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VALIDATION OF A GEOTHERMAL SIMULATOR

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VALIDATION OF A GEOTHERMAL RESERVOIR SIMULATOR

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ABSTRACT

A geothermal simulator, TETRAD, is validated against the Stanford Geothermal Problem Set. The governing equations, formulation, and solution technique employed by TETRAD are first outlined. Each problem in the Stanford Problem Set is then discussed in detail, and results from the simulations are presented. The results obtained using TETRAD are compared against several other geothermal simulators. Favorable comparison between results indicates that TETRAD is capable of solving the highly non-linear equations describing the flow of mass and energy in porous media. This validation exercise allows for the use of TETRAD in studying geothermal problems with a high degree of confidence.

Introduction

Geothermal resources constitute an important renewable energy resource in the US. Management of such a resource requires an understanding of the complex set of interactions that include interphase mass transfer, convective transport of fluids, and conductive and convective heat flow. The coupled nature of these phenomena requires that these issues be considered simultaneously, making the study of these processes difficult without an accompanying numerical simulation study.

In a numerical simulator, the partial differential equations that govern the processes under investigation are specified. For the simulation of a geothermal reservoir, this involves writing the equations that describe the conservation of mass (an equation for each component) and energy, and transport equations (Darcy's Law for mass transport and Fourier's Law for heat transport). These equations are then converted to an algebraic form through finite differences; thus the system of partial differential equations is replaced by a system of algebraic equations. Solution of this system of equations through time allows the researcher to investigate individual mechanisms that influence a given process.

The numerical simulator used by the INEL's Geothermal Reservoir Technology Program is TETRAD¹. This report discusses the governing equations used in TETRAD for a two-component geothermal case and touches on the method of solution of the relevant equations of conservation of mass and energy. Finally, we will show the results of several validation cases, comparing results obtained using TETRAD against those presented at the 6th Stanford Workshop on Geothermal Reservoir Engineering (Stanford Special Panel, 1980). Favorable comparison between results demonstrates that TETRAD is capable of solving the highly non-linear partial differential equations that describe the conservation of mass and energy.

Description of the Simulator

TETRAD is a three-dimensional, multiphase, multi-component finite difference simulator. In geothermal mode (one of four application options available in TETRAD), an arbitrary number of aqueous species and noncondensable gases may be simulated. The physical phenomena that can be modelled include phase partitioning of components, conductive and convective heat flow, relative permeability effects, capillary pressure, flow in fractured media, and semi-analytic aquifers and heat losses (Vinsome and Westerveld, 1980).

In a two-component geothermal simulation, three conservation equations must be solved: conservation of mass for each component and conservation

¹ Mention of specific products and/or manufacturers in this document implies neither endorsement of preference nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho Inc. or the use of a specific product for any purpose.

of energy for the system as a whole. Mathematically, these can be expressed as (see Nomenclature for definition of terms):

$$\frac{\delta}{\delta t} [\phi(\rho_1 S_1 \omega_{i1} + \rho_2 S_2 \omega_{i2})] + \vec{\nabla} [\rho_1 \vec{u}_1 \omega_{i1} + \rho_1 \vec{u}_1 \omega_{i2}] = Q_i \quad (1)$$

$$\frac{\delta}{\delta t} [\phi(\rho_1 S_1 U_1 + \rho_2 S_2 U_2) + (1-\phi)U_R] + \vec{\nabla} [\rho_1 \vec{u}_1 H_1 + \rho_1 \vec{u}_2 H_1] - \vec{\nabla} \cdot (k_T \vec{\nabla} T) - E_L = E_J \quad (2)$$

where the subscript "i" in Eq 1 denotes either component 1 or 2. Constitutive equations required to solve Eqs. 1 and 2 above include "flow equations" (of both mass and energy) and "constraint equations" (saturation and mole fraction constraints). A summary of the equations required to solve this problem is given in Appendix A.

The above equations, including the constitutive equations, can be written in terms of three "primary" variables (one for each conservation equation is required), and three "secondary" variables. The secondary variables can be obtained from the primary variables and the constraint equations. Changes in the primary variables over a time step are obtained from the solution of the system of equations of the form:

$$F(u, t + \Delta t) = F(u, t) + \frac{\partial F}{\partial u} \delta u \quad (3)$$

where F denotes Eqs 1 and 2, u represents a vector containing the primary variables, and $\partial F / \partial u$ is the Jacobian matrix of partial derivatives. δu , then, represents changes in the primary variables over the time step, Δt .

Which variables are selected as primary, and which are secondary depends on the nature of the problem being solved, and the number of phases present. For example, in the case of a geothermal simulation with both the liquid and steam phases present, the primary variables are the pressure P, the aqueous mole fraction of the second component, ω_{21} , and the steam saturation, S_g . The primary variables are aligned such that the resulting Jacobian is as diagonally-dominant as possible; thus, the pressure is aligned on the water conservation equation, mole fraction of the second component is aligned on the conservation equation for that species, and the steam saturation is aligned on the energy equation. Temperature can be found from the Claysius-Clapeyron equation; species 1 mole fraction and liquid saturation are obtained from mole fraction and saturation constraints ($\sum S_j = 1$; $\sum \omega_i = 1$). If either phase disappears, steam saturation is replaced by temperature as the primary variable; other variables remain as they are. This alignment enhances the numerical stability of the system of equations.

Prior to solving Eq 3, one additional step is required. The primary variables all have different units, whose scales can differ by orders of magnitude. The residuals involved in solving Eq 3 are also of different scales, which can cause poor convergence characteristics in the solution

routine. Therefore, before solving Eq 3, each equation is normalized by a quantity that causes the dimensionless variables to vary between 0 and 1. This forces all residuals to be of the same order of magnitude, resulting in an easier selection of convergence criteria and improved convergence in the solver. The mass conservation equations are normalized by the total mass in the grid block; the energy conservation equation is divided by total energy in the block. The solver used in TETRAD is a modification of the ORTHOMIN method (Vinsome, 1976; Behie and Vinsome, 1982). ORTHOMIN is not very sensitive to how the equations are scaled; any reasonable form of scaling the equations will work (Behie and Vinsome, 1982).

The formulation briefly discussed above (selection of primary variables, alignment, scaling, and solution) insures that the solution of the system of equations is numerically stable. For additional details on the mathematical models employed by TETRAD, see Vinsome (1990).

Validation of TETRAD

In May, 1979 the Technical Review Committee on Reservoir Engineering recommended to the U.S. Department of Energy that all major geothermal simulators be tested on a given problem set and their results compared. A special panel of code developers and industry users met in February, 1980 and designed the problem set used for code comparison. Many of the problems that were established have no analytic solution; in these cases, the reviewers determined which result was, in their opinion, "most correct."

Results from this special panel were presented at the 6th Workshop on Geothermal Reservoir Engineering, held at Stanford University in 1980, and are loosely known as the Stanford Geothermal Problem Set. In an attempt to validate TETRAD against other geothermal simulators, this problem set was selected as the validation exercise presented here. The problem specifications are discussed, and results obtained from TETRAD are presented. In order to measure the accuracy these solutions, we also present the analytic solution to the problem (where available), or the solution deemed "most correct" by the Stanford Special Panel. In many cases the results presented in 1980 by S-Cubed (S³) of La Jolla, California have been used in this report for comparison purposes. This is due primarily to our having a copy of their report, and thus results are in tabular form. In nearly every case S³ results and the other geothermal simulators agree quite closely; our use of the S³ data does not imply that we consider their results "better" than the other solutions.

Problem 1: 1-D Avdonin Solution

This problem involves one-dimensional, radial, steady-state flow, unsteady state heat transport of a single-phase liquid. From an initial condition of 170° C and 5000 kPa, water is withdrawn from $r=0$ at the rate of 10 kg/s. Constant pressure of 5000 kPa and temperature of 160° C are maintained at the outer boundary. Petrophysical and thermal properties of the reservoir and grid and time step requirements are summarized in Table 1. Thermal properties of the water are provided by

the modeler. Requested output is a) a temperature profile at 10^9 seconds (60 time steps), b) the temperature history in block 2, at 37.5 m from the center of the reservoir, and c) specific heat capacity, viscosity and density of water at 5000 kPa and 165°C . For constant density, viscosity and heat capacity an analytic solution is available (Avdonin, 1964).

Table 1. Problem Specifications for Problem 1

External Reservoir radius (m)	1000.
Reservoir Thickness (m)	100.
Permeability (md)	1000.
Porosity	.2
Rock Density (kg/m^3)	2500.
Rock Specific Heat ($\text{J/g } ^\circ\text{C}$)	1.0
Thermal Conductivity ($\text{W/m } ^\circ\text{C}$)	20.
Grid Spacing (m)	25.
Time step size (sec)	1.67×10^7

The solution of Problem 1 is straightforward; however, due to the coarse grid that was specified, there is an appreciable amount of numerical dispersion present. Figures 1 and 2 show the temperature history and profile, respectively. Also shown in these figures is the analytic solution (Avdonin, 1964). The constants used for water density, viscosity and specific heat capacity are as follows:

$$\rho = 902.85 \text{ kg/m}^3$$

$$\mu = 0.1636 \text{ mPa-s}$$

$$C_p = 4.1868 \text{ J/g-}^\circ\text{C}$$

The apparent numerical dispersion seen in Figure 1 can be qualitatively explained in the following manner. The solutions obtained from TETRAD actually apply to the centroid of each grid block; that is, the point at which the block volume is exactly halved. In radial coordinates, half-distance of the block length ($\bar{r} = \Delta r/2$) and the radius $\hat{r}$ at which the block volume is halved differ (see Figure 3 for a schematic showing these differences). When block lengths are large the ratio of these lengths can also be quite large, though at large radii the ratio tends toward unity. At grid block #2, for example, the temperature solution obtained by TETRAD applies to a point 39.5 m from the origin, not 37.5 m. This difference is what causes the apparent disagreement between the analytic solution and that obtained from TETRAD. This discrepancy is much less noticeable in the temperature profile of Figure 2 for the same reason. For example, at node # 5 ($\bar{r} = 112.5 \text{ m}$), there is less than 1% difference between the mid-point of the block and the point at which the block volume is halved.

This explanation can be further illustrated by making another simulation of Problem # 1. In this case, we have used one extra grid block near the origin. The midpoint of block 3 is now at 37.5 m; the centroid of the block is at 37.5033 m. Temperature history in this block is given

Figure 1. Stanford Problem #1: Temperature History in Node 2. Coarse Grid Apparent.

Figure 2. Stanford Problem #1. Temperature Profile after 60 Time Steps.

Figure 3. Schematic Showing the Difference in Location Between Half-Radius and Half Volume in a Radial Grid Block

Figure 4. Stanford Problem #1. Temperature History at 37.5 m from Injector.

in Figure 4. By comparing Figure 1 and 4, one can note a significant improvement in matching the analytic solution. In this case the temperature history and profile given in Figure 2 deviate from the analytic solution by about the same amount, indicating the true amount of numerical dispersion present in this problem.

The data set used to run this problem is given in Appendix B.

Problem # 2: 1-D Well Test Analysis

This problem involves a set of three constant discharge, transient well test cases. Each case has 1-D radial flow to a line sink (zero radius well) in a homogeneous porous media. In Case a, the fluid is a single phase liquid; in Case b the fluid is two phase, with both water and steam mobile; and in Case c the fluid changes from liquid to steam as a boiling front moves away from the well. Case d uses the same reservoir properties and conditions as Case b, but in this case the reservoir is represented by a single grid block of volume 314 m^3 . Reservoir properties, and initial and boundary conditions are summarized in Table 2. Output requirements consist of pressure, saturation, and flowing enthalpy vs. t/r^2 for $r = 0.5 \text{ m}$, 0.707 m , and 1 m for Cases a-c, and at the origin for Case d.

Table 2. Problem Specifications for Problem 2.

Property	Case a	Case b	Case c
Initial Pressure (kPa)	9000	3000	9000
Initial Temp. ($^{\circ}\text{C}$)	260.	233.8	300.
Init Liquid Saturation	1.	0.65	1.
Porosity	0.2	0.15	0.2
Permeability (md)	10.	240.	10.
Thickness (m)	100.	100.	100.
Discharge rate (kg/s)	14.0	16.7	14.0
Rock Heat Capacity ($\text{kJ/m}^3\text{^{\circ}C}$)	2650.	2000.	2650.
Rock Thermal Conduct. ($\text{W/m}^{\circ}\text{C}$)	0	0	0
Rock Compressibility (kPa^{-1})	0	0	0
Relative permeability	single phase	$k_{rw} = S^4$; $k_{rs} = [1-S^2][1-S]^2$ $S = (S_w - 0.3)/0.65$	

The grid arrangement that was suggested was appropriate for face centered finite differencing (where the nodes are on the boundaries between grid blocks); however, TETRAD utilizes block centered finite difference. Therefore, a slight modification to the grid was made in order to have grid block centers at the specified locations.

Results for Case a are given in Figure 5. For this single phase problem, and using constant viscosity and compressibility (as we did in our simulation), there exists an analytic solution for pressure as a function of time and position (Theis, 1935). As can be seen from Figure 3, TETRAD provides an excellent match of this analytic result.

The presence of an initially mobile vapor phase adds some complexity to the problem. In the interest of brevity, not all of the requested results will be plotted; however, results shown are representative of the match obtained. Pressure and steam saturation as functions of the combined variable t/r^2 are given in Figures 6 and 7, respectively. Also shown in these figures are the semi-analytic solution obtained by O'Sullivan and Pruess (1980). As can be seen from these figures, the solution obtained by TETRAD compares quite favorably with the analytic solutions.

Case c adds still more complexity to the problems, as a boiling front forms and moves away from the producer. Pressure and saturation as a function of the combined variable t/r^2 are given in Figures 8 and 9. Both of these plots show appreciable difference between the semi-analytic solution and that obtained by TETRAD. Also shown in these figures is the solution obtained by S³; one can see that the accuracy of TETRAD on this problem is comparable to that of other geothermal simulators. Differences between the semi-analytic result and the simulated results arise in part from the coarse grid specified and from the effects of phase transitions and relative mobility effects.

Case d is a single-node case with Case b initial conditions. Pressure and discharge enthalpy histories are given for this case in Figures 10 and 11. Again, the solutions obtained using TETRAD compare quite favorably with solutions obtained elsewhere.

Input decks used for Problem 2 are given in Appendix C.

Problem # 3: 2-D Flow to a Well in Fracture/Block Media

This problem represents a simplification of the more general problem of well testing in a fractured geothermal media. The reservoir is idealized as an explicit horizontal fracture of infinite length in contact from above with a porous media. The bottom of the fracture is a no-flow boundary. Vertical flow occurs in the matrix down to the fracture, while radial flow occurs within the fracture. A single producer is located at the origin, and a constant rate was specified. In Case a of this problem the initial liquid saturation is zero; in Case b an initially immobile liquid saturation boils as the well is produced. Parameter specifications for these two cases are summarized in Table 3. Output requirements were plots of pressure vs. time at the well face, and a point 2.5 m from the well center and 0.25 m above the fracture for Cases a and b, and a plot of water saturation vs time at the same point in the reservoir for Case b. The time period of interest is 10^4 seconds.

Solution of this problem was straightforward; pressure histories for the two cases are given in Figures 12 and 13, and the saturation history for

Figure 5. Stanford Problem #2a. Block Pressures as Functions of Time and Position.

Figure 6. Stanford Problem #2b. Pressure as a Function of Time and Position.

Figure 7. Stanford Problem #2b. Steam Saturation as a Function of Time and Position.

Figure 8. Stanford Problem #2c. Pressure as a Function of Time and Position.

Figure 9. Stanford Problem #2c. Steam Saturation as a Function of Time and Position.

Figure 10. Stanford Problem #2d. Pressure History.

Figure 11. Stanford Problem #2d. Discharge Enthalpy History.

Figure 12. Stanford Problem #3a. Pressure Histories.

Case b is given in Figure 14. Also shown in these figures are the results considered "most correct" by the review panel. As can be seen from these figures, TETRAD solutions are virtually identical to the "most correct" solutions.

Table 3. Problem Specifications for Problem 3.

	Case a	Case b
Initial Pressure (kPa)	3050.	3050.
Initial Temperature (°C)	234.	234.
Initial Liquid Saturation	0	0.2
Fracture Porosity	0.1	0.1
Matrix Porosity	0.1	0.1
Fracture Permeability (md)	300.	300.
Matrix Permeability (md)	.03	.03
Fracture Thickness (m)	.1	.1
Matrix Thickness (m)	1.	1.
Well radius (m)	0.16	0.16
Well discharge (kg/s)	0.028	0.028
Rock Heat Capacity (kJ/m ³ °C)	2570.	2570.
Rock compressibility (kPa ⁻¹)	0	0
Rock thermal conductivity (W/m°C)	0	0

Input decks used for this problem are given in Appendix D.

Problem # 4: Expanding 2-Phase System with Drainage

This problem involves 1-D, vertical flow of two phases. From an initial condition of hydrostatic equilibrium, mass is withdrawn from the bottom of the column. Boiling occurs in portions of the reservoir, and cold water recharge is induced at the top. The grid specified was 20 blocks of equal size extending from the surface ($D = 0$) to a depth of 2 km. Different petrophysical properties (permeability and porosity) and different temperature gradients were specified for the upper 1 km and the lower 1 km. The pressure gradient was specified as hydrostatic. Constant pressure and temperature were specified as the boundary condition at the top of the reservoir, and a constant mass withdrawal rate was specified at the bottom of the reservoir. Output requested included pressure, temperature and saturation at several points in the reservoir, and recharge rates at the surface. Input specifications are summarized in Table 4.

In order to replicate the required boundary conditions, two additional grid blocks were used in the simulations. A thin ($\Delta z = 0.003$ m) layer was included at the top and bottom of the reservoir. A steady state aquifer was then attached to this top layer and the pressure and temperature were held constant. The other boundary condition specified a constant mass rate withdrawn from the bottom of the reservoir; this was done by completing a well in this lowest layer.

Figure 13. Stanford Problem #3b. Pressure Histories.

Figure 14. Stanford Problem #3b. Liquid Saturation in Grid Block vs. Time.

Selected results from this problem are given in Figures 15-17. The variables plotted represent the most dynamic of the requested output. The largest discrepancy between TETRAD results and S^3 (for example) is in the enthalpy history at late times. This difference is likely due to a difference in the location of the production well. From the S^3 report, it appears that the well was located in the 20th grid block, and was therefore at 1.95 km rather than 2 km.

Table 4. Problem Specifications for Problem 4

Layer Parameters	Layer "A"	Layer "B"
Thickness (m)	1000. ($0 \leq D \leq 1$ km)	1000. ($1 \leq D \leq 2$ km)
Porosity	0.15	0.15
Permeability (md)	5.	100.
Heat Capacity (kJ/m ³ °C)	2500.	2500.
Rock Thermal Cond (W/m°C)	1.	1.
Initial Temperature (°C)	$10 + 280 D/1\text{km}$	$270 + 20 D/1\text{km}$
Initial Pressure (kPa)	Atmospheric at $D = 0.$; hydrostatic with depth	
Other		
Discharge Mass Flux (kg/s/m ²)	100.	
Relative Permeability	$k_{rw} = S^4$; $k_{rs} = [1-S^2][1-S]^2$ $S = (S_w - 0.3)/0.65$	

In order to explore the feasibility of this explanation, a second simulation of problem 4 was made, but with the production well at 1.95 km from the surface. When this change was made, the discharge enthalpy history changed accordingly. This "new" result is also plotted in Figure 16. As can be seen, differences in well location is likely what led to the differences between the results obtained by TETRAD and those obtained elsewhere. Comparisons in histories of the other requested variables showed excellent agreement between TETRAD and other simulators.

The dataset used in for this problem is given in Appendix E.

Problem # 5: Flow in a 2-D Areal Reservoir

This problem involves multiphase flow in a 2-D, horizontal reservoir. Reservoir size is given as $0 \leq x \leq 3$ km and $0 \leq y \leq 2$ km and is modelled using a specified 12 x 8 grid. Pressure is initially uniform throughout the reservoir, but a temperature gradient is specified. Three boundaries (at $x = 0$ and $x = 3$ km, and $y = 0$) are impermeable and insulated, whereas the fourth boundary is to be held at its initial pressure and temperature. In Case a mass is withdrawn at a constant rate of 0.05 kg/s/meter thickness from a well in block 63 (see Figure 18 for grid numbering). For Case b, the same producing well exists, but an

Figure 15. Stanford Problem #4. Liquid Saturations at 2 Locations Within the Reservoir.

Figure 16. Stanford Problem #4. Effect of Well Location on Discharge Enthalpy.

Figure 17. Stanford Problem 4. Surface Recharge Rate Histories.

Figure 18. Schematic Showing Grid Numbering for Problem 5.

1	2	3	4	5	6	7	8	9	10	11	12
13	.	.	.	.	.	.	.	.	.	.	24
25					30	Inj.	32				36
37											48
49											60
61	62	Prod.	64								72
73											84
85	86	87	88	89	90	91	92	93	94	95	96

injector is also specified. The injection well is in block 31, and is inoperative until $t = 1$ year. Thereafter it injects 80°C water at a rate of $0.03\text{ kg/s/meter-thickness}$. Petrophysical properties are summarized in Table 5. Output specifications requested include pressure and temperature histories in blocks 31 and 63, and discharge enthalpy history for the producer.

Table 5. Problem Specifications for Problem 5.

Porosity	0.35
Permeability (md)	250.
Rock Heat Capacity ($\text{kJ/m}^3\text{C}$)	2500.
Rock Thermal Conductivity ($\text{W/m}^{\circ}\text{C}$)	1.
Relative Permeability	$k_{rw} = S^4$; $k_{rs} = [1-S^2][1-S]^2$ $S = (S_w - 0.3)/0.6$

Solutions for the producing block pressure and discharge enthalpy for Case a are given in Figures 19 and 20. Again, the variables not plotted here show similar agreement with results given by the Stanford Special Panel. Pressure and discharge enthalpy histories for Case b are given in Figures 21 and 22. These figures show excellent agreement between TETRAD and other geothermal models.

Datasets required to run these problems are given in Appendix F.

Problem # 6: Flow in a 3-D Reservoir

Problem # 6 is the only problem set that involves three-dimensional flow. The reservoir is a "Wairakei-type" field, with single-phase liquid at depth overlain by a two-phase zone with immobile steam, and capped off with a zone of colder single-phase water. Production comes from a single grid block below the two-phase zone. The reservoir dimensions are 5 km by 4 km areally, and 1.8 km vertically. Pressures are specified such that the reservoir is initially in hydrostatic equilibrium. Boundary conditions are given such that the top of the reservoir is maintained at its initial pressure, and 100°C ; the reservoir bottom and the plane $x = 5\text{ km}$ are both kept at its initial pressure and temperature. All other boundaries are impermeable and insulated. Production rates increase every two years, beginning at 1000 kg/s withdrawal, and increasing to 6000 kg/s at $t = 6$ years. All relevant rock properties and initial conditions are summarized in Table 6. Output requested includes discharge enthalpy and pressure, temperature, and saturation histories for each layer for up to 10 years.

Table 6. Problem Specifications for Problem 6.

Property	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Porosity	0.2	0.25	0.25	0.25	0.2
Areal Permeability (md)	100.	200.	200.	200.	100.
Vertical Perm. (md)	2.	50.	50.	50.	2.
Heat Capacity ($\text{kJ/m}^3\text{C}$)	2500.	2500.	2500.	2500.	2500.

Figure 19. Stanford Problem #5. Pressure History in the Producing Well Block.

Figure 20. Stanford Problem #5. Discharge Enthalpy Histories.

Figure 21. Stanford Problem #5b. Production Well Block History.

Figure 22. Stanford Problem #5b. Produced Enthalpy History.

Thermal Cond. (W/m°C)	1.	1.	1.	1.	1.
Relative Permeability	$k_{rw} = S^4$; $k_{rs} = [1-S^2][1-S]^2$ $S = (S_w - 0.3)/0.6$				
Initial Temperature (°C)	160.	280.	280.	280.	280.
Initial Pressure	Hydrostatic; based on pressure given for Layer 2 = Saturation pressure at 280 °C.				
Initial Steam Saturation	0.	.1	0.	0.	0.

Figures 23-25 show saturation and pressure histories for the producing well block and discharge enthalpy history, three of the more sensitive variables in this simulation. Comparison between these results and those of S^3 show remarkable similarity between these simulators; remarkable because this problem becomes unstable somewhere between 6 and 7 years. The withdrawal rate specified for $t \geq 6$ years causes such a dramatic pressure drop that the pressure in the producing grid block becomes negative. In our simulator this occurred at $t = 6.5$ years, slightly earlier than in the S^3 or LBL models. Nevertheless, the agreement between these different simulators is quite good up until this time, and clearly demonstrates that TETRAD is as capable of solving this complex case involving phase transitions, gravity drainage, recharge, and depletion.

The dataset for problem 6 is given in Appendix G.

Summary

In this report we have documented a validation study performed by the INEL Geothermal Reservoir Technology Program on TETRAD. The simulator has been compared to several other geothermal reservoir simulators, and has been shown to operate with similar precision on a set of test problems. Such a validation exercise is an important step in a project, and ensures that the simulator has a firm foundation in the physics of multiphase, multicomponent flow of fluids and energy, and can therefore be used in additional studies with confidence.

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Figure 23. Stanford Problem # 6. Producer Well Block Pressure History.

Figure 24. Stanford Problem # 6. Steam Saturation History in the Producing Well Block

Figure 25. Stanford Problem 6. Discharge Enthalpy History.

Nomenclature

D	elevation above a datum [=] L
E_j	Rate of injection/production of energy [=] Energy/t
E_L	Rate of heat loss [=] Energy/time
H_{ij}	molar enthalpy of pure component i in phase j [=] Energy/mol
H_j	molar enthalpy of phase j [=] Energy/mol
k	absolute permeability [=] L^2
k_{rj}	relative permeability of phase j
N_c	number of components
N_p	number of phases
P_j	pressure in phase j [=] F/ L^2
Q_i	Rate of injection of component i [=] m/t
S_j	Saturation of phase j
T	temperature [=] T
t	time [=] t
U_{ij}	molar internal energy of component i in phase j [=] Energy/mol
U_j	molar internal energy of phase j [=] Energy/mol
u_j	Darcy velocity of phase j [=] L/t
U_R	internal energy of the rock [=] Energy/mol

Greek

ϕ	porosity
μ_j	viscosity of phase j [=] F-t/ L^2
ρ_j	density of phase j [=] m/ L^3
ω_i	overall mole fraction of component i
ω_{ij}	mole fraction of species i in phase j

References

- Avdonin, N.A., "Some Formulas for Calculating the Temperature Field of a Stratum Subject to Thermal Injection," *Meft'i Gaz*, 3, 1964.
- Behie, A. and P.K.W. Vinsome, "Block Iterative Methods for Fully Implicit Reservoir Simulation," *Soc. Petroleum Engin J*, Oct 1982, pp. 658-668.
- O'Sullivan, M.J., and K. Pruess, "Analysis of Injection Testing of Geothermal Reservoirs," *Trans. Geothermal Resources Council*, 4, 1980, pp. 401-404.
- Stanford Special Panel on Geothermal Model Intercomparison Study, *Proc*, 6th Workshop on Geothermal Reservoir Engineering, SGP-TR-42, Stanford, Ca., Dec. 1980.
- Theis, C.V., "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage," *Trans. Amer. Geophysical Union*, 16, 1935, pp. 519-524.
- Vinsome, P.K.W., "Orthomin, an Iterative Method for Solving Sparse Sets of Simultaneous Linear Equations," SPE 5729, presented at the 4th Symposium of Numerical Simulation of Reservoir Performance of the SPE, Los Angeles, CA., Feb. 19-20, 1976.
- Vinsome, P.K.W. and J.D. Westerveld, "A Simple Method for Predicting Cap and Base Rock Heat Losses in Thermal Reservoir Simulators," *J Canadian Petroleum Tech.*, July-Sept. 1980, pp. 87-90.
- Vinsome, P.K.K., "TETRAD Users Manual," Dyad Engineering, Calgary, Alberta, Canada, 1990.

Appendix A: Governing Equations for 2-Component Geothermal Case

In a geothermal simulation of a two-component system, three equations must be solved. These equations describe the conservation of mass for each of the components and the conservation of energy for the system as a whole. These statements can be expressed as:

$$\frac{\partial}{\partial t} [\phi(\rho_1 S_1 \omega_{i1} + \rho_2 S_2 \omega_{i2})] + \vec{\nabla} \cdot [\rho_1 \vec{u}_1 \omega_{i1} + \rho_2 \vec{u}_2 \omega_{i2}] = Q_{ij} \quad (A1)$$

$$\frac{\partial}{\partial t} [\phi(\rho_1 S_1 U_1 + \rho_2 S_2 U_2) + (1-\phi)U_R] + \vec{\nabla} \cdot [\rho_1 \vec{u}_1 H_1 + \rho_2 \vec{u}_2 H_2] - \vec{\nabla} \cdot (k_T \vec{\nabla} T) - E_L = E_J \quad (A2)$$

where the subscript i denotes component 1 or 2. Thus Eq A1 embodies mass conservation for each of the components.

Eqs A1 and A2 represent three equations in 12 unknowns (ρ_1 , ρ_2 , S_1 , S_2 , u_1 , u_2 , ω_{11} , ω_{12} , ω_{21} , ω_{22} , U_1 , U_2 , H_1 , H_2). To solve such a system of equations, additional equations are necessary. These new equations can be thought of as "auxiliary" equations and "constraint" equations. Auxiliary equations define the unknowns found in the above equations, whereas the constraint equations are used to constrain mole fractions and saturations. These are discussed in more detail below.

The volumetric flux of each phase is assumed to obey Darcy's Law; thus:

$$\vec{u}_j = -k \frac{k_{rj}}{\mu_j} (\vec{\nabla} P_j + \rho_j g \vec{\nabla} D) \quad (A3)$$

Eq A3 defines the two phase fluxes in terms of six additional unknowns: k_{r1} , k_{r2} , μ_1 , μ_2 , P_1 , and P_2 . Phase pressures (P_1 and P_2) are related through the capillary pressure, P_c :

$$P_1 = P_2 + P_c$$

where phase 1 is assumed to be the wetting phase. Relative permeabilities of the two phases are assumed to be known functions of saturation, as is the capillary pressure, P_c . In a geothermal simulation, viscosities are functions of pressure, temperature, and phase composition. In the case of two aqueous species (such as water and a tracer), such variables can be included in a steam table. The steam table used in TETRAD includes temperature, pressure (at saturated conditions), densities, viscosities, internal energies, enthalpies, and compressibilities. In the case of a noncondensable gas, for example, an equation of state must be used to determine these component properties.

Phase internal energies and enthalpies are obtained by summing the product of species mole fractions and component internal energy (enthalpy):

$$U_j = \sum_{i=1}^{N_c} \omega_{ij} U_i$$

$$H_j = \sum_{i=1}^{N_c} \omega_{ij} H_i$$

where the species' internal energy and enthalpy are known functions of P and T.

The final set of equations needed to solve our system of equations are the "constraint" equations. Briefly, they state that saturations and mole fractions must sum to unity, or:

$$\sum_{i=1}^{N_c} \omega_i = 1$$

$$\sum_{i=1}^{N_c} \omega_{ij} = 1$$

$$\sum_{j=1}^{N_p} S_j = 1$$

$$\omega_i = \sum_{j=1}^{N_p} S_j \omega_{ij}$$

This completes the equations required to fully describe the two-component, two-phase, non-isothermal flow of fluids in a porous media. In order to solve such a system, one must also specify a similarly complete set of initial and boundary conditions.

These equations and corresponding unknowns are summarized in Table A1.

Table A1. Summary of Equations Required to Solve 2-Component Geothermal Simulation

Equation	# Eqs	Comments	Unknowns	# Unknowns
$\frac{\partial}{\partial t} [\phi(\rho_1 S_1 \omega_{11} + \rho_2 S_2 \omega_{12})] + \vec{\nabla} \cdot [\rho_1 \vec{u}_1 \omega_{11} + \rho_1 \vec{u}_2 \omega_{12}] = Q_u$	2	Conservation of Mass, Species 1 and 2	$\rho_1, \rho_2, S_1, S_2, \omega_{11}, \omega_{12}, \omega_{21}, \omega_{22}, u_1, u_2$	10
$\frac{\partial}{\partial t} [\phi(\rho_1 S_1 U_1 + \rho_2 S_2 U_2) + (1-\phi)U_R] + \vec{\nabla} \cdot [\rho_1 \vec{u}_1 H_1 + \rho_1 \vec{u}_2 H_2] - \vec{\nabla} \cdot (k_T \vec{\nabla} T) - E_L = E_J$	1	Conservation of Energy	U_1, U_2, H_1, H_2	4
$\vec{u}_j = -k \frac{k_{rj}}{\mu_j} (\vec{\nabla} P_j + \rho_j g \vec{\nabla} D)$	2	Darcy Velocity for each phase	$k_{r1}, k_{r2}, \mu_1, \mu_2, P_1, P_2$	6
$P_1 = P_2 + P_c$	1	Capillary Pressure	P_c	1
$P_c = P_c(S)$	1	P_c known function of saturation		0
$k_{rj} = k_{rj}(S)$	2	Rel Perms functions of saturation		0
$\mu_j = \mu_j(P, T, \omega_{ij})$	2	included in steam table		0
$U_j = \sum_{i=1}^{N_c} \omega_{ij} U_i$	2		U_1, U_2	2
$H_j = \sum_{i=1}^{N_c} \omega_{ij} H_i$	2		H_1, H_2	2
$U_i = U_i(P, T)$	2	included in steam table		0
$H_i = H_i(P, T)$	2	included in steam table		0
$\rho_j = \rho_j(P, T, \omega_{ij})$	2	included in steam table		0
$\sum_{i=1}^{N_c} \omega_i = 1$	1	definition of overall mole fraction	ω_1, ω_2	2
$\sum_{i=1}^{N_c} \omega_{ij} = 1$	2	definition of phase mole fraction		0
$\sum_{j=1}^{N_p} S_j = 1$	1	Saturation constraint		0
$\sum_{j=1}^{N_p} S_j \omega_{ij} = 1$	2 —	phase distribution of species i		2 —
Totals	27			27

APPENDIX B: DATASETS USED FOR STANFORD PROBLEM 1

```

'COMMENT' 'STANFORD TEST PROBLEM #1'
'COMMENT' '1-D RADIAL FLOW OF WATER'
'COMMENT' 'SINGLE PHASE LIQUID WATER'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'CONSTANT SPECIFIC HEAT, VISCOSITY & DENSITY OF WATER'
'COMMENT' 'USING METRIC UNITS'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 40 1 1 60
'PRINT' 35 1 1 2 0
'OUTFUN' 0 0 0 0 0 0 0 8 9 0
'OUTPROP' 0 0 0 0 0 0 0 0 0 0
'PLOT' 1
      3 'PBHW' 'PAV' 'TAV'
'GVWRITE' 0 30
2 'P' 'T'
'TMSTEP' 3 3 193.287 ,,,,,,
'COMMENT' 'SET RADIAL GRID DIMENSIONS, WITH 40 BLOCKS AT 25 M EACH'
'DELX' 1
40 40*25.
'DELY' 1
1 1.
'COMMENT' 'MODEL IS 100 M THICK'
'DELZ' 1
1 100.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESSIBLE PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'COMMENT' 'SET POROSITIES TO 20%'
'PORALL' 1
40 40*.2
'COMMENT' 'SET PERMEABILITIES TO 1000 mD'
'PERMALL' 1 1
40 40*1000.
'PERMALL' 1 2
40 40*1000.
'PERMALL' 1 3
40 40*1000.
'RADIAL' 1 0.
'PROPERTY'
'RELOW' 1 5 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0.3 0. 0.
.5 .5 0. 0.
.7 .7 0. 0.
1. 1. 0. 0.
'RELOG' 1 5 1 1. 0.
0. 0. 0. 0.
.1 1. 0. 0.
.5 1. 0. 0.
.7 1. 0. 0.
1. 1. 0. 0.

```

```

'COMMENT' 'SET CONSTANT WATER PROPERTIES'
'DENCS' 62.4
1
18.02
'COMMENT' 'SET INITIAL PRESSURE AT 50 BARS'
'PRESALL' 1
40 40*5000.
'COMMENT' 'SET INITIAL TEMPERATURE AT 170-C'
'TEMPALL' 1
40 40*170.
'SATMOD' 1 40 1 0. 0.
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1. 0. 25. 2500.
4.1868 0. 25. 0. 10.
'GASSH'
.56 0. 60. 0. 15.
'LIQTCON' 1728. 0. 25.
4.3268 0. 25.
'GASTCON'
0. 0. 60.
'COMMENT' 'STEAM TABLES SET TO GIVE CONSTANT PROPERTIES'
'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG
DHG/DP'
'STEAMT' 5
160.00 618.05 902.85 3.26 675.44 2756.66 0.1636 0.01 0.0 1.60E-03 -13.02
162.78 663.00 902.85 3.49 687.54 2759.68 0.1636 0.01 0.0 1.45E-03 -12.30
165.56 710.51 902.85 3.72 699.63 2762.47 0.1636 0.01 0.0 1.41E-03 -11.64
168.33 760.63 902.85 3.97 711.73 2765.26 0.1636 0.01 0.0 1.31E-03 -11.03
171.11 813.52 902.85 4.23 724.05 2768.05 0.1636 0.01 0.0 1.22E-03 -10.46
'RECUR'
'TIMEYR' 0
'TIME' 0. 193.287
'COMMENT' 'ATTACH STEADY STATE AQUIFER AT OUTER BOUNDARY'
'AQUIFER' 'SSTATE' 40 40 1 1 0.
'COMMENT' 'CONSTANT TEMPERATURE AT OUTER BOUNDARY'
'HLOSS' 'SSTATE' 40 40 1 1 0.
'COMMENT' 'INJECT 100 KG/S WATER AT 160-C AT R=0'
'INJECTOR' 'DOG' 1 3
1
.282 .1 0. 0.
1000.
0. 0. 0
1000.
160. 0.
',,
'COMMENT' 'SET UP OBSERVATION WELL AT R=37.5 M'
'PRODUCER' 'OBS' 1 3
2
.282 .1 0. 0.
,
0. 0. 0.
'R' 'DOG' 0. 36.0
'TIME' 12000. 0.

```

```

'COMMENT' 'STANFORD TEST PROBLEM #1- pass 2'
'COMMENT' '1-D radial flow of water.'
'COMMENT' 'undersaturated water'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'SOLVING THE LIMITING CASE OF CONST VIS, ETC'
'COMMENT' 'metric...'
'COMMENT' 'using 1 add. grid for grid center at 37.5 m'
'COMMENT' 'OBSERVATION WELL NOW IN BLOCK 3'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 40 1 1 60
'PRINT' 35 1 1 2 0
'OUTFUN' 0 0 0 0 0 0 0 8 9 0
'OUTPROP' 0 0 0 0 0 0 0 0 0 0
'PLOT' 1
3 'PBHW' 'PAV' 'TAV'
'GVWRITE' 0 30
2 'P' 'T'
'TMSTEP' 3 3 193.287 ,,,,,,
'DELX' 1
40 15. 22. 1. 37*25.
'DELY' 1
1 1.
'DELZ' 1
1 100.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'PORALL' 1
40 40*.2
'COMMENT' 'SET PERMS...'
'PERMALL' 1 1
40 40*1000.
'PERMALL' 1 2
40 40*1000.
'PERMALL' 1 3
40 40*1000.
'RADIAL' 1 0.
'PROPERTY'
'RELOW' 1 5 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0.3 0. 0.
.5 .5 0. 0.
.7 .7 0. 0.
1. 1. 0. 0.
'RELOG' 1 5 1 1. 0.
0. 0. 0. 0.
.1 1. 0. 0.
.5 1. 0. 0.
.7 1. 0. 0.
1. 1. 0. 0.
'DENCS' 62.4
1
18.02

```

```

'PRESALL' 1
40 40*5000.
'TEMPALL' 1
40 40*170.
'SATMOD' 1 40 1 0. 0.
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1. 0. 25. 2500.
4.1868 0. 25. 0. 10.
'GASSH'
.56 0. 60. 0. 15.
'LIQTCON' 1728. 0. 25.
4.3268 0. 25.
'GASTCON'
0. 0. 60.
'COMMENT' 'STEAM TABLES ..only to give constant dens, visc.'
'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'
'SEAMT' 5
160.00 618.05 902.85 3.26 675.44 2756.66 0.1636 0.01 0.0 1.60E-03 -13.02
162.78 663.00 902.85 3.49 687.54 2759.68 0.1636 0.01 0.0 1.45E-03 -12.30
165.56 710.51 902.85 3.72 699.63 2762.47 0.1636 0.01 0.0 1.41E-03 -11.64
168.33 760.63 902.85 3.97 711.73 2765.26 0.1636 0.01 0.0 1.31E-03 -11.03
171.11 813.52 902.85 4.23 724.05 2768.05 0.1636 0.01 0.0 1.22E-03 -10.46
'RECUR'
'TIMEYR' 0
'TIME' 0. 193.287
'AQUIFER' 'SSTATE' 40 40 1 1 0. ,,,,,,,,,,,,,,
'HLOSS' 'SSTATE' 40 40 1 1 0. ,,,,,,,,,,,,,,
'INJECTOR' 'DOG' 1 3
1
.282 .1 0. 0.
1000.
0. 0. 0
1000.
160. 0.
',,
'PRODUCER' 'OBS' 1 3
3
.282 .1 0. 0.
,
0. 0. 0.
'R' 'DOG' 0. 36.0
'TIME' 12000. 0.

```

APPENDIX C: DATASETS USED FOR STANFORD PROBLEM 2

```

'COMMENT' 'STANFORD TEST PROBLEM #2A'
'COMMENT' '1-D RADIAL FLOW OF WATER.'
'COMMENT' 'TRANSIENT TEST ANALYSIS'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MANY DEFAULT, USING RADIAL HARMONIC K'
'COMMENT' 'SHOULD MATCH THE Ei SOLUTION'
'COMMENT' 'USING STEAM TABLES W/ CONSTANT DENSITY & VISCOSITY'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 26 1 1 200
'PRINT' 10 0 1 0 0
'OUTFUN' 1 2 0 0 0 0 0 8 9 0
'OUTPROP' 0 0 0 1 1 1 0 0 0 0
'PLOT' 2
2 'PBHW' 'PAV'
'GVWRITE' 0 60
2 'P' 'T'
'SHIFT' '','',''
'TMSTEP' 3 3 .5 '','',''
'NEWT' '','',''
'GRAV' '','',''
'COMMENT' 'SET UP RADIAL GRID SIZE'
'DELX' 3
11 .4 .2 .2142 .3716 .6 1.0426 1.1716 1.6569 2.3431 3.3137 4.6863
9 6.6274 9.3726 13.2548 18.7452 26.5097 37.49 53.0193 74.98 106.0387
6 149.96 212.077 299.923 424.1587 599.84 848.31
'DELY' 1
1 1.
'COMMENT' 'MODEL IS 100 M THICK'
'DELZ' 1
1 100.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESSIBLE PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'PORALL' 1
26 26*.2
'COMMENT' 'SET UNIFORM PERMEABILITY AT 10 mD'
'PERMALL' 1 1
26 26*10.
'PERMALL' 1 2
26 26*10.
'PERMALL' 1 3
26 26*10.
'RADIAL' 1 0.
'PROPERTY'
'COMMENT' 'RELATIVE PERMEABILITY TABLE'
'RELOW' 1 5 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0.3 0. 0.
.5 .5 0. 0.
.7 .7 0. 0.
1. 1. 0. 0.

```


'RELOG' 1 5 1 1. 0.

0. 0. 0. 0.

.1 1. 0. 0.

.5 1. 0. 0.

.7 1. 0. 0.

1. 1. 0. 0.

'COMMENT' 'SET WATER DENSITY'

'DENS' 62.4

1

18.02

'COMMENT' 'SET INITIAL PRESSURE AT 90 BARS'

'PRESALL' 1

26 26*9000.

'COMMENT' 'SET INITIAL TEMPERATURE AT 260-C'

'TEMPALL' 1

26 26*260.

'SATMOD' 1 26 1 0. 0.

'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'

'LIQSH' 1. 0. 25. 2650.

4.1868 0. 25. 0. 15.

'GASSH'

1.8422 0. 60. 0. 15.

'LIQTCON' 0. 0. 60.

59.8 0. 25.

'GASTCON'

4.1122 0. 25.

'COMMENT' 'STEAM TABLES ...'

'COMMENT' 'TABLES MODIFIED FOR CONST DEN, VISC, COMPRESS OF FLUIDS OVER'

'COMMENT' 'RANGE OF PRESSURE EXPECTED.'

'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'

'STEAMT' 114

46.11 10.14 990.46 0.07 193.05 2585.24 0.58 0.01 4.64E-07 7.40E-02 -408.73

48.89 11.65 989.24 0.08 204.68 2590.12 0.55 0.01 4.35E-07 6.67E-02 -361.84

51.67 13.38 987.98 0.09 216.31 2595.01 0.53 0.01 4.35E-07 5.95E-02 -321.17

54.44 15.31 986.65 0.10 227.94 2599.89 0.51 0.01 4.35E-07 5.37E-02 -285.79

57.22 17.51 985.27 0.12 239.57 2604.78 0.48 0.01 4.64E-07 4.79E-02 -254.95

60.00 19.93 983.86 0.13 251.20 2609.66 0.46 0.01 4.64E-07 4.35E-02 -227.98

62.78 22.61 982.38 0.15 262.83 2614.31 0.44 0.01 4.64E-07 3.77E-02 -204.34

65.56 25.65 980.88 0.17 274.46 2619.20 0.43 0.01 4.64E-07 3.48E-02 -183.56

68.33 28.96 979.32 0.19 286.09 2624.08 0.41 0.01 4.64E-07 3.05E-02 -165.26

71.11 32.68 977.72 0.21 297.72 2628.73 0.39 0.01 4.64E-07 2.76E-02 -149.11

73.89 36.82 976.08 0.23 309.34 2633.38 0.38 0.01 4.93E-07 2.47E-02 -134.82

76.67 41.30 974.40 0.26 320.97 2638.04 0.37 0.01 4.64E-07 2.18E-02 -122.14

79.44 46.33 972.68 0.29 332.60 2642.69 0.35 0.01 4.93E-07 2.03E-02 -110.88

82.22 51.78 970.92 0.32 344.23 2647.34 0.34 0.01 4.64E-07 1.74E-02 -100.84

85.00 57.78 969.13 0.35 355.86 2651.99 0.33 0.01 4.64E-07 1.60E-02 -91.89

87.78 64.40 967.30 0.39 367.49 2656.41 0.32 0.01 4.93E-07 1.45E-02 -83.87

90.56 71.57 965.42 0.43 379.35 2660.83 0.31 0.01 4.93E-07 1.33E-02 -76.70

93.33 79.50 963.53 0.48 390.98 2665.48 0.30 0.01 4.93E-07 1.20E-02 -70.27

96.11 88.05 961.59 0.52 402.61 2669.90 0.29 0.01 4.93E-07 1.09E-02 -64.48

98.89 97.35 959.60 0.58 414.48 2674.09 0.28 0.01 5.22E-07 9.86E-03 -59.27

101.67 107.49 957.60 0.63 426.10 2678.51 0.27 0.01 5.22E-07 8.99E-03 -54.56

104.44 118.52 955.56 0.69 437.73 2682.69 0.27 0.01 5.22E-07 8.27E-03 -50.31

107.22 130.38 953.48 0.76 449.60 2687.11 0.26 0.01 5.08E-07 7.54E-03 -46.46

110.00	143.27	951.38	0.83	461.23	2691.30	0.25	0.01	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	0.01	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	0.01	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	0.01	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	0.01	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	0.01	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	0.01	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	0.01	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	0.01	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	0.01	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	0.01	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	0.01	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	0.01	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	0.01	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	0.01	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	0.01	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	0.01	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	0.01	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	0.01	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	0.01	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	0.01	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	0.01	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	0.01	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	0.01	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	0.01	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	0.01	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	0.02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	0.02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	0.02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	0.02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	0.02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	0.02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	0.02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	0.02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	0.02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	0.02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	0.02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	0.02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	0.02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	0.02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	0.02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	0.02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	0.02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	0.02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	0.02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	0.02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	0.02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	0.02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	0.02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	0.02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	0.02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	785.23	23.75	1093.87	2799.92	0.11	0.02	1.74E-06	3.05E-04	-2.97
254.44	4284.98	785.23	23.75	1107.59	2798.76	0.11	0.02	1.74E-06	3.05E-04	-2.92
257.22	4486.10	785.23	23.75	1121.08	2797.59	0.11	0.02	1.74E-06	3.05E-04	-2.87

260.00	4694.39	785.23	75	1134.81	2796.20	0.11	0.02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	785.0	23.75	1148.76	2794.80	0.11	0.02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	785.23	75	1162.72	2792.94	0.11	0.02	1.74E-06	3.05E-04	-2.73
268.33	5363.67	771.08	23.75	1176.67	2791.08	0.11	0.02	1.89E-06	3.05E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.11	0.02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.11	0.02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	0.02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	0.02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	0.02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	720.66	45.0	1263.20	2774.33	0.09	0.02	3.05E-06	3.48E-04	-2.41
287.78	7208.03	720.66	45.	1278.08	2770.61	0.09	0.02	3.05E-06	3.48E-04	-2.36
296.11	8131.87	720.66	45.	1323.44	2757.82	0.09	0.02	3.05E-06	3.48E-04	-2.25
301.67	8796.25	720.66	45.0	1354.37	2747.82	0.09	0.02	3.05E-06	3.48E-04	-2.16
304.44	9143.68	720.66	45.0	1370.19	2742.24	0.09	0.02	3.05E-06	3.48E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	0.02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	0.02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	0.02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	0.02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	0.02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	0.02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	0.02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	0.02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	0.02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	0.02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	0.02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	0.02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	0.02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	0.02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	0.02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	0.03	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	0.03	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	0.03	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	0.03	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	0.03	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	0.03	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	0.03	6.96E-05	6.09E-04	-1.46
368.33	20639.58	469.44	187.05	1862.12	2376.84	0.06	0.03	1.13E-04	6.53E-04	-1.43

'RECUR'

'TIMEYR' 0

'TIME' 0. 1.E-5

'COMMENT' 'SET PRODUCER AT R=0'

'PRODUCER' 'DOG' 1 3

1

.282 .01 0. 0.

400.

0. 0. 0

'COMMENT' 'SET OBSERVATION WELL IN SECOND GRID'

'PRODUCER' 'OBS1' 1 3

2

.282 .1 0. 0.

3

164. 0. 3

'COMMENT' 'SET OBSERVATION WELL IN THIRD GRID'

'PRODUCER' 'OBS2' 1 3

3

.282 .1 0. 0.

164. 0. 3

'COMMENT' 'SET OBSERVATION WELL IN FOURTH GRID'

'PRODUCER' 'OBS3' 1 3

4

.282 .1 0. 0.

164. 0. 3

'COMMENT' 'PRODUCE WELL AT 14 KG/S (OR 50.4K KG/H)'

'P' 'DOG' 0. 14.7 50.4

'TIME' 1. 0.

```

'COMMENT' 'STANFORD TEST PROBLEM #2B'
'COMMENT' '1-D RADIAL FLOW OF WATER'
'COMMENT' 'TRANSIENT TEST ANALYSIS'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MANY DEFAULT, using radial harm k'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 26 1 1 200
'PRINT' 5 0 1 0 0
'OUTFUN' 0 1 0 0 0 0 0 0 0 0
'OUTPROP' 0 2 0 0 1 1 7 0 0 0
'PLOT' 2
3 'PBHW' 'PAV' 'SGAV'
'GVWRITE' 0 3
3 'P' 'T' 'SW'
'SHIFT' ',,,,,'
'TMSTEP' '3' '3' .1 ',,,,,'
'NEWT' ',,,,,'
'GRAV' ',,,,,'
'DELX' 3
11 .4 .2 .2142 .3716 .6 1.0426 1.1716 1.6569 2.3431 3.3137 4.6863
9 6.6274 9.3726 13.2548 18.7452 26.5097 37.49 53.0193 74.98 106.0387
6 149.96 212.077 299.923 424.1587 599.84 848.31
'DELY' 1
1 1.
'DELZ' 1
1 100.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'COMMENT' 'SET POROSITY AT 15%'
'PORALL' 1
26 26*.15
'COMMENT' 'SET UNIFORM PERMEABILITY AT 240 mD'
'PERMALL' 1 1
26 26*240.
'PERMALL' 1 2
26 26*240.
'PERMALL' 1 3
26 26*240.
'RADIAL' 1 0.
'PROPERTY'
'COMMENT' 'USING COREY RELATIVE PERMEABILTY CURVES'
'RELOW' 1 12 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0. 0. 0.
.35 .00004 0. 0.
.4 .0006 0. 0.
.5 .009 0. 0.
.6 .045 0. 0.
.7 .143 0. 0.
.8 .35 0. 0.
.9 .72 0. 0.
.93 .8825 0. 0.

```

```

.95 1. 0. 0.
1. 1. 0. 0.
'RELOG' 1 12 1 1. 0.
0. 0. 0. 0.
.05 0. 0. 0.
.06 7.2E-6 0. 0.
.1 .0009 0. 0.
.2 .0217 0. 0.
.3 .092 0. 0.
.4 .228 0. 0.
.5 .434 0. 0.
.6 .7 0. 0.
.7 1. 0. 0.
.8 1. 0. 0.
1. 1. 0. 0.
'DENCS' 62.4

```

1

18.02

'COMMENT' 'SET INITIAL PRESSURE AT 30 BARS'

'PRESALL' 1

26 26*3000.

'COMMENT' 'SET INITIAL TEMPERATURE AT 233.8-C'

'TEMPALL' 1

26 26*233.8

'COMMENT' 'SET INITIAL WATER SATURATION AT 65%'

'SATMOD' 1 26 1 0.35 0.

'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'

'LIQSH' 1. 0. 25. 2000.

4.1868 0. 25. 0. 15.

'GASSH'

1.8422 0. 60. 0. 15.

'LIQTCON' 0. 0. 60.

59.8 0. 25.

'GASTCON'

4.1122 0. 25.

'COMMENT' 'STEAM TABLES ...'

'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'

'STEAMT' 118

46.11	10.14	990.46	0.07	193.05	2585.24	0.58	0.01	4.64E-07	7.40E-02	-408.73
48.89	11.65	989.24	0.08	204.68	2590.12	0.55	0.01	4.35E-07	6.67E-02	-361.84
51.67	13.38	987.98	0.09	216.31	2595.01	0.53	0.01	4.35E-07	5.95E-02	-321.17
54.44	15.31	986.65	0.10	227.94	2599.89	0.51	0.01	4.35E-07	5.37E-02	-285.79
57.22	17.51	985.27	0.12	239.57	2604.78	0.48	0.01	4.64E-07	4.79E-02	-254.95
60.00	19.93	983.86	0.13	251.20	2609.66	0.46	0.01	4.64E-07	4.35E-02	-227.98
62.78	22.61	982.38	0.15	262.83	2614.31	0.44	0.01	4.64E-07	3.77E-02	-204.34
65.56	25.65	980.88	0.17	274.46	2619.20	0.43	0.01	4.64E-07	3.48E-02	-183.56
68.33	28.96	979.32	0.19	286.09	2624.08	0.41	0.01	4.64E-07	3.05E-02	-165.26
71.11	32.68	977.72	0.21	297.72	2628.73	0.39	0.01	4.64E-07	2.76E-02	-149.11
73.89	36.82	976.08	0.23	309.34	2633.38	0.38	0.01	4.93E-07	2.47E-02	-134.82
76.67	41.30	974.40	0.26	320.97	2638.04	0.37	0.01	4.64E-07	2.18E-02	-122.14
79.44	46.33	972.68	0.29	332.60	2642.69	0.35	0.01	4.93E-07	2.03E-02	-110.88
82.22	51.78	970.92	0.32	344.23	2647.34	0.34	0.01	4.64E-07	1.74E-02	-100.84
85.00	57.78	969.13	0.35	355.86	2651.99	0.33	0.01	4.64E-07	1.60E-02	-91.89
87.78	64.40	967.30	0.39	367.49	2656.41	0.32	0.01	4.93E-07	1.45E-02	-83.87

90.56	71.57	965.42	0.43	379.35	2660.83	0.31	0.01	4.93E-07	1.33E-02	-76.70
93.33	79.50	963.53	0.48	390.98	2665.48	0.30	0.01	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	0.01	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	0.01	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	0.01	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	0.01	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	0.01	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	0.01	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	0.01	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	0.01	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	0.01	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	0.01	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	0.01	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	0.01	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	0.01	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	0.01	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	0.01	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	0.01	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	0.01	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	0.01	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	0.01	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	0.01	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	0.01	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	0.01	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	0.01	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	0.01	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	0.01	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	0.01	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	0.01	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	0.01	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	0.01	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	0.01	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	0.01	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	0.02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	0.02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	0.02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	0.02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	0.02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	0.02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	0.02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	0.02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	0.02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	0.02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	0.02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	0.02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	0.02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	0.02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	0.02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	0.02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	0.02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	0.02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	0.02	1.19E-06	3.48E-04	-3.83
233.8	3000.0	822.72	15.05	1008.10	2802.15	0.12	0.02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	0.02	1.25E-06	3.34E-04	-3.69

237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	0.02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	0.02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	0.02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	0.02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	0.02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	785.23	23.75	1093.87	2799.92	0.11	0.02	1.74E-06	3.05E-04	-2.97
254.44	4284.98	785.23	23.75	1107.59	2798.76	0.11	0.02	1.74E-06	3.05E-04	-2.92
257.22	4486.10	785.23	23.75	1121.08	2797.59	0.11	0.02	1.74E-06	3.05E-04	-2.87
260.00	4694.39	785.23	23.75	1134.81	2796.20	0.11	0.02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	785.0	23.75	1148.76	2794.80	0.11	0.02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	785.23	23.75	1162.72	2792.94	0.11	0.02	1.74E-06	3.05E-04	-2.73
268.33	5363.67	771.08	23.75	1176.67	2791.08	0.11	0.02	1.89E-06	3.05E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.11	0.02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.11	0.02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	0.02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	0.02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	0.02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	0.02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	0.02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	0.02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	0.02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	0.02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	0.02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	0.02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	0.02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	0.02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	0.02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	0.02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	0.02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	0.02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	0.02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	0.02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	0.02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	0.02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	0.02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	0.02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	0.02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	0.02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	0.02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	0.02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	0.03	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	0.03	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	0.03	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	0.03	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	0.03	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	0.03	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	0.03	6.96E-05	6.09E-04	-1.46
368.33	20639.58	469.44	187.05	1862.12	2376.84	0.06	0.03	1.13E-04	6.53E-04	-1.43

'RECUR'

'TIMEYR' 0

'TIME' 0. 1.E-5

'COMMENT' 'SET PRODUCER AT R=0'

'PRODUCER' 'DOG' 1 3

1

.282 .01 0. 0.

165.

0. 0. 0

'COMMENT' 'SET OBSERVATION WELL IN SECOND GRID'

'PRODUCER' 'OBS1' 1 3

2

.282 .1 0. 0.

3

164. 0. 3

'COMMENT' 'SET OBSERVATION WELL IN THIRD GRID'

'PRODUCER' 'OBS2' 1 3

3

.282 .1 0. 0.

4

164. 0. 3

'COMMENT' 'SET OBSERVATION WELL IN FOURTH GRID'

'PRODUCER' 'OBS3' 1 3

4

.282 .1 0. 0.

5

164. 0. 3

'COMMENT' 'PRODUCE WELL AT 16.7 KG/S (60.12K KG/H)'

'P' 'DOG' 0. 14.7 60.12

'TIME' 1. 0.

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'COMMENT' 'STANFORD TEST PROBLEM #2C'
'COMMENT' '1-D RADIAL FLOW OF WATER'
'COMMENT' 'TRANSIENT TEST ANALYSIS'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MANY DEFAULT, using radial harm k'
'COMMENT' 'SINGLE PHASE I.C.; SHOULD CREATE BOILING FRONT'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 26 1 1 200
'PRINT' 10 0 1 0 0
'OUTFUN' 0 1 0 0 0 0 0 0 0 0
'OUTPROP' 0 2 0 1 1 1 7 0 0 0
'PLOT' 2
3 'PBHW' 'PAV' 'SGAV'
'GVWRITE' 0 3
3 'P' 'T' 'SW'
'SHIFT' ' ',' ',' ',' ',' '
'TMSTEP' 3 3 .5 ' ',' ',' ',' '
'NEWT' ' ',' ',' ',' '
'GRAV' ' ',' ',' ',' '
'COMMENT' 'SET UP RADIAL GRID'
'DELX' 3
11 .4 .2 .2142 .3716 .6 1.0426 1.1716 1.6569 2.3431 3.3137 4.6863
9 6.6274 9.3726 13.2548 18.7452 26.5097 37.49 53.0193 74.98 106.0387
6 149.96 212.077 299.923 424.1587 599.84 848.31
'DELY' 1
1 1.
'COMMENT' 'MODEL IS 100 M THICK'
'DELZ' 1
1 100.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'PORALL' 1
26 26*.2
'COMMENT' 'SET UNIFORM PERMEABILTY OF 10 mD'
'PERMALL' 1 1
26 26*10.
'PERMALL' 1 2
26 26*10.
'PERMALL' 1 3
26 26*10.
'RADIAL' 1 0.
'PROPERTY'
'COMMENT' 'COREY RELATIVE PERMEABILTY CURVES'
'RELOW' 1 12 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0. 0. 0.
.35 .00004 0. 0.
.4 .0006 0. 0.
.5 .009 0. 0.
.6 .045 0. 0.
.7 .143 0. 0.
.8 .35 0. 0.

```

```

.9 .72 0. 0.
.93 .8825 0. 0.
.95 1. 0. 0.
1. 1. 0. 0.
'RELOG' 1 12 1 1. 0.
0. 0. 0. 0.
.05 0. 0. 0.
.06 7.2E-6 0. 0.
.1 .0009 0. 0.
.2 .0217 0. 0.
.3 .092 0. 0.
.4 .228 0. 0.
.5 .434 0. 0.
.6 .7 0. 0.
.7 1. 0. 0.
.8 1. 0. 0.
1. 1. 0. 0.
'DENCS' 62.4

```

```

1
18.02
'COMMENT' 'SET INITIAL PRESSURE AT 90 BARS'
'PRESALL' 1
26 26*9000.
'COMMENT' 'SET INITIAL TEMPERATURE AT 300-C'
'TEMPALL' 1
26 26*300.
'COMMENT' 'SET INITIAL LIQUID SATURATION AT 1.0'
'SATMOD' 1 26 1 0. 0.
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1. 0. 25. 2650.
4.1868 0. 25. 0. 15.
'GASSH'
1.8422 0. 60. 0. 15.
'LIQTCON' 0. 0. 60.
59.8 0. 25.
'GASTCON'
4.1122 0. 25.
'COMMENT' 'STEAM TABLES ...'
'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'
'STEAMT' 117

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	T	P	DEN1	DEN2	W	ENTH	G	ENER	U-W	U-G	CW	CG	DHG/DP
46.11	10.14	990.46	0.07	193.05	2585.24	0.58	0.01	4.64E-07	7.40E-02	-408.73			
48.89	11.65	989.24	0.08	204.68	2590.12	0.55	0.01	4.35E-07	6.67E-02	-361.84			
51.67	13.38	987.98	0.09	216.31	2595.01	0.53	0.01	4.35E-07	5.95E-02	-321.17			
54.44	15.31	986.65	0.10	227.94	2599.89	0.51	0.01	4.35E-07	5.37E-02	-285.79			
57.22	17.51	985.27	0.12	239.57	2604.78	0.48	0.01	4.64E-07	4.79E-02	-254.95			
60.00	19.93	983.86	0.13	251.20	2609.66	0.46	0.01	4.64E-07	4.35E-02	-227.98			
62.78	22.61	982.38	0.15	262.83	2614.31	0.44	0.01	4.64E-07	3.77E-02	-204.34			
65.56	25.65	980.88	0.17	274.46	2619.20	0.43	0.01	4.64E-07	3.48E-02	-183.56			
68.33	28.96	979.32	0.19	286.09	2624.08	0.41	0.01	4.64E-07	3.05E-02	-165.26			
71.11	32.68	977.72	0.21	297.72	2628.73	0.39	0.01	4.64E-07	2.76E-02	-149.11			
73.89	36.82	976.08	0.23	309.34	2633.38	0.38	0.01	4.93E-07	2.47E-02	-134.82			
76.67	41.30	974.40	0.26	320.97	2638.04	0.37	0.01	4.64E-07	2.18E-02	-122.14			
79.44	46.33	972.68	0.29	332.60	2642.69	0.35	0.01	4.93E-07	2.03E-02	-110.88			
82.22	51.78	970.92	0.32	344.23	2647.34	0.34	0.01	4.64E-07	1.74E-02	-100.84			

85.00	57.78	969.13	0.35	355.86	2651.99	0.33	0.01	4.64E-07	1.60E-02	-91.89
87.78	64.40	967.30	0.39	367.49	2656.41	0.32	0.01	4.93E-07	1.45E-02	-83.87
90.56	71.57	965.42	0.43	379.35	2660.83	0.31	0.01	4.93E-07	1.33E-02	-76.70
93.33	79.50	963.53	0.48	390.98	2665.48	0.30	0.01	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	0.01	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	0.01	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	0.01	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	0.01	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	0.01	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	0.01	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	0.01	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	0.01	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	0.01	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	0.01	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	0.01	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	0.01	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	0.01	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	0.01	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	0.01	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	0.01	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	0.01	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	0.01	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	0.01	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	0.01	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	0.01	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	0.01	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	0.01	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	0.01	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	0.01	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	0.01	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	0.01	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	0.01	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	0.01	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	0.01	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	0.01	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	0.02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	0.02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	0.02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	0.02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	0.02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	0.02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	0.02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	0.02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	0.02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	0.02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	0.02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	0.02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	0.02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	0.02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	0.02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	0.02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	0.02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	0.02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	0.02	1.19E-06	3.48E-04	-3.83

235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	0.02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	0.02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	0.02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	0.02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	0.02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	0.02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	785.23	23.75	1093.87	2799.92	0.11	0.02	1.74E-06	3.05E-04	-2.97
254.44	4284.98	785.23	23.75	1107.59	2798.76	0.11	0.02	1.74E-06	3.05E-04	-2.92
257.22	4486.10	785.23	23.75	1121.08	2797.59	0.11	0.02	1.74E-06	3.05E-04	-2.87
260.00	4694.39	785.23	23.75	1134.81	2796.20	0.11	0.02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	785.0	23.75	1148.76	2794.80	0.11	0.02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	785.23	23.75	1162.72	2792.94	0.11	0.02	1.74E-06	3.05E-04	-2.73
268.33	5363.67	771.08	23.75	1176.67	2791.08	0.11	0.02	1.89E-06	3.05E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.11	0.02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.11	0.02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	0.02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	0.02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	0.02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	0.02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	0.02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	0.02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	0.02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	0.02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	0.02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	0.02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	0.02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	0.02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	0.02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	0.02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	0.02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	0.02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	0.02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	0.02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	0.02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	0.02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	0.02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	0.02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	0.02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	0.02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	0.02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	0.02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	0.03	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	0.03	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	0.03	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	0.03	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	0.03	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	0.03	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	0.03	6.96E-05	6.09E-04	-1.46
368.33	20639.58	469.44	187.05	1862.12	2376.84	0.06	0.03	1.13E-04	6.53E-04	-1.43

'RECUR'

'TIMEYR' 0

'TIME' 0. 1.E-5

'COMMENT' 'SET PRODUCER AT R=0'

'PRODUCER' 'DOG' 1 3

1

.282 .01 0. 0.

165.

0. 0. 0

'COMMENT' 'SET OBSERVATION WELL IN SECOND GRID'

'PRODUCER' 'OBS1' 1 3

2

.282 .1 0. 0.

164. 0. 3

'COMMENT' 'SET OBSERVATION WELL IN THIRD GRID'

'PRODUCER' 'OBS2' 1 3

3

.282 .1 0. 0.

164. 0. 3

'COMMENT' 'SET OBSERVATION WELL IN FOURTH GRID'

'PRODUCER' 'OBS3' 1 3

4

.282 .1 0. 0.

164. 0. 3

'COMMENT' 'PRODUCE WELL AT 14 KG/S (50.4K KG/HR)'

'P' 'DOG' 0. 14.7 50.4

'TIME' 1. 0.

```

COMMENT ' STANFORD TEST PROBLEM #2D '
COMMENT ' 1-D radial flow of water. '
COMMENT ' TRANSIENT TEST ANALYSIS '
COMMENT ' SINGLE BLOCK CASE OF B '
TYPE 4 1 1 0. 0.
UNITS 1 1 0 1
DIMEN 1 1 1 200
PRINT 5 0 1 0 0
OUTFUN 0 1 0 0 0 0 0 0 0 0
OUTPROP 0 2 0 0 1 1 7 0 0 0
PLOT 1
      4 'PBHW' 'PAV' 'SGAV' 'QTOTENTH'
GVWRITE 0 3
3 'P' 'T' 'SW'
SHIFT ' ', ' ', ' ', ' ', ' '
TMSTEP '3' '3' .5 ' ', ' ', ' '
NEWT ' ', ' ', ' ', ' ', ' '
GRAV ' ', ' ', ' ', ' ', ' '
DELX 1
1 10.
DELY 1
1 1.
DELZ 1
1 1.
FTOPS 0 0
COMMENT ' INCOMPRESS PORE SPACE AND ROCK... '
COMP 0. 15. 0. 23.
PORALL 1
1 1*.15
COMMENT ' SET PERMS... '
PERMALL 1 1
1 1*240.
PERMALL 1 2
1 1*240.
PERMALL 1 3
1 1*240.
RADIAL 1 0.
PROPERTY
COMMENT ' COREY RELATIVE PERMEABILTY CURVES '
RELOW 1 12 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0. 0. 0.
.35 .00004 0. 0.
.4 .0006 0. 0.
.5 .009 0. 0.
.6 .045 0. 0.
.7 .143 0. 0.
.8 .35 0. 0.
.9 .72 0. 0.
.93 .8825 0. 0.
.95 1. 0. 0.
1. 1. 0. 0.
RELOG 1 12 1 1. 0.
0. 0. 0. 0.

```

.05 0. 0. 0.
 .06 7.2E-6 0. 0.
 .1 .0009 0. 0.
 .2 .0217 0. 0.
 .3 .092 0. 0.
 .4 .228 0. 0.
 .5 .434 0. 0.
 .6 .7 0. 0.
 .7 1. 0. 0.
 .8 1. 0. 0.
 1. 1. 0. 0.
 'DENCs' 62.4

1
 18.02
 'PRESALL' 1
 1 1*3000.
 'TEMPALL' 1
 1 1*233.8

'SATMOD' 1 1 1 0.35 0.
 'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
 'LIQSH' 1. 0. 25. 2000.
 4.1868 0. 25. 0. 15.

'GASSH'
 1.8422 0. 60. 0. 15.
 'LIQTCON' 0. 0. 60.
 59.8 0. 25.

'GASTCON'
 4.1122 0. 25.
 'COMMENT' 'STEAM TABLES ...'

'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'
 'STEAMT' 117

46.11	10.14	990.46	0.07	193.05	2585.24	0.58	0.01	4.64E-07	7.40E-02	-408.73
48.89	11.65	989.24	0.08	204.68	2590.12	0.55	0.01	4.35E-07	6.67E-02	-361.84
51.67	13.38	987.98	0.09	216.31	2595.01	0.53	0.01	4.35E-07	5.95E-02	-321.17
54.44	15.31	986.65	0.10	227.94	2599.89	0.51	0.01	4.35E-07	5.37E-02	-285.79
57.22	17.51	985.27	0.12	239.57	2604.78	0.48	0.01	4.64E-07	4.79E-02	-254.95
60.00	19.93	983.86	0.13	251.20	2609.66	0.46	0.01	4.64E-07	4.35E-02	-227.98
62.78	22.61	982.38	0.15	262.83	2614.31	0.44	0.01	4.64E-07	3.77E-02	-204.34
65.56	25.65	980.88	0.17	274.46	2619.20	0.43	0.01	4.64E-07	3.48E-02	-183.56
68.33	28.96	979.32	0.19	286.09	2624.08	0.41	0.01	4.64E-07	3.05E-02	-165.26
71.11	32.68	977.72	0.21	297.72	2628.73	0.39	0.01	4.64E-07	2.76E-02	-149.11
73.89	36.82	976.08	0.23	309.34	2633.38	0.38	0.01	4.93E-07	2.47E-02	-134.82
76.67	41.30	974.40	0.26	320.97	2638.04	0.37	0.01	4.64E-07	2.18E-02	-122.14
79.44	46.33	972.68	0.29	332.60	2642.69	0.35	0.01	4.93E-07	2.03E-02	-110.88
82.22	51.78	970.92	0.32	344.23	2647.34	0.34	0.01	4.64E-07	1.74E-02	-100.84
85.00	57.78	969.13	0.35	355.86	2651.99	0.33	0.01	4.64E-07	1.60E-02	-91.89
87.78	64.40	967.30	0.39	367.49	2656.41	0.32	0.01	4.93E-07	1.45E-02	-83.87
90.56	71.57	965.42	0.43	379.35	2660.83	0.31	0.01	4.93E-07	1.33E-02	-76.70
93.33	79.50	963.53	0.48	390.98	2665.48	0.30	0.01	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	0.01	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	0.01	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	0.01	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	0.01	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	0.01	5.08E-07	7.54E-03	-46.46

110.00	143.27	951.38	0.83	461.23	2691.30	0.25	0.01	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	0.01	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	0.01	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	0.01	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	0.01	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	0.01	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	0.01	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	0.01	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	0.01	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	0.01	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	0.01	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	0.01	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	0.01	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	0.01	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	0.01	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	0.01	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	0.01	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	0.01	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	0.01	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	0.01	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	0.01	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	0.01	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	0.01	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	0.01	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	0.01	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	0.01	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	0.02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	0.02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	0.02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	0.02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	0.02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	0.02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	0.02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	0.02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	0.02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	0.02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	0.02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	0.02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	0.02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	0.02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	0.02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	0.02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	0.02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	0.02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	0.02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	0.02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	0.02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	0.02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	0.02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	0.02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	0.02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	785.23	23.75	1093.87	2799.92	0.11	0.02	1.74E-06	3.05E-04	-2.97
254.44	4284.98	785.23	23.75	1107.59	2798.76	0.11	0.02	1.74E-06	3.05E-04	-2.92
257.22	4486.10	785.23	23.75	1121.08	2797.59	0.11	0.02	1.74E-06	3.05E-04	-2.87

260.00	4694.39	785.	23.75	1134.81	2796.20	0.11	0.02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	785.0	23.75	1148.76	2794.80	0.11	0.02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	785.	23.75	1162.72	2792.94	0.11	0.02	1.74E-06	3.05E-04	-2.73
268.33	5363.67	771.08	23.75	1176.67	2791.08	0.11	0.02	1.89E-06	3.05E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.11	0.02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.11	0.02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	0.02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	0.02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	0.02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	0.02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	0.02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	0.02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	0.02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	0.02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	0.02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	0.02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	0.02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	0.02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	0.02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	0.02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	0.02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	0.02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	0.02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	0.02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	0.02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	0.02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	0.02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	0.02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	0.02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	0.02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	0.02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	0.02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	0.03	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	0.03	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	0.03	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	0.03	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	0.03	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	0.03	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	0.03	6.96E-05	6.09E-04	-1.46
368.33	20639.58	469.44	187.05	1862.12	2376.84	0.06	0.03	1.13E-04	6.53E-04	-1.43

'RECUR'

'TIMEYR' 0

'TIME' 0. 1.E-5

'PRODUCER' 'DOG' 1 3

1

.282 .01 0. 0.

165.

0. 0. 0

'P' 'DOG' 0. 14.7 60.12

'TIME' .01 0.

APPENDIX D: DATASETS FOR STANFORD PROBLEM 3

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'COMMENT' 'STANFORD TEST PROBLEM #3'
'COMMENT' 'CASE A: 2-D FLOW THROUGH EXPLICIT FRACTURE'
'COMMENT' 'NO INITIAL WATER PRESENT, ALL STEAM'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MANY DEFAULTS'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 11 1 11 200
'PRINT' 0 1 1 0 0
'OUTFUN' 1 1 0 0 0 0 0 0 0 0
'OUTPROP' 0 0 0 0 0 0 0 0 0 0
'PLOT' 1
      2 'PBHW' 'PAV'
'SHIFT' ',,,,,,'
'TMSTEP' '3' 3 .005 ',,,,,,'
'COMMENT' 'TIME STEPS DEFAULTED'
'NORM' ',,,,,,'
'NEWT' ',,,,,,'
'COMMENT' ',,,,,,'
'ITER' ',,,,,,'
'GRAV' ',,,,,,'
'COMMENT' ',,,,,,'
'DELX' 1
11 .16 .54 1.05 2.6 6.75 16.4 41. 102.5 256. 641. 916.
'DELY' 1
1 100.
'COMMENT' 'MODEL THICKNESS IS 1.1 M'
'DELZ' 1
11 11*.1
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'COMMENT' 'SET POROSITY IN MATRIX AND FRACTURE AT 10%'
'PORALL' 1
121 110*.1,1.,10*.1
'COMMENT' 'SET X PERMEABILITY'
'COMMENT' 'IN MATRIX AT 0, 3 D IN WELL AND 300 mD IN FRACTURE'
'PERMALL' 1 1
121 110*0. 3000., 10*300.
'COMMENT' 'SET Y PERMEABILITY, NOTE: IN RADIAL PROBLEM Y NOT USED'
'COMMENT' 'IN MATRIX AND FRACTURE AT 3 mD'
'PERMALL' 1 2
121 121*3.
'COMMENT' 'SET Z PERMEABILITY'
'COMMENT' 'IN MATRIX AT 0, 3 D IN WELL AND 300 mD IN FRACTURE'
'PERMALL' 1 3
121 110*.03 ,3000., 10*300.
'COMMENT' 'RADIAL GRID'
'RADIAL' 1 0.
'COMMENT' 'NULL OUT ALL BUT BOTTOM GRID FOR WELL'
'NULL' 1,100,11
'PROPERTY'

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'RELOW' 1 5 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0.3 0. 0.
.5 .5 0. 0.
.7 .7 0. 0.
1. 1. 0. 0.
'COMMENT' 'REL PERM TO STEAM IS 1.0 AT ALL SATURATIONS'
'RELOG' 1 5 1 1. 0.
0. 0. 0. 0.
.1 1. 0. 0.
.5 1. 0. 0.
.7 1. 0. 0.
1. 1. 0. 0.
'DENCS' 62.4
1
18.02
'COMMENT' 'INITIAL PRESSURE IS 30.5 BARS'
'PRESALL' 1
121 121*3050.
'COMMENT' 'INITIAL TEMPERATURE IS 236-C'
'TEMPALL' 1
121 121*236.
'COMMENT' 'INITIAL STEAM SATURATION IS 1.0'
'SGALL' 1 1
121 121*1.
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1. 0. 70. 2750.
1. 0. 60. 0. 15.
'GASSH'
.56 0. 60. 0. 15.
'LIQTCON' 0. 0. 60.
0. 0. 60.
'GASTCON'
0. 0. 60.
'COMMENT' 'STEAM TABLES ...'
'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'
'STEAMT' 117
46.11 10.14 990.46 0.07 193.05 2585.24 0.58 0.01 4.64E-07 7.40E-02 -408.73
48.89 11.65 989.24 0.08 204.68 2590.12 0.55 0.01 4.35E-07 6.67E-02 -361.84
51.67 13.38 987.98 0.09 216.31 2595.01 0.53 0.01 4.35E-07 5.95E-02 -321.17
54.44 15.31 986.65 0.10 227.94 2599.89 0.51 0.01 4.35E-07 5.37E-02 -285.79
57.22 17.51 985.27 0.12 239.57 2604.78 0.48 0.01 4.64E-07 4.79E-02 -254.95
60.00 19.93 983.86 0.13 251.20 2609.66 0.46 0.01 4.64E-07 4.35E-02 -227.98
62.78 22.61 982.38 0.15 262.83 2614.31 0.44 0.01 4.64E-07 3.77E-02 -204.34
65.56 25.65 980.88 0.17 274.46 2619.20 0.43 0.01 4.64E-07 3.48E-02 -183.56
68.33 28.96 979.32 0.19 286.09 2624.08 0.41 0.01 4.64E-07 3.05E-02 -165.26
71.11 32.68 977.72 0.21 297.72 2628.73 0.39 0.01 4.64E-07 2.76E-02 -149.11
73.89 36.82 976.08 0.23 309.34 2633.38 0.38 0.01 4.93E-07 2.47E-02 -134.82
76.67 41.30 974.40 0.26 320.97 2638.04 0.37 0.01 4.64E-07 2.18E-02 -122.14
79.44 46.33 972.68 0.29 332.60 2642.69 0.35 0.01 4.93E-07 2.03E-02 -110.88
82.22 51.78 970.92 0.32 344.23 2647.34 0.34 0.01 4.64E-07 1.74E-02 -100.84
85.00 57.78 969.13 0.35 355.86 2651.99 0.33 0.01 4.64E-07 1.60E-02 -91.89
87.78 64.40 967.30 0.39 367.49 2656.41 0.32 0.01 4.93E-07 1.45E-02 -83.87
90.56 71.57 965.42 0.43 379.35 2660.83 0.31 0.01 4.93E-07 1.33E-02 -76.70

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93.33	79.50	963.53	0.48	390.98	2665.48	0.30	0.01	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	0.01	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	0.01	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	0.01	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	0.01	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	0.01	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	0.01	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	0.01	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	0.01	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	0.01	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	0.01	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	0.01	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	0.01	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	0.01	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	0.01	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	0.01	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	0.01	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	0.01	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	0.01	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	0.01	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	0.01	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	0.01	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	0.01	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	0.01	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	0.01	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	0.01	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	0.01	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	0.01	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	0.01	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	0.01	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	0.01	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	0.01	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	0.02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	0.02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	0.02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	0.02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	0.02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	0.02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	0.02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	0.02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	0.02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	0.02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	0.02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	0.02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	0.02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	0.02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	0.02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	0.02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	0.02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	0.02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	0.02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	0.02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	0.02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	0.02	1.35E-06	2.90E-04	-3.42

243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	0.02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	0.02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	0.02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	797.27	20.59	1093.87	2799.92	0.11	0.02	1.45E-06	3.05E-04	-2.97
254.44	4284.98	793.07	21.60	1107.59	2798.76	0.11	0.02	1.60E-06	3.05E-04	-2.92
257.22	4486.10	788.82	22.65	1121.08	2797.59	0.10	0.02	1.60E-06	3.05E-04	-2.87
260.00	4694.39	784.49	23.75	1134.81	2796.20	0.10	0.02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	780.08	24.90	1148.76	2794.80	0.10	0.02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	775.61	26.10	1162.72	2792.94	0.10	0.02	1.89E-06	3.19E-04	-2.73
268.33	5363.67	771.08	27.34	1176.67	2791.08	0.10	0.02	1.89E-06	3.19E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.10	0.02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.10	0.02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	0.02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	0.02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	0.02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	0.02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	0.02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	0.02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	0.02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	0.02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	0.02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	0.02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	0.02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	0.02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	0.02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	0.02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	0.02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	0.02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	0.02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	0.02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	0.02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	0.02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	0.02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	0.02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	0.02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	0.02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	0.02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	0.02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	0.03	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	0.03	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	0.03	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	0.03	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	0.03	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	0.03	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	0.03	6.96E-05	6.09E-04	-1.46
368.33	20639.58	469.44	187.05	1862.12	2376.84	0.06	0.03	1.13E-04	6.53E-04	-1.43

'RECUR'

'TIMEYR' 0

'TIME' 0. 1.1574E-5

'COMMENT' 'SET PRODUCER IN BLOCK 111 OPPOSITE EXPLICIT FRACTURE'

'PRODUCER' 'DOG' 1 3

111

.282 .03 0. 0.

0.7482

0. 0. 0

'COMMENT' 'OBSERVATION WELL LOCATED IN GRID 81'

'PRODUCER' 'OBS' 1 3

81

.282 .1 0. 0.

0. 0. 0.

'COMMENT' 'PRODUCE WELL AT .028 KG/S (.1008K KG/H)'

'P' 'DOG' 0. 100. .1008

'TIME' .116 0.

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'COMMENT' 'STANFORD TEST PROBLEM #3'
'COMMENT' 'CASE B: 2-D FLOW THROUGH FRACTURE'
'COMMENT' 'INITIAL WATER PRESENT = 0.2'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MANY DEFAULTS'
'COMMENT' 'SAME CONDITIONS AND COMMENTS AS STAN3.DAT, EXCEPT WHERE NOTED'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 11 1 11 200
'PRINT' 0 1 1 0 0
'OUTFUN' 1 1 0 0 0 0 0 0 0 0
'OUTPROP' 0 0 0 0 0 0 0 0 0 0
'PLOT' 1
      3 'PBHW' 'PAV' 'SGAV'
'SHIFT' ',,,,,'
'TMSTEP' '3' '3' .005 ',,,,,,'
'COMMENT' 'TIME STEPS DEFAULTED'
'NORM' ',,,,,'
'NEWT' ',,,,,'
'COMMENT' 'ALLOW ITERATIVE SOLVER TO DEFAULT'
'ITER' ',,,,,'
'GRAV' ',,,,,'
'COMMENT' 'USING AN ADDITIONAL X-GRID FOR WELL. TO BE NULLED BELOW'
'DELX' 1
11 .16 .54 1.05 2.6 6.75 16.4 41. 102.5 256. 641. 916.
'DELY' 1
1 100.
'DELZ' 1
11 11*.1
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'PORALL' 1
121 110*.1,1.,10*.1
'COMMENT' 'SET PERMS...'
'PERMALL' 1 1
121 110*0. 3000., 10*300.
'PERMALL' 1 2
121 121*3.
'PERMALL' 1 3
121 110*.03 ,3000., 10*300.
'RADIAL' 1 0.
'COMMENT' 'NULL OUT ALL BUT BOTTOM GRID FOR WELL'
'NULL' 1,100,11
'PROPERTY'
'RELOW' 1 6 0 1 1. 1. 0.
0. 0. 0. 0.
.2 0. 0. 0.
.3 0.2 0. 0.
.5 .5 0. 0.
.7 .7 0. 0.
1. 1. 0. 0.
'RELOG' 1 5 1 1. 0.
0. 0. 0. 0.

```



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.1 1. 0. 0.
.5 1. 0. 0.
.7 1. 0. 0.
1. 1. 0. 0.
'DENCS' 62.4
1
18.02
'PRESALL' 1
121 121*3050.
'TEMPALL' 1
121 121*234.
'COMMENT' '***** NOTE *****'
'COMMENT' 'INITIAL SATURATIONS IS ONLY DIFFERENCE FROM STAN3A.DAT'
'COMMENT' 'INITIAL STEAM SATURATION OF 80% IN MATRIX'
'SATMOD' 1 110 1 0.8 0.
'COMMENT' 'INITIAL STEAM SATURATION OF 100% IN FRACTURE'
'SATMOD' 111,121,1 1. 0.
'COMMENT' '*****'
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1. 0. 70. 2750.
1. 0. 60. 0. 15.
'GASSH'
.56 0. 60. 0. 15.
'LIQTCON' 0. 0. 60.
0. 0. 60.
'GASTCON'
0. 0. 60.
'COMMENT' 'STEAM TABLES ....'
'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'
'STEAMT' 117
46.11 10.14 990.46 0.07 193.05 2585.24 0.58 0.01 4.64E-07 7.40E-02 -408.73
48.89 11.65 989.24 0.08 204.68 2590.12 0.55 0.01 4.35E-07 6.67E-02 -361.84
51.67 13.38 987.98 0.09 216.31 2595.01 0.53 0.01 4.35E-07 5.95E-02 -321.17
54.44 15.31 986.65 0.10 227.94 2599.89 0.51 0.01 4.35E-07 5.37E-02 -285.79
57.22 17.51 985.27 0.12 239.57 2604.78 0.48 0.01 4.64E-07 4.79E-02 -254.95
60.00 19.93 983.86 0.13 251.20 2609.66 0.46 0.01 4.64E-07 4.35E-02 -227.98
62.78 22.61 982.38 0.15 262.83 2614.31 0.44 0.01 4.64E-07 3.77E-02 -204.34
65.56 25.65 980.88 0.17 274.46 2619.20 0.43 0.01 4.64E-07 3.48E-02 -183.56
68.33 28.96 979.32 0.19 286.09 2624.08 0.41 0.01 4.64E-07 3.05E-02 -165.26
71.11 32.68 977.72 0.21 297.72 2628.73 0.39 0.01 4.64E-07 2.76E-02 -149.11
73.89 36.82 976.08 0.23 309.34 2633.38 0.38 0.01 4.93E-07 2.47E-02 -134.82
76.67 41.30 974.40 0.26 320.97 2638.04 0.37 0.01 4.64E-07 2.18E-02 -122.14
79.44 46.33 972.68 0.29 332.60 2642.69 0.35 0.01 4.93E-07 2.03E-02 -110.88
82.22 51.78 970.92 0.32 344.23 2647.34 0.34 0.01 4.64E-07 1.74E-02 -100.84
85.00 57.78 969.13 0.35 355.86 2651.99 0.33 0.01 4.64E-07 1.60E-02 -91.89
87.78 64.40 967.30 0.39 367.49 2656.41 0.32 0.01 4.93E-07 1.45E-02 -83.87
90.56 71.57 965.42 0.43 379.35 2660.83 0.31 0.01 4.93E-07 1.33E-02 -76.70
93.33 79.50 963.53 0.48 390.98 2665.48 0.30 0.01 4.93E-07 1.20E-02 -70.27
96.11 88.05 961.59 0.52 402.61 2669.90 0.29 0.01 4.93E-07 1.09E-02 -64.48
98.89 97.35 959.60 0.58 414.48 2674.09 0.28 0.01 5.22E-07 9.86E-03 -59.27
101.67 107.49 957.60 0.63 426.10 2678.51 0.27 0.01 5.22E-07 8.99E-03 -54.56
104.44 118.52 955.56 0.69 437.73 2682.69 0.27 0.01 5.22E-07 8.27E-03 -50.31
107.22 130.38 953.48 0.76 449.60 2687.11 0.26 0.01 5.08E-07 7.54E-03 -46.46
110.00 143.27 951.38 0.83 461.23 2691.30 0.25 0.01 5.08E-07 6.82E-03 -42.96

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112.78	157.13	949.23	0.90	473.09	2695.25	0.25	0.01	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	0.01	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	0.01	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	0.01	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	0.01	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	0.01	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	0.01	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	0.01	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	0.01	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	0.01	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	0.01	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	0.01	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	0.01	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	0.01	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	0.01	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	0.01	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	0.01	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	0.01	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	0.01	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	0.01	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	0.01	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	0.01	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	0.01	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	0.01	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	0.01	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	0.02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	0.02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	0.02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	0.02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	0.02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	0.02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	0.02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	0.02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	0.02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	0.02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	0.02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	0.02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	0.02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	0.02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	0.02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	0.02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	0.02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	0.02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	0.02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	0.02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	0.02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	0.02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	0.02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	0.02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	0.02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	797.27	20.59	1093.87	2799.92	0.11	0.02	1.45E-06	3.05E-04	-2.97
254.44	4284.98	793.07	21.60	1107.59	2798.76	0.11	0.02	1.60E-06	3.05E-04	-2.92
257.22	4486.10	788.82	22.65	1121.08	2797.59	0.10	0.02	1.60E-06	3.05E-04	-2.87
260.00	4694.39	784.49	23.75	1134.81	2796.20	0.10	0.02	1.74E-06	3.05E-04	-2.82

262.78	4909.92	780.08	24.90	1148.76	2794.80	0.10	0.02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	775.61	26.10	1162.72	2792.94	0.10	0.02	1.89E-06	3.19E-04	-2.73
268.33	5363.67	771.08	27.34	1176.67	2791.08	0.10	0.02	1.89E-06	3.19E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.10	0.02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.10	0.02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	0.02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	0.02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	0.02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	0.02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	0.02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	0.02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	0.02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	0.02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	0.02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	0.02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	0.02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	0.02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	0.02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	0.02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	0.02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	0.02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	0.02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	0.02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	0.02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	0.02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	0.02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	0.02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	0.02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	0.02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	0.02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	0.02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	0.03	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	0.03	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	0.03	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	0.03	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	0.03	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	0.03	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	0.03	6.96E-05	6.09E-04	-1.46
368.33	20639.58	469.44	187.05	1862.12	2376.84	0.06	0.03	1.13E-04	6.53E-04	-1.43

'RECUR'

'TIMEYR' 0

'TIME' 0. 1.1574E-5

'PRODUCER' 'DOG' 1 3

111

.282 .03 0. 0.

0.7482

0. 0. 0

'PRODUCER' 'OBS' 1 3

81

.282 .1 0. 0.

0. 0. 0.

'P' 'DOG' 0. 100. .1008

'TIME' .116 0.

APPENDIX E: DATASET USED FOR STANFORD PROBLEM 4

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'COMMENT' 'STANFORD TEST PROBLEM #4 '
'COMMENT' 'EXPANDING 2-PHASE SYSTEM WITH DRAINAGE'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'USING 2 EXTRA GRID BLOCKS, ONE FOR DISCHRG, ONE RECHRG'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 1 1 22 6500
'PRINT' 5 1 1 11 -3
'OUTFUN' 0 0 0 0 0 0 0 0 0 10
'OUTPROP' 0 0 0 0 0 0 0 0 0 0
'OUTGEO' 0 0 0 0 0 0 0 0 0 0
'PLOT' 5
6 'PBHW' 'QTOTENTH' 'QTOTMASS' 'PAV' 'TAV' 'SGAV'
'GVWRITE' 0 12
3 'P' 'T' 'SW'
'SHIFT' '','','','',''
'NORM' '','','','',''
'NEWT' '','','',''
'TMSTEP' 3 3 150. 1000. 1000. 1. 0.
'GRAV' '','',''
'COMMENT' 'SET UP ONE 1000M GRID'
'DELX' 1
1 1000.
'COMMENT' 'SET UP ONE 1000M GRID'
'DELY' 1
1 1000.
'COMMENT' 'SET UP A .003 M LAYER AT TOP AND BOTTOM OF MODEL'
'COMMENT' 'SET UP 20 LAYERS OF 100 M EACH'
'DELZ' 1
22 .003048 20*100. 0.003048
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'COMMENT' 'POROSITY ASSIGNMENT BY LAYERS'
'COMMENT' 'REMEMBER LAYER 1 AND 22 ARE THE .003 M THICK DUMMY LAYERS'
'COMMENT' 'IZ POROSITY'
'PORZLAY' 1 1.0
'PORZLAY' 2 .15
'PORZLAY' 3 .15
'PORZLAY' 4 .15
'PORZLAY' 5 .15
'PORZLAY' 6 .15
'PORZLAY' 7 .15
'PORZLAY' 8 .15
'PORZLAY' 9 .15
'PORZLAY' 10 .15
'PORZLAY' 11 .15
'PORZLAY' 12 .25
'PORZLAY' 13 .25
'PORZLAY' 14 .25
'PORZLAY' 15 .25
'PORZLAY' 16 .25

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'PORZLAY' 17 .25
'PORZLAY' 18 .25
'PORZLAY' 19 .25
'PORZLAY' 20 .25
'PORZLAY' 21 .25
'PORZLAY' 22 1.0
'COMMENT' 'PERM IN MD, LAYERS 2-11, 5E-15 M^2, LAYERS 12-21 100E-15 M^2'
'COMMENT' 'REMEMBER LAYER 1 AND 22 ARE THE .003 M THICK DUMMY LAYERS'
'COMMENT' 'IZ PERMX PERMY PERMZ'
'PERMZLAY' 1 5000. 5000. 5000.
'PERMZLAY' 2 4.935 4.935 4.935
'PERMZLAY' 3 4.935 4.935 4.935
'PERMZLAY' 4 4.935 4.935 4.935
'PERMZLAY' 5 4.935 4.935 4.935
'PERMZLAY' 6 4.935 4.935 4.935
'PERMZLAY' 7 4.935 4.935 4.935
'PERMZLAY' 8 4.935 4.935 4.935
'PERMZLAY' 9 4.935 4.935 4.935
'PERMZLAY' 10 4.935 4.935 4.935
'PERMZLAY' 11 4.935 4.935 4.935
'PERMZLAY' 12 98.69 98.69 98.69
'PERMZLAY' 13 98.69 98.69 98.69
'PERMZLAY' 14 98.69 98.69 98.69
'PERMZLAY' 15 98.69 98.69 98.69
'PERMZLAY' 16 98.69 98.69 98.69
'PERMZLAY' 17 98.69 98.69 98.69
'PERMZLAY' 18 98.69 98.69 98.69
'PERMZLAY' 19 98.69 98.69 98.69
'PERMZLAY' 20 98.69 98.69 98.69
'PERMZLAY' 21 98.69 98.69 98.69
'PERMZLAY' 22 5000. 5000. 5000.
'COMMENT' '*****'
'PROPERTY'
'COMMENT' 'COREY RELATIVE PERMEABILTY CURVES'
'RELOW' 1 12 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0. 0. 0.
.35 .00004 0. 0.
.4 .0006 0. 0.
.5 .009 0. 0.
.6 .045 0. 0.
.7 .143 0. 0.
.8 .35 0. 0.
.9 .72 0. 0.
.93 .8825 0. 0.
.95 1. 0. 0.
1. 1. 0. 0.
'RELOG' 1 12 1 1. 0.
0. 0. 0. 0.
.05 0. 0. 0.
.06 7.2E-6 0. 0.
.1 .0009 0. 0.
.2 .0217 0. 0.
.3 .092 0. 0.

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.4 .228 0. 0.
.5 .434 0. 0.
.6 .7 0. 0.
.7 1. 0. 0.
.8 1. 0. 0.
1. 1. 0. 0.

'UPVIS' 1. 1. 1.

'DENS' 1000.

1

18.015

'COMMENT' 'SET INITIAL PRESSURE SUCH THAT IN HYDROSTATIC EQUILIBRIUM'

'COMMENT' 'BOUNDARY CONDITION PRESSURE EQUALS 1.013 BAR AT D=0'

'COMMENT' 'IX P'

'PRESZLAY' 1 101.33

'PRESZLAY' 2 590.19

'PRESZLAY' 3 1562.42

'PRESZLAY' 4 2522.86

'PRESZLAY' 5 3466.2

'PRESZLAY' 6 4388.79

'PRESZLAY' 7 5287.45

'PRESZLAY' 8 6158.88

'PRESZLAY' 9 6999.49

'PRESZLAY' 10 7804.93

'PRESZLAY' 11 8569.77

'PRESZLAY' 12 9299.3

'PRESZLAY' 13 10013.6

'PRESZLAY' 14 10723.97

'PRESZLAY' 15 11430.4

'PRESZLAY' 16 12132.77

'PRESZLAY' 17 12831.21

'PRESZLAY' 18 13525.51

'PRESZLAY' 19 14215.61

'PRESZLAY' 20 14901.57

'PRESZLAY' 21 15583.19

'PRESZLAY' 22 15922.61

'COMMENT' 'SET TEMPERATURE DISTRIBUTION'

'COMMENT' 'TEMP @ D=0 IS 10-C, INCREASE BY 28-C EVERY 100 M'

'COMMENT' 'IZ T

'TEMPZLAY' 1 10.

'TEMPZLAY' 2 24.

'TEMPZLAY' 3 52.

'TEMPZLAY' 4 80.0

'TEMPZLAY' 5 108.

'TEMPZLAY' 6 136.

'TEMPZLAY' 7 164.0

'TEMPZLAY' 8 192.

'TEMPZLAY' 9 220.

'TEMPZLAY' 10 248.

'TEMPZLAY' 11 276.

'COMMENT' 'NOW INCREASE BY 2-C EVERY 100 M'

'TEMPZLAY' 12 291.

'TEMPZLAY' 13 293.

'TEMPZLAY' 14 295.

'TEMPZLAY' 15 297.

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'TEMPZLAY' 16 299.
'TEMPZLAY' 17 301.
'TEMPZLAY' 18 303.
'TEMPZLAY' 19 305.
'TEMPZLAY' 20 307.
'TEMPZLAY' 21 309.
'TEMPZLAY' 22 310.
'COMMENT' 'INITIALLY AT 100% WATER EVERYWHERE'
'COMMENT' 'I1 I2 I3 SG SO'
'SATMOD' 1 22 1 0. 0.
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1. 0. 25. 2500.
4.1868 .0007 25. 0. 100.
'GASSH'
2.7633 1.36E-4 25. 0. 100.
'LIQTCON' 86.4 0. 60.
59.8 0. 60.
'GASTCON'
4.36 0. 60.
'COMMENT' 'SI STEAM TABLES ...'
'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'
'STEAMT' 130
7.22 1.03 1000.66 0.01 32.56 2515.69 1.42 9.00E-03 5.37E-07 2.12E-01 -1443.32
10.00 1.24 1000.43 0.01 42.10 2519.88 1.31 9.10E-03 5.22E-07 2.02E-01 -1363.13
12.78 1.45 1000.19 0.01 53.73 2525.00 1.21 9.20E-03 5.22E-07 1.91E-01 -1282.95
15.56 1.79 999.81 0.01 65.36 2529.88 1.12 9.20E-03 5.08E-07 1.81E-01 -1202.76
18.33 2.14 999.31 0.02 76.99 2535.00 1.04 9.30E-03 5.08E-07 1.71E-01 -1124.87
21.11 2.48 998.75 0.02 88.62 2540.12 0.98 9.30E-03 4.93E-07 1.61E-01 -998.85
23.89 2.96 998.14 0.02 100.01 2545.23 0.91 9.40E-03 4.93E-07 1.51E-01 -945.02
26.67 3.52 997.39 0.03 111.64 2550.12 0.86 9.40E-03 4.79E-07 1.41E-01 -891.17
29.44 4.14 996.62 0.03 123.27 2555.23 0.81 9.50E-03 4.79E-07 1.31E-01 -818.09
32.22 4.83 995.72 0.03 134.90 2560.35 0.76 9.50E-03 4.79E-07 1.20E-01 -745.01
35.00 5.65 994.79 0.04 146.53 2565.24 0.72 9.60E-03 4.64E-07 1.10E-01 -671.93
37.78 6.55 993.80 0.05 158.16 2570.35 0.68 9.60E-03 4.64E-07 1.00E-01 -598.85
40.56 7.58 992.75 0.05 169.79 2575.24 0.64 9.70E-03 4.35E-07 8.99E-02 -525.77
43.33 8.76 991.63 0.06 181.42 2580.12 0.61 9.80E-03 4.35E-07 8.12E-02 -462.94
46.11 10.14 990.46 0.07 193.05 2585.24 0.58 9.90E-03 4.35E-07 7.40E-02 -408.73
48.89 11.65 989.24 0.08 204.68 2590.12 0.55 1.00E-02 4.35E-07 6.67E-02 -361.84
51.67 13.38 987.98 0.09 216.31 2595.01 0.53 1.01E-02 4.35E-07 5.95E-02 -321.17
54.44 15.31 986.65 0.10 227.94 2599.89 0.51 1.02E-02 4.35E-07 5.37E-02 -285.79
57.22 17.51 985.27 0.12 239.57 2604.78 0.48 1.04E-02 4.64E-07 4.79E-02 -254.95
60.00 19.93 983.86 0.13 251.20 2609.66 0.46 1.05E-02 4.64E-07 4.35E-02 -227.98
62.78 22.61 982.38 0.15 262.83 2614.31 0.44 1.06E-02 4.64E-07 3.77E-02 -204.34
65.56 25.65 980.88 0.17 274.46 2619.20 0.43 1.07E-02 4.64E-07 3.48E-02 -183.56
68.33 28.96 979.32 0.19 286.09 2624.08 0.41 1.08E-02 4.64E-07 3.05E-02 -165.26
71.11 32.68 977.72 0.21 297.72 2628.73 0.39 1.09E-02 4.64E-07 2.76E-02 -149.11
73.89 36.82 976.08 0.23 309.34 2633.38 0.38 1.10E-02 4.93E-07 2.47E-02 -134.82
76.67 41.30 974.40 0.26 320.97 2638.04 0.37 1.11E-02 4.64E-07 2.18E-02 -122.14
79.44 46.33 972.68 0.29 332.60 2642.69 0.35 1.12E-02 4.93E-07 2.03E-02 -110.88
82.22 51.78 970.92 0.32 344.23 2647.34 0.34 1.13E-02 4.64E-07 1.74E-02 -100.84
85.00 57.78 969.13 0.35 355.86 2651.99 0.33 1.15E-02 4.64E-07 1.60E-02 -91.89
87.78 64.40 967.30 0.39 367.49 2656.41 0.32 1.16E-02 4.93E-07 1.45E-02 -83.87
90.56 71.57 965.42 0.43 379.35 2660.83 0.31 1.17E-02 4.93E-07 1.33E-02 -76.70
93.33 79.50 963.53 0.48 390.98 2665.48 0.30 1.18E-02 4.93E-07 1.20E-02 -70.27

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96.11	88.05	961.59	0.52	402.61	2669.90	0.29	1.19E-02	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	1.20E-02	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	1.21E-02	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	1.22E-02	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	1.23E-02	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	1.24E-02	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	1.25E-02	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	1.26E-02	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	1.27E-02	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	1.28E-02	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	1.29E-02	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	1.30E-02	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	1.31E-02	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	1.32E-02	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	1.34E-02	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	1.35E-02	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	1.36E-02	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	1.37E-02	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	1.38E-02	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	1.39E-02	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	1.40E-02	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	1.41E-02	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	1.42E-02	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	1.43E-02	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	1.44E-02	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	1.45E-02	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	1.45E-02	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	1.46E-02	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	1.47E-02	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	1.48E-02	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	1.49E-02	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	1.50E-02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	1.51E-02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	1.52E-02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	1.53E-02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	1.54E-02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	1.55E-02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	1.56E-02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	1.57E-02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	1.58E-02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	1.59E-02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	1.60E-02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	1.61E-02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	1.62E-02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	1.63E-02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	1.64E-02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	1.65E-02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	1.66E-02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	1.67E-02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	1.68E-02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	1.69E-02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	1.70E-02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	1.71E-02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	1.72E-02	1.36E-06	2.76E-04	-3.29

246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	1.73E-02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	1.74E-02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	797.27	20.59	1093.87	2799.92	0.11	1.75E-02	1.45E-06	3.05E-04	-2.97
254.44	4284.98	793.07	21.60	1107.59	2798.76	0.11	1.76E-02	1.60E-06	3.05E-04	-2.92
257.22	4486.10	788.82	22.65	1121.08	2797.59	0.10	1.77E-02	1.74E-06	3.05E-04	-2.87
260.00	4694.39	784.49	23.75	1134.81	2796.20	0.10	1.79E-02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	780.08	24.90	1148.76	2794.80	0.10	1.80E-02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	775.61	26.10	1162.72	2792.94	0.10	1.81E-02	1.74E-06	3.19E-04	-2.73
268.33	5363.67	771.08	27.34	1176.67	2791.08	0.10	1.82E-02	1.89E-06	3.19E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.10	1.83E-02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.10	1.85E-02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	1.86E-02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	1.87E-02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	1.89E-02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	1.90E-02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	1.91E-02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	1.93E-02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	1.95E-02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	1.96E-02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	1.98E-02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	1.99E-02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	2.01E-02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	2.03E-02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	2.05E-02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	2.07E-02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	2.09E-02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	2.11E-02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	2.13E-02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	2.16E-02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	2.18E-02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	2.21E-02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	2.24E-02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	2.27E-02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	2.30E-02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	2.34E-02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	2.40E-02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	2.47E-02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	2.54E-02	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	2.61E-02	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	2.69E-02	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	2.77E-02	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	2.87E-02	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	2.97E-02	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	3.09E-02	6.96E-05	6.09E-04	-1.46

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'COMMENT' '*****'
'RECUR'
'COMMENT' 'RECHARGE ALLOWED AT SURFACE - USE SS AQUIFER'
'COMMENT' 'ALLOW AQUIFER PRESS, TEMP, ETC TO DEFAULT...'
'AQUIFER' 'SSTATE' 1 1 1 -3 ,, 1.0 ,,,,,,,,,,
'TIMEYR' 1
'COMMENT' 'DISCHARGE TO OCCUR OVER WHOLE AREA, SO USE A WELL IN BOTTOM'
'COMMENT' 'BLOCK AND USE A PI-MULTIPLIER TO MINIMIZE WELL DRAWDOWN'
'PRODUCER' 'DOG' 1 3

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50. ,,,,,,,,,,,,,,

, 0. 0
'COMMENT' 'OBSERVATION WELL LOCATED AT D=500 M'
'PRODUCER' 'OBS1' 1 3

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'COMMENT' 'OBSERVATION WELL LOCATED AT D=1000 M'
'PRODUCER' 'OBS2' 1 3

12 ,,,,,,,,,,,,,,

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'COMMENT' 'OBSERVATION WELL LOCATED AT D=1500 M'
'PRODUCER' 'OBS3' 1 3

17 ,,,,,,,,,,,,,,

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'COMMENT' 'OBSERVATION WELL LOCATED AT D=2000 M'
'PRODUCER' 'OBS4' 1 3

21 ,,,,,,,,,,,,,,

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'TIME' 0. 1.E-6
'COMMENT' 'PRODUCE WELL AT 100 KG/S (360K KG/H)
'P' 'DOG' 0. 10. 360.
'COMMENT' 'PRODUCE FOR 40 YEARS'
'TIME' 40. 0

APPENDIX F: DATASETS USED FOR STANFORD PROBLEM 5

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'COMMENT' 'STANFORD TEST PROBLEM #5a'
'COMMENT' '2-D AREAL FLOW, NON-EQUIL INIT CONDS.'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MOSTLY DEFAULTS, but using thresh'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 12 8 1 7000
'PRINT' 20 1 1 0 0
'OUTFUN' 1 1 0 0 0 0 0 8 9 0
'OUTPROP' 0 0 0 1 0 1 0 0 0 0
'PLOT' 1
4 'PBHW' 'PAV' 'TAV' 'QTOTENTH'
'GVWRITE' 0 60
2 'P' 'T'
'SHIFT'
'COMMENT' 'SET UP 12 X GRIDS OF 25 M EACH'
'DELX' 1
12 12*25.
'COMMENT' 'SET UP 8 Y GRIDS OF 25 M EACH'
'DELY' 1
8 8*25.
'COMMENT' 'INJECTION RATE 0.05 KG/S/M-thick, SO THICK=10 M, Q=.5 KG/S'
'DELZ' 1
1 10.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'PORALL' 1
96 96*.35
'COMMENT' 'SET UNIFORM PERMEABILITIES OF 25 mD'
'PERMALL' 1 1
96 96*25.
'PERMALL' 1 2
96 96*25.
'PERMALL' 1 3
96 96*25.
'PROPERTY'
'COMMENT' 'USE COREY REL PERMS FROM PROBLEM STAN2.DAT'
'RELOW' 1 9 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0. 0. 0.
.4 .0008 0. 0.
.5 .0123 0. 0.
.6 .0625 0. 0.
.7 .1979 0. 0.
.8 .4822 0. 0.
.9 1. 0. 0.
1. 1. 0. 0.
'RELOG' 1 9 1 1. 0.
0. 0. 0. 0.
.1 0. 0. 0.
.2 .0085 0. 0.

```

.3 .0616 0. 0.
 .4 .1875 0. 0.
 .5 .3952 0. 0.
 .6 .6751 0. 0.
 .7 1. 0. 0.
 1. 1. 0. 0.

'DENS' 1000.

1

18.02

'COMMENT' 'PRESSURE = P(SAT) FOR T=240 C + 2.5 BARS'

'PRESALL' 1

96 96*3597.8

'COMMENT' 'INITIAL TEMPERATURE DISTRIBUTION AS PER SPECIFICATION TABLE'

'COMMENT' 'COMPLICATED, IS IT NOT?'

'TEMPALL' 10

12 212.07 210.18 206.41 200.81 193.59 185.18 176.31 168.09 162.03 3*160.

12 224.92 223.16 219.54 213.95 206.41 197.16 186.79 176.31 167.13 161.12 2*160.

11 234.31 232.93 229.92 224.92 217.7 208.29 197.16 185.18 173.71 164.58 160.11

1 160.

11 239.31 238.62 236.74 232.93 226.64 217.7 206.41 193.59 180.56 169.11 161.54

1 160.

12 2*240. 239.77 237.76 232.93 224.92 213.95 200.81 186.79 173.71 163.85 160.

12 3*240. 239.77 236.74 229.92 219.54 206.41 191.85 177.68 166.22 160.26

12 4*240. 238.62 232.93 223.16 210.18 195.36 180.56 168.09 160.77

12 4*240. 239.31 234.31 224.92 212.07 197.16 182.06 169.11 161.12

'COMMENT' 'INITIALLY 100% WATER SATURATION'

'SATMOD' 1 40 1 0. 0.

'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'

'LIQSH' 1.0 0. 25. 2500.

4.1868 0.0007 25. 0. 100.

'GASSH'

1.842 1.36E-4 0. 0. 100.

'LIQTCON' 86.4 0. 25.

59.8 0. 25.

'GASTCON'

4.11 0. 200.

'COMMENT' 'STEAM TABLES ...'

'COMMENT' ' T,P DEN1 DEN2 H1 H2 VIS1 VIS2 COMP1 COMP2 DH/DP'

'STEAMT' 130

7.22 1.03 1000.66 0.01 32.56 2515.69 1.42 9.00E-03 5.37E-07 2.12E-01 -1443.32

10.00 1.24 1000.43 0.01 42.10 2519.88 1.31 9.10E-03 5.22E-07 2.02E-01 -1363.13

12.78 1.45 1000.19 0.01 53.73 2525.00 1.21 9.20E-03 5.22E-07 1.91E-01 -1282.95

15.56 1.79 999.81 0.01 65.36 2529.88 1.12 9.20E-03 5.08E-07 1.81E-01 -1202.76

18.33 2.14 999.31 0.02 76.99 2535.00 1.04 9.30E-03 5.08E-07 1.71E-01 -1124.87

21.11 2.48 998.75 0.02 88.62 2540.12 0.98 9.30E-03 4.93E-07 1.61E-01 -998.85

23.89 2.96 998.14 0.02 100.01 2545.23 0.91 9.40E-03 4.93E-07 1.51E-01 -945.02

26.67 3.52 997.39 0.03 111.64 2550.12 0.86 9.40E-03 4.79E-07 1.41E-01 -891.17

29.44 4.14 996.62 0.03 123.27 2555.23 0.81 9.50E-03 4.79E-07 1.31E-01 -818.09

32.22 4.83 995.72 0.03 134.90 2560.35 0.76 9.50E-03 4.79E-07 1.20E-01 -745.01

35.00 5.65 994.79 0.04 146.53 2565.24 0.72 9.60E-03 4.64E-07 1.10E-01 -671.93

37.78 6.55 993.80 0.05 158.16 2570.35 0.68 9.60E-03 4.64E-07 1.00E-01 -598.85

40.56 7.58 992.75 0.05 169.79 2575.24 0.64 9.70E-03 4.35E-07 8.99E-02 -525.77

43.33 8.76 991.63 0.06 181.42 2580.12 0.61 9.80E-03 4.35E-07 8.12E-02 -462.94

46.11 10.14 990.46 0.07 193.05 2585.24 0.58 9.90E-03 4.35E-07 7.40E-02 -408.73

48.89	11.65	989.24	0.08	204.68	2590.12	0.55	1.00E-02	4.35E-07	6.67E-02	-361.84
51.67	13.38	987.98	0.09	216.31	2595.01	0.53	1.01E-02	4.35E-07	5.95E-02	-321.17
54.44	15.31	986.65	0.10	227.94	2599.89	0.51	1.02E-02	4.35E-07	5.37E-02	-285.79
57.22	17.51	985.27	0.12	239.57	2604.78	0.48	1.04E-02	4.64E-07	4.79E-02	-254.95
60.00	19.93	983.86	0.13	251.20	2609.66	0.46	1.05E-02	4.64E-07	4.35E-02	-227.98
62.78	22.61	982.38	0.15	262.83	2614.31	0.44	1.06E-02	4.64E-07	3.77E-02	-204.34
65.56	25.65	980.88	0.17	274.46	2619.20	0.43	1.07E-02	4.64E-07	3.48E-02	-183.56
68.33	28.96	979.32	0.19	286.09	2624.08	0.41	1.08E-02	4.64E-07	3.05E-02	-165.26
71.11	32.68	977.72	0.21	297.72	2628.73	0.39	1.09E-02	4.64E-07	2.76E-02	-149.11
73.89	36.82	976.08	0.23	309.34	2633.38	0.38	1.10E-02	4.93E-07	2.47E-02	-134.82
76.67	41.30	974.40	0.26	320.97	2638.04	0.37	1.11E-02	4.64E-07	2.18E-02	-122.14
79.44	46.33	972.68	0.29	332.60	2642.69	0.35	1.12E-02	4.93E-07	2.03E-02	-110.88
82.22	51.78	970.92	0.32	344.23	2647.34	0.34	1.13E-02	4.64E-07	1.74E-02	-100.84
85.00	57.78	969.13	0.35	355.86	2651.99	0.33	1.15E-02	4.64E-07	1.60E-02	-91.89
87.78	64.40	967.30	0.39	367.49	2656.41	0.32	1.16E-02	4.93E-07	1.45E-02	-83.87
90.56	71.57	965.42	0.43	379.35	2660.83	0.31	1.17E-02	4.93E-07	1.33E-02	-76.70
93.33	79.50	963.53	0.48	390.98	2665.48	0.30	1.18E-02	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	1.19E-02	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	1.20E-02	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	1.21E-02	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	1.22E-02	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	1.23E-02	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	1.24E-02	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	1.25E-02	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	1.26E-02	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	1.27E-02	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	1.28E-02	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	1.29E-02	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	1.30E-02	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	1.31E-02	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	1.32E-02	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	1.34E-02	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	1.35E-02	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	1.36E-02	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	1.37E-02	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	1.38E-02	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	1.39E-02	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	1.40E-02	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	1.41E-02	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	1.42E-02	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	1.43E-02	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	1.44E-02	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	1.45E-02	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	1.45E-02	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	1.46E-02	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	1.47E-02	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	1.48E-02	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	1.49E-02	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	1.50E-02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	1.51E-02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	1.52E-02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	1.53E-02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	1.54E-02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	1.55E-02	8.56E-07	6.96E-04	-6.67

198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	1.56E-02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	1.57E-02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	1.58E-02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	1.59E-02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	1.60E-02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	1.61E-02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	1.62E-02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	1.63E-02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	1.64E-02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	1.65E-02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	1.66E-02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	1.67E-02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	1.68E-02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	1.69E-02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	1.70E-02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	1.71E-02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	1.72E-02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	1.73E-02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	1.74E-02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	797.27	20.59	1093.87	2799.92	0.11	1.75E-02	1.45E-06	3.05E-04	-2.97
254.44	4284.98	793.07	21.60	1107.59	2798.76	0.11	1.76E-02	1.60E-06	3.05E-04	-2.92
257.22	4486.10	788.82	22.65	1121.08	2797.59	0.10	1.77E-02	1.74E-06	3.05E-04	-2.87
260.00	4694.39	784.49	23.75	1134.81	2796.20	0.10	1.79E-02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	780.08	24.90	1148.76	2794.80	0.10	1.80E-02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	775.61	26.10	1162.72	2792.94	0.10	1.81E-02	1.74E-06	3.19E-04	-2.73
268.33	5363.67	771.08	27.34	1176.67	2791.08	0.10	1.82E-02	1.89E-06	3.19E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.10	1.83E-02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.10	1.85E-02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	1.86E-02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	1.87E-02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	1.89E-02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	1.90E-02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	1.91E-02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	1.93E-02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	1.95E-02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	1.96E-02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	1.98E-02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	1.99E-02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	2.01E-02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	2.03E-02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	2.05E-02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	2.07E-02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	2.09E-02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	2.11E-02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	2.13E-02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	2.16E-02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	2.18E-02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	2.21E-02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	2.24E-02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	2.27E-02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	2.30E-02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	2.34E-02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	2.40E-02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	2.47E-02	1.33E-05	4.64E-04	-1.65

348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	2.54E-02	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	2.61E-02	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	2.69E-02	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	2.77E-02	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	2.87E-02	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	2.97E-02	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	3.09E-02	6.96E-05	6.09E-04	-1.46

'RECUR'

'COMMENT' 'BOUNDARY CONDITION OF INITIAL P&T MAINTAINED AT X=300 M'

'AQUIFER' 'SSTATE' 12,96,12 1 ,,,,675.44

'TIMEYR' 0

'COMMENT' 'PRODUCER LOCATED AT X=62.5 M & AT Y=62.5 M'

'PRODUCER' 'DOG' 1 3

63

.208 .15 0. 0.

0. 0. 2

'COMMENT' 'OBSERVATION WELL LOCATED IN BLOCK 31'

'PRODUCER' 'OBS1' 1 3

31

.208 .15 0. 0.

0. 0. 2

'TIME' 0. .2

'COMMENT' 'WELL PRODUCES AT A RATE OF .5 KG/S (1.8K KG/H)'

'P' 'DOG' 0. 15. 1.80

'COMMENT' 'PRODUCE FOR 10 YEARS'

'TIME' 3652.5 0.

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'COMMENT' 'STANFORD TEST PROBLEM #5b'
'COMMENT' '2-D AREAL FLOW, NON-EQUIL INIT CONDS.'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'MOSTLY DEFAULTS, but using thresh'
'COMMENT' 'CONDITIONS EXACTLY STAN5a.DAT EXCEPT FOR INJECTION WELL, AS NOTED'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 12 8 1 7000
'PRINT' 20 1 1 0 0
'OUTFUN' 1 1 0 0 0 0 0 8 9 0
'OUTPROP' 0 0 0 1 0 1 0 0 0 0
'PLOT' 1
      4 'PBHW' 'PAV' 'TAV' 'QTOTENTH'
'GVWRITE' 0 60
2 'P' 'T'
'SHIFT' ',,,,,'
'DELX' 1
12 12*25.
'DELY' 1
8 8*25.
'COMMENT' 'INJECTION RATE 0.05 KG/S/M-thick, SO THICK=10 M, Q=.5 KG/S'
'DELZ' 1
      1 10.
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'PORALL' 1
96 96*.35
'COMMENT' 'SET PERMS...'
'PERMALL' 1 1
96 96*25.
'PERMALL' 1 2
96 96*25.
'PERMALL' 1 3
96 96*25.
'PROPERTY'
'RELOW' 1 9 0 1 1. 1. 0.
0. 0. 0. 0.
.3 0. 0. 0.
.4 .0008 0. 0.
.5 .0123 0. 0.
.6 .0625 0. 0.
.7 .1979 0. 0.
.8 .4822 0. 0.
.9 1. 0. 0.
1. 1. 0. 0.
'RELOG' 1 9 1 1. 0.
0. 0. 0. 0.
.1 0. 0. 0.
.2 .0085 0. 0.
.3 .0616 0. 0.
.4 .1875 0. 0.
.5 .3952 0. 0.
.6 .6751 0. 0.

```



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.7 1. 0. 0.
1. 1. 0. 0.
'DENCS' 1000.
1
18.02
'COMMENT' 'PRESSURE = P(SAT) FOR T=240 C + 2.5 BARS'
'PRESALL' 1
96 96*3597.8
'TEMPALL' 10
12 212.07 210.18 206.41 200.81 193.59 185.18 176.31 168.09 162.03 3*160.
12 224.92 223.16 219.54 213.95 206.41 197.16 186.79 176.31 167.13 161.12 2*160.
11 234.31 232.93 229.92 224.92 217.7 208.29 197.16 185.18 173.71 164.58 160.11
1 160.
11 239.31 238.62 236.74 232.93 226.64 217.7 206.41 193.59 180.56 169.11 161.54
1 160.
12 2*240. 239.77 237.76 232.93 224.92 213.95 200.81 186.79 173.71 163.85 160.
12 3*240. 239.77 236.74 229.92 219.54 206.41 191.85 177.68 166.22 160.26
12 4*240. 238.62 232.93 223.16 210.18 195.36 180.56 168.09 160.77
12 4*240. 239.31 234.31 224.92 212.07 197.16 182.06 169.11 161.12
'SATMOD' 1 40 1 0. 0.
'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'
'LIQSH' 1.0 0. 25. 2500.
4.1868 0.0007 25. 0. 100.
'GASSH'
1.842 1.36E-4 0. 0. 100.
'LIQTCON' 86.4 0. 25.
59.8 0. 25.
'GASTCON'
4.11 0. 200.
'COMMENT' 'STEAM TABLES ...'
'COMMENT' ' T,P DEN1 DEN2 H1 H2 VIS1 VIS2 COMP1 COMP2 DH/DP '
'STEAMT' 130
7.22 1.03 1000.66 0.01 32.56 2515.69 1.42 9.00E-03 5.37E-07 2.12E-01 -1443.32
10.00 1.24 1000.43 0.01 42.10 2519.88 1.31 9.10E-03 5.22E-07 2.02E-01 -1363.13
12.78 1.45 1000.19 0.01 53.73 2525.00 1.21 9.20E-03 5.22E-07 1.91E-01 -1282.95
15.56 1.79 999.81 0.01 65.36 2529.88 1.12 9.20E-03 5.08E-07 1.81E-01 -1202.76
18.33 2.14 999.31 0.02 76.99 2535.00 1.04 9.30E-03 5.08E-07 1.71E-01 -1124.87
21.11 2.48 998.75 0.02 88.62 2540.12 0.98 9.30E-03 4.93E-07 1.61E-01 -998.85
23.89 2.96 998.14 0.02 100.01 2545.23 0.91 9.40E-03 4.93E-07 1.51E-01 -945.02
26.67 3.52 997.39 0.03 111.64 2550.12 0.86 9.40E-03 4.79E-07 1.41E-01 -891.17
29.44 4.14 996.62 0.03 123.27 2555.23 0.81 9.50E-03 4.79E-07 1.31E-01 -818.09
32.22 4.83 995.72 0.03 134.90 2560.35 0.76 9.50E-03 4.79E-07 1.20E-01 -745.01
35.00 5.65 994.79 0.04 146.53 2565.24 0.72 9.60E-03 4.64E-07 1.10E-01 -671.93
37.78 6.55 993.80 0.05 158.16 2570.35 0.68 9.60E-03 4.64E-07 1.00E-01 -598.85
40.56 7.58 992.75 0.05 169.79 2575.24 0.64 9.70E-03 4.35E-07 8.99E-02 -525.77
43.33 8.76 991.63 0.06 181.42 2580.12 0.61 9.80E-03 4.35E-07 8.12E-02 -462.94
46.11 10.14 990.46 0.07 193.05 2585.24 0.58 9.90E-03 4.35E-07 7.40E-02 -408.73
48.89 11.65 989.24 0.08 204.68 2590.12 0.55 1.00E-02 4.35E-07 6.67E-02 -361.84
51.67 13.38 987.98 0.09 216.31 2595.01 0.53 1.01E-02 4.35E-07 5.95E-02 -321.17
54.44 15.31 986.65 0.10 227.94 2599.89 0.51 1.02E-02 4.35E-07 5.37E-02 -285.79
57.22 17.51 985.27 0.12 239.57 2604.78 0.48 1.04E-02 4.64E-07 4.79E-02 -254.95
60.00 19.93 983.86 0.13 251.20 2609.66 0.46 1.05E-02 4.64E-07 4.35E-02 -227.98
62.78 22.61 982.38 0.15 262.83 2614.31 0.44 1.06E-02 4.64E-07 3.77E-02 -204.34
65.56 25.65 980.88 0.17 274.46 2619.20 0.43 1.07E-02 4.64E-07 3.48E-02 -183.56

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68.33	28.96	979.32	0.19	286.09	2624.08	0.41	1.08E-02	4.64E-07	3.05E-02	-165.26
71.11	32.68	977.72	0.21	297.72	2628.73	0.39	1.09E-02	4.64E-07	2.76E-02	-149.11
73.89	36.82	976.08	0.23	309.34	2633.38	0.38	1.10E-02	4.93E-07	2.47E-02	-134.82
76.67	41.30	974.40	0.26	320.97	2638.04	0.37	1.11E-02	4.64E-07	2.18E-02	-122.14
79.44	46.33	972.68	0.29	332.60	2642.69	0.35	1.12E-02	4.93E-07	2.03E-02	-110.88
82.22	51.78	970.92	0.32	344.23	2647.34	0.34	1.13E-02	4.64E-07	1.74E-02	-100.84
85.00	57.78	969.13	0.35	355.86	2651.99	0.33	1.15E-02	4.64E-07	1.60E-02	-91.89
87.78	64.40	967.30	0.39	367.49	2656.41	0.32	1.16E-02	4.93E-07	1.45E-02	-83.87
90.56	71.57	965.42	0.43	379.35	2660.83	0.31	1.17E-02	4.93E-07	1.33E-02	-76.70
93.33	79.50	963.53	0.48	390.98	2665.48	0.30	1.18E-02	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	1.19E-02	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	1.20E-02	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	1.21E-02	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	1.22E-02	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	1.23E-02	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	1.24E-02	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	1.25E-02	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	1.26E-02	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	1.27E-02	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	1.28E-02	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	1.29E-02	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	1.30E-02	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	1.31E-02	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	1.32E-02	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	1.34E-02	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	1.35E-02	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	1.36E-02	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	1.37E-02	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	1.38E-02	6.24E-07	2.32E-03	-17.50
148.89	462.02	918.47	2.48	627.30	2743.86	0.18	1.39E-02	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	1.40E-02	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	1.41E-02	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	1.42E-02	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	1.43E-02	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	1.44E-02	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	1.45E-02	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	1.45E-02	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	1.46E-02	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	1.47E-02	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	1.48E-02	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	1.49E-02	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	1.50E-02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	1.51E-02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	1.52E-02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	1.53E-02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	1.54E-02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	1.55E-02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	1.56E-02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	1.57E-02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	1.58E-02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	1.59E-02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	1.60E-02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	1.61E-02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	1.62E-02	1.06E-06	4.64E-04	-4.89

218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	1.63E-02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	1.64E-02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	1.65E-02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	1.66E-02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	1.67E-02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	1.68E-02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	1.69E-02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	1.70E-02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	1.71E-02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	1.72E-02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	1.73E-02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	1.74E-02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	797.27	20.59	1093.87	2799.92	0.11	1.75E-02	1.45E-06	3.05E-04	-2.97
254.44	4284.98	793.07	21.60	1107.59	2798.76	0.11	1.76E-02	1.60E-06	3.05E-04	-2.92
257.22	4486.10	788.82	22.65	1121.08	2797.59	0.10	1.77E-02	1.74E-06	3.05E-04	-2.87
260.00	4694.39	784.49	23.75	1134.81	2796.20	0.10	1.79E-02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	780.08	24.90	1148.76	2794.80	0.10	1.80E-02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	775.61	26.10	1162.72	2792.94	0.10	1.81E-02	1.74E-06	3.19E-04	-2.73
268.33	5363.67	771.08	27.34	1176.67	2791.08	0.10	1.82E-02	1.89E-06	3.19E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.10	1.83E-02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.10	1.85E-02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	1.86E-02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	1.87E-02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	1.89E-02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	1.90E-02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	1.91E-02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	1.93E-02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	1.95E-02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	1.96E-02	3.05E-06	3.48E-04	-2.25
298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	1.98E-02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	1.99E-02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	2.01E-02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	2.03E-02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	2.05E-02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	2.07E-02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	2.09E-02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	2.11E-02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	2.13E-02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	2.16E-02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	2.18E-02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	2.21E-02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	2.24E-02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	2.27E-02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	2.30E-02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	2.34E-02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	2.40E-02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	2.47E-02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	2.54E-02	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	2.61E-02	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	2.69E-02	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	2.77E-02	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	2.87E-02	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	2.97E-02	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	3.09E-02	6.96E-05	6.09E-04	-1.46

'RECUR'
'TIMEYR' 0
'PRODUCER' 'DOG' 1 3

63

.208 .15 0. 0.

0. 0. 2

'COMMENT' '***** NOTE *****'
'COMMENT' 'INJECTION WELL LOCATED A X=162.5M AND Y=137.5 M'
'COMMENT' 'WELL INJECTS 80-C WATER, STARTING AT T=1 YEAR'
'COMMENT' '*****'
'INJECTOR' 'INJ' 1 3

31

.208 .15 0. 0.

0. 0. 2

80. 0.

''''''
'AQUIFER' 'SSTATE' 12,96,12 1 ,,,,675.44

'TIME' 0. .2

'P' 'DOG' 0. 15. 1.80

'COMMENT' 'AT ONE YEAR START INJECTION WELL AT .3 KG/S (1.08K KG/H)'

'TIME' 365.25 -1.

'P' 'DOG' 0. 15. 1.8

'R' 'INJ' 0. 1.08

'TIME' 3652.5 0.

APPENDIX G: DATASET USED FOR STANFORD PROBLEM 6

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'COMMENT' 'STANFORD TEST PROBLEM #6'
'COMMENT' '3-D WAIRAKEI TYPE PROBLEM'
'COMMENT' 'STANDARD 5-PT, FULLY IMPLICIT FORMULATION'
'COMMENT' 'USING ADDITIONAL LAYERS FOR PRESSURE SUPPORT'
'COMMENT' 'ALSO USING QTR SYM. WELL GF'
'TYPE' 4 1 1 0. 0.
'UNITS' 1 1 0 1
'DIMEN' 5 5 7 7000
'PRINT' 50 1 1 1 0
'OUTFUN' 0 0 0 0 0 0 0 0 9 0
'OUTPROP' 0 0 0 0 0 0 0 0 0 0
'PLOT' 5
5 'SGAV' 'PAV' 'TAV' 'QTOTENTH' 'QTOTMASS'
'GVWRITE' 0 15
3 'P' 'T' 'SG'
'SHIFT' ''''''
'TMSTEP' '3' 3 30.437,,,,,,,,,,,,
'COMMENT' 'SET UP 3-D GRID'
'COMMENT' 'X DIRECTION CONSISTS OF 5 GRIDS AT 1000M EACH'
'DELX' 1
5 5*1000.
'COMMENT' 'Y DIRECTION CONSISTS OF 5 GRIDS AT 800M EACH'
'DELY' 1
5 5*800.
'COMMENT' 'Z DIRECTION CONSISTS OF 7 LAYERS'
'COMMENT' 'A VERY THIN LAYER AT TOP AND BOTTOM FOR BOUNDARY CONDITIONS'
'COMMENT' 'AND THE SPECIFIED LAYER THICKNESS'
'DELZ' 1
7 .3048 4*300. 600. .3048
'FTOPS' 0 0
'COMMENT' 'INCOMPRESS PORE SPACE AND ROCK...'
'COMP' 0. 15. 0. 23.
'COMMENT' 'SET POROSITY AT 25%'
'COMMENT' 'REMEMBER LAYER 1&7 ARE DUMMY LAYERS'
'PORZLAY' 1 1.
'PORZLAY' 2 .2
'PORZLAY' 3 .25
'PORZLAY' 4 .25
'PORZLAY' 5 .25
'PORZLAY' 6 .2
'PORZLAY' 7 1.
'COMMENT' 'SET UP PERMEABILITIES'
'COMMENT' 'IZ KX KY KZ'
'PERMZLAY' 1 100. 100. 2.
'PERMZLAY' 2 100. 100. 2.
'PERMZLAY' 3 200. 200. 50.
'PERMZLAY' 4 200. 200. 50.
'PERMZLAY' 5 200. 200. 50.
'PERMZLAY' 6 100. 100. 2.
'PERMZLAY' 7 100. 100. 2.
'PROPERTY'
'COMMENT' 'USE COREY REL PERM CURVES WITH S1r=.3 & Sgr=.1'

```

'RELOW' 1 9 0 1 1. 1. 0.

0. 0. 0. 0.

.3 0. 0. 0.

.4 .0008 0. 0.

.5 .0123 0. 0.

.6 .0625 0. 0.

.7 .1979 0. 0.

.8 .4822 0. 0.

.9 1. 0. 0.

1. 1. 0. 0.

'RELOG' 1 9 1 1. 0.

0. 0. 0. 0.

.1 0. 0. 0.

.2 .0085 0. 0.

.3 .0616 0. 0.

.4 .1875 0. 0.

.5 .3952 0. 0.

.6 .6751 0. 0.

.7 1. 0. 0.

1. 1. 0. 0.

'UPVIS' 1. 1. 1.

'DENS' 1000.

1

18.02

'COMMENT' 'SET PRESSURE FIELD AS SPECIFIED'

'PRESZLAY' 1 2989.7

'PRESZLAY' 2 4317.45

'COMMENT' 'NOTE FOR LAYER 3 THIS PRESSURE IS AT SATURATION WITH STEAM & WATER'

'PRESZLAY' 3 6420.23

'PRESZLAY' 4 8523.0

'PRESZLAY' 5 10731.34

'PRESZLAY' 6 14043.81

'PRESZLAY' 7 16123.97

'COMMENT' 'SET UP INITIAL TEMPERATURES'

'TEMPZLAY' 1 160

'TEMPZLAY' 2 160

'TEMPZLAY' 3 280.

'TEMPZLAY' 4 280.

'TEMPZLAY' 5 280.

'TEMPZLAY' 6 280.

'TEMPZLAY' 7 280.

'COMMENT' 'SET INITIAL WATER SATURATIONS AT 100%'

'SATMOD' 1 175 1 0. 0.

'COMMENT' 'NOW OVERRIDE FOR LAYER 3 TO GIVE A 10% INITIAL STEAM SATURATION'

'SATZLAY' 3 .1 0.

'COMMENT' 'SPECIFIC HEATS FOR ROCK AND FLUID...'

'LIQSH' 1.0 0. 25. 2500.

4.1868 .0003 25. 0. 101.

'GASSH'

1.842 4.244E-5 0. 0. 15.

'LIQTCON' 86.4 0. 60.

59.8 0.0 100.

'GASTCON'

4.11 0. 100.

'COMMENT' 'STEAM TABLES ...'

'COMMENT' 'T P DEN1 DEN2 W ENTH G ENER U-W U-G CW CG DHG/DP'

'STEAMT' 130

7.22	1.03	1000.66	0.01	32.56	2515.69	1.42	9.00E-03	5.37E-07	2.12E-01	-1443.32
10.00	1.24	1000.43	0.01	42.10	2519.88	1.31	9.10E-03	5.22E-07	2.02E-01	-1363.13
12.78	1.45	1000.19	0.01	53.73	2525.00	1.21	9.20E-03	5.22E-07	1.91E-01	-1282.95
15.56	1.79	999.81	0.01	65.36	2529.88	1.12	9.20E-03	5.08E-07	1.81E-01	-1202.76
18.33	2.14	999.31	0.02	76.99	2535.00	1.04	9.30E-03	5.08E-07	1.71E-01	-1124.87
21.11	2.48	998.75	0.02	88.62	2540.12	0.98	9.30E-03	4.93E-07	1.61E-01	-998.85
23.89	2.96	998.14	0.02	100.01	2545.23	0.91	9.40E-03	4.93E-07	1.51E-01	-945.02
26.67	3.52	997.39	0.03	111.64	2550.12	0.86	9.40E-03	4.79E-07	1.41E-01	-891.17
29.44	4.14	996.62	0.03	123.27	2555.23	0.81	9.50E-03	4.79E-07	1.31E-01	-818.09
32.22	4.83	995.72	0.03	134.90	2560.35	0.76	9.50E-03	4.79E-07	1.20E-01	-745.01
35.00	5.65	994.79	0.04	146.53	2565.24	0.72	9.60E-03	4.64E-07	1.10E-01	-671.93
37.78	6.55	993.80	0.05	158.16	2570.35	0.68	9.60E-03	4.64E-07	1.00E-01	-598.85
40.56	7.58	992.75	0.05	169.79	2575.24	0.64	9.70E-03	4.35E-07	8.99E-02	-525.77
43.33	8.76	991.63	0.06	181.42	2580.12	0.61	9.80E-03	4.35E-07	8.12E-02	-462.94
46.11	10.14	990.46	0.07	193.05	2585.24	0.58	9.90E-03	4.35E-07	7.40E-02	-408.73
48.89	11.65	989.24	0.08	204.68	2590.12	0.55	1.00E-02	4.35E-07	6.67E-02	-361.84
51.67	13.38	987.98	0.09	216.31	2595.01	0.53	1.01E-02	4.35E-07	5.95E-02	-321.17
54.44	15.31	986.65	0.10	227.94	2599.89	0.51	1.02E-02	4.35E-07	5.37E-02	-285.79
57.22	17.51	985.27	0.12	239.57	2604.78	0.48	1.04E-02	4.64E-07	4.79E-02	-254.95
60.00	19.93	983.86	0.13	251.20	2609.66	0.46	1.05E-02	4.64E-07	4.35E-02	-227.98
62.78	22.61	982.38	0.15	262.83	2614.31	0.44	1.06E-02	4.64E-07	3.77E-02	-204.34
65.56	25.65	980.88	0.17	274.46	2619.20	0.43	1.07E-02	4.64E-07	3.48E-02	-183.56
68.33	28.96	979.32	0.19	286.09	2624.08	0.41	1.08E-02	4.64E-07	3.05E-02	-165.26
71.11	32.68	977.72	0.21	297.72	2628.73	0.39	1.09E-02	4.64E-07	2.76E-02	-149.11
73.89	36.82	976.08	0.23	309.34	2633.38	0.38	1.10E-02	4.93E-07	2.47E-02	-134.82
76.67	41.30	974.40	0.26	320.97	2638.04	0.37	1.11E-02	4.64E-07	2.18E-02	-122.14
79.44	46.33	972.68	0.29	332.60	2642.69	0.35	1.12E-02	4.93E-07	2.03E-02	-110.88
82.22	51.78	970.92	0.32	344.23	2647.34	0.34	1.13E-02	4.64E-07	1.74E-02	-100.84
85.00	57.78	969.13	0.35	355.86	2651.99	0.33	1.15E-02	4.64E-07	1.60E-02	-91.89
87.78	64.40	967.30	0.39	367.49	2656.41	0.32	1.16E-02	4.93E-07	1.45E-02	-83.87
90.56	71.57	965.42	0.43	379.35	2660.83	0.31	1.17E-02	4.93E-07	1.33E-02	-76.70
93.33	79.50	963.53	0.48	390.98	2665.48	0.30	1.18E-02	4.93E-07	1.20E-02	-70.27
96.11	88.05	961.59	0.52	402.61	2669.90	0.29	1.19E-02	4.93E-07	1.09E-02	-64.48
98.89	97.35	959.60	0.58	414.48	2674.09	0.28	1.20E-02	5.22E-07	9.86E-03	-59.27
101.67	107.49	957.60	0.63	426.10	2678.51	0.27	1.21E-02	5.22E-07	8.99E-03	-54.56
104.44	118.52	955.56	0.69	437.73	2682.69	0.27	1.22E-02	5.22E-07	8.27E-03	-50.31
107.22	130.38	953.48	0.76	449.60	2687.11	0.26	1.23E-02	5.08E-07	7.54E-03	-46.46
110.00	143.27	951.38	0.83	461.23	2691.30	0.25	1.24E-02	5.08E-07	6.82E-03	-42.96
112.78	157.13	949.23	0.90	473.09	2695.25	0.25	1.25E-02	5.51E-07	6.24E-03	-39.79
115.56	172.16	947.05	0.98	484.95	2699.44	0.24	1.26E-02	5.37E-07	5.66E-03	-36.90
118.33	188.30	944.86	1.07	496.58	2703.39	0.23	1.27E-02	5.37E-07	5.22E-03	-34.27
121.11	205.60	942.61	1.16	508.44	2707.35	0.23	1.28E-02	5.66E-07	4.79E-03	-31.87
123.89	224.29	940.34	1.26	520.30	2711.30	0.22	1.29E-02	5.66E-07	4.35E-03	-29.67
126.67	244.28	938.04	1.36	532.17	2715.26	0.22	1.30E-02	5.66E-07	4.06E-03	-27.66
129.44	265.66	935.70	1.47	544.03	2718.98	0.21	1.31E-02	5.95E-07	3.77E-03	-25.82
132.22	288.62	933.33	1.59	555.89	2722.70	0.21	1.32E-02	5.95E-07	3.48E-03	-24.14
135.00	313.09	930.94	1.72	567.75	2726.42	0.20	1.34E-02	5.95E-07	3.19E-03	-22.58
137.78	339.22	928.51	1.85	579.61	2730.14	0.20	1.35E-02	5.95E-07	2.90E-03	-21.15
140.56	367.08	926.04	2.00	591.48	2733.63	0.19	1.36E-02	5.95E-07	2.76E-03	-19.84
143.33	396.80	923.55	2.15	603.34	2737.12	0.19	1.37E-02	6.24E-07	2.47E-03	-18.62
146.11	428.37	921.02	2.31	615.43	2740.61	0.19	1.38E-02	6.24E-07	2.32E-03	-17.50

148.89	462.02	918.47	2.48	627.30	2743.86	0.18	1.39E-02	6.53E-07	2.18E-03	-16.45
151.67	497.67	915.87	2.66	639.39	2747.12	0.18	1.40E-02	6.53E-07	2.03E-03	-15.49
154.44	535.52	913.25	2.85	651.25	2750.38	0.18	1.41E-02	6.82E-07	1.89E-03	-14.61
157.22	575.58	910.60	3.05	663.35	2753.63	0.17	1.42E-02	6.82E-07	1.74E-03	-13.79
160.00	618.05	907.91	3.26	675.44	2756.66	0.17	1.43E-02	7.11E-07	1.60E-03	-13.02
162.78	663.00	905.18	3.49	687.54	2759.68	0.17	1.44E-02	6.96E-07	1.45E-03	-12.30
165.56	710.51	902.42	3.72	699.63	2762.47	0.16	1.45E-02	6.96E-07	1.41E-03	-11.64
168.33	760.63	899.64	3.97	711.73	2765.26	0.16	1.45E-02	6.96E-07	1.31E-03	-11.03
171.11	813.52	896.81	4.23	724.05	2768.05	0.16	1.46E-02	7.25E-07	1.22E-03	-10.46
173.89	869.30	893.95	4.51	736.15	2770.61	0.15	1.47E-02	7.54E-07	1.15E-03	-9.91
176.67	928.04	891.06	4.80	748.47	2773.17	0.15	1.48E-02	7.54E-07	1.07E-03	-9.41
179.44	989.89	888.13	5.10	760.57	2775.73	0.15	1.49E-02	7.83E-07	1.00E-03	-8.93
182.22	1054.97	885.16	5.42	772.90	2778.05	0.15	1.50E-02	8.12E-07	9.43E-04	-8.50
185.00	1123.37	882.16	5.76	785.22	2780.38	0.15	1.51E-02	7.98E-07	8.85E-04	-8.08
187.78	1195.14	879.12	6.11	797.55	2782.47	0.14	1.52E-02	8.27E-07	8.41E-04	-7.70
190.56	1270.50	876.06	6.48	809.88	2784.57	0.14	1.53E-02	8.27E-07	7.83E-04	-7.34
193.33	1349.52	872.93	6.86	822.44	2786.43	0.14	1.54E-02	8.56E-07	7.40E-04	-6.99
196.11	1432.33	869.79	7.27	834.77	2788.29	0.14	1.55E-02	8.56E-07	6.96E-04	-6.67
198.89	1519.06	866.60	7.69	847.33	2790.15	0.13	1.56E-02	8.70E-07	6.53E-04	-6.37
201.67	1609.87	863.36	8.14	859.89	2791.78	0.13	1.57E-02	8.99E-07	6.24E-04	-6.09
204.44	1704.81	860.09	8.60	872.45	2793.41	0.13	1.58E-02	9.28E-07	5.80E-04	-5.82
207.22	1804.02	856.77	9.09	885.00	2794.80	0.13	1.59E-02	9.57E-07	5.51E-04	-5.56
210.00	1907.72	853.42	9.60	897.80	2795.96	0.13	1.60E-02	9.72E-07	5.22E-04	-5.32
212.78	2016.04	850.02	10.13	910.36	2797.36	0.13	1.61E-02	1.00E-06	4.93E-04	-5.10
215.56	2128.98	846.58	10.69	923.15	2798.29	0.12	1.62E-02	1.06E-06	4.64E-04	-4.89
218.33	2246.81	843.08	11.27	935.94	2799.22	0.12	1.63E-02	1.04E-06	4.50E-04	-4.70
221.11	2369.54	839.56	11.88	948.73	2800.15	0.12	1.64E-02	1.07E-06	4.21E-04	-4.51
223.89	2497.50	835.96	12.51	961.76	2800.85	0.12	1.65E-02	1.10E-06	4.06E-04	-4.33
226.67	2630.64	832.34	13.17	974.55	2801.31	0.12	1.66E-02	1.15E-06	3.77E-04	-4.15
229.44	2769.23	828.65	13.86	987.58	2801.78	0.12	1.67E-02	1.20E-06	3.63E-04	-3.99
232.22	2913.40	824.92	14.59	1000.60	2802.01	0.12	1.68E-02	1.19E-06	3.48E-04	-3.83
235.00	3063.22	821.15	15.34	1013.86	2802.24	0.11	1.69E-02	1.25E-06	3.34E-04	-3.69
237.78	3218.98	817.31	16.12	1026.88	2802.24	0.11	1.70E-02	1.29E-06	3.05E-04	-3.54
240.56	3380.66	813.41	16.94	1040.14	2802.01	0.11	1.71E-02	1.35E-06	2.90E-04	-3.42
243.33	3548.55	809.47	17.80	1053.63	2801.78	0.11	1.72E-02	1.36E-06	2.76E-04	-3.29
246.11	3722.78	805.46	18.69	1066.89	2801.31	0.11	1.73E-02	1.41E-06	2.76E-04	-3.18
248.89	3903.49	801.39	19.62	1080.38	2800.62	0.11	1.74E-02	1.45E-06	3.05E-04	-2.98
251.67	4090.82	797.27	20.59	1093.87	2799.92	0.11	1.75E-02	1.45E-06	3.05E-04	-2.97
254.44	4284.98	793.07	21.60	1107.59	2798.76	0.11	1.76E-02	1.60E-06	3.05E-04	-2.92
257.22	4486.10	788.82	22.65	1121.08	2797.59	0.10	1.77E-02	1.74E-06	3.05E-04	-2.87
260.00	4694.39	784.49	23.75	1134.81	2796.20	0.10	1.79E-02	1.74E-06	3.05E-04	-2.82
262.78	4909.92	780.08	24.90	1148.76	2794.80	0.10	1.80E-02	1.74E-06	3.05E-04	-2.77
265.56	5132.97	775.61	26.10	1162.72	2792.94	0.10	1.81E-02	1.74E-06	3.19E-04	-2.73
268.33	5363.67	771.08	27.34	1176.67	2791.08	0.10	1.82E-02	1.89E-06	3.19E-04	-2.68
271.11	5602.23	766.44	28.65	1190.86	2788.75	0.10	1.83E-02	2.03E-06	3.19E-04	-2.63
273.89	5848.72	761.73	30.01	1205.05	2786.43	0.10	1.85E-02	2.03E-06	3.19E-04	-2.58
276.67	6103.48	756.94	31.43	1219.47	2783.87	0.10	1.86E-02	2.18E-06	3.19E-04	-2.53
279.44	6366.59	752.06	32.91	1233.89	2780.85	0.10	1.87E-02	2.18E-06	3.19E-04	-2.49
282.22	6638.24	747.08	34.46	1248.54	2777.82	0.10	1.89E-02	2.32E-06	3.34E-04	-2.45
285.00	6918.66	742.01	36.08	1263.20	2774.33	0.09	1.90E-02	2.47E-06	3.34E-04	-2.41
287.78	7208.03	736.83	37.78	1278.08	2770.61	0.09	1.91E-02	2.61E-06	3.34E-04	-2.36
290.56	7506.58	731.56	39.55	1292.97	2766.66	0.09	1.93E-02	2.76E-06	3.34E-04	-2.33
293.33	7814.43	726.16	41.41	1308.09	2762.47	0.09	1.95E-02	2.90E-06	3.34E-04	-2.28
296.11	8131.87	720.66	43.35	1323.44	2757.82	0.09	1.96E-02	3.05E-06	3.48E-04	-2.25

298.89	8459.09	715.02	45.38	1338.79	2752.94	0.09	1.98E-02	3.19E-06	3.48E-04	-2.20
301.67	8796.25	709.26	47.52	1354.37	2747.82	0.09	1.99E-02	3.34E-06	3.48E-04	-2.16
304.44	9143.68	703.36	49.76	1370.19	2742.24	0.09	2.01E-02	3.48E-06	3.63E-04	-2.13
307.22	9501.52	697.32	52.11	1386.24	2736.19	0.09	2.03E-02	3.77E-06	3.63E-04	-2.08
310.00	9870.04	691.12	54.59	1402.29	2729.91	0.09	2.05E-02	3.92E-06	3.63E-04	-2.05
312.78	10249.53	684.75	57.19	1418.80	2723.16	0.09	2.07E-02	4.21E-06	3.63E-04	-2.02
315.56	10640.19	678.21	59.94	1435.31	2715.95	0.09	2.09E-02	4.50E-06	3.77E-04	-1.99
318.33	11042.30	671.50	62.84	1452.29	2708.28	0.08	2.11E-02	4.93E-06	3.77E-04	-1.96
321.11	11456.12	664.57	65.91	1469.50	2700.14	0.08	2.13E-02	5.22E-06	3.92E-04	-1.92
323.89	11881.95	657.44	69.16	1486.95	2691.53	0.08	2.16E-02	5.66E-06	3.92E-04	-1.89
326.67	12320.11	650.06	72.62	1504.62	2682.00	0.08	2.18E-02	6.24E-06	3.92E-04	-1.86
329.44	12770.89	642.43	76.32	1522.77	2671.99	0.08	2.21E-02	6.82E-06	4.06E-04	-1.83
332.22	13234.64	634.53	80.26	1541.37	2661.06	0.08	2.24E-02	7.40E-06	4.21E-04	-1.80
335.00	13711.76	626.32	84.50	1560.21	2649.20	0.08	2.27E-02	8.12E-06	4.21E-04	-1.76
337.78	14202.53	617.78	89.05	1579.52	2636.41	0.08	2.30E-02	9.14E-06	4.35E-04	-1.73
340.56	14707.37	608.85	93.98	1599.52	2622.45	0.08	2.34E-02	1.03E-05	4.35E-04	-1.70
343.33	15226.75	599.49	99.31	1619.99	2607.33	0.07	2.40E-02	1.16E-05	4.50E-04	-1.67
346.11	15761.10	589.62	105.11	1640.92	2591.05	0.07	2.47E-02	1.33E-05	4.64E-04	-1.65
348.89	16310.89	579.15	111.42	1662.79	2573.14	0.07	2.54E-02	1.60E-05	4.79E-04	-1.62
351.67	16876.61	568.04	117.98	1686.28	2555.70	0.07	2.61E-02	1.89E-05	4.93E-04	-1.59
354.44	17458.81	555.90	125.71	1711.40	2534.53	0.07	2.69E-02	2.18E-05	5.08E-04	-1.56
357.22	18058.17	542.62	134.36	1737.21	2511.51	0.07	2.77E-02	2.76E-05	5.22E-04	-1.54
360.00	18675.19	527.85	144.20	1764.20	2485.22	0.07	2.87E-02	3.63E-05	5.51E-04	-1.51
362.78	19310.61	511.34	155.63	1792.80	2455.69	0.06	2.97E-02	4.79E-05	5.80E-04	-1.48
365.56	19965.13	492.38	169.47	1824.67	2420.33	0.06	3.09E-02	6.96E-05	6.09E-04	-1.46

'RECIP'

'COMMENT' 'SET UP BOUNDARY CONDITONS USING AQUIFERS'

'AQUIFER' 'SSTATE' 1,25,1 -3 , , , , 419.06

'AQUIFER' 'SSTATE' 151,175,1 3 , , , , ,

'AQUIFER' 'SSTATE' 30,50,5 1 , , , , ,

'AQUIFER' 'SSTATE' 55,75,5 1 , , , , ,

'AQUIFER' 'SSTATE' 80,100,5 1 , , , , ,

'AQUIFER' 'SSTATE' 105,125,5 1 , , , , ,

'AQUIFER' 'SSTATE' 130,150,5 1 , , , , ,

'TIME' 0

'PRODUCER' 'OBS1' 1 3

46

.208 .492 0. 0.

,

,

2

'PRODUCER' 'OBS2' 1 3

71

.208 .492 0. 0.

,

,

0. 2

'PRODUCER' 'OBS3' 1 3

96

.208 .492 0. 0.

,

,

0. 2

'PRODUCER' 'OBS0' 1 3

12

.208 .492 0. 0.

,

0. 2
'PRODUCER' 'OBS5' 1 3
146
.208 .492 0. 0.

0. 2
'COMMENT' 'PRODUCER IS GIVEN AN EXTREMELY HIGH PI OF -2000'
'COMMENT' 'THIS ALLOWS WELL TO PRODUCE AT SPECIFIED RATE UNTIL RESERVOIR'
'COMMENT' 'EXPERENCES A CATASTROPIC COLLAPSE IN PRESSURE'
'PRODUCER' 'DOG' 1 3
121
.721 2.0 0. 0.
-2000.

0. 0
'COMMENT' 'PRODUCTIONS RATES WILL BE INCREASING UNTIL A CATASTROPIC COLLAPSE'
'COMMENT' 'IN RESERVOIR PRESSURE OCCURS IN BOTTOM LAYER'
'COMMENT' 'WITH LAST RATE INCREASE'
'TIME' 0. .2
'P' 'DOG' 0. 0. 3600.
'TIME' 730.5 -1.
'P' 'DOG' 0. 0. 9000.
'TIME' 1461 -1.
'P' 'DOG' 0. 0. 14400.
'TIME' 2191.5 -1.
'P' 'DOG' 0. -9000. 21600.
'TIME' 2556.75 0.