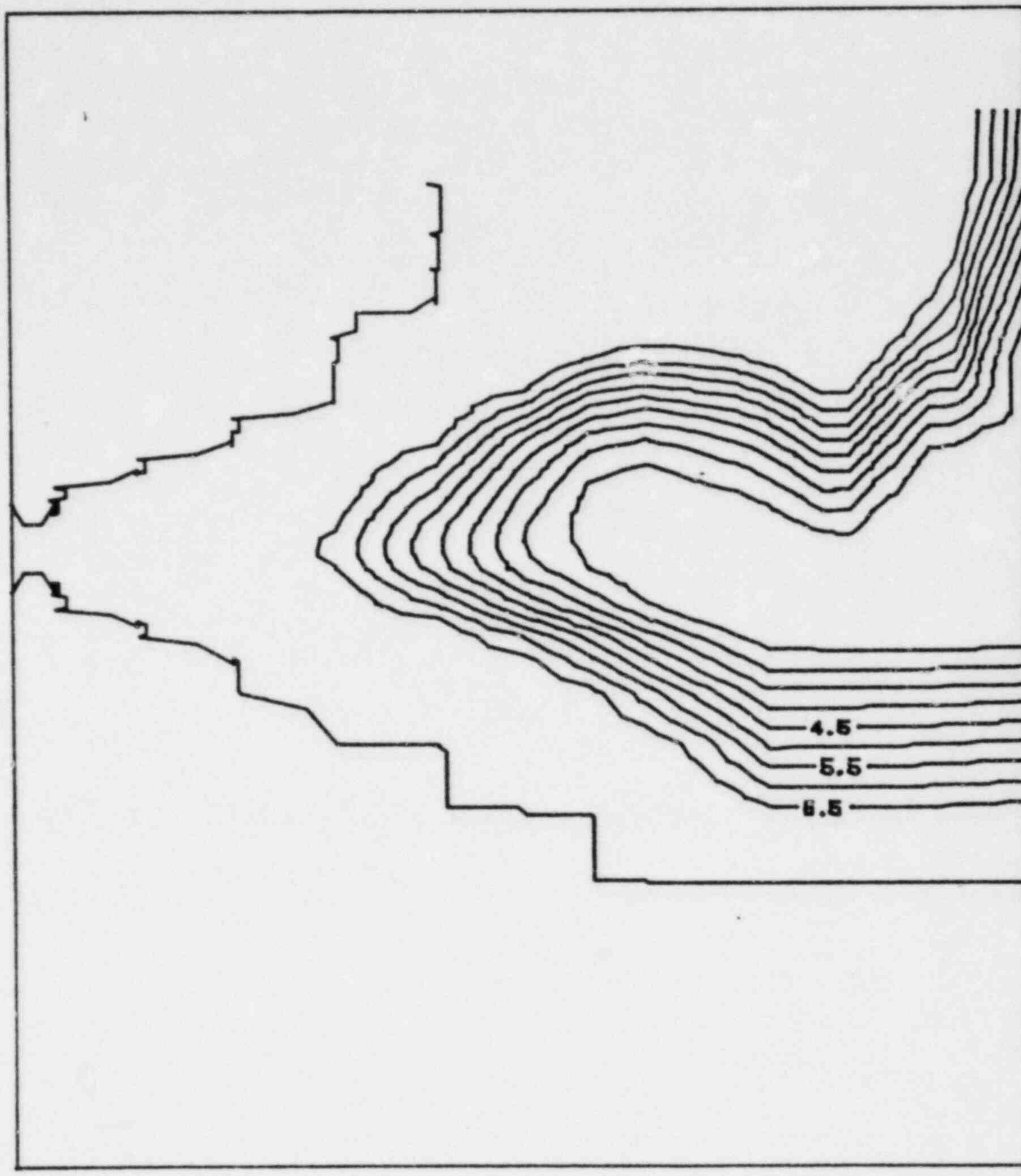


PH LEVELS

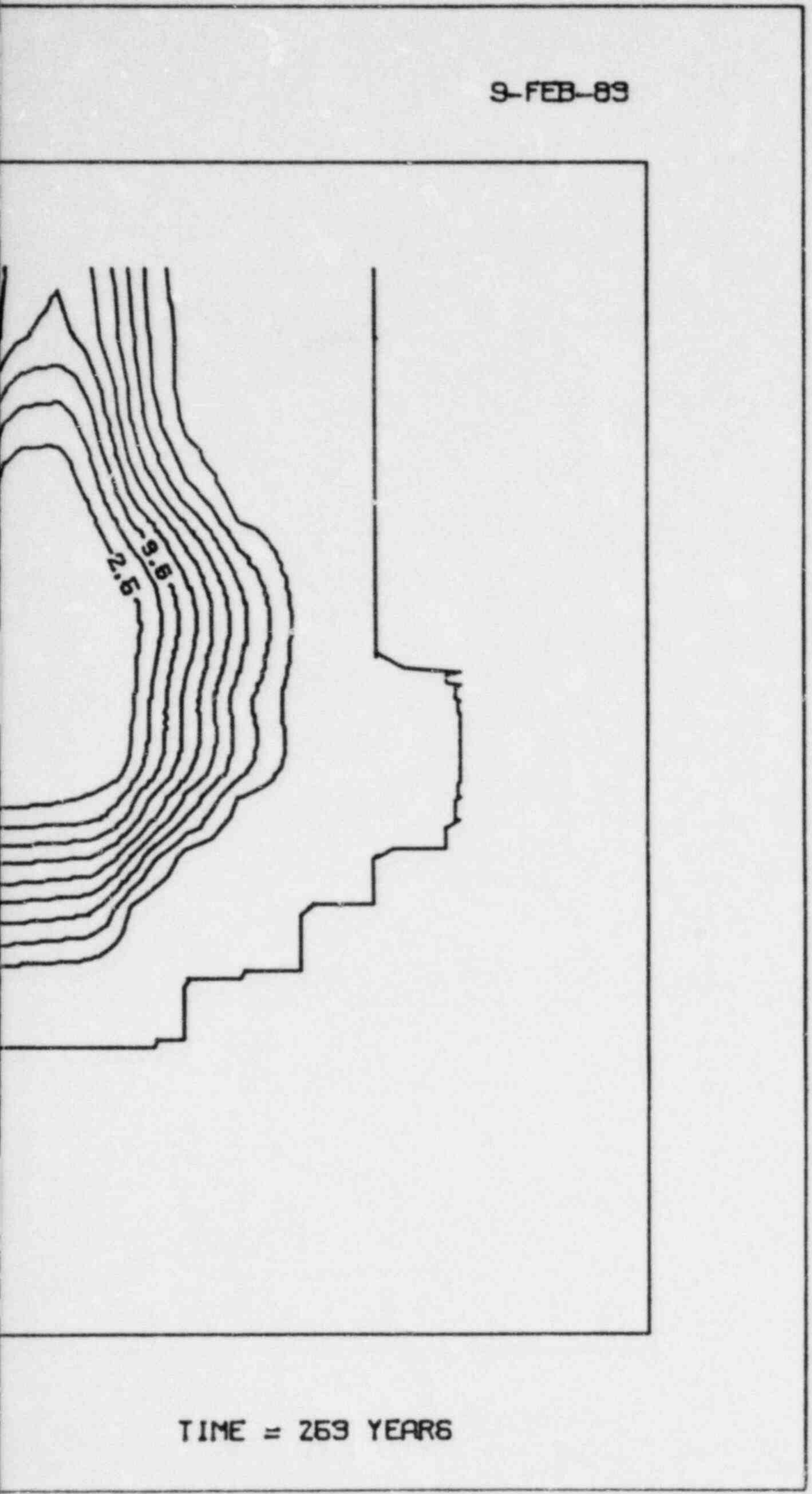
DAMES & MOORE

FIGURE 23

CONTOUR INTERVAL = 0.5



ALTERNATE IV - HIGH CONDUCTIVITY

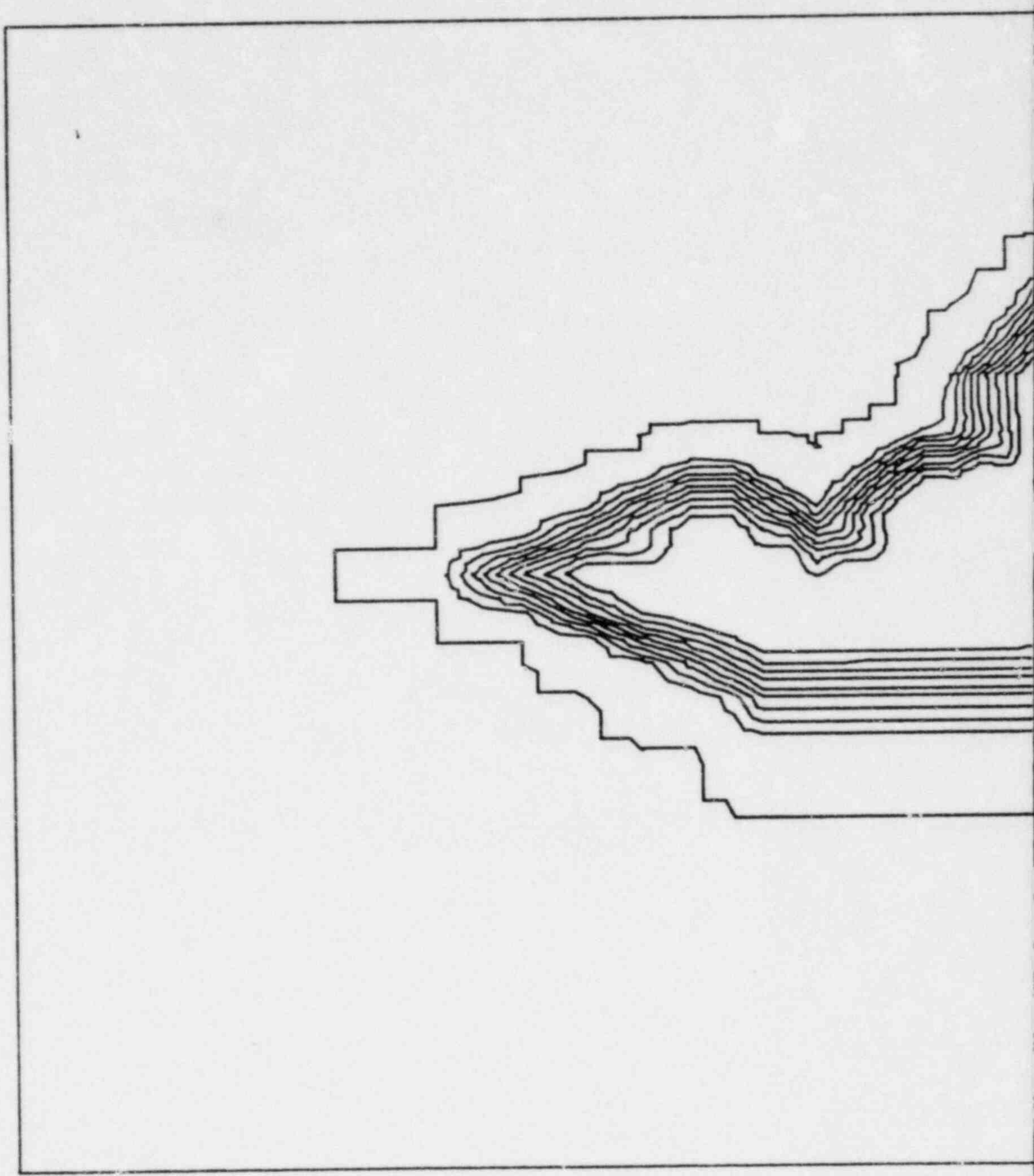


PH LEVELS

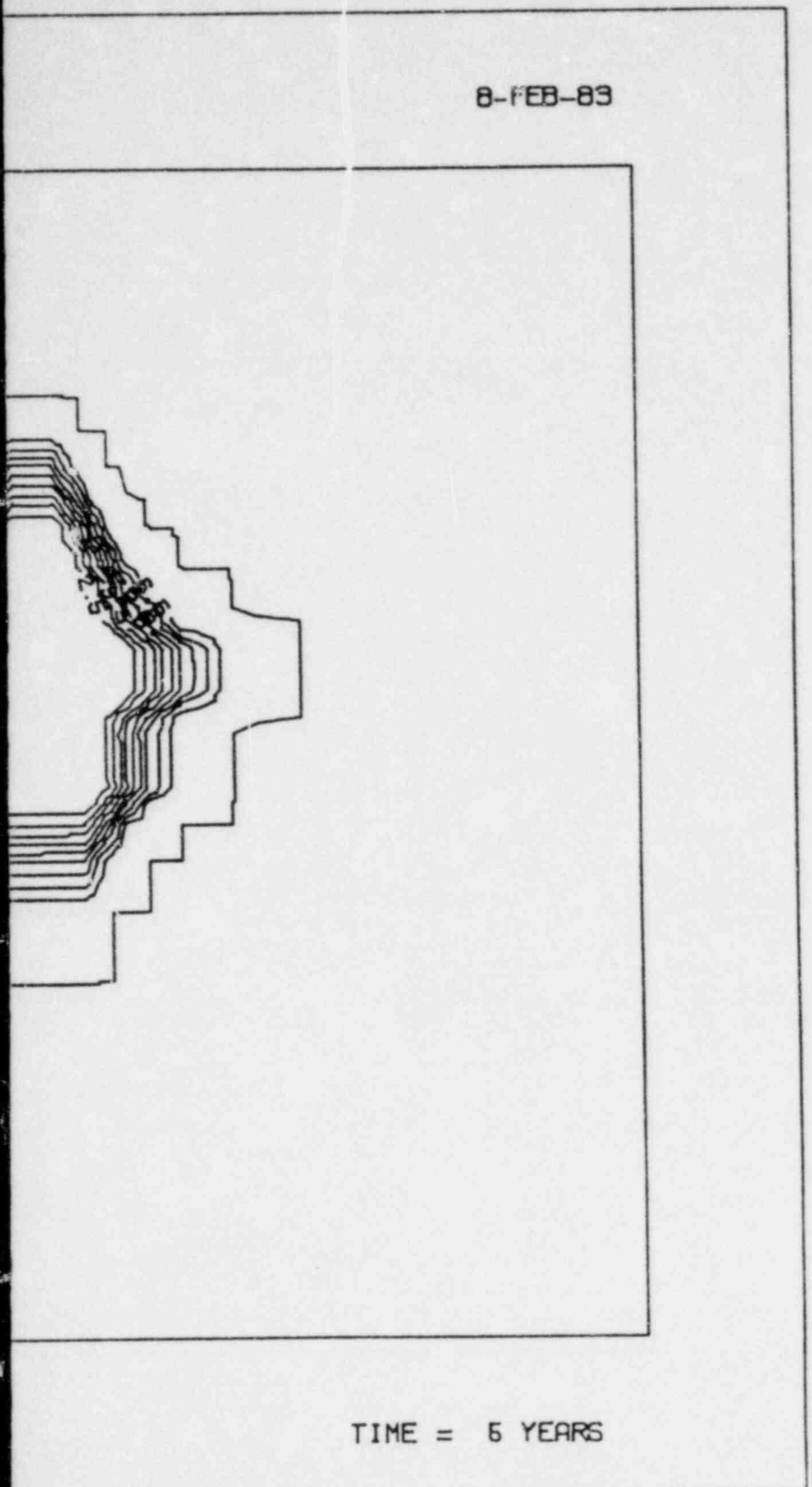
DAMES & MOORE

FIGURE 24

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.65 ML/GM

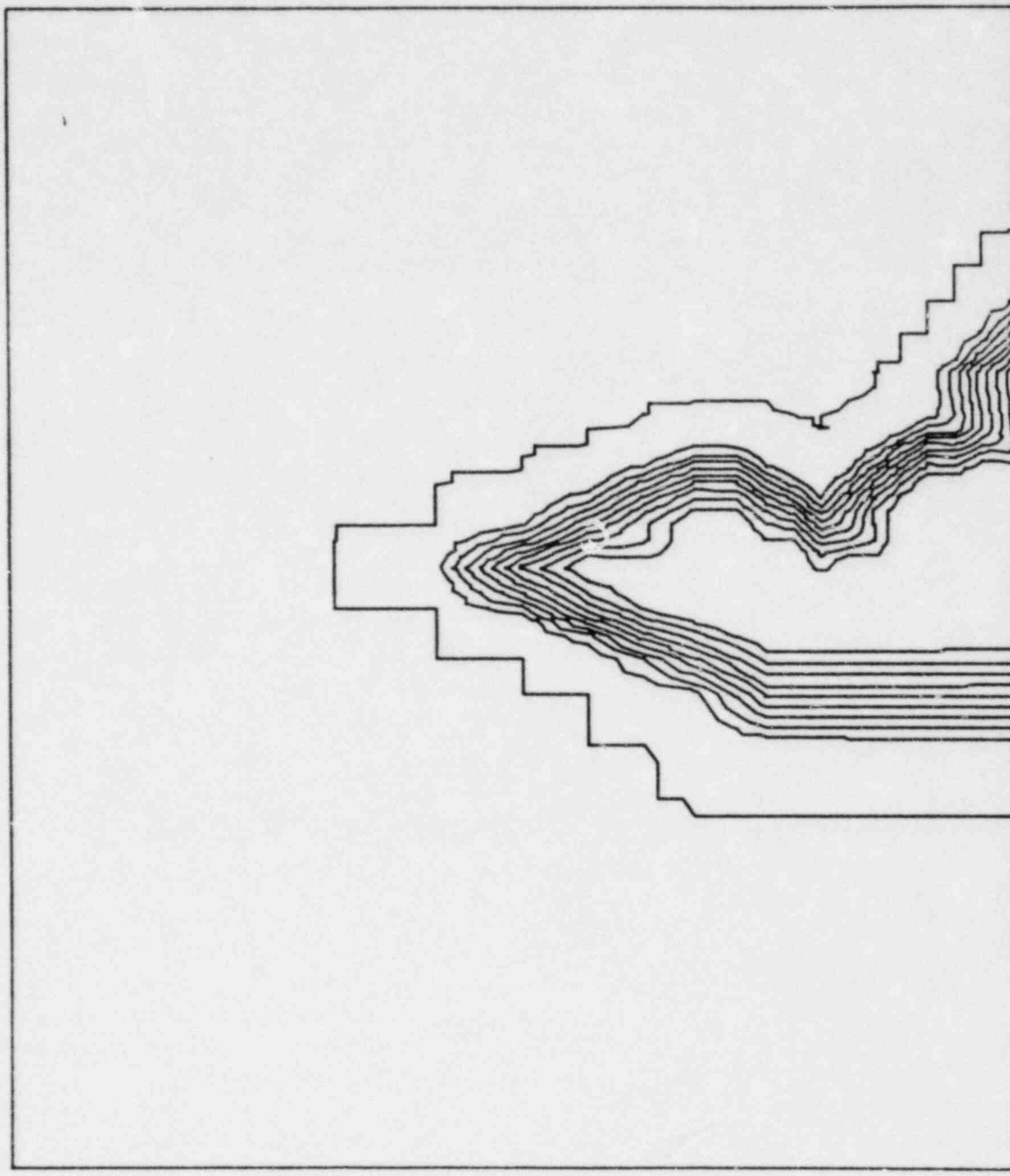


PH LEVELS

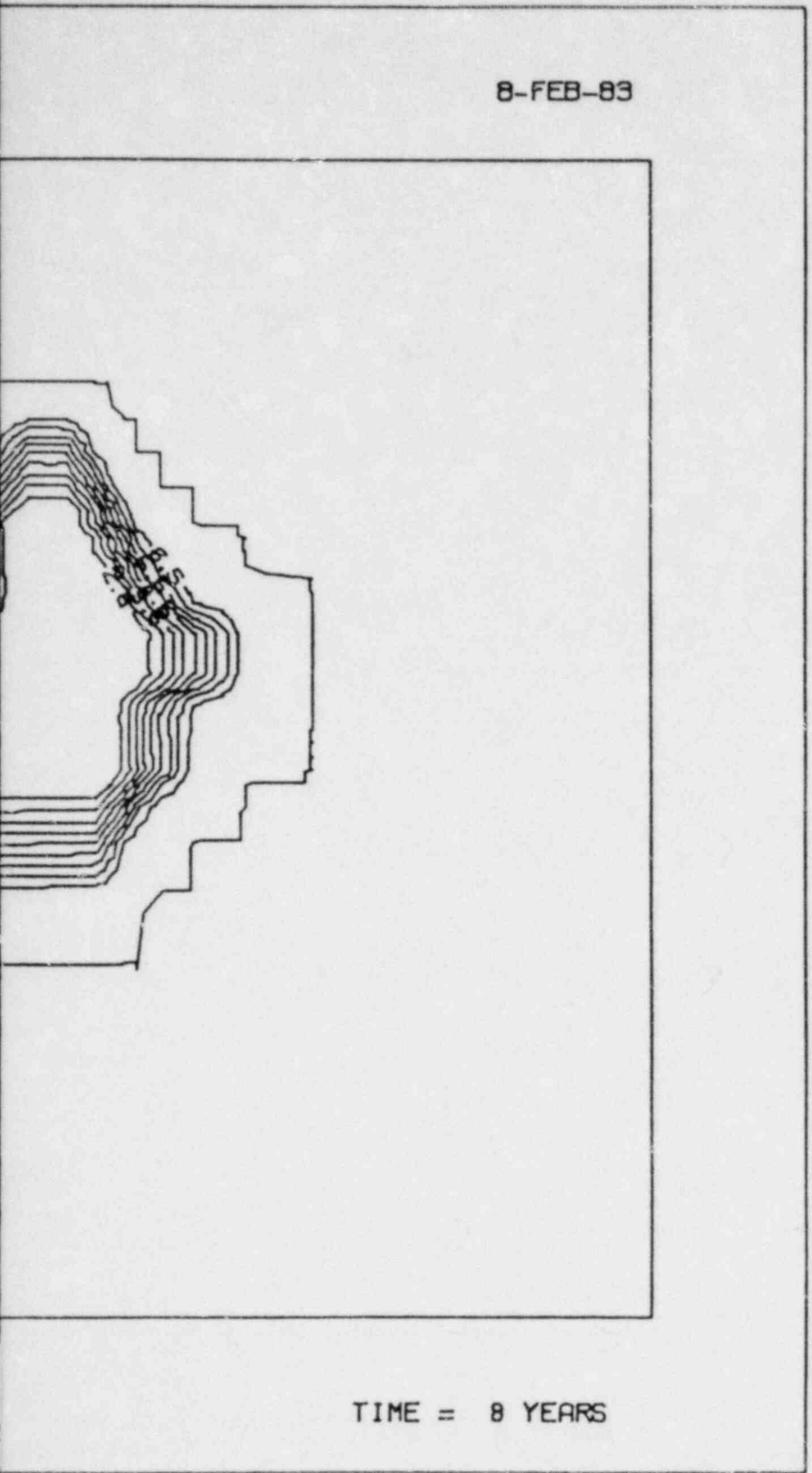
DAMES & MOORE

FIGURE 25

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.65 ML/GM



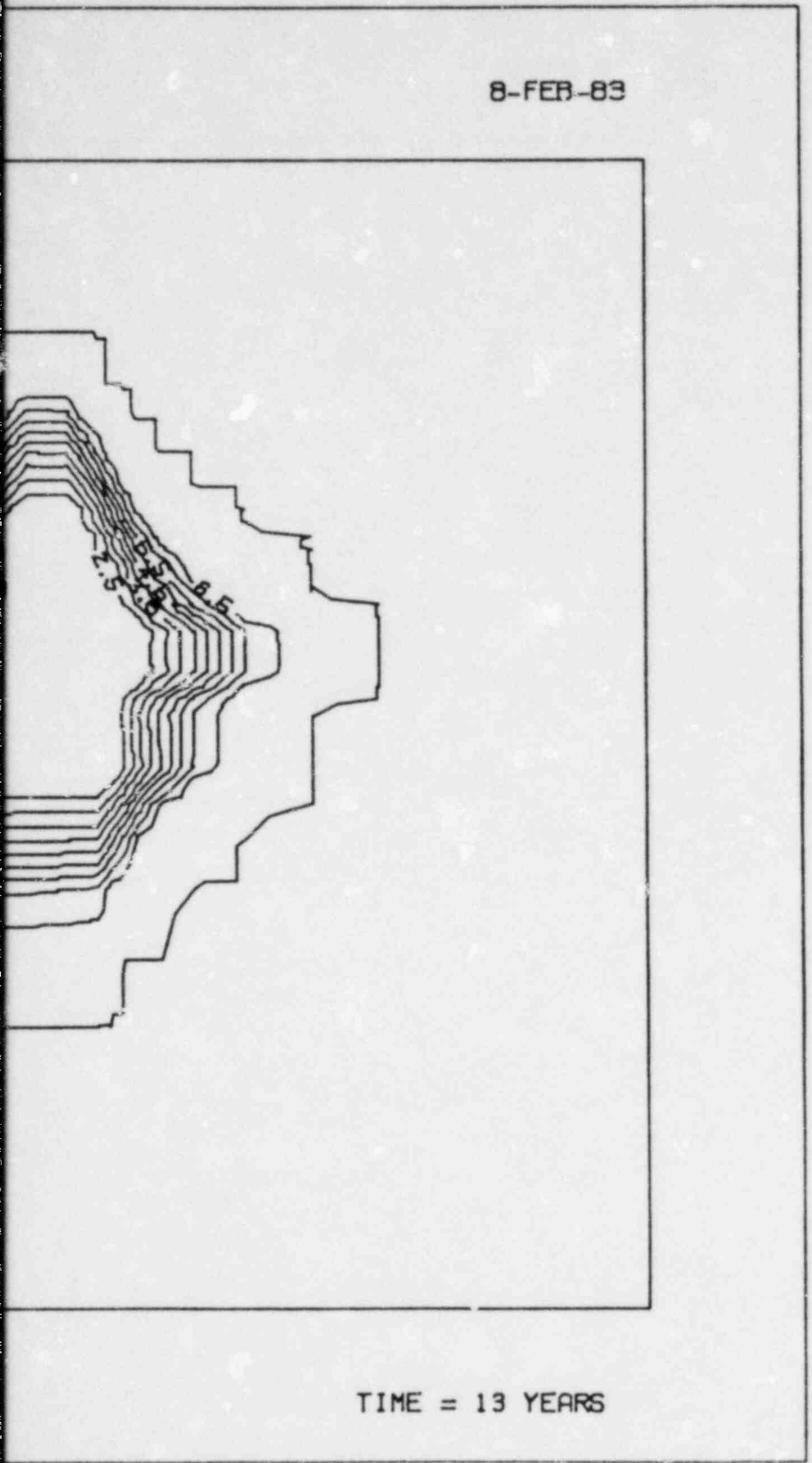
PH LEVELS

DAMES & MOORE

FIGURE 26

CONTOUR INTERVAL = 0.5

ALTERNATE IV - KD = 0.65 ML./GM

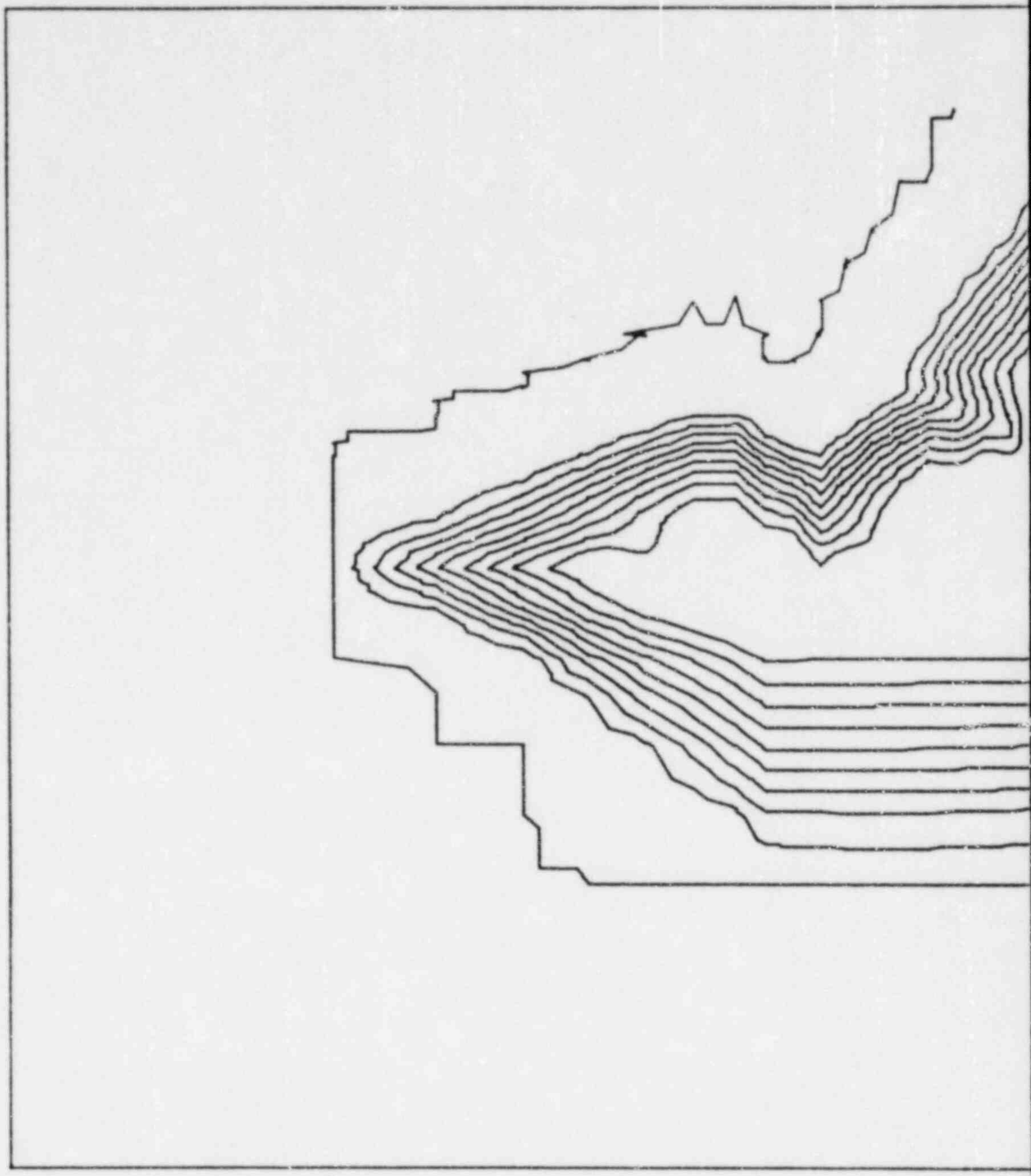


PH LEVELS

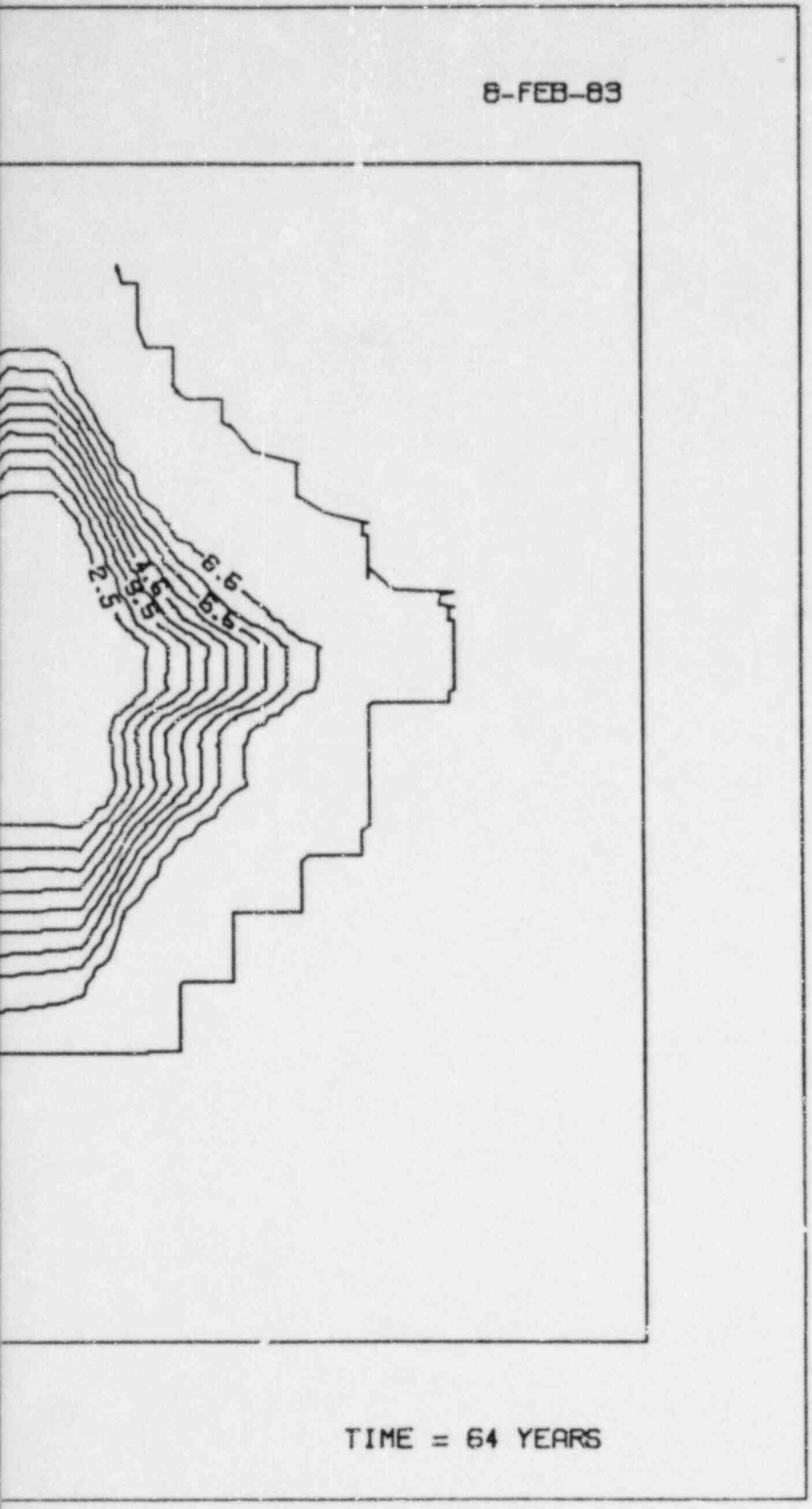
DAMES & MOORE

FIGURE 27

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.65 ML/GM



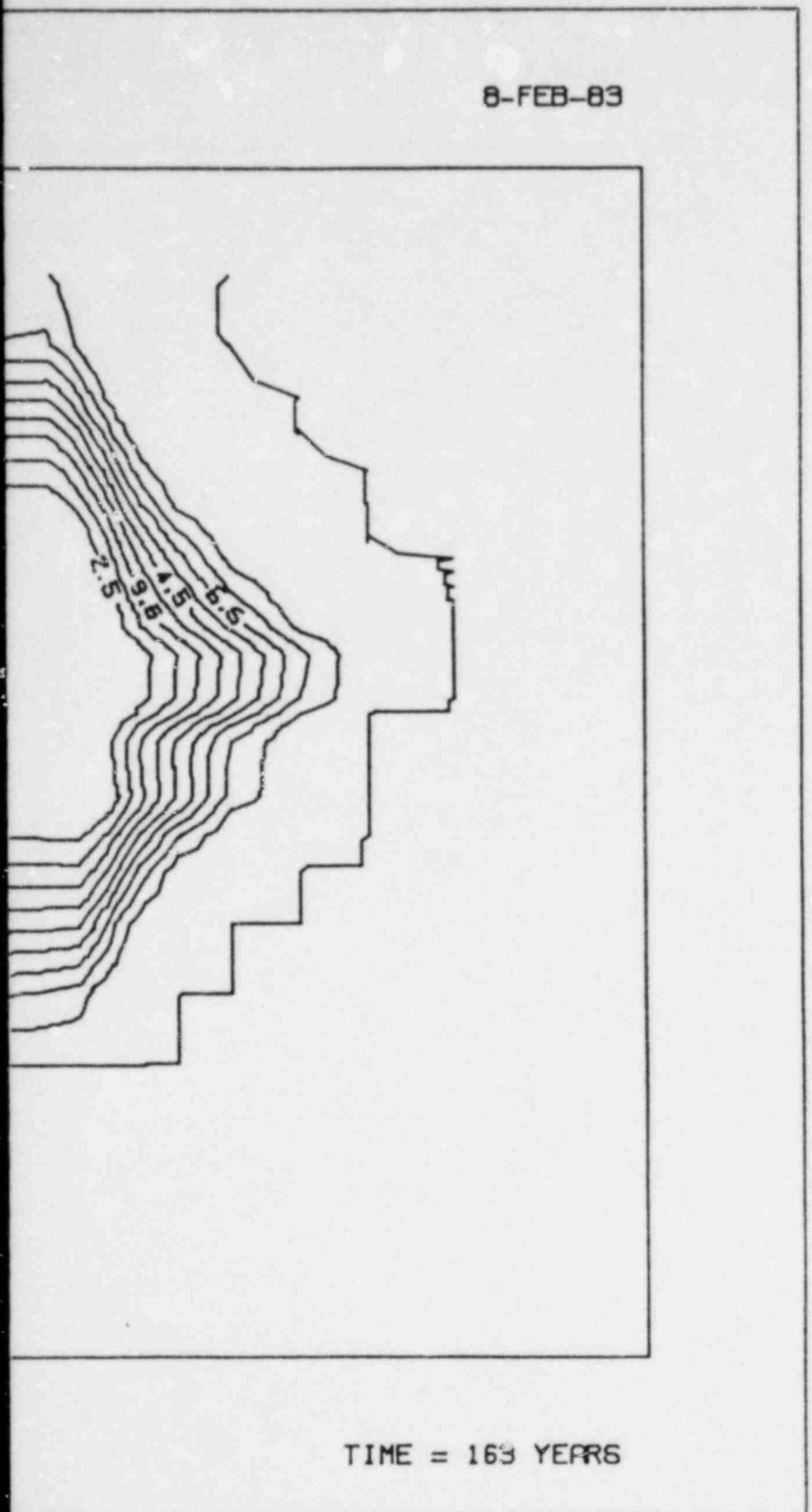
PH LEVELS

DAMES & MOORE

FIGURE 28

CONTOUR INTERVAL = 0.5

ALTERNATE IV - KD = 0.65 ML/GM

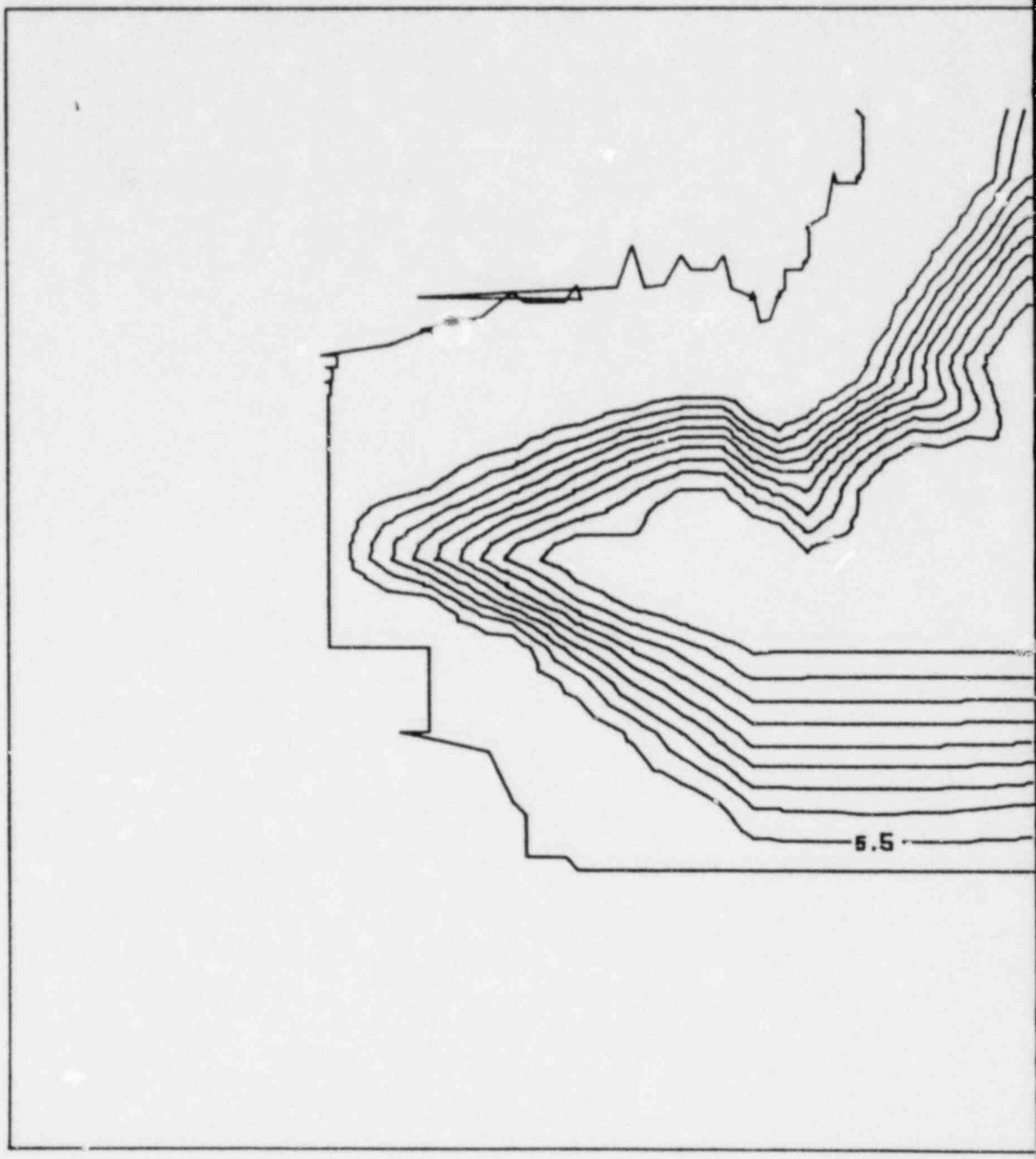


PH LEVELS

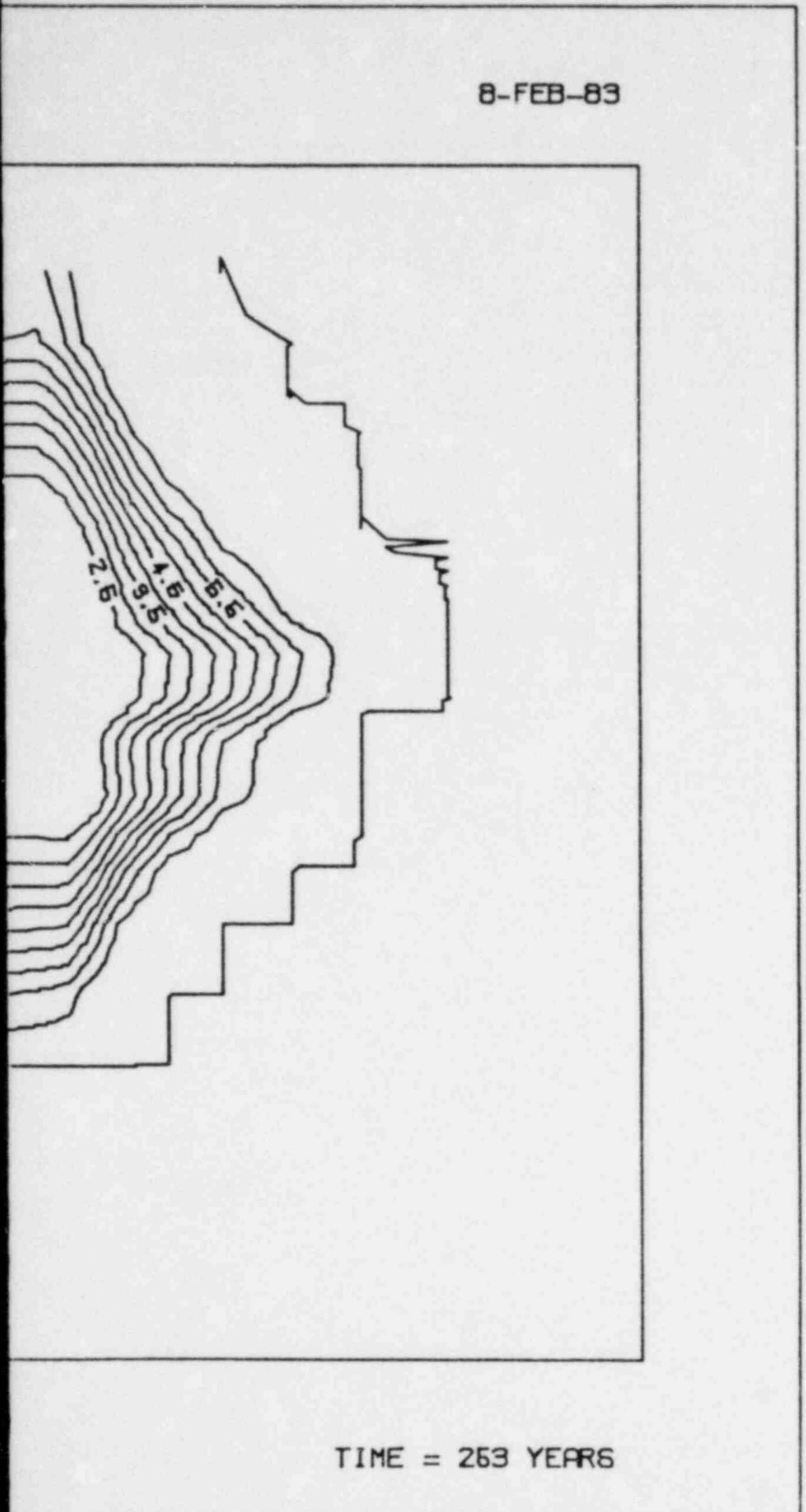
DAMES & MOORE

FIGURE 29

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.66 ML/GM

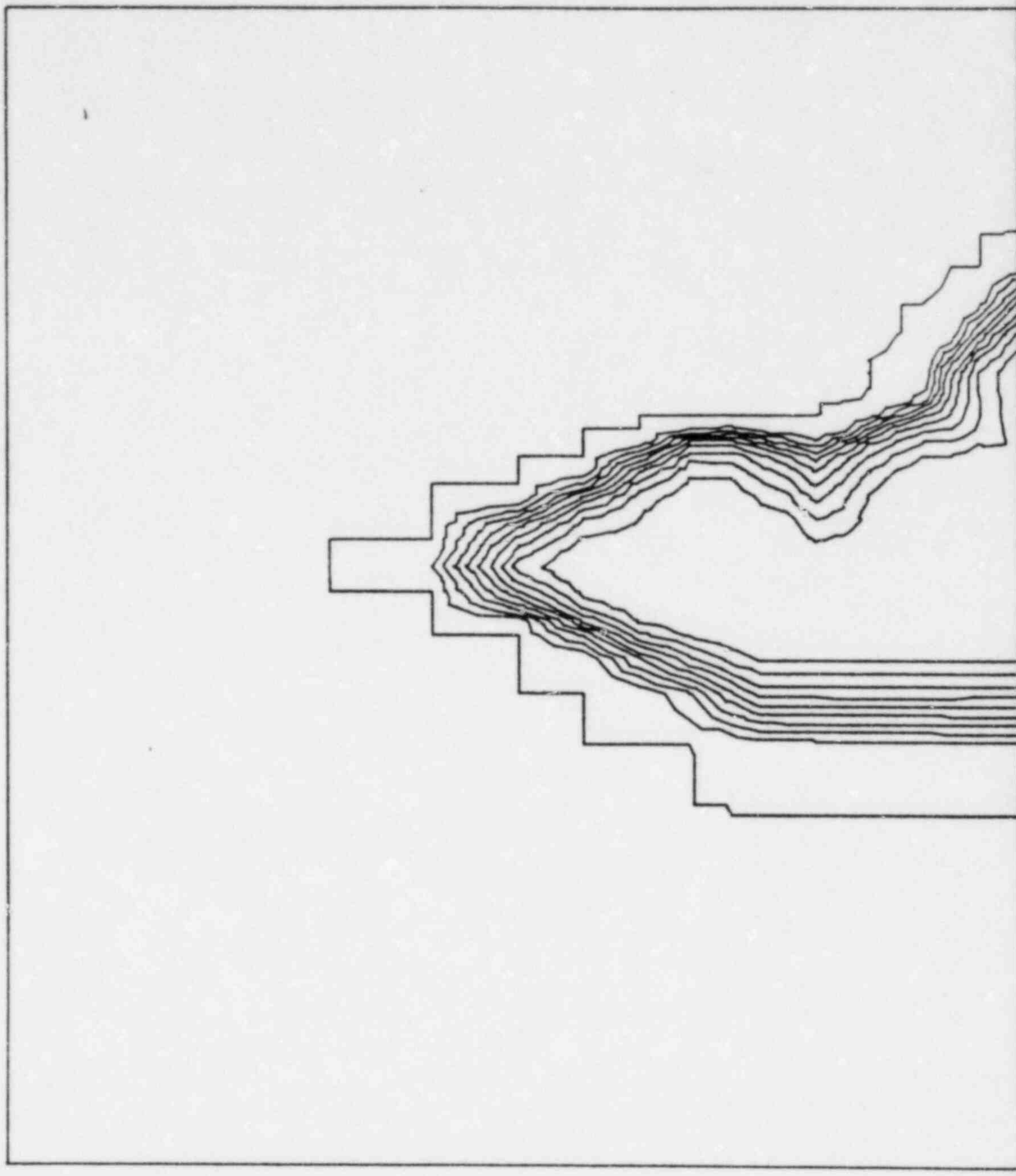


PH LEVELS

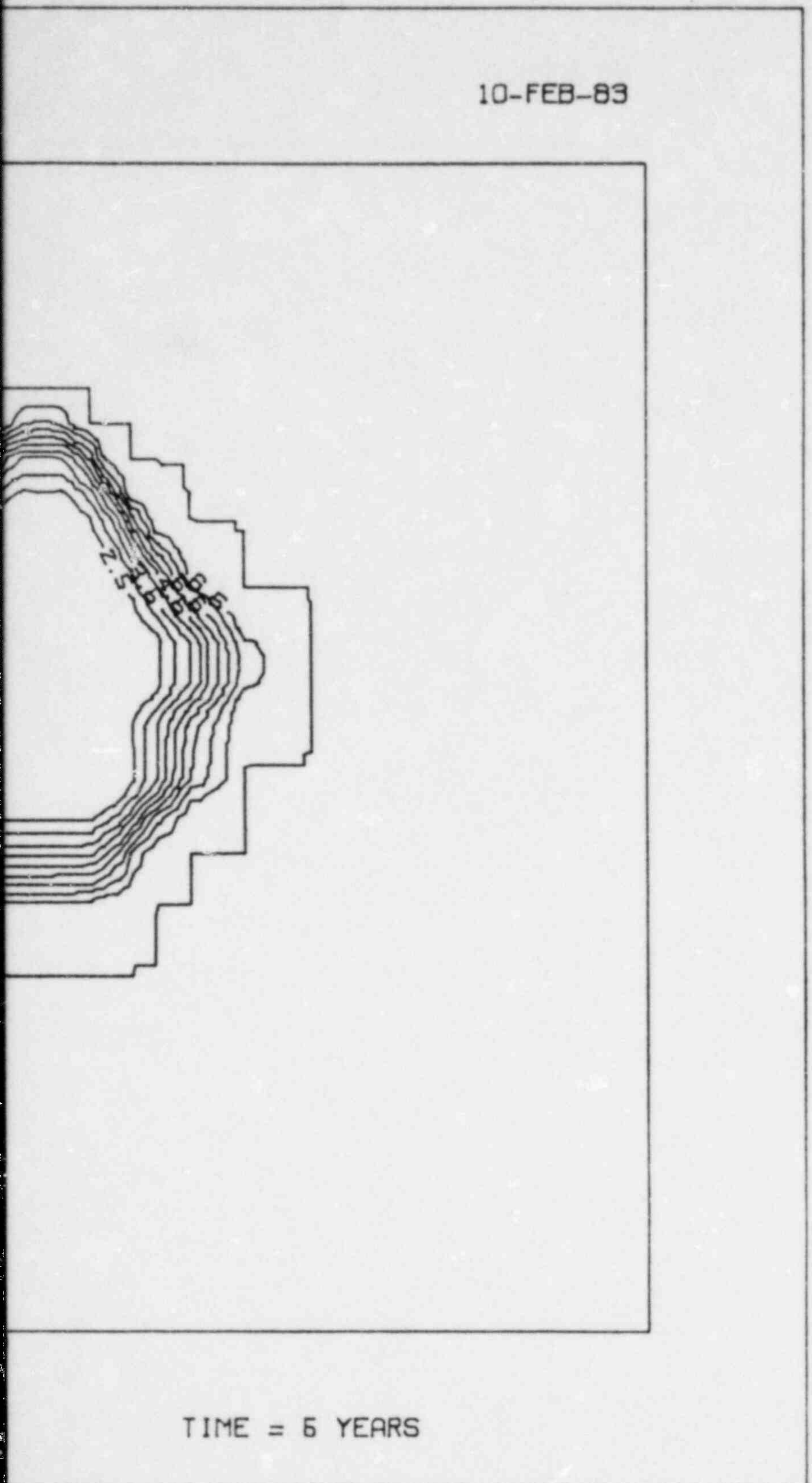
DAMES & MOORE

FIGURE 30

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.0

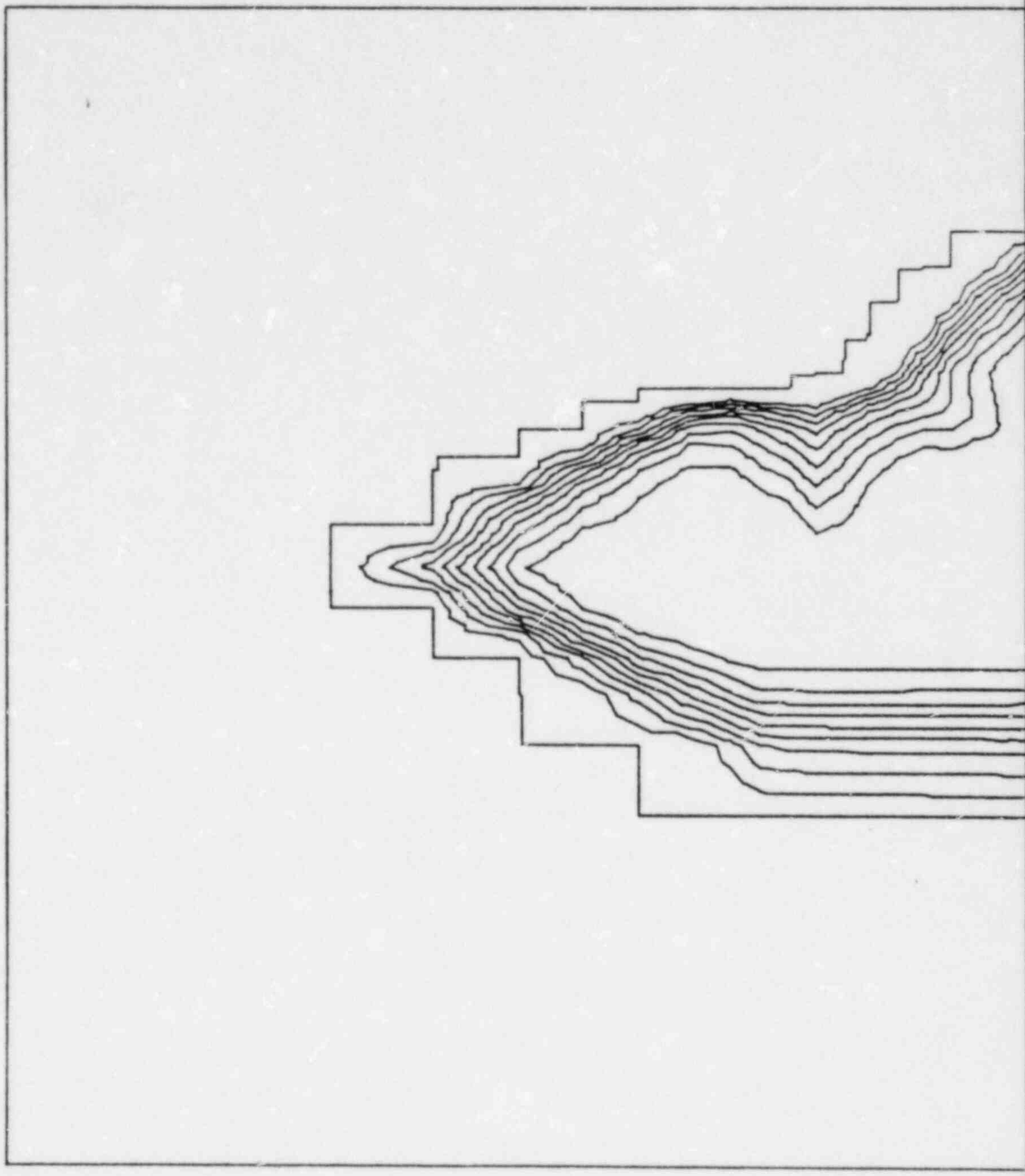


PH LEVELS

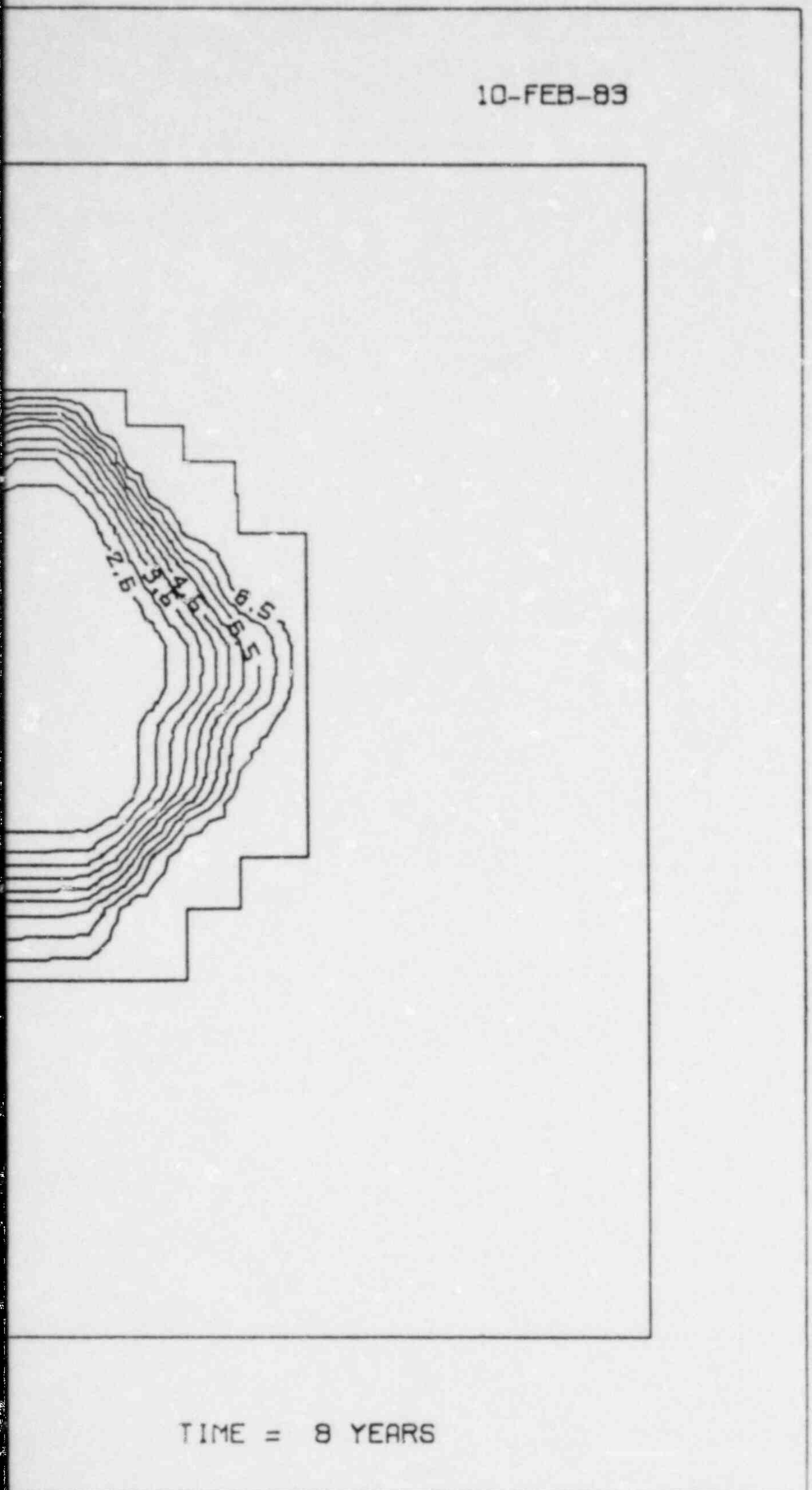
DAMES & MOORE

FIGURE 31

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.0

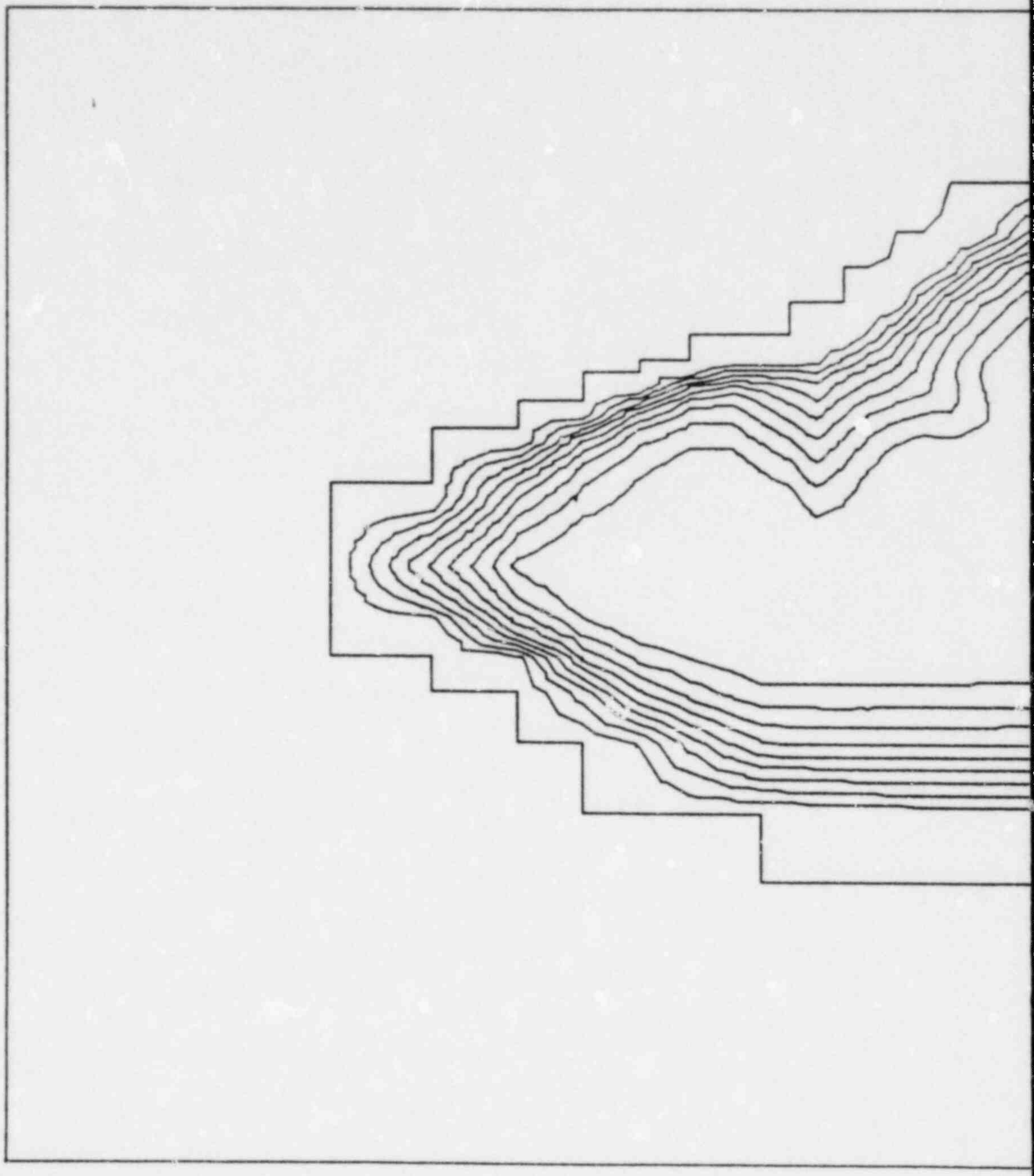


PH LEVELS

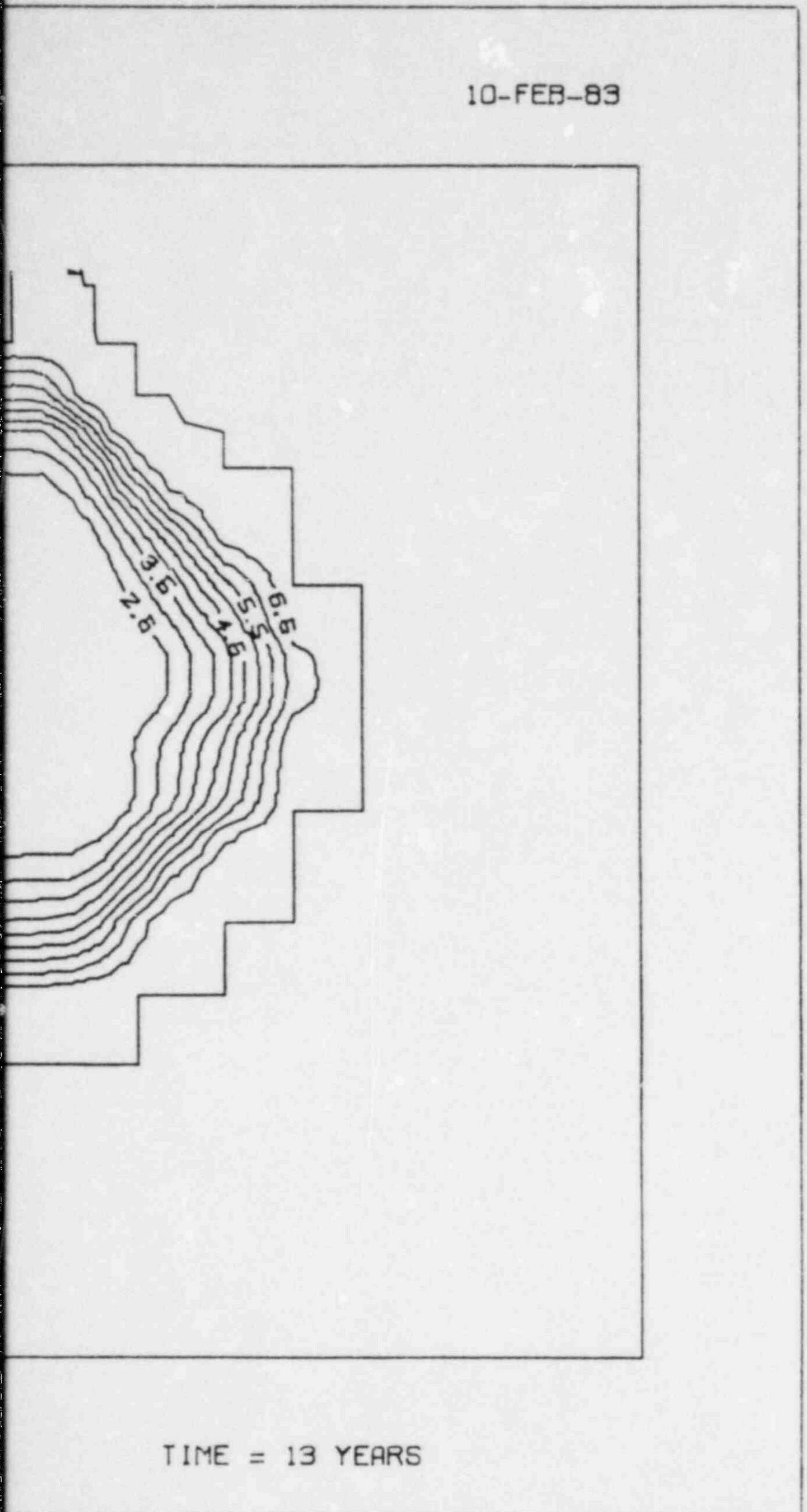
DAMES & MOORE

FIGURE 32

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.0

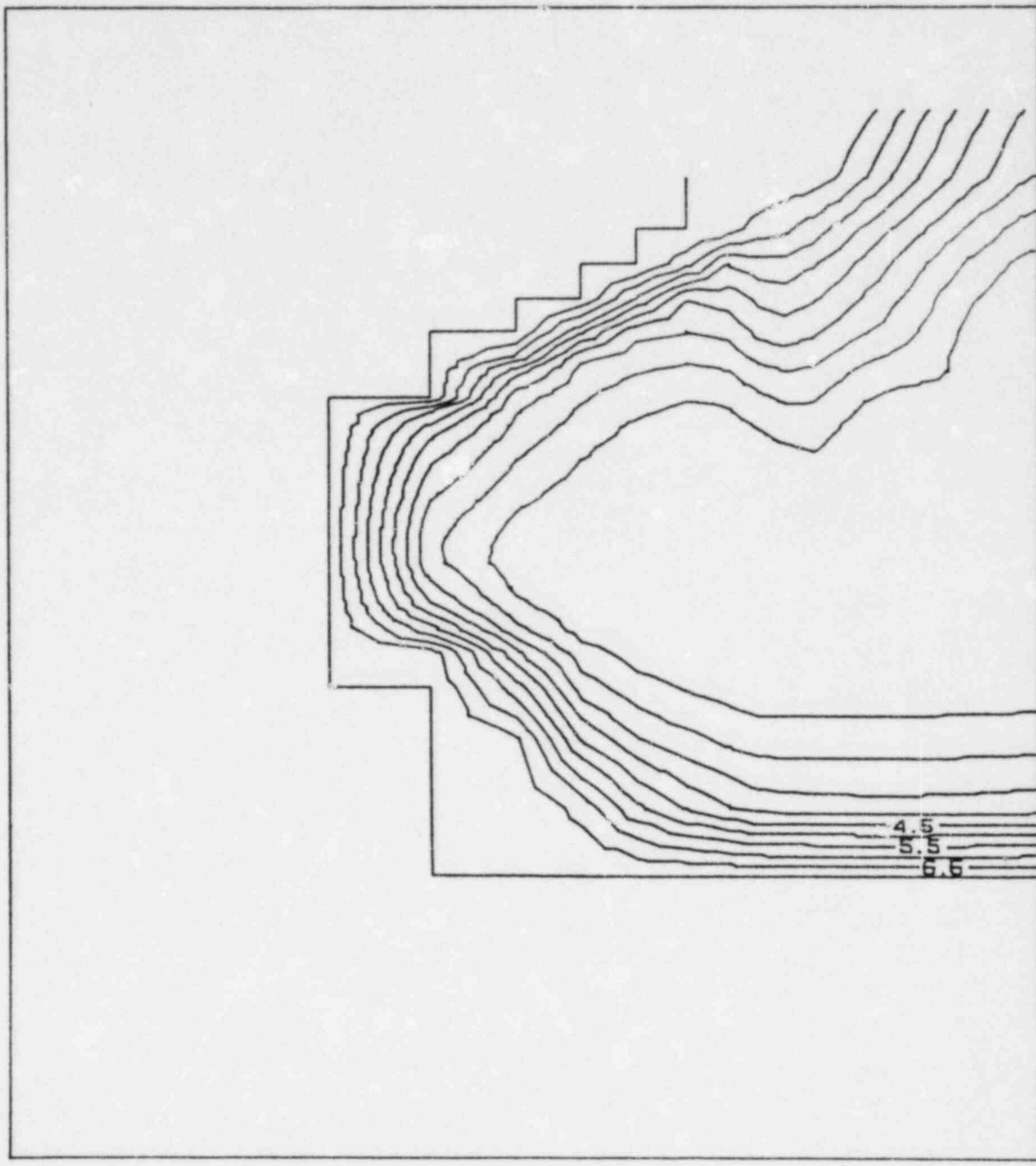


PH LEVELS

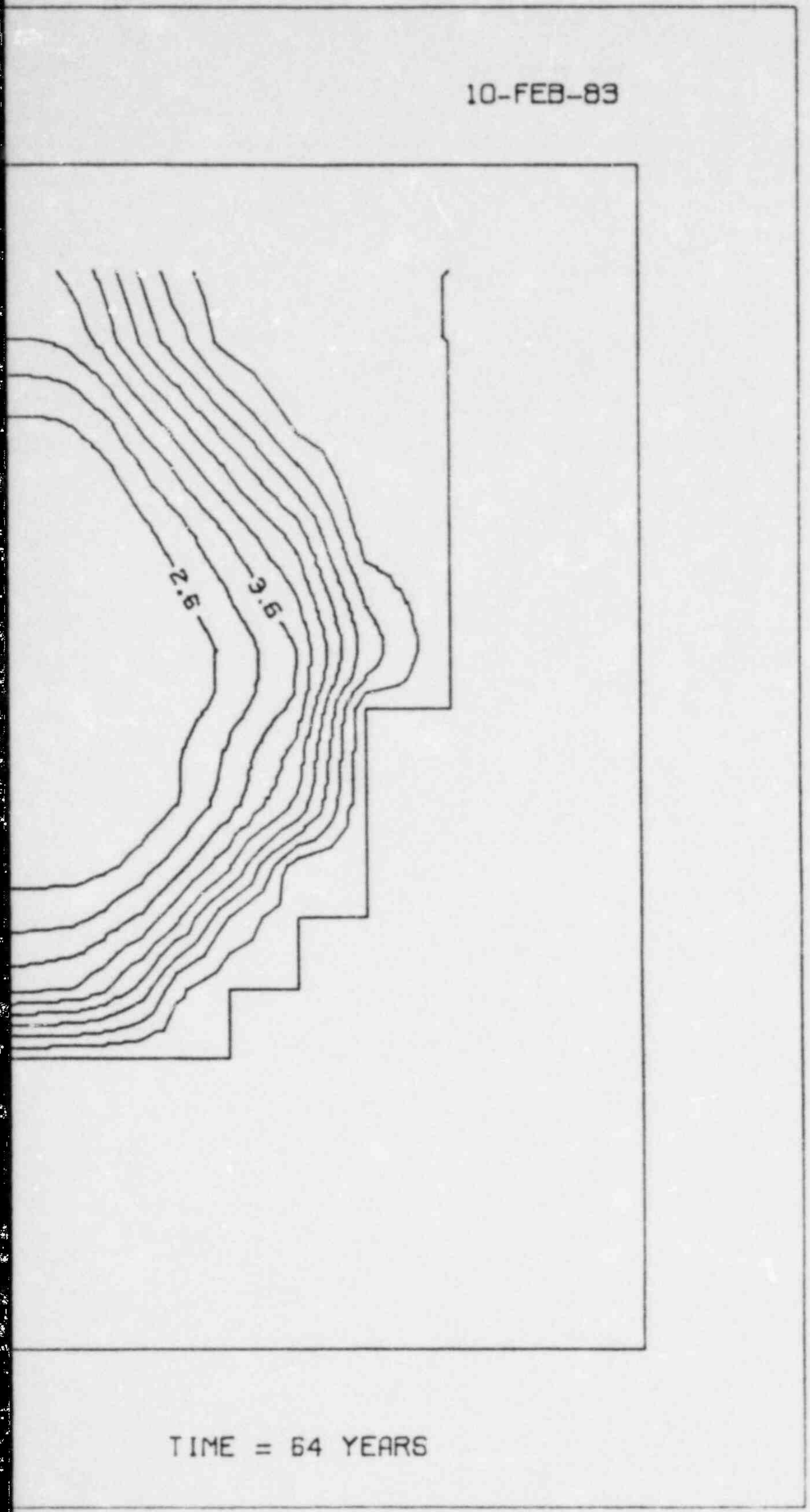
DAMES & MOORE

FIGURE 33

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.0

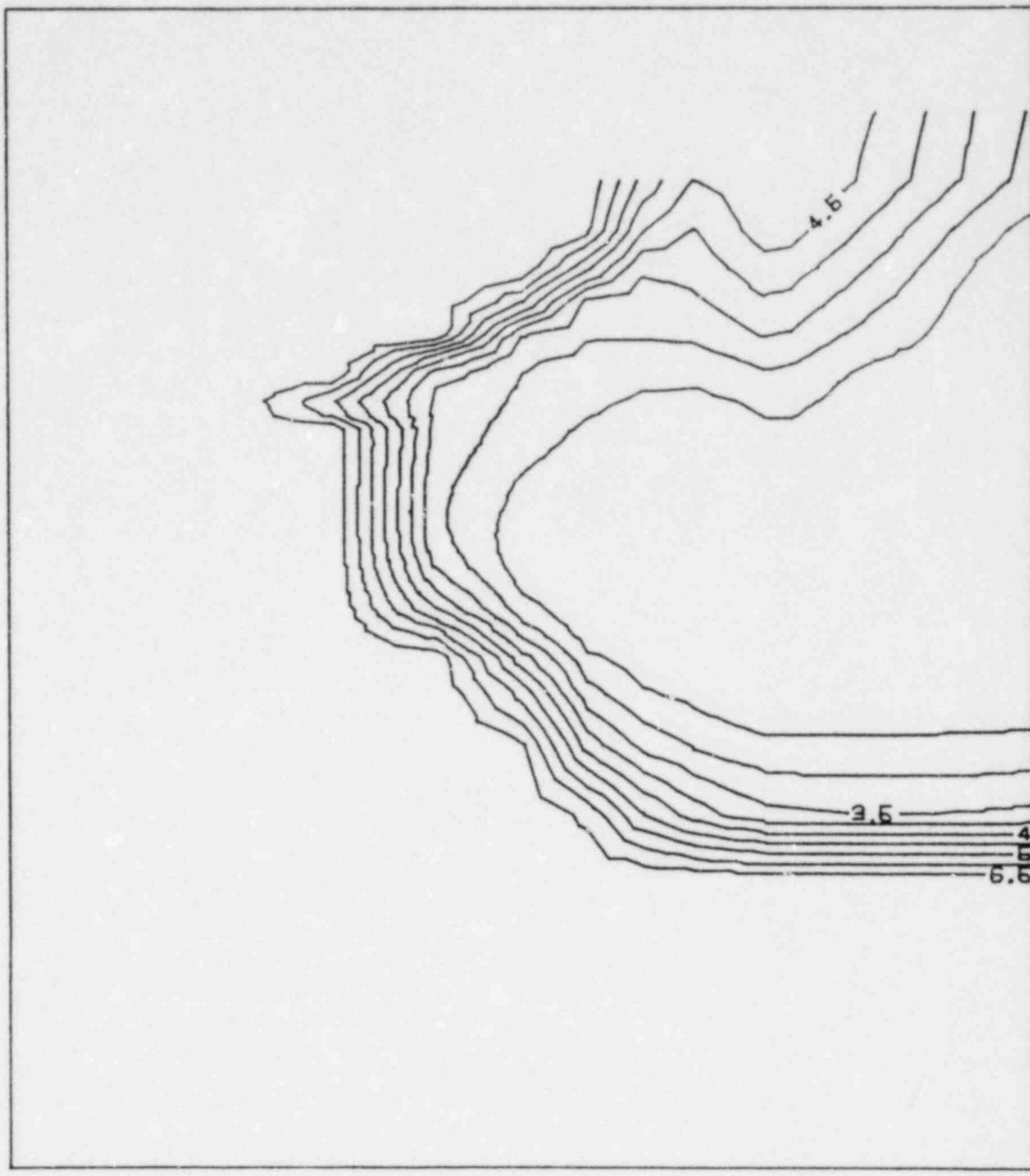


PH LEVELS

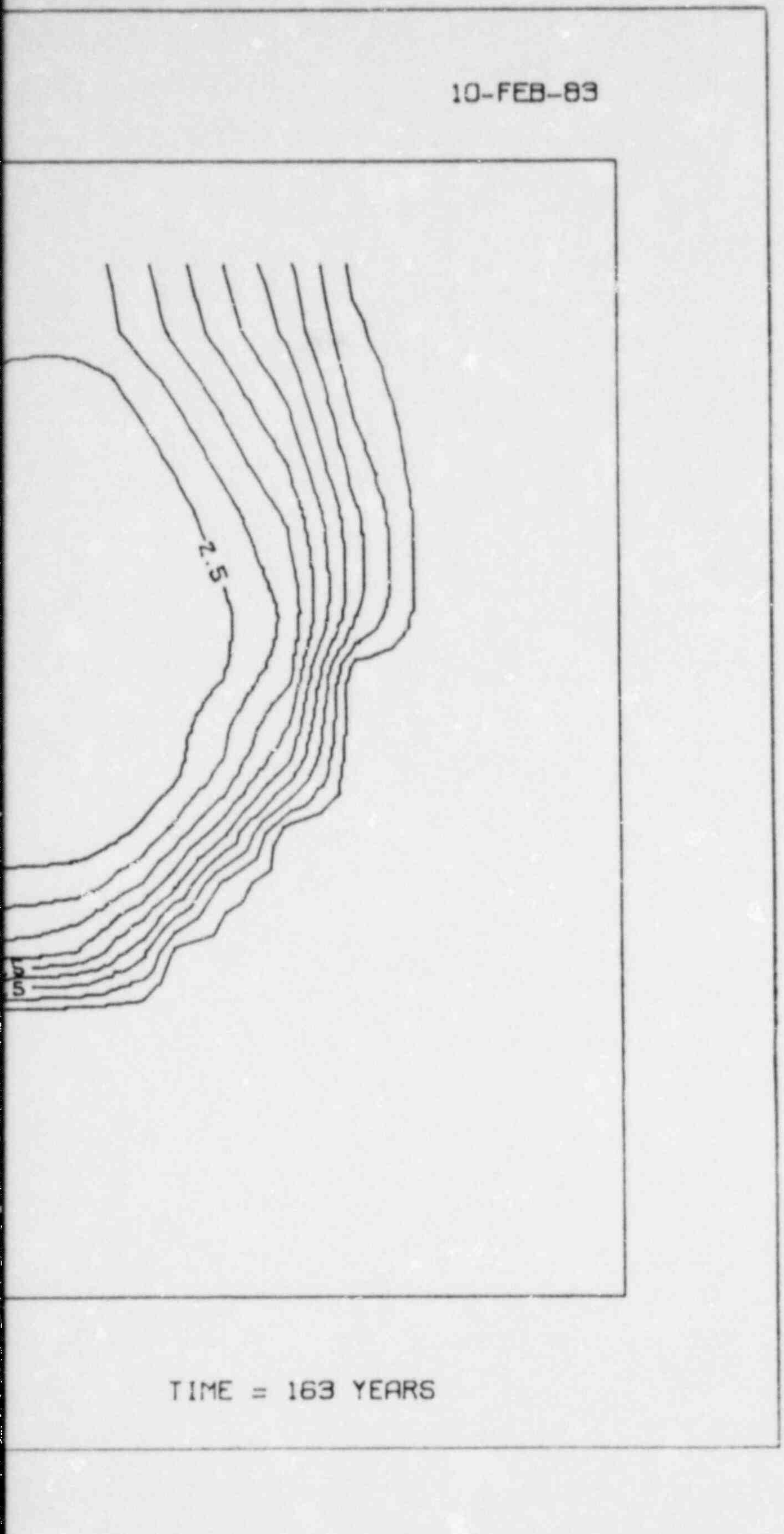
DAMES & MOORE

FIGURE 34

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.0

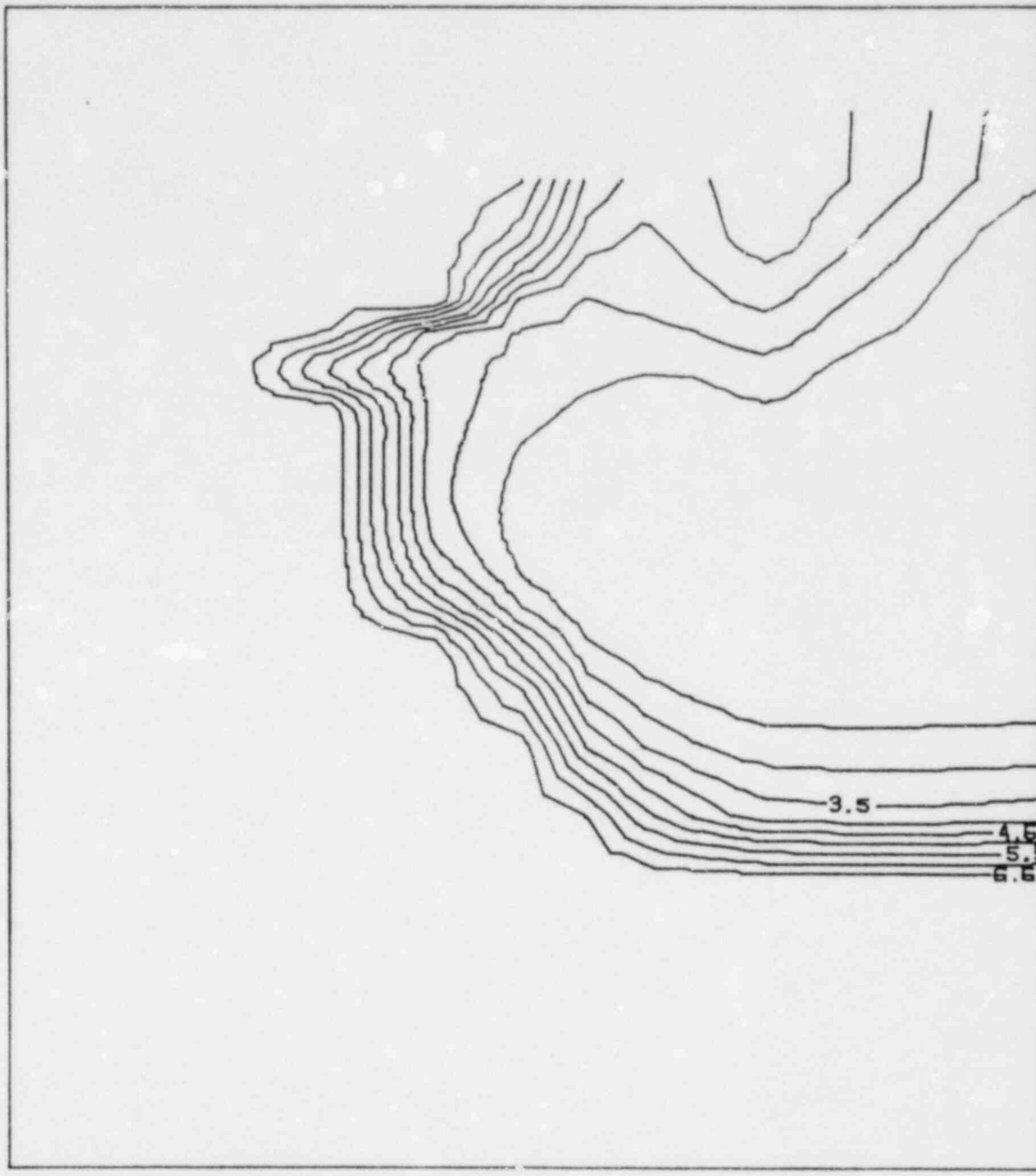


PH LEVELS

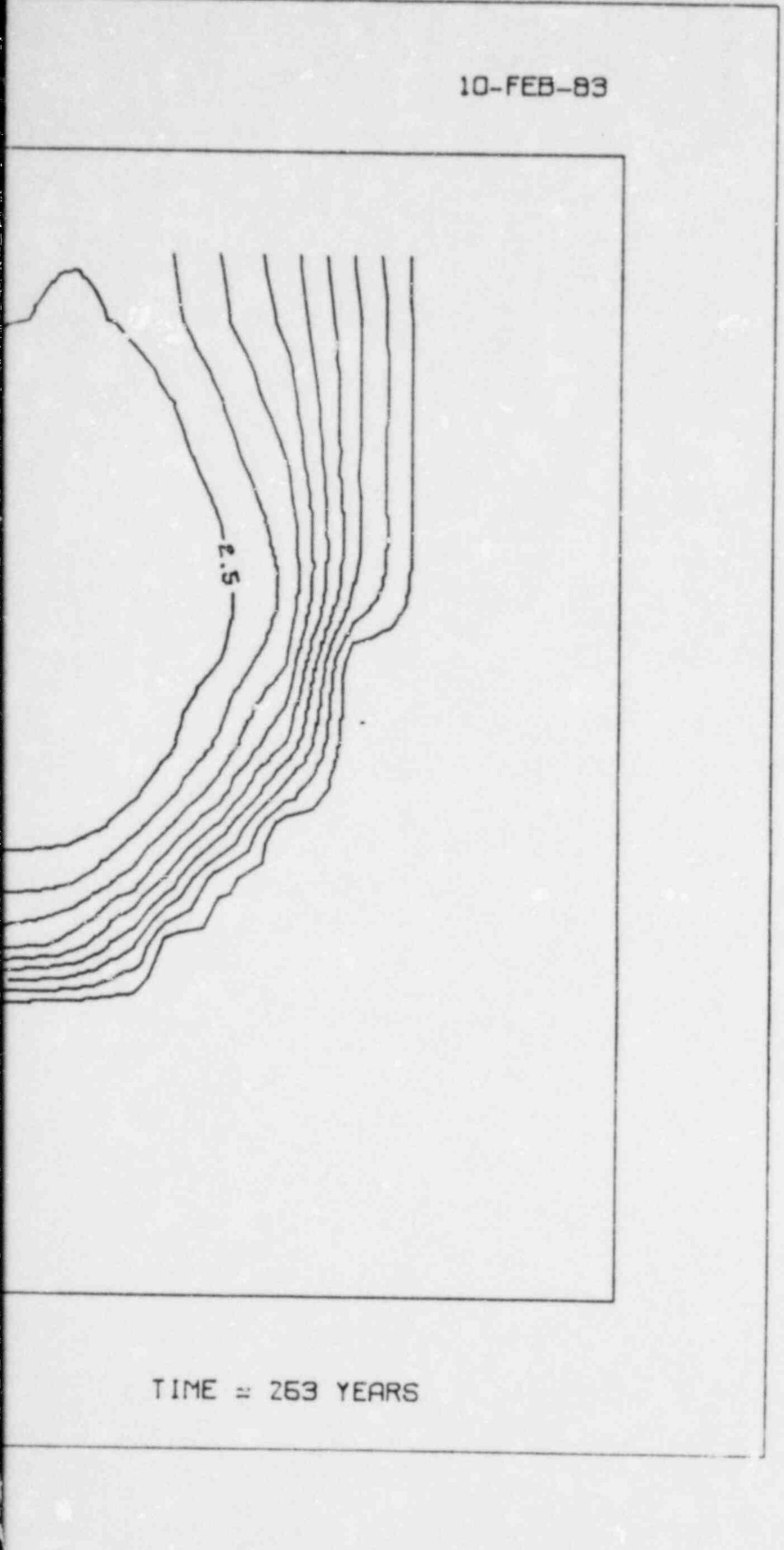
DAMES & MOORE

FIGURE 35

CONTOUR INTERVAL = 0.5



ALTERNATE IV - KD = 0.0



PH LEVELS

DAMES & MOORE

FIGURE 36