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APR 1 1983

Dr. Robert J. Wright
Senior Technical Advisor
High Level Waste Technical
  Development Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Wright:

REQUEST FOR CLARIFICATION OF BWIP SCR (SCR-13)

As requested by your letter dated February 17, 1983, and discussed with you, M. Gordon, M. Webber, NRC; and R. Baca and J. H. LaRue, Rockwell Basalt Project staff on March 9, 1983, the enclosure states the DOE replies to the eight questions which the NRC noted in the subject letter.

If you have any questions covering the enclosed material, please call D. J. Squires of my staff.

D. J. Squires
for O. L. Olson, Project Manager
Basalt Waste Isolation Project Office

BWI:DJS

Enclosure

cc, w/encl: R. Stein, DOE-HQ

00378

These dimensions give a total effective volume of $1.148 \times 10^7 m^3$. Thus, the peak volumetric heat generation rate is:

$$Q = \underset{\{J/sec\}}{(5.355 \times 10^7)} \times \underset{\{sec/yr\}}{(3.154 \times 10^7)}/\underset{\{m^3\}}{1.148 \times 10^7}$$

The time variation of the volumetric heat generation rate is obtained by multiplying the peak value by the appropriate heat generation rate factors (see RHO-BWI-ST-18).

Question #3

Does the heat input into PORFLO neglect end effects of the repository, or are these effects taken into account by the supplied thermal sources.

Reply:

In the PORFLO simulations, the repository is modeled as a region of finite dimensions (as opposed to a line source approximation). Thus, the heat source term is only a function of the effective dimensions of the repository and the decay heat of the waste form. End effects or heat transfer at the ends of the repository are accounted for in the numerical solution of the heat transport equation.

Question #4

Please specify the precise gridding of the PORFLO model in terms of numbers and lengths of grid blocks in the horizontal and vertical directions.

Reply:

The PORFLO model uses a rectangular finite difference grid, an example of which is shown in Figure 1. With reference to this figure, definition of some grid components follows. A simple rectangle determined by the intersection of any two adjacent horizontal grid lines with any two adjacent vertical grid lines is called to grid block. Every intersection of two grid lines determines a node. Each interior (boundary) node is the nodal point of a distinct interior (boundary) grid cell. Each horizontal (vertical) interior cell face is midway between two horizontal (vertical) grid lines. Each horizontal (vertical) boundary cell is symetric about the horizontal (vertical) grid line on which its node lies. A zone is defined as a set of grid cells with the same thermal and hydraulic properties.

By virtue of the solution algorithm employed in PORFLO, the above grid system is sometimes referred to as a staggered grid system. This nomenclature is indicative of the manner in which the code locates the transport variables (i.e., hydraulic head, temperature, and radiocontainment concentration) and velocities (i.e., horizontal and vertical specific discharge). In particular, for a given grid cell each transport varable is defined at the grid node and velocities are defined at the grid cell faces. These relationships are shown in Figure 2 in which:

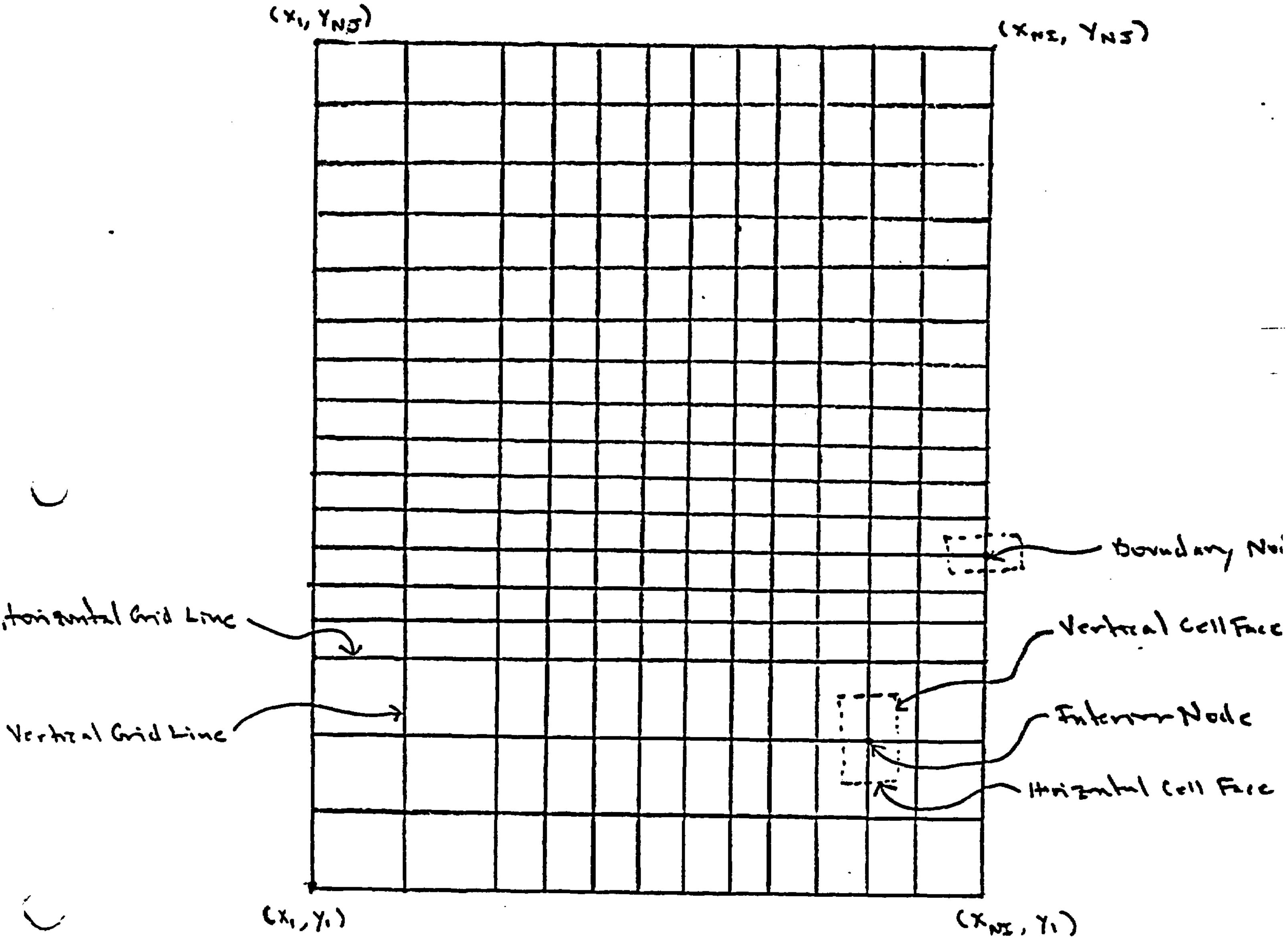
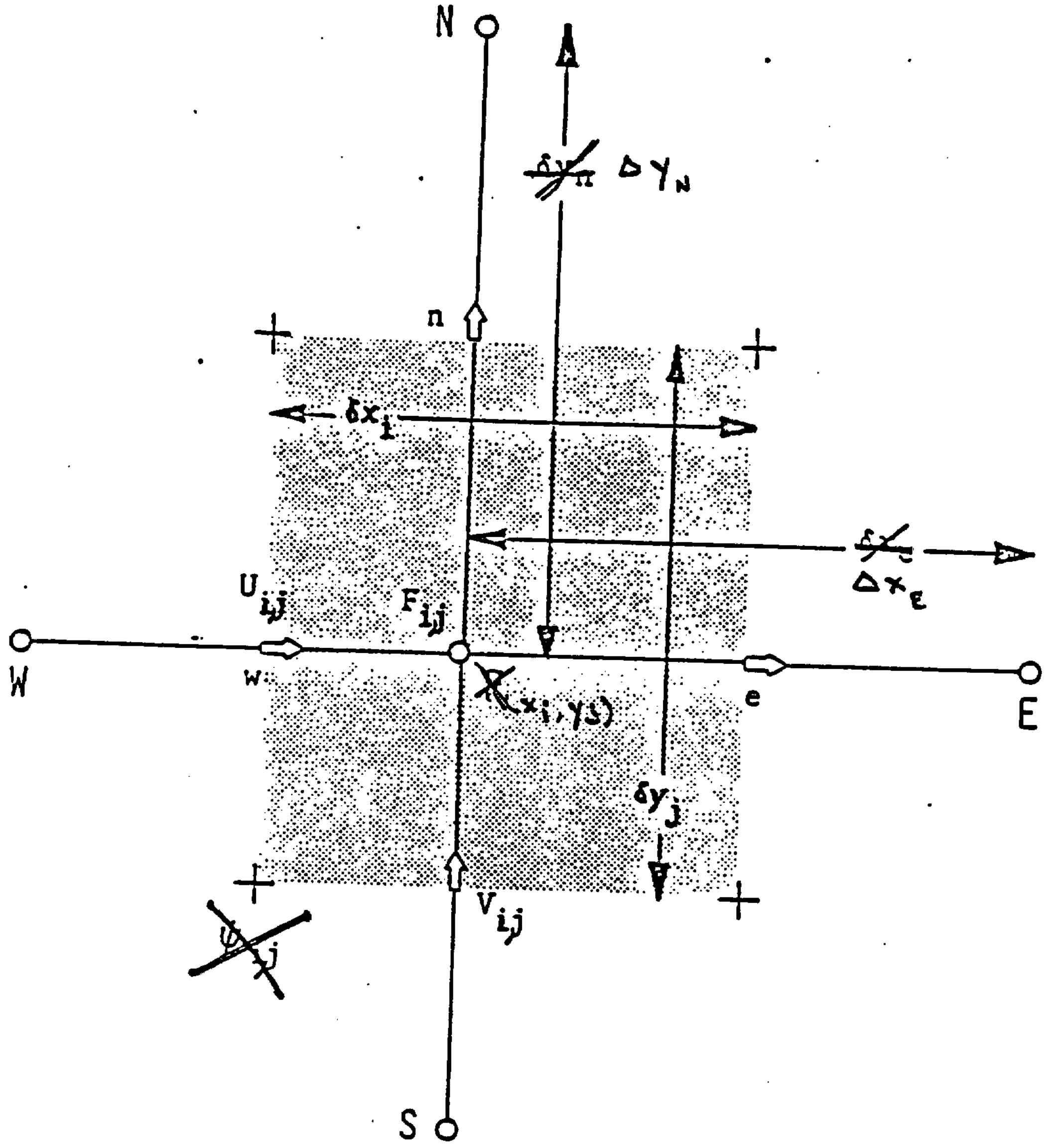


Figure 1

Example Rectangular Finite Difference Grid



~~Fig. 1.1~~

FIGURE ~~[illegible]~~ 2
TYPICAL FINITE DIFFERENCE GRID CELL

~~Fig. E~~

ATTACHMENT

Question #1

Can you supply a format guide for PORFLO along with a listing of the input used in the PORFLO modeling effort that is documented in Chapter 12 of the Basalt Waste Isolation Project (BWIP) Site Characterization Report (SCR). This could eliminate the need for anwsers to questions 2-8.

Reply:

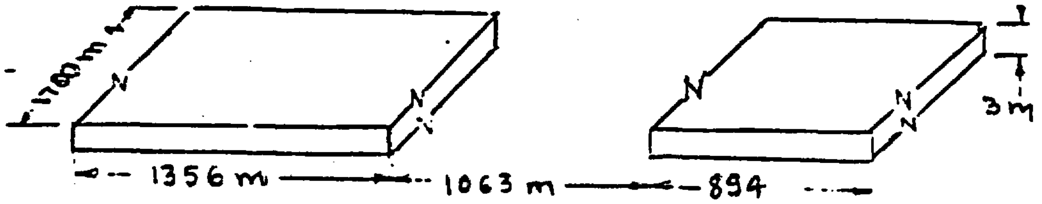
A user's guide for the PORFLO code is currently being prepared which will contain an input format guide. The user's guide will also contain listing of sample input and output results for a set of simulations. Copies of this user's guide will be mailed to the Nuclear Regulatory Commission (NRC) when the document is completed and cleared for general distribution. We expect that the report will be available later this fiscal year. In lieu of this user's guide, we have elected to answer questions 2 thru 8 directly.

Question #2

The heat input from the repository in the PORFLO model, sent by the Department of Energy (DOE) to NRC on December 22, 1982, was given in terms of Joules per year per cubic meter. Does this normalized volume include pillar volumes and the host rock between the two repository halves, does it only include the storage areas pictured in Figure 12-13 (BWIP SCR: Ch. 12), is it the volume of the waste packages themselves, or is it a different volume.

Reply:

In modeling the heat release from the repository, the heat source term was computed for a 47,000 t inventory of 10-yr spent fuel. The initial thermal power output, i.e. power output at t=0, was 53,550 kilowatts. The peak "volumetric" heat generation rate (J/m^3-yr) was computed by dividing the initial thermal power output by the effective volume of the repository, i.e. volume of the two repository halves. The effective dimensions of the repository are shown in the sketch below:



x_i, y_j	is the node at the intersection of the i^{th} vertical grid line and the j^{th} horizontal grid line,
$F_{i,j}$	is a transport variable defined at x_i, y_j
$U_{i,j}$	is the horizontal component of Darcian velocity,
$V_{i,j}$	is the vertical component of Darcian velocity,
Δx	is a grid block width,
Δy	is a grid block height,
δx_i	is the grid cell width, and
δy_j	is the grid cell height.

The x and y coordinate lists (which determine the vertical and horizontal grid line locations respectively) as used in the base case repository performance simulations reported in the BWIP SCR are shown in two tables. These tables are Table 1 and Table 2 giving the x and y coordinates in asending order for the Umtanum and Cohassett grid systems. Note that all grid block and grid cell dimensions are determined by the coordinate lists.

Table 3 and Table 4 contain stratigraphic zone definitions for the Umtanum and Cohassett basecase simulations respectively. A zone, which is in general a collection of grid cells, is not necessarily rectangular in shape, and more fundamentally, is not necessarily connected. In these two particular cases, all zones are rectangular and connected with the exception that the repository zone in both instances is composed of two disconnected rectangles. Definition of a connected rectangular segment of a zone is accomplished by specifying the following four indices in order:

i) index of the x-coordinate of the node in the lower left-hand corner,

ii) index of the y-coordinate of the node in the lower left-hand corner,

iii) index of the x-coordinate of the node in the upper right-hand corner, and

iv) index of the y-coordinate of the node in the upper right-hand corner.

Note that in the tables, the nodal indices defining a zone are followed by the name of the layer to which the zone corresponds, the effective thickness of the layer in meters, and the borehole from which the effective thickness was derermined.

As a final comment, it is noteworthy that Tables 1, 2, 3, and 4 are reproduced from listings of the actual PORFLO input streams as used to generate results for the SCR.

Question #5

Are the hydraulic conductivities used in the PORFLO model referenced to a specific temperature or the ambient temperatures encountered at depth. If a reference temperature is used, what is this temperature.

Reply:

The hydraulic conductivities are referenced with respect to the ambient temperature at depth. The temperature profile was assumed to be linear, increasing with depth. The equation for the linear variation of temperature was based on a geothermal gradient of 40°C/km and a reference temperature of 57°C at the level of the repository in the Umtanum.

Question #6

Does PATH (the particle tracking program used in Chapter 12 with PORFLO) interpolate groundwater velocities between adjacent nodes or does it allow for step changes in velocity between adjacent nodes. If interpolation is used, is it linear or does it follow another function (please specify).

Reply:

As described in the reply to question 5, the PORFLO grid system is based on representation where the velocity components are defined at the faces of the grid cell. The horzontal velocities are defined at the left and right faces only, whereas, the vertical velocities are defined at the top and bottom faces of the grid cell. The PATH code uses this same grid system. The particle tracking algorithm is somewhat complex, however, it uses bilinear interpolation within a grid cell to obtain the velocity components. In general, the finite difference grid is specifically selected so as to assure a smooth transition in the potentiometric field, which in turn assures a gradual variation in the dominant velocity component.

Question #7

Where does the geothermal gradient (40°C/km) begin in the PORFLO model (eg., at the ground surface, 20 m below, or at the regional water table). What is the temperature, depth and pressure at the repository nodes prior to thermal production by the HLW?

Reply:

The initial temperature profile in the PORFLO simulations varies linearly from the top to the bottom of the grid according to a geothermal gradient of 40°C/km. A reference temperature of 57°C is specified at the repository level in the Umtanum. Thus, within the grid the temperature at any depth (from ground surface) can be computed from:

$$T(z) = 10.6 + 0.04\ z$$

where z is in meters.

The PORFLO code uses a "head-based" formulation (see Baca, and others, 1981) for the groundwater flow equation. This approach is more convenient for nonisothermal conditions and where the hydraulic head data is referenced to the insitu temperature. In addition, it avoids the numerical problems (errors) inherent in the numerical solution of the "pressure-based" formulation, often used in the petroleum reservoir simulation models. These numerical problems can be particularly significant in cases where the natural head gradients are relatively small, eg. 10^{-3} or less, such as we find in the basalt. In any case, the fluid pressure (gage) can be computed from the following relation:

$$P = \rho^{*}gh - g\int_{a}^{b} \rho\, dz$$

where h: hydraulic head,m
p: pressure, Pa
ρ^{*}: reference fluid density, eg. ρ at 20°C, kg/m^3
ρ: fluid density, kg/m^3.
g: acceleration of gravity (9.8), m/sec^2

The vertical head profile can be obtained from Figure 5-41 on page 5.1-72 of the SCR.

Attached are a series of temperatures (T) and head (h) contour plots which give an indication of the time variations, of T and h around the repository.

Reference: R. G. Baca, D. W. Langford, and R. L. England, 1981, "Analysis of Host Rock Performance for a Nuclear Waste Repository Using Flow and Transport Models," RHO-BWI-SA-140.

Question #8

What is the initial hydraulic gradient beneath the repository.

Reply:

The horizontal gradient below the Umtanum was assumed to be 10^{-3} m/m whereas the vertical gradient was assumed to be zero.

Table 1

X and Y Coordinates for Umtanum Basecase Grid

```
GRID 120 BY 104
X COORDINATES = -3500.0  -3300.0  -3100.0  -2900.0  -2700.0
        -2500.0  -2300.0  -2150.0  -2050.0  -1975.0  -1925.0
        -1897.5  -1877.5  -1857.5  -1830.0  -1780.0  -1730.0
        -1680.0  -1630.0  -1580.0  -1530.0  -1480.0  -1430.0
        -1380.0  -1330.0  -1280.0  -1230.0  -1180.0  -1130.0
        -1080.0  -1030.0  -980.00  -930.00  -880.00  -830.00
        -780.00  -730.00  -680.00  -630.00  -580.00  -561.50
        -541.50  -521.50  -500.00  -450.00  -400.00  -350.00
        -300.00  -250.00  -200.00  -150.00  -100.00  -50.000
         0.0000   50.000   100.00   150.00   200.00   250.00
         300.00   350.00   400.00   450.00   500.00   521.50
         541.50   561.50   600.00   650.00   700.00   750.00
         800.00   850.00   900.00   950.00   1000.0   1050.0
         1100.0   1150.0   1200.0   1250.0   1300.0   1320.0
         1340.0   1395.5   1415.5   1435.5   1470.0   1520.0
         1570.0   1620.0   1670.0   1720.0   1770.0   1820.0
         1870.0   1920.0   1970.0   2020.0   2070.0   2120.0
         2170.0   2220.0   2270.0   2320.0   2370.0   2420.0
         2470.0   2520.0   2570.0   2620.0   2670.0   2720.0
         2770.0   2820.0   2870.0   2920.0   2970.0   3020.0
         3070.0

Y COORDINATES = -1625.00 -1575.00 -1525.00 -1475.00 -1425.00
       -1375.0  -1325.0  -1275.0  -1250.0  -1225.0  -1204.7
       -1191.7  -1180.9  -1173.9  -1166.9  -1163.45 -1161.45
       -1159.95 -1158.45 -1156.95 -1154.95 -1152.4  -1149.4
       -1146.4  -1143.4  -1139.4  -1136.4  -1133.4  -1130.4
       -1127.3  -1123.3  -1119.3  -1115.3  -1111.3  -1107.3
       -1103.3  -1099.3  -1095.3  -1090.0  -1085.0  -1080.0
       -1075.0  -1068.1
       -1062.5  -1056.5  -1052.0  -1047.7  -1045.5  -1038.3
       -1034.9  -1030.9  -1022.0  -1014.0  -1005.6  -1000.6
       -994.90  -989.90  -984.00  -977.80  -972.80  -968.80
       -966.80  -962.80  -957.00  -951.10  -947.10  -942.60
       -938.60  -930.00  -919.70
       -914.50  -910.5   -900.00  -888.00
       -875.00  -863.30  -858.10  -852.90  -840.00  -827.20
       -821.00  -815.00  -809.40  -806.40  -803.40  -789.30
       -786.30  -783.30  -767.00  -750.90  -747.50  -744.10
       -734.00  -725.20  -717.00  -708.80  -683.90
       -680.90  -677.90  -668.00  -664.60  -661.20
       -632.90  -629.90
```

Table 2

X and Y Coordinates for Cohassett Basecase Grid

```
GRID 120 BY 98
X COORDINATES = -3500.0  -3300.0  -3100.0  -2900.0  -2700.0
        -2500.0  -2300.0  -2150.0  -2050.0  -1975.0  -1925.0
        -1897.5  -1877.5  -1857.5  -1830.0  -1780.0  -1730.0
        -1680.0  -1630.0  -1580.0  -1530.0  -1480.0  -1430.0
        -1380.0  -1330.0  -1280.0  -1230.0  -1180.0  -1130.0
        -1080.0  -1030.0  -980.00  -930.00  -880.00  -830.00
        -780.00  -730.00  -680.00  -630.00  -580.00  -561.50
        -541.50  -521.50  -500.00  -450.00  -400.00  -350.00
        -300.00  -250.00  -200.00  -150.00  -100.00  -50.000
         0.0000   50.000   100.00   150.00   200.00   250.00
         300.00   350.00   400.00   450.00   500.00   521.50
         541.50   561.50   600.00   650.00   700.00   750.00
         800.00   850.00   900.00   950.00   1000.0   1050.0
         1100.0   1150.0   1200.0   1250.0   1300.0   1320.0
         1340.0   1395.5   1415.5   1435.5   1470.0   1520.0
         1570/0   1620.0   1670.0   1720.0   1770.0   1820.0
         1870.0   1920.0   1970.0   2020.0   2070.0   2120.0
         2170.0   2220.0   2270.0   2320.0   2370.0   2420.0
         2470.0   2520.0   2570.0   2620.0   2670.0   2720.0
         2770.0   2820.0   2870.0   2920.0   2970.0   3020.0
         3070.0

Y COORDINATES = -1425.0  -1375.0  -1325.0  -1275.0  -1225.0
        -1200.0  -1175.0  -1150.0  -1125.0  -1100.0  -1080.0
        -1060.0  -1050.0  -1042.0  -1037.3  -1035.9  -1029.9
        -1024.0  -1018.0  -1012.0  -1006.1  -1000.1  -995.40
        -989.40  -986.00  -982.00  -978.00  -975.00  -973.00
        -971.50  -970.00  -968.50  -966.50  -964.00  -961.00
        -958.00  -955.00  -951.10  -947.10  -942.60  -938.60
        -934.60  -930.60  -926.60  -922.60  -919.70
        -914.50  -910.5   -900.00  -888.00
        -875.00  -863.30  -858.10  -852.90  -840.00  -827.20
        -821.00  -815.00  -809.40  -806.40  -803.40  -789.30
        -786.30  -783.30  -767.00  -750.90  -747.50  -744.10
        -734.00  -725.20  -717.00  -708.80  -683.90
        -680.90  -677.90  -668.00  -664.60  -661.20
        -632.90  -629.90
        -626.90  -605.00  -583.40  -576.400 -569.40  -551.00
        -533.50  -530.50  -527.50  -525.30  -521.90  -518.50
        -513.70  -505.90  -497.90  -476.60  -456.10  -446.50
```

Table 3

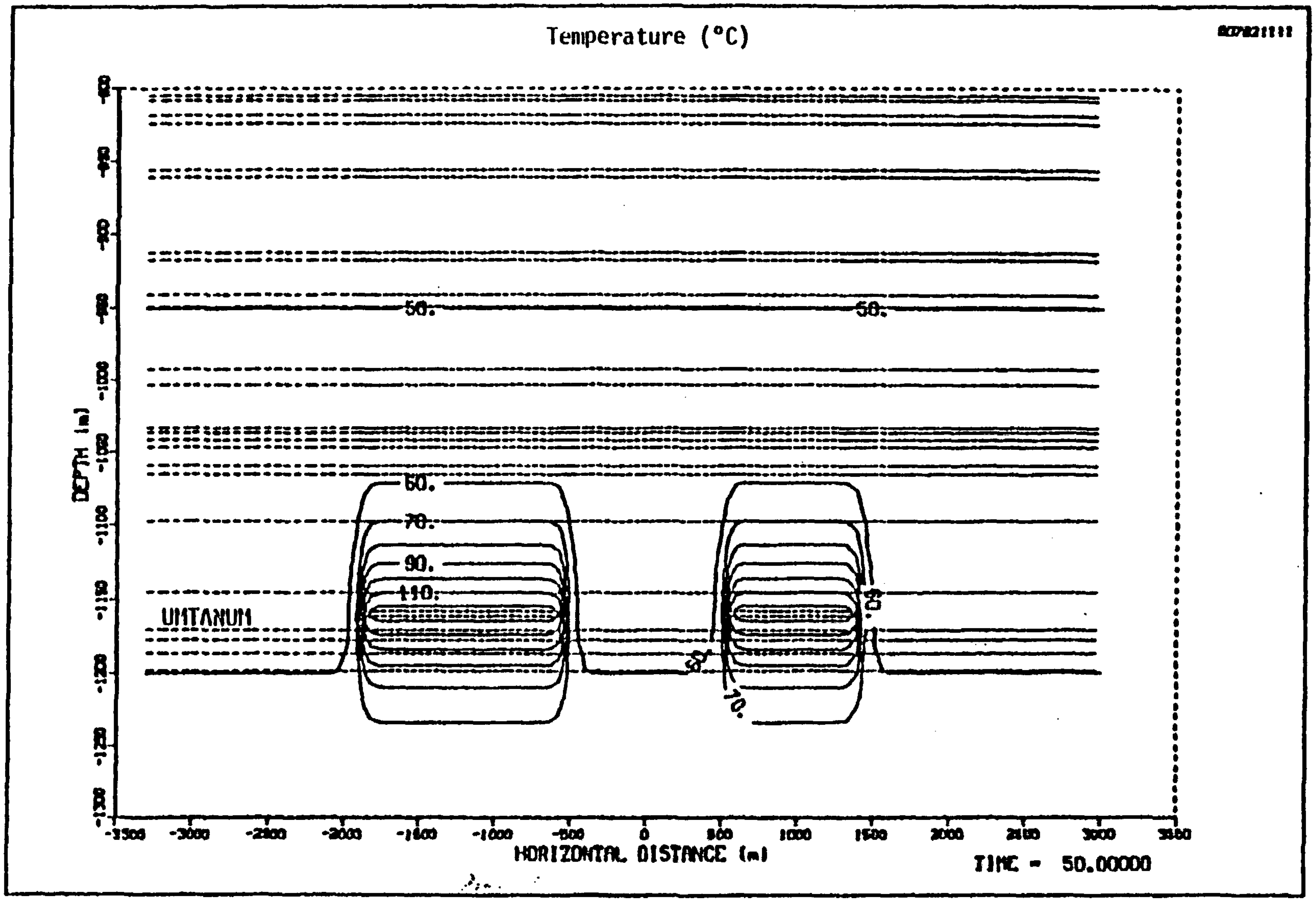
Umtanum Basecase Zone Definition

$ ZONE	IL	JL	IH	JH	NAME	THICKNESS (M)	SOURCE
ZONE 1	1	1	120	11	$ COMPOSITE	451.8	DC-12
ZONE 2	1	12	120	12	$ GR-11 FT	11.9	RRL-2
ZONE 3	1	13	120	13	$ GR-10	8.9	RRL-2
ZONE 4	1	14	120	14	$ GR-10 FT	7	RRL-2
ZONE 5	1	15	120	24	$ UMTANUM	25.5	RRL-2
ZONE 6	1	25	120	37	$ UMTANUM FT	47.6	RRL-2
ZONE 7	1	38	120	43	$ GR-8	32	RRL-2
ZONE 8	1	44	120	44	$ GR-8 FT	5.8	RRL-2
ZONE 9	1	45	120	47	$ GR-7	12.9	RRL-2
ZONE 10	1	48	120	48	$ GR-7 FT	4.7	RRL-2
ZONE 11	1	49	120	49	$ GR-6	5.3	RRL-2
ZONE 12	1	50	120	50	$ GR-6 FT	3.7	RRL-2
ZONE 13	1	51	120	54	$ GR-5	29.8	RRL-2
ZONE 14	1	55	120	56	$ GR-5 FT	10.7	RRL-2
ZONE 15	1	57	120	65	$ GR-4	43.3	RRL-2
ZONE 16	1	66	120	67	$ VESICULAR	8.5	DC-4
ZONE 17	1	68	120	70	$ GR-4	23.5	RRL-2
ZONE 18	1	71	120	71	$ GR-4 FT	4.6	RRL-2
ZONE 19	1	72	120	76	$ GR-3	51.8	RRL-2
ZONE 20	1	77	120	77	$ GR-3 FT	5.2	RRL-2
ZONE 21	1	78	120	80	$ GR-2	31.4	RRL-2
ZONE 22	1	81	120	81	$ GR-2 FT	6.1	RRL-2
ZONE 23	1	82	120	83	$ GR-1	10.1	RRL-2
ZONE 24	1	84	120	84	$ VANTAGE	3	RRL-2
ZONE 25	1	85	120	86	$ FS-7	17.1	RRL-2
ZONE 26	1	87	120	87	$ FS-7 FT	3	RRL-2
ZONE 27	1	88	120	90	$ FS-6	35.6	RRL-2
ZONE 28	1	91	120	91	$ FS-6 FT	3.4	RRL-2
ZONE 29	1	92	120	94	$ FS-5	24.7	RRL-2
ZONE 30	1	95	120	95	$ FS-5 FT	8.2	RRL-2
ZONE 31	1	96	120	97	$ FS-4	30.5	RRL-2
ZONE 32	1	98	120	98	$ FS-4 FT	3	RRL-2
ZONE 33	1	99	120	100	$ FS-3	13.1	RRL-2
ZONE 34	1	101	120	101	$ FS-3 FT	3.4	RRL-2
ZONE 35	1	102	120	103	$ FS-2	31.5	RRL-2
ZONE 36	1	104	120	104	$ FS-2 FT	3	RRL-2
ZONE 37	13	18	42	19	$ REPOSITORY	3	
ZONE 37	66	18	86	19	$ REPOSITORY	3	

Table 4

Cohassett Basecase Zone Definition

$ ZONE	IL	JL	IH	JH	NAME	THICKNESS (M)	SOURCE
ZONE 1	1	1	120	15	$ COMPOSITE	413.4	DC-12 & RRL-
ZONE 2	1	16	120	16	$ GR-6 FT	3.7	RRL-2
ZONE 3	1	17	120	21	$ GR-5	29.8	RRL-2
ZONE 4	1	22	120	23	$ GR-5 FT	10.7	RRL-2
ZONE 5	1	24	120	38	$ GR-4	43.3	RRL-2
ZONE 6	1	39	120	40	$ VESICULAR	8.5	DC-4
ZONE 7	1	41	120	46	$ GR-4	23.5	RRL-2
ZONE 8	1	47	120	47	$ GR-4 FT	4.6	RRL-2
ZONE 9	1	48	120	52	$ GR-3	51.8	RRL-2
ZONE 10	1	53	120	53	$ GR-3 FT	5.2	RRL-2
ZONE 11	1	54	120	56	$ GR-2	31.4	RRL-2
ZONE 12	1	57	120	57	$ GR-2 FT	6.1	RRL-2
ZONE 13	1	58	120	59	$ GR-1	10.1	RRL-2
ZONE 14	1	60	120	60	$ VANTAGE	3	RRL-2
ZONE 15	1	61	120	62	$ FS-7	17.1	RRL-2
ZONE 16	1	63	120	63	$ FS-7 FT	3	RRL-2
ZONE 17	1	64	120	66	$ FS-6	35.6	RRL-2
ZONE 18	1	67	120	67	$ FS-6 FT	3.4	RRL-2
ZONE 19	1	68	120	70	$ FS-5	24.7	RRL-2
ZONE 20	1	71	120	71	$ FS-5 FT	8.2	RRL-2
ZONE 21	1	72	120	73	$ FS-4	30.5	RRL-2
ZONE 22	1	74	120	74	$ FS-4 FT	3	RRL-2
ZONE 23	1	75	120	76	$ FS-3	13.1	RRL-2
ZONE 24	1	77	120	77	$ FS-3 FT	3.4	RRL-2
ZONE 25	1	78	120	79	$ FS-2	31.5	RRL-2
ZONE 26	1	80	120	80	$ FS-2 FT	3	RRL-2
ZONE 27	1	81	120	83	$ FS-1	48.5	RRL-2
ZONE 28	1	84	120	84	$ FS-1 FT	7	RRL-2
ZONE 29	1	85	120	87	$ ROZA-2	40.9	RRL-2
ZONE 30	1	88	120	88	$ ROZA-2 FT	3	RRL-2
ZONE 31	1	89	120	90	$ ROZA-1	5.4	RRL-2
ZONE 32	1	91	120	91	$ ROZA-1 FT	3.4	RRL-2
ZONE 33	1	92	120	93	$ PR-2	10.4	RRL-2
ZONE 34	1	94	120	94	$ PR-2 FT	7.9	RRL-2
ZONE 35	1	95	120	97	$ PR-1	50.6	RRL-2
ZONE 36	1	98	120	98	$ MABTON	37.35	RRL-2
ZONE 37	13	30	42	31	$ REPOSITORY	3	
ZONE 37	66	30	86	31	$ REPOSITORY	3	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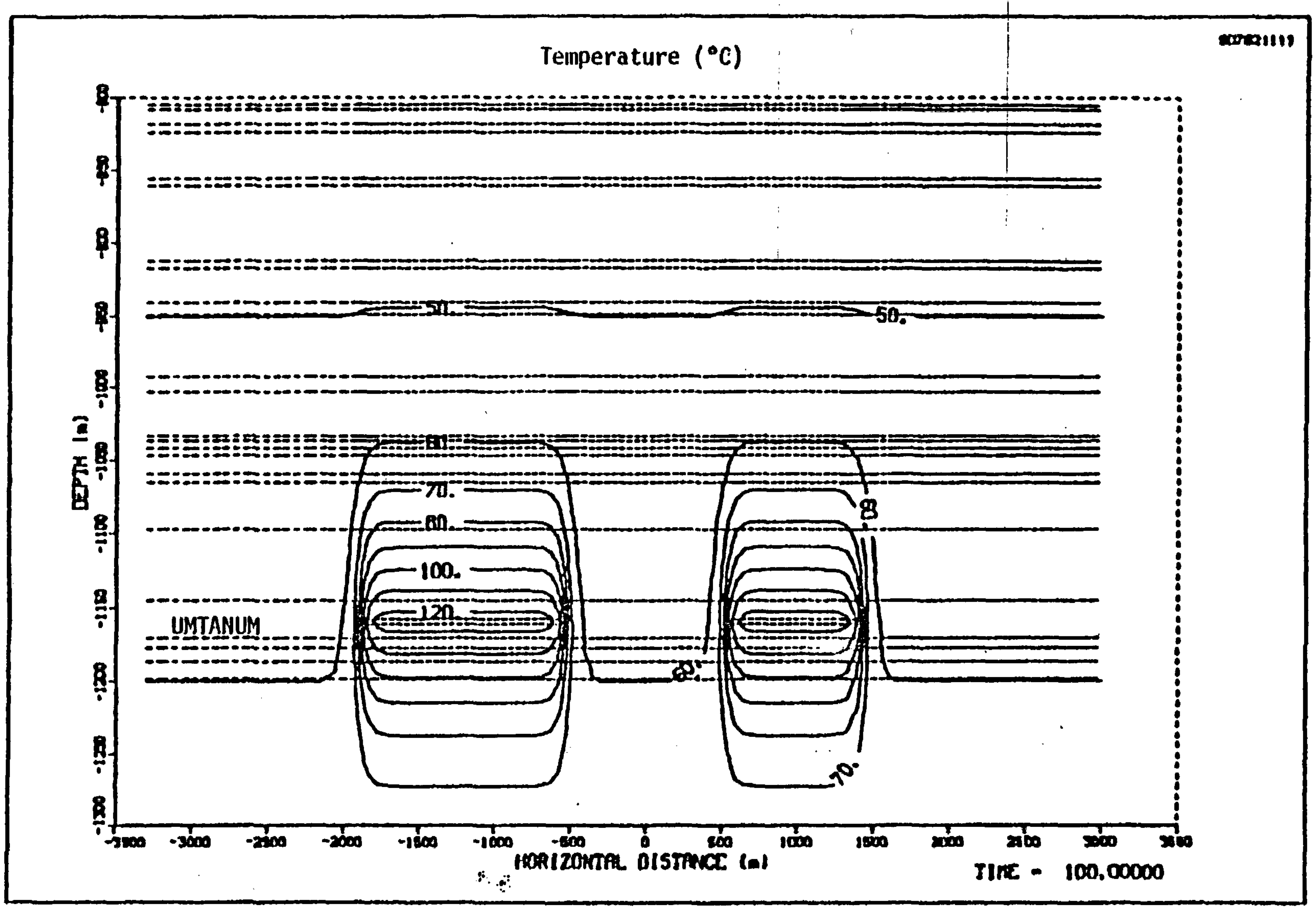
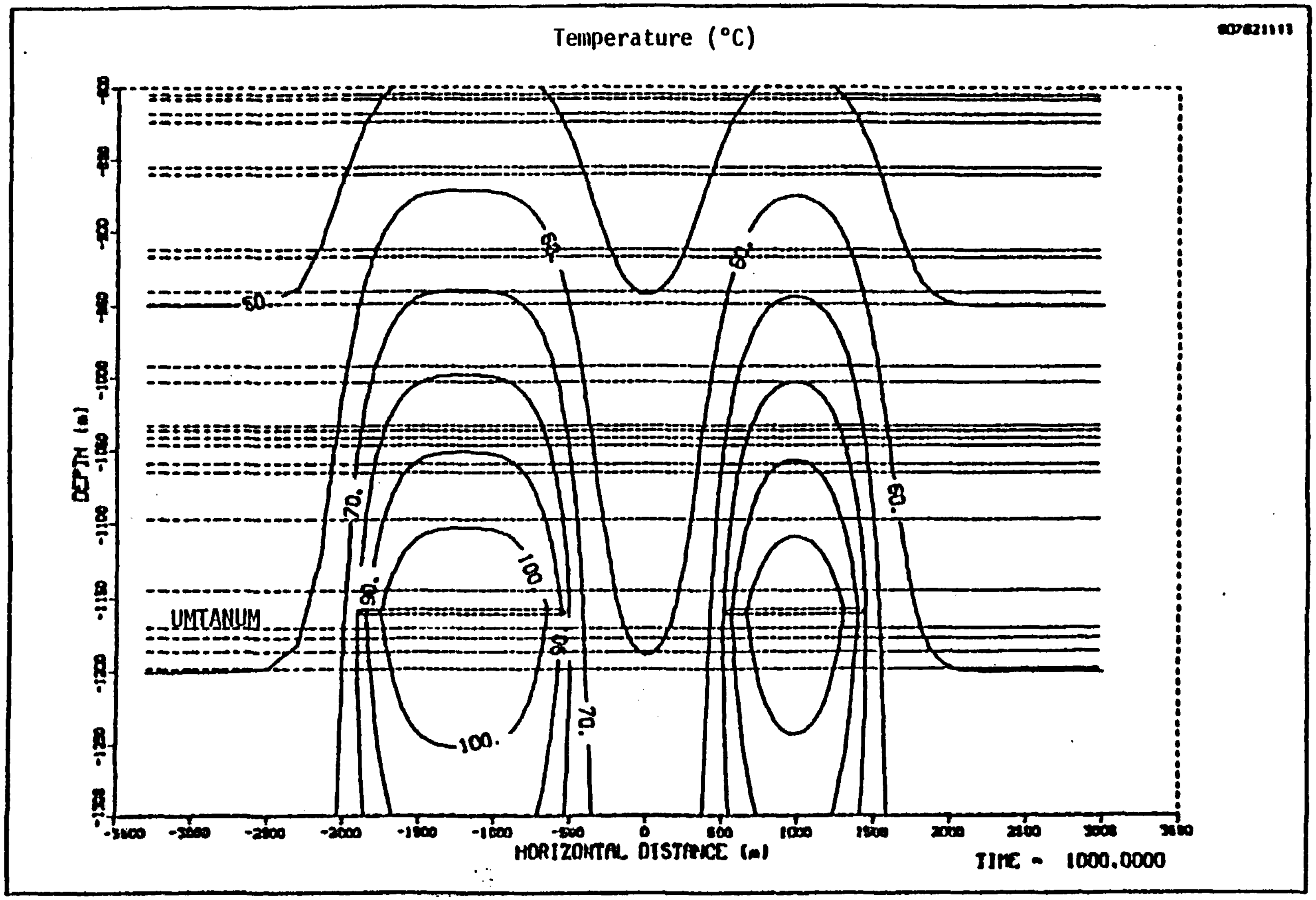
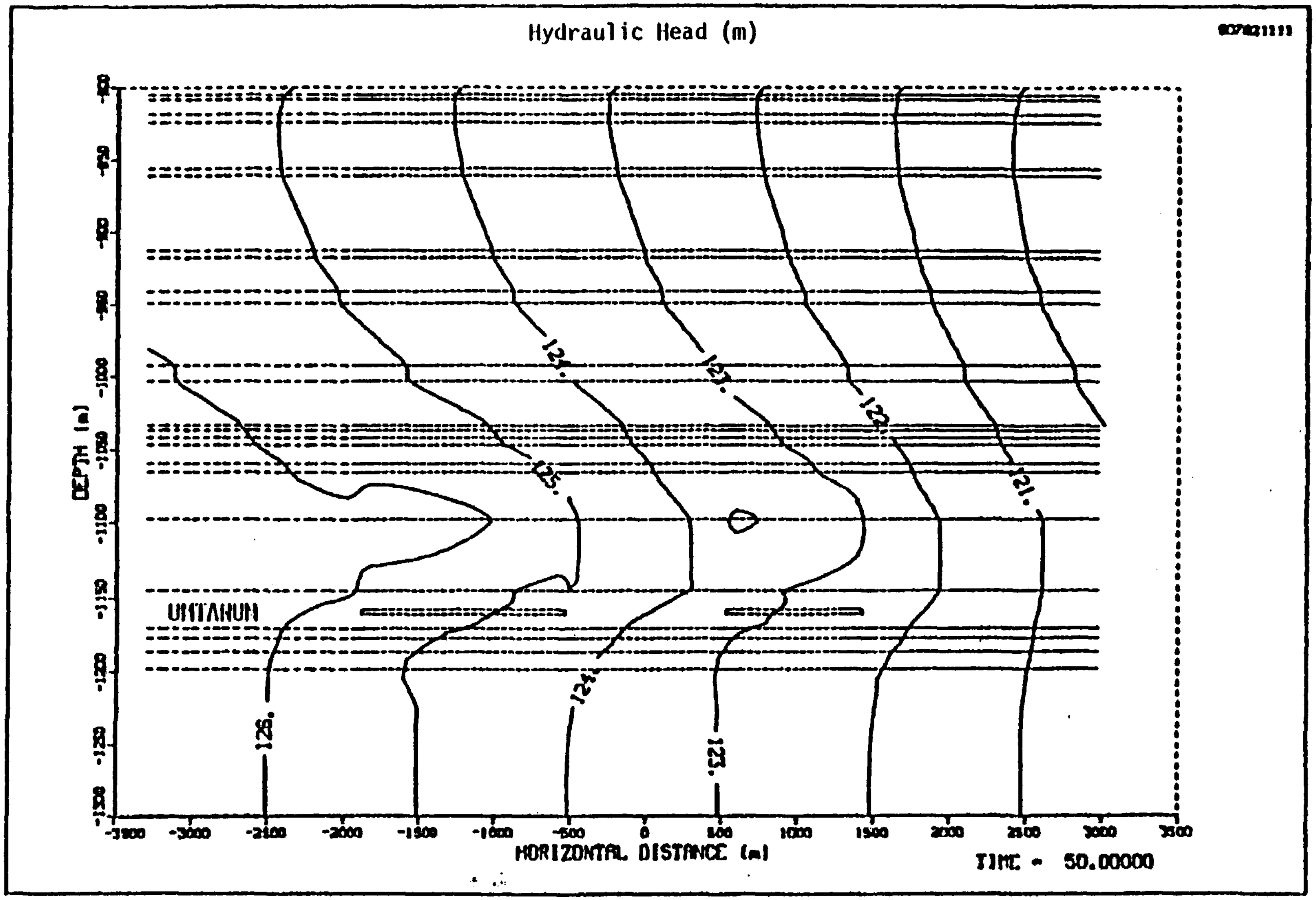
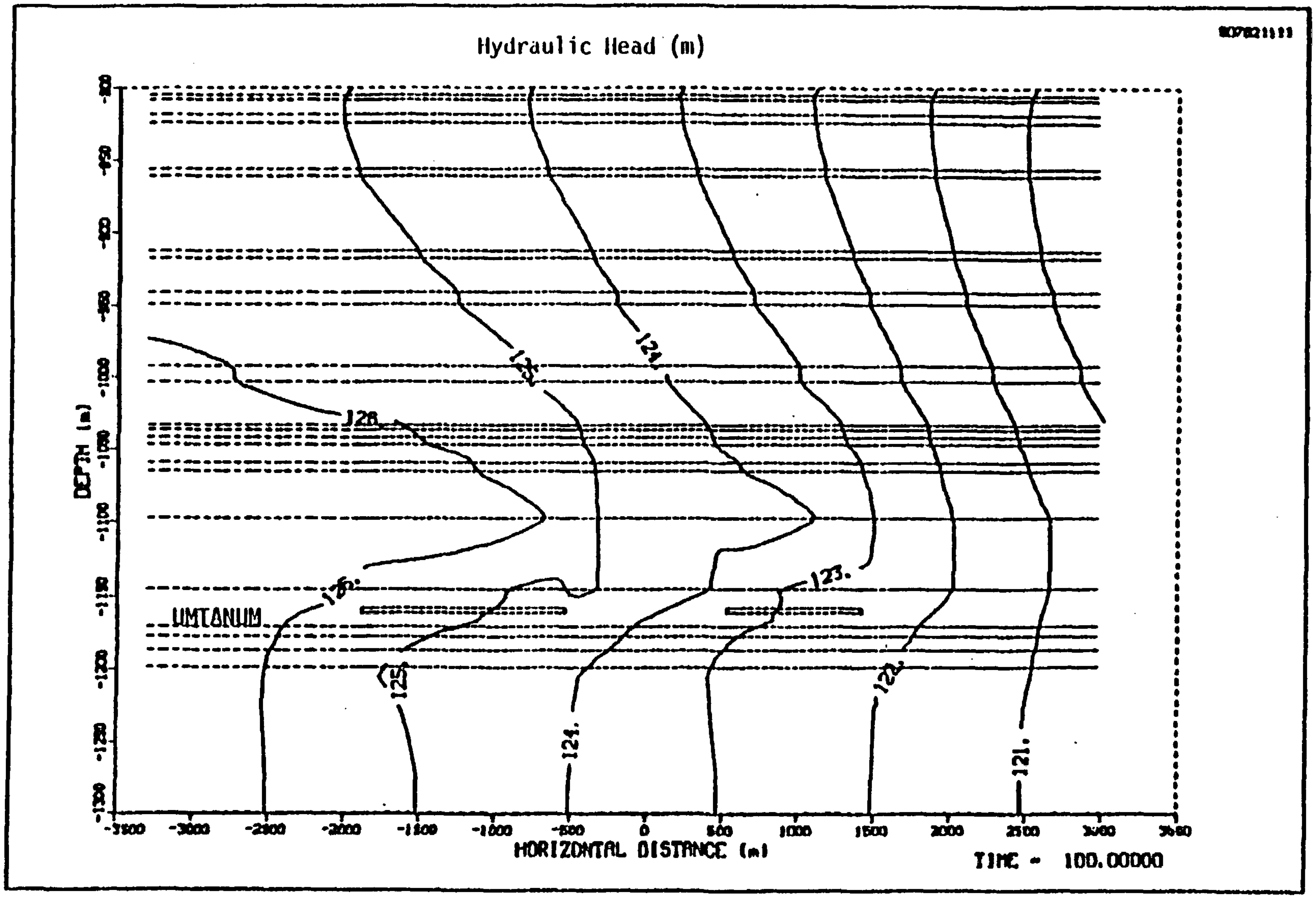
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
-1250
-1300
50.
50.
60.
70.
90.
110.
UMTANUM
60.
50.
70.
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
TIME = 50.00000

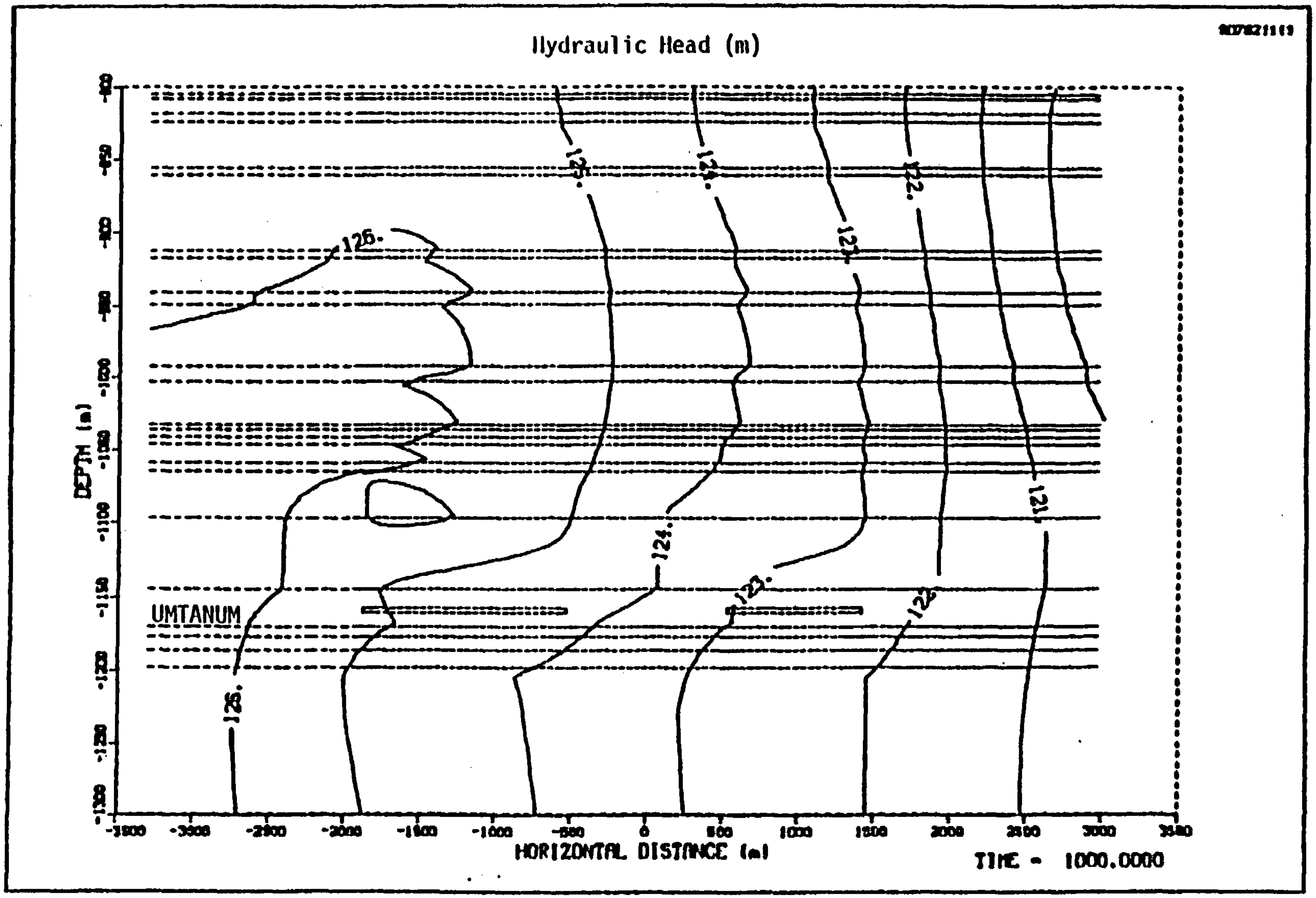

Temperature (°C)
DEPTH (m)
HORIZONTAL DISTANCE (m)
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
50.
50.
80.
70.
80.
100.
120.
UMTANUM
60.
60.
70.
TIME = 100.00000

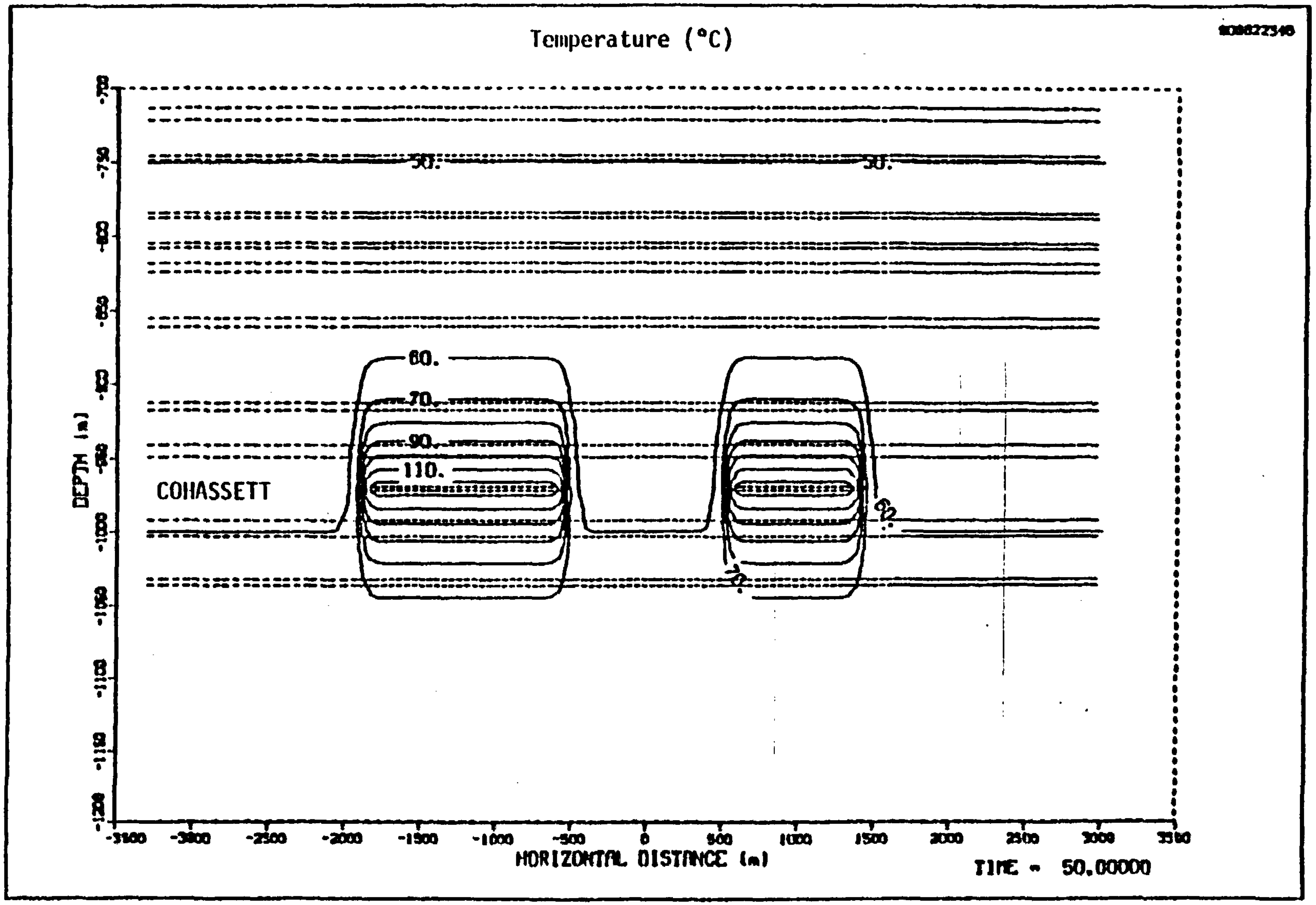

Temperature (°C)
DEPTH (m)
HORIZONTAL DISTANCE (m)
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
50.
60.
60.
60.
70.
70.
90.
90.
100.
100.
UMTANUM
TIME = 1000.0000

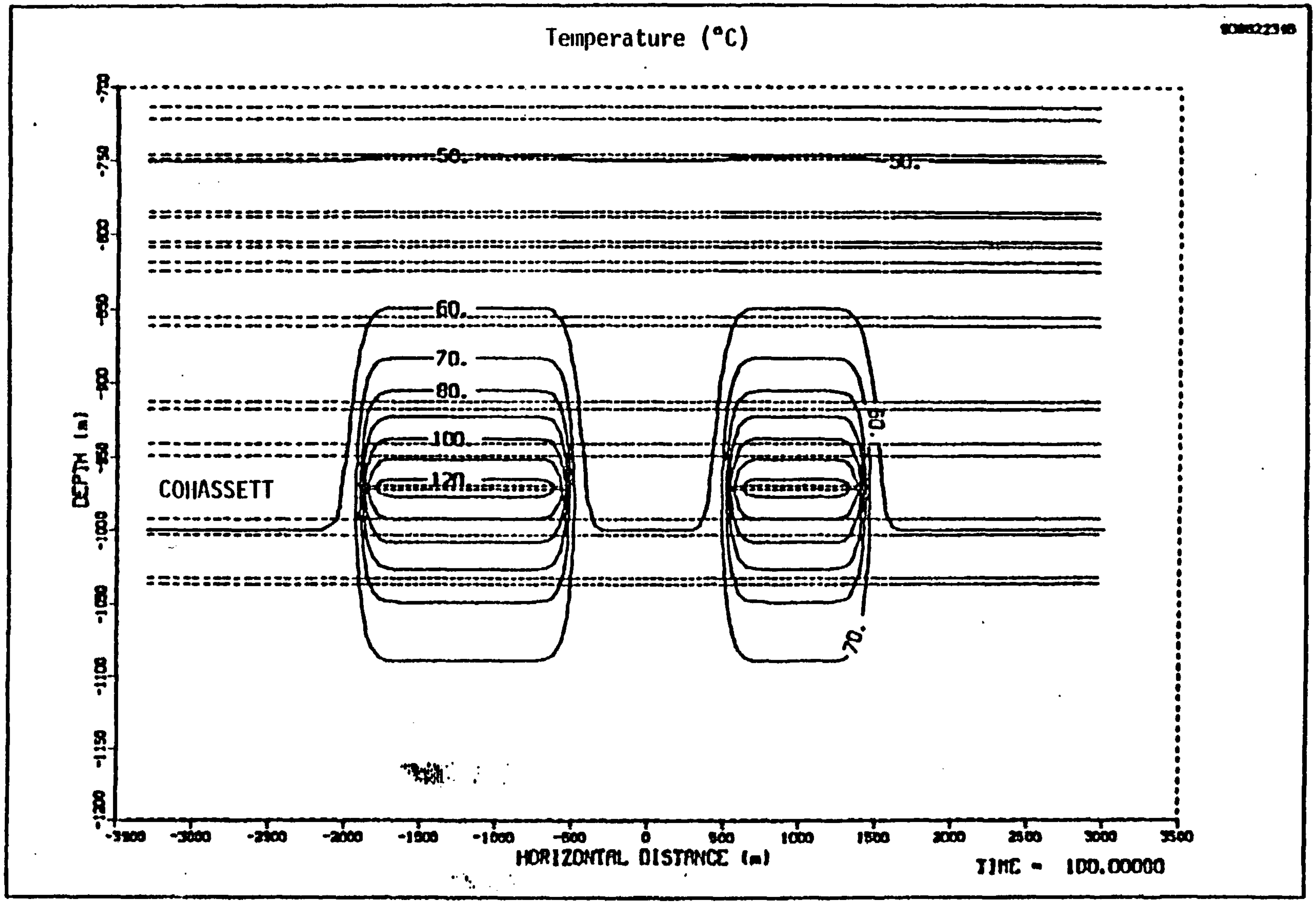

Hydraulic Head (m)
DEPTH (m)
-800
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
-1250
-1300
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
UNTAHUN
126.
125.
125.
124.
124.
123.
122.
122.
121.
TIME = 50.00000

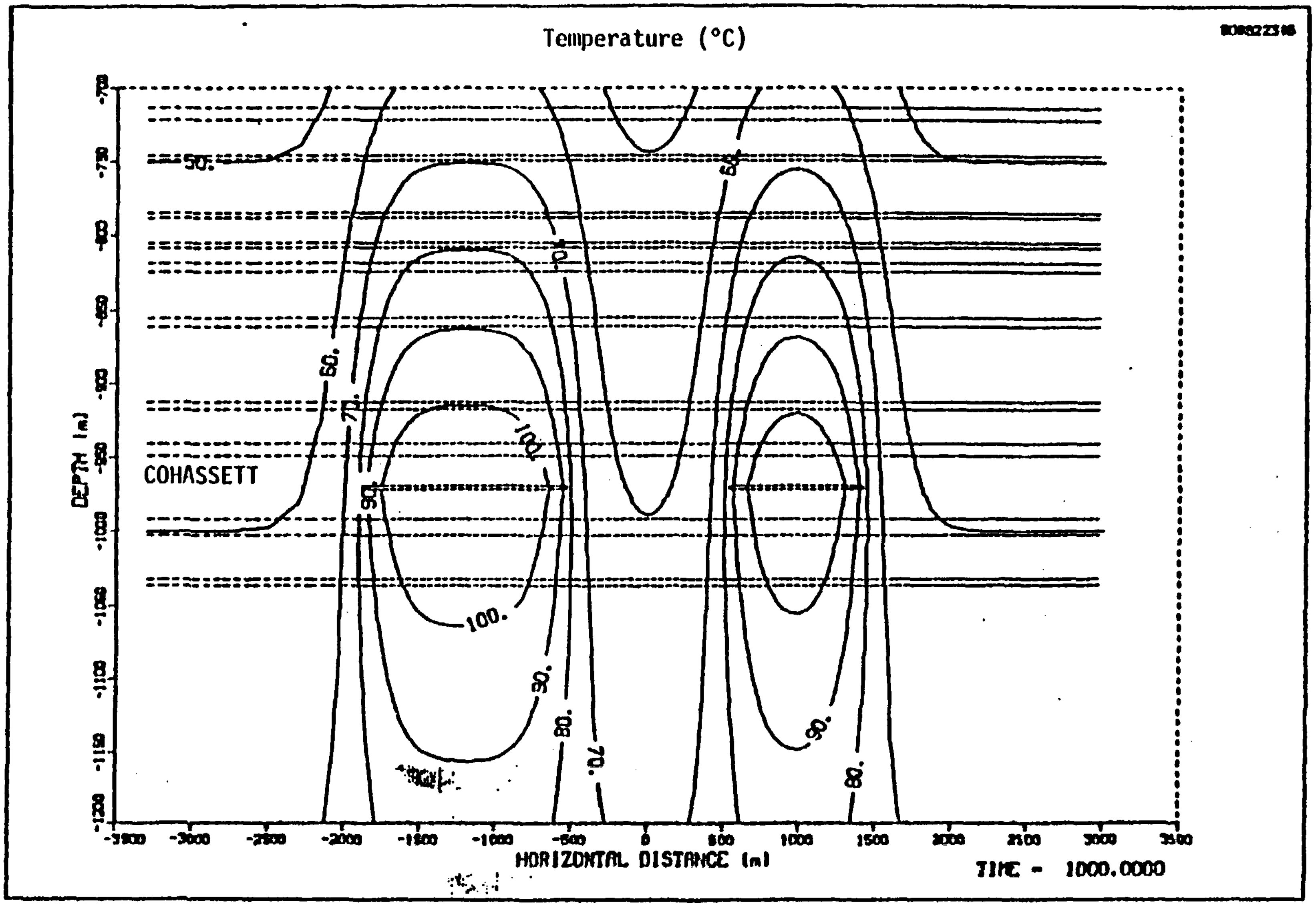


Hydraulic Head (m)

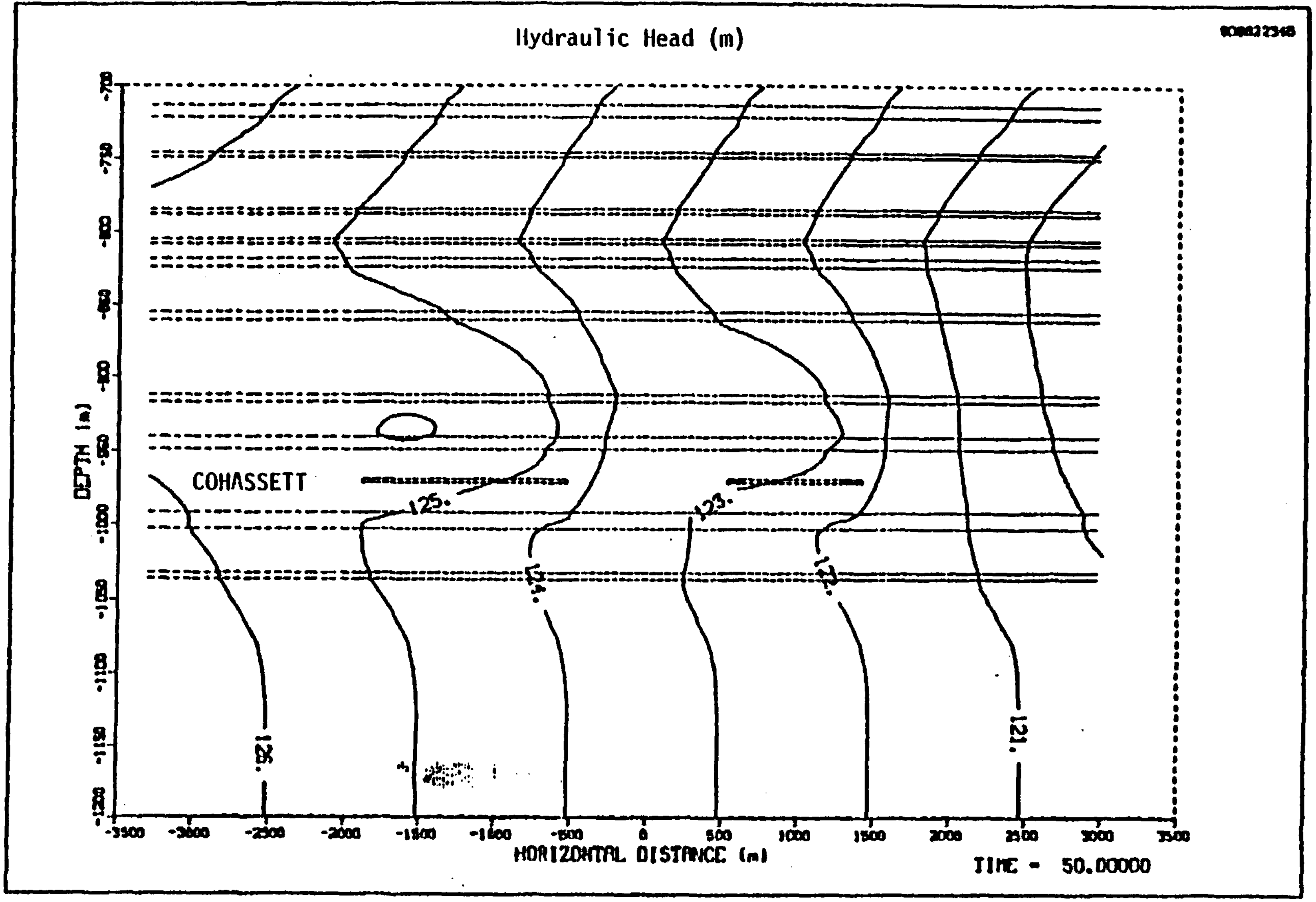
Hydraulic Head (m)
126.
125.
124.
123.
122.
121.
UMTANUM
DEPTH (m)
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
TIME = 1000.0000

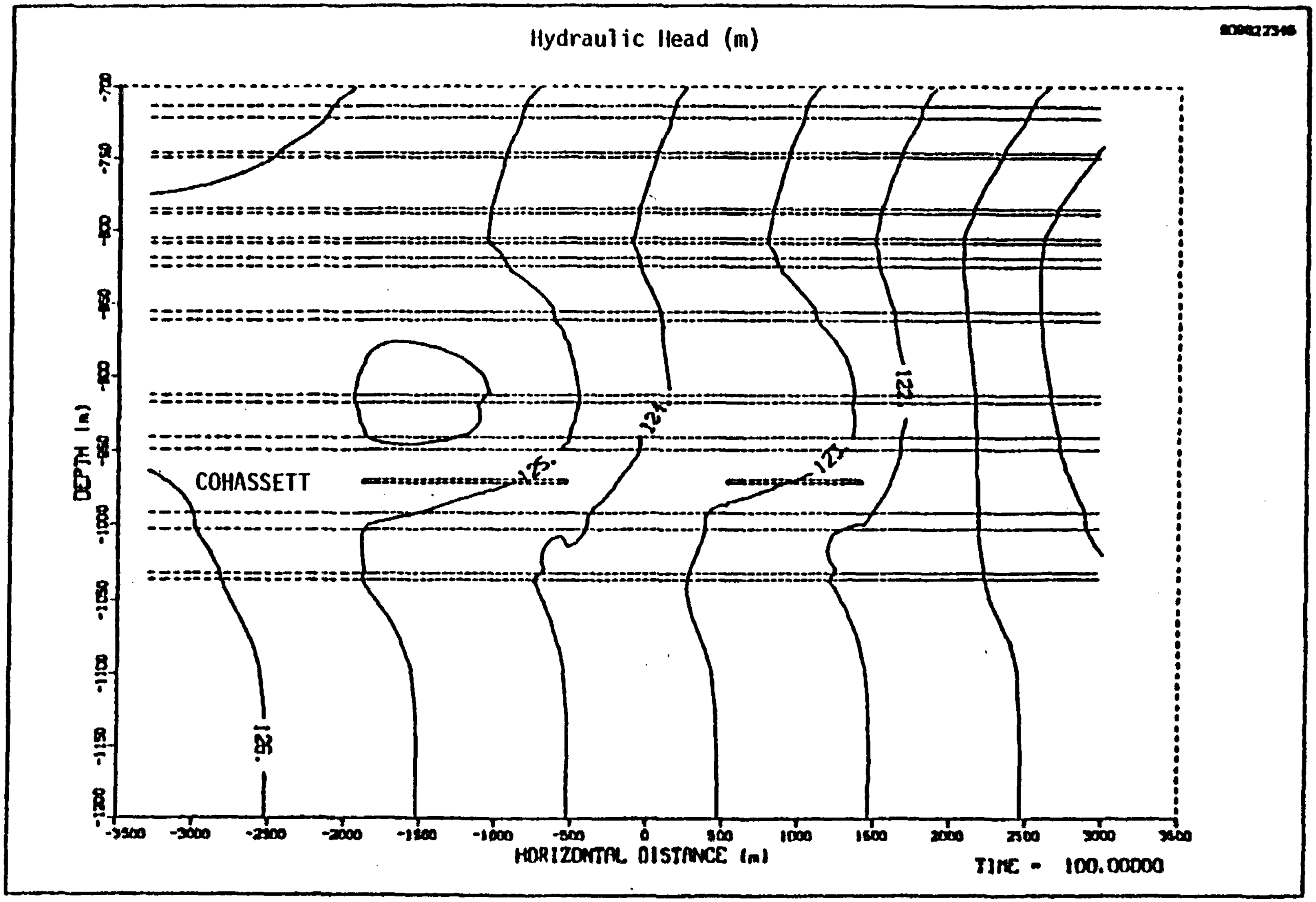

Temperature (°C)
DEPTH (m)
-700
-750
-800
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
50.
50.
60.
70.
90.
110.
62
70
COHASSETT
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
TIME = 50.00000

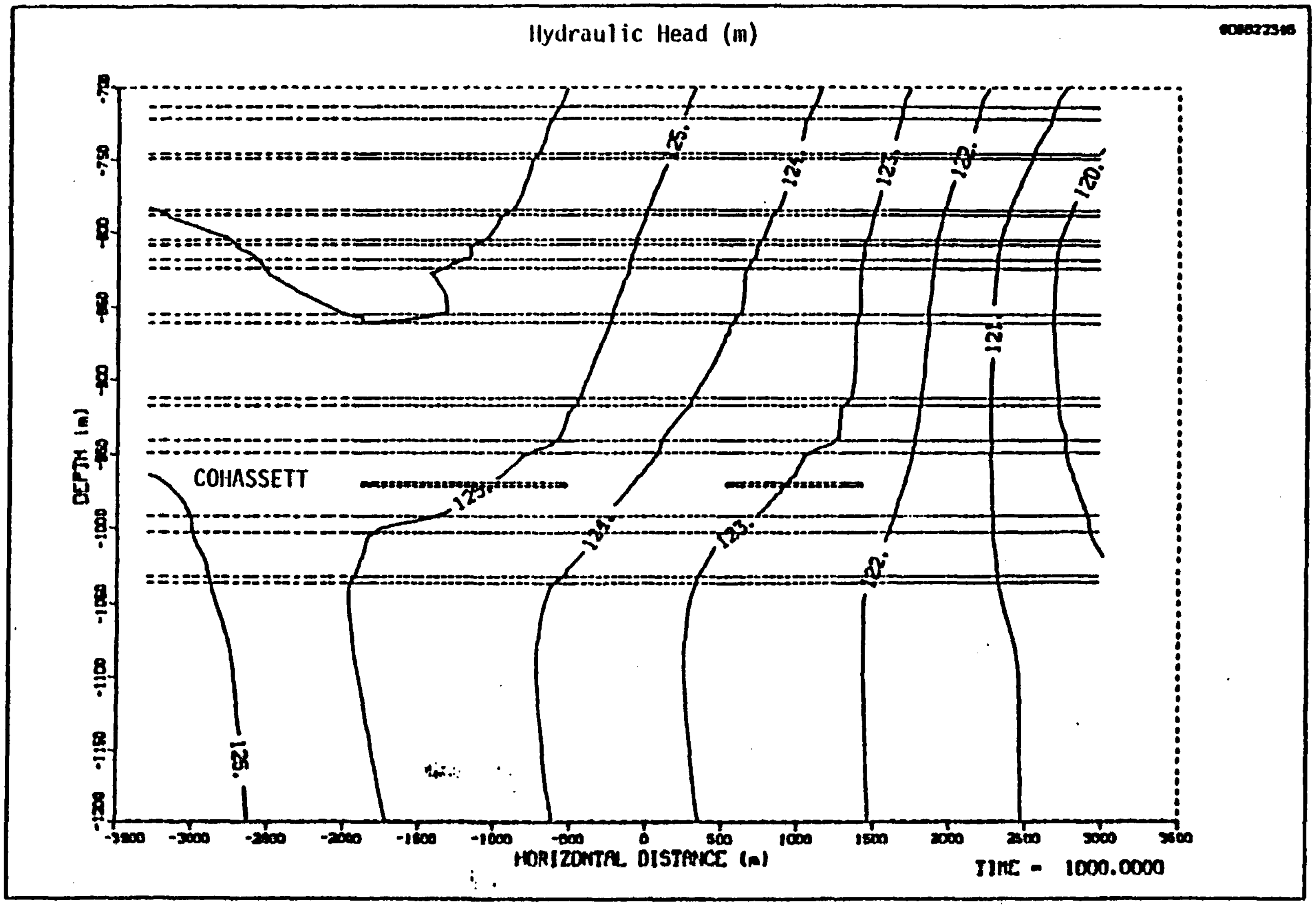

Temperature (°C)
DEPTH (m)
-700
-750
-800
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
50.
50.
60.
70.
80.
100.
120.
60.
70.
COHASSETT
TIME = 100.00000



Temperature (°C)


Hydraulic Head (m)
900822348
COHASSETT
126.
125.
124.
123.
122.
121.
DEPTH (m)
-700
-750
-800
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
TIME = 50.00000


Hydraulic Head (m)
DEPTH (m)
-700
-750
-800
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
HORIZONTAL DISTANCE (m)
COHASSETT
126.
125.
124.
123.
122.
TIME = 100.00000


Hydraulic Head (m)
DEPTH (m)
-700
-750
-800
-850
-900
-950
-1000
-1050
-1100
-1150
-1200
HORIZONTAL DISTANCE (m)
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
COHASSETT
125.
124.
123.
122.
121.
120.
TIME = 1000.0000