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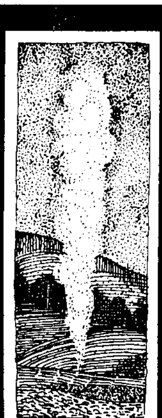

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PRESSURE DRAWDOWN ANALYSIS FOR THE TRAVALE 22 WELL

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Introduction

This work presents preliminary results on the analysis of drawdown data for Travale 22. Both wellhead pressure and flow rate data were recorded in this well for over a period of almost two years.

In the past, Barelli et al. (1975) and Atkinson et al. (1977) presented the analysis of five pressure buildup tests. Figure 1 shows the Horner plot for these cases. They found that to have a good match in all cases, it was necessary to assume that the Travale 22 well is intersected by a partially penetrating vertical fracture in a parallelepiped whose bottom side is maintained at constant pressure (boiling front), as shown in Fig. 2.

Atkinson et al. also presented an analysis for a pressure interface test run in the Travale-Radicondoli area. In this case, the Travale 22 well was flowing and the pressure recorded at wells R1, R3, R5, R6, R9, and Ch1 (see Fig. 3). Analysis of these data showed that pressure interference in this reservoir can be matched by considering pure linear flow (Figs. 4 and 5). This indicated the possible presence of a vertical fracture intersecting the Travale 22 well. It was determined that fracture is oriented along the N73°W direction. In addition, the pressure interference data showed that no boundary exists within 2 kilometers from the fracture plane. It was mentioned that linear flow should take place in both horizontal and vertical directions.

Analysis of Drawdown Data

As mentioned previously, both wellhead pressure and flow rate were measured when this well was continuously flowing during almost two years. First the bottomhole pressure was calculated and plotted on a semilog paper (Fig. 6). Data on this graph show a curve of increasing slope similar to a fractured well case. The pressure seems to stabilize at 400 days, indicating a possible constant pressure boundary.

A log-log graph of the pressure data is shown in Fig. 7. It can be seen that the first data points follow a one-half slope straight line, suggesting linear flow.

Since previous buildup analysis and interference analysis suggested that the well is intersected by a fracture and the reservoir has a constant pressure boundary, two models are used to analyze the pressure drawdown data:

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1) a well intersected by a fully penetrating vertical fracture in a finite system (Gringarten, Ramey, and Raghavan), and,

2) a well intersected by a partially penetrating vertical fracture in a parallelepiped whose bottom side is a constant pressure boundary.

Figure 8 presents the application of the type-curve matching technique by using the first model. Agreement between most of the pressure data and the dimensionless pressure curve is good; however, at very long time (about 400 days), the system seems to reach steady-state flow, indicating the existence of a constant pressure boundary.

Figure 9 presents the match of data with the second flow model (parallelepiped model). The data appears to match the curve for dimensionless formation thickness ≈ 2.5.

Results from this analysis and from previous work are summarized in Table I. It can be seen that although both the results from buildup and drawdown analysis suggest the same type of geometry for the system, they do not agree regarding the dimensions of the reservoir.

Further effort is needed in the analysis of additional drawdown data not presented in this work. At this point, the results from the buildup data are more reliable because the analysis was based on several tests.

Conclusions

A preliminary analysis of the drawdown data for the Travale 22 well seems to indicate the following:

1) the well is intersected by a highly conductive fracture, as found from the buildup and interference data, and

2) a constant pressure boundary seems to exist, causing the system to reach pseudosteady flow at about 400 days.

References

Atkinson, P., Barelli, A., Brigham, W.E., Celati, R., Manetti, G., Miller, F., Nery, G., and Ramey, H.J., Jr.: "Well-Testing in Travale-Radicondoli Field," Proc., Lardarello Workshop on Geothermal Resource Assessment and Reservoir Engineering, Pisa, Italy, Sept. 12-16, 1977.

Barelli, A., Celati, R., Manetti, G., and Neri, G.: "Horner's Method Applied to Buildup Tests on Travale 22 Well," Summaries of the Second Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, Dec. 15-17, 1975.

Nomenclature

c_t = compressibility $(Kg/cm^2)^{-1}$

h = reservoir thickness (m)

k = permeability (m)

p = pressure (Kg/cm^2)

q = flow rate (tons/hour)

t = time (days)

x_f = half fracture length (m)

ϕ = porosity

μ = viscosity (cp)

TABLE I: RESULTS FROM PRESSURE TESTS

	$kx_f h_f$ (Darcy m^2)	$\phi h_f x_f$ (m^2)
Interference	$5x10^4$	$1.5x10^4$
Buildup	$2.5x10^5 k$	$2.5x10^4$ (ϕ=.1)
Drawdown (Parallelepiped)	$1.4x10^3$ (ϕ=.1)	$1.2x10^4$ (ϕ=.1)
Drawdown (Vertical Fracture)	$6.552\ x_f$	$3.66x10^6/x_f$

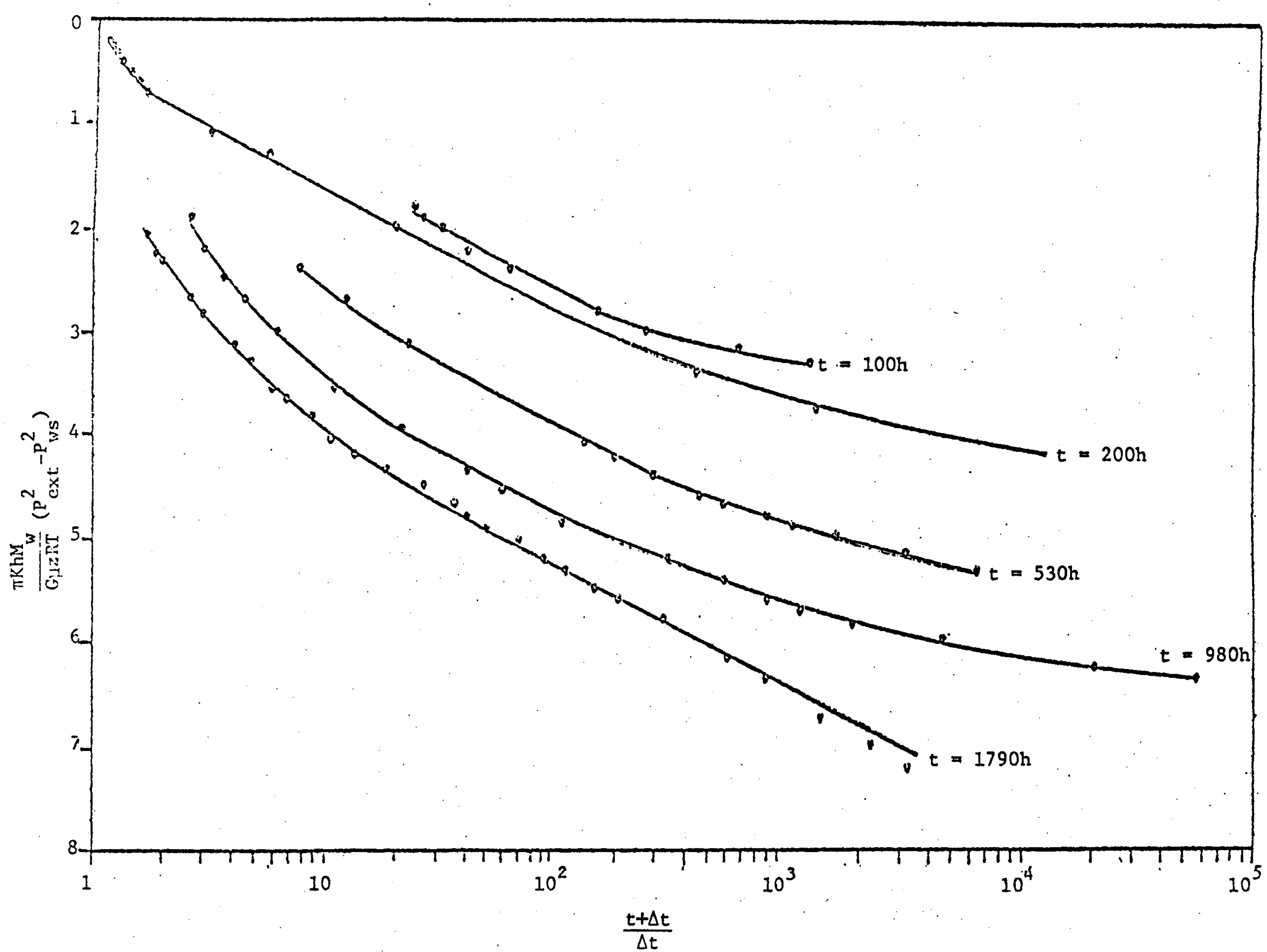

FIG. 1: RECONSTRUCTED HORNER BUILDUP GRAPH FOR T-22 WELL, 1972-1973 (Barelli et al., 1975)

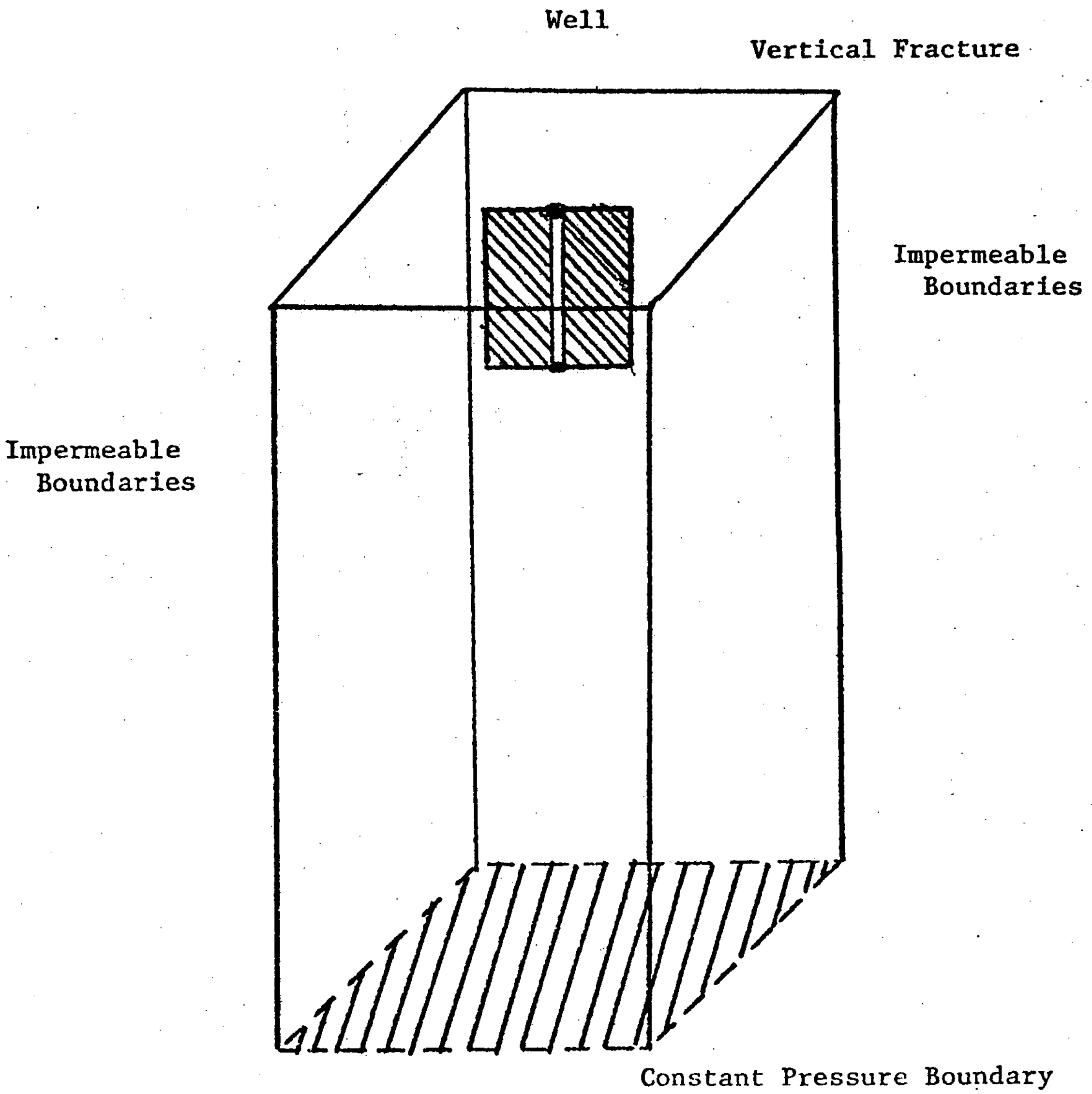

FIG. 2: PARALLELEPIPED MODEL FOR A WELL INTERSECTED BY A PARTIALLY PENETRATING VERTICAL FRACTURE

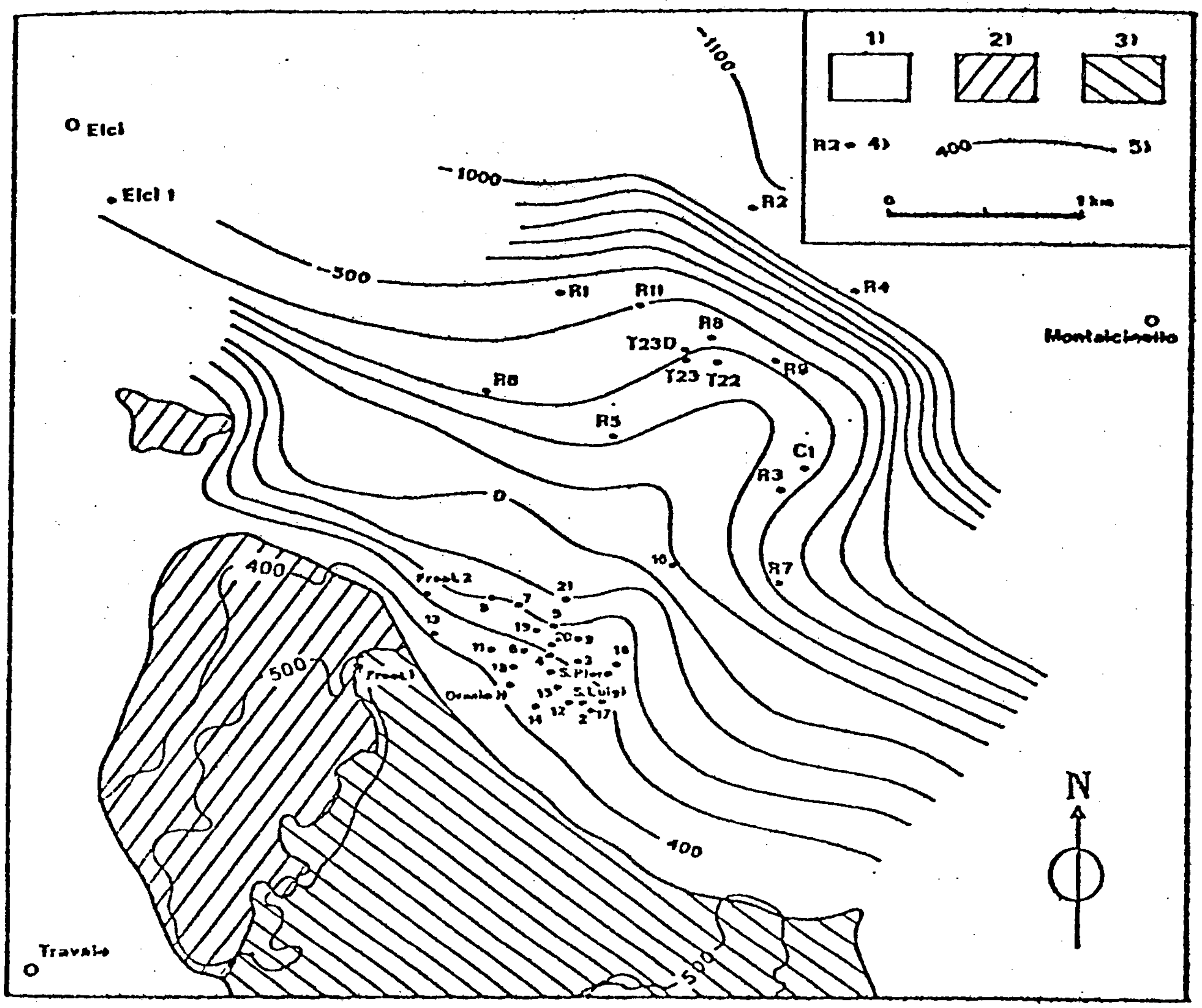

FIG. 3: TRAVALE GEOTHERMAL FIELD. STRUCTURAL MAP OF THE RESERVOIR TOP.
1: COVER COMPLEX: 2: RADIOLARITES AND LIMESTONES (PREDOMINATING);
3: CAVERNOUS LIMESTONES; 4: WELLS; 5: ISOBATHS (ELEVATION m a.s.l.)

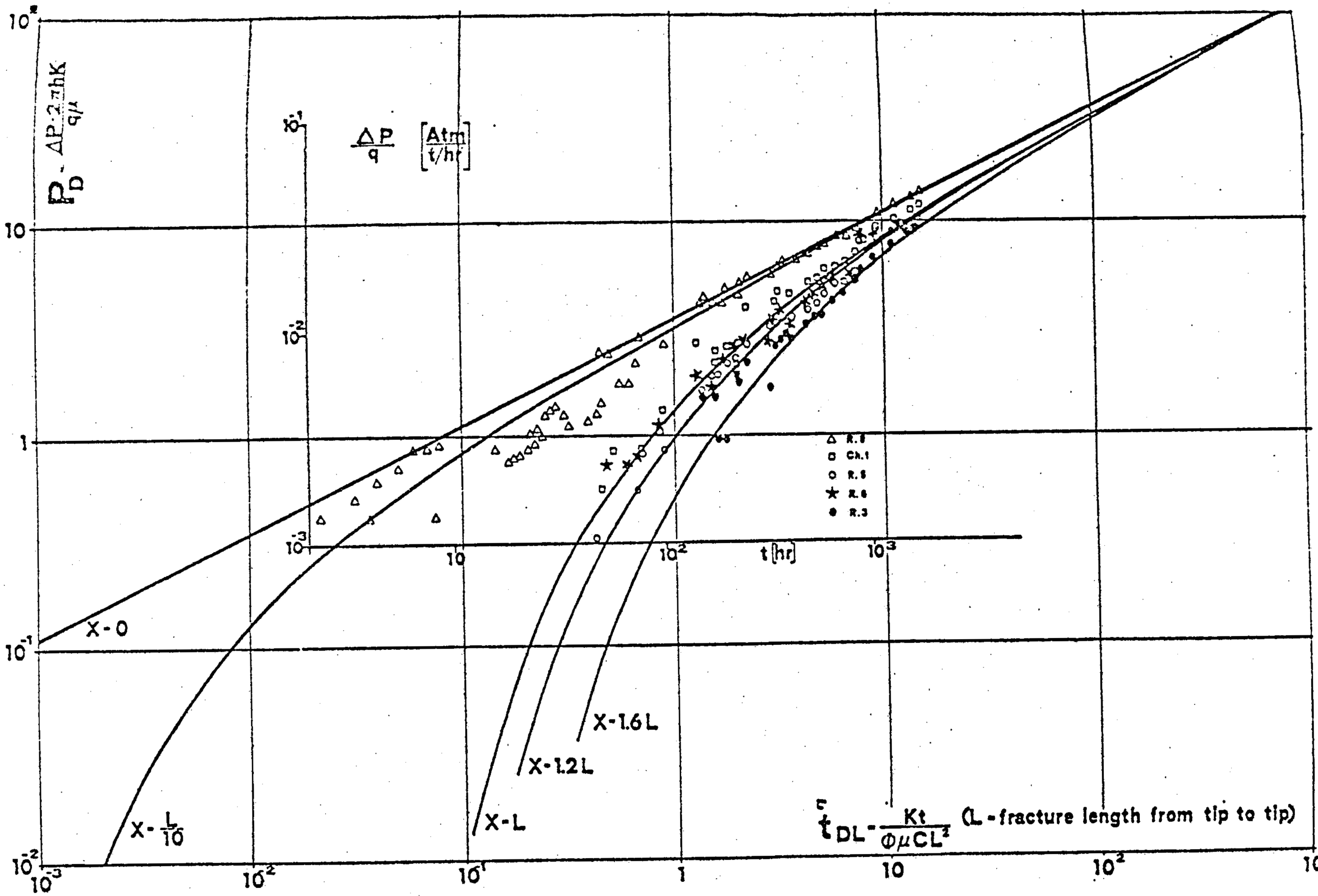

FIG. 4: INTERFERENCE DATA MATCHED WITH TYPE CURVES (Atkinson et al.)

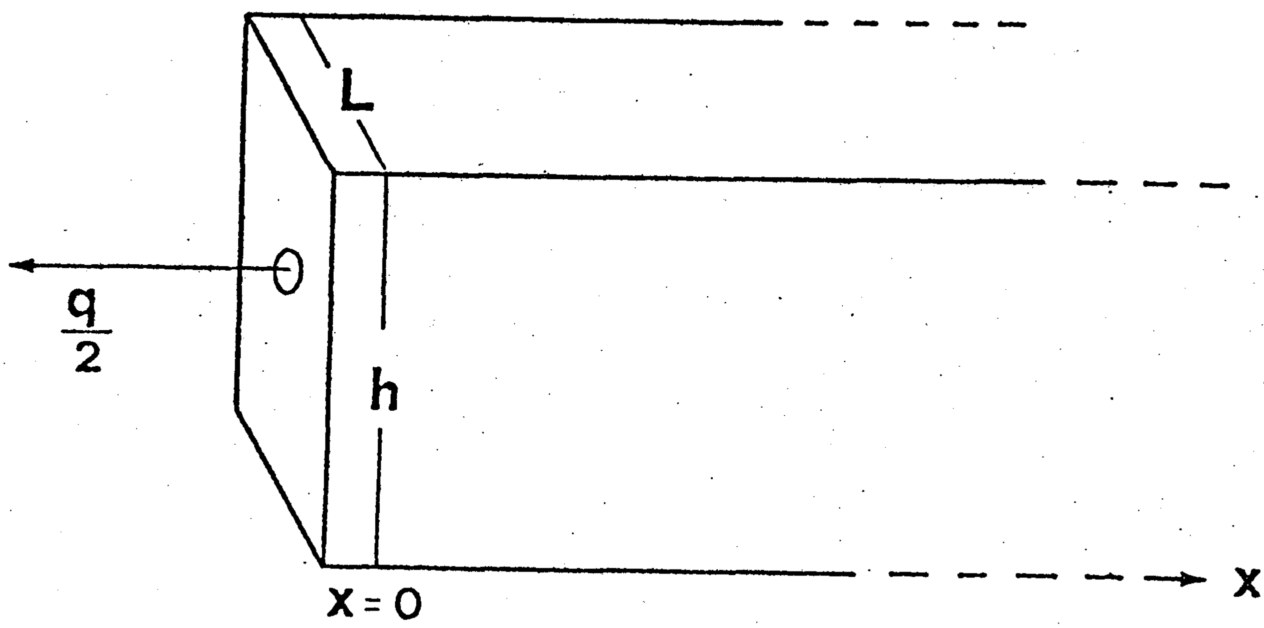

FIG. 5: LINEAR FLOW GEOMETRY (Atkinson et al.)

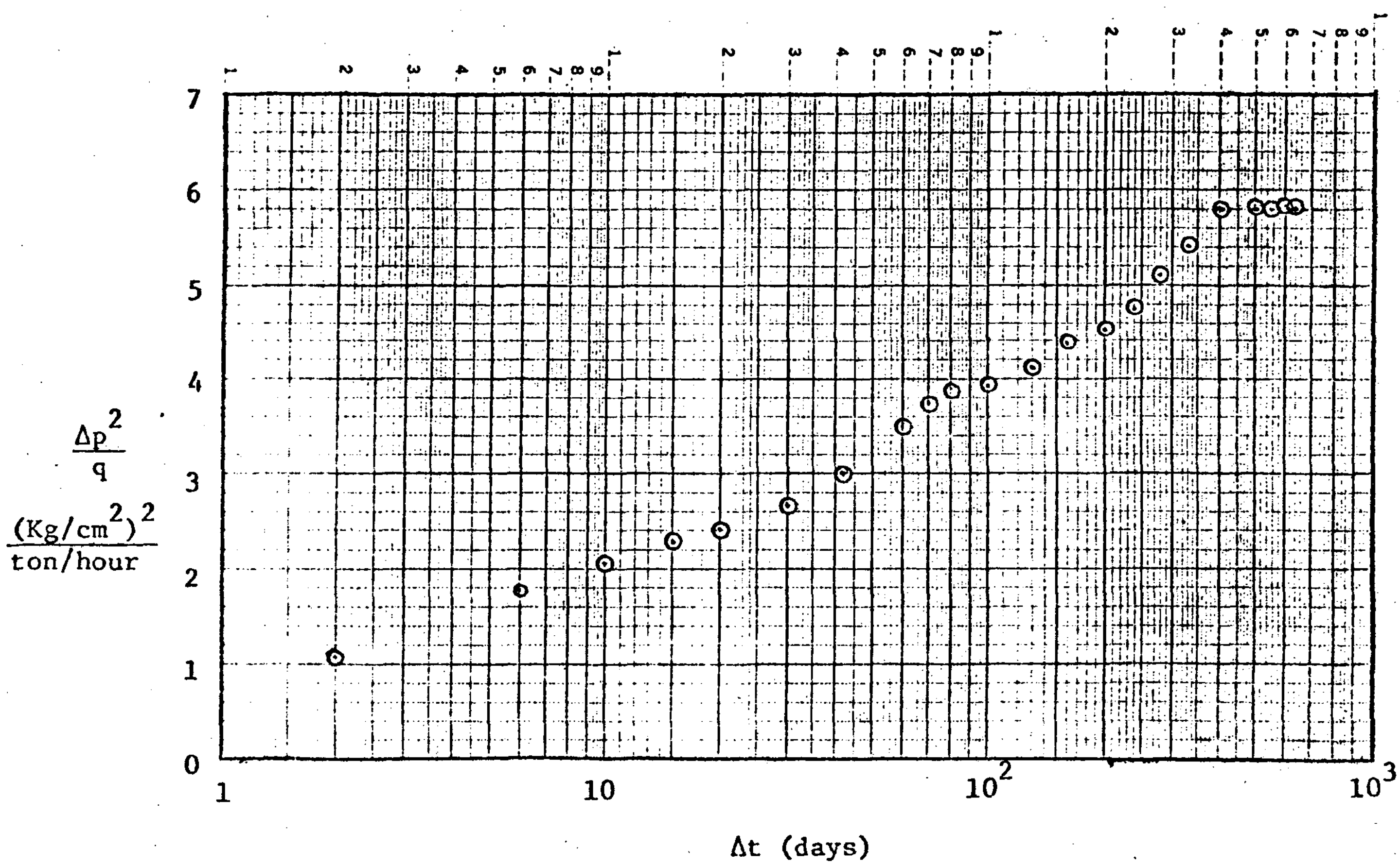

FIG. 6: SEMILOGARITHMIC PLOT FOR THE TRAVALE 22 WELL DRAWDOWN DATA

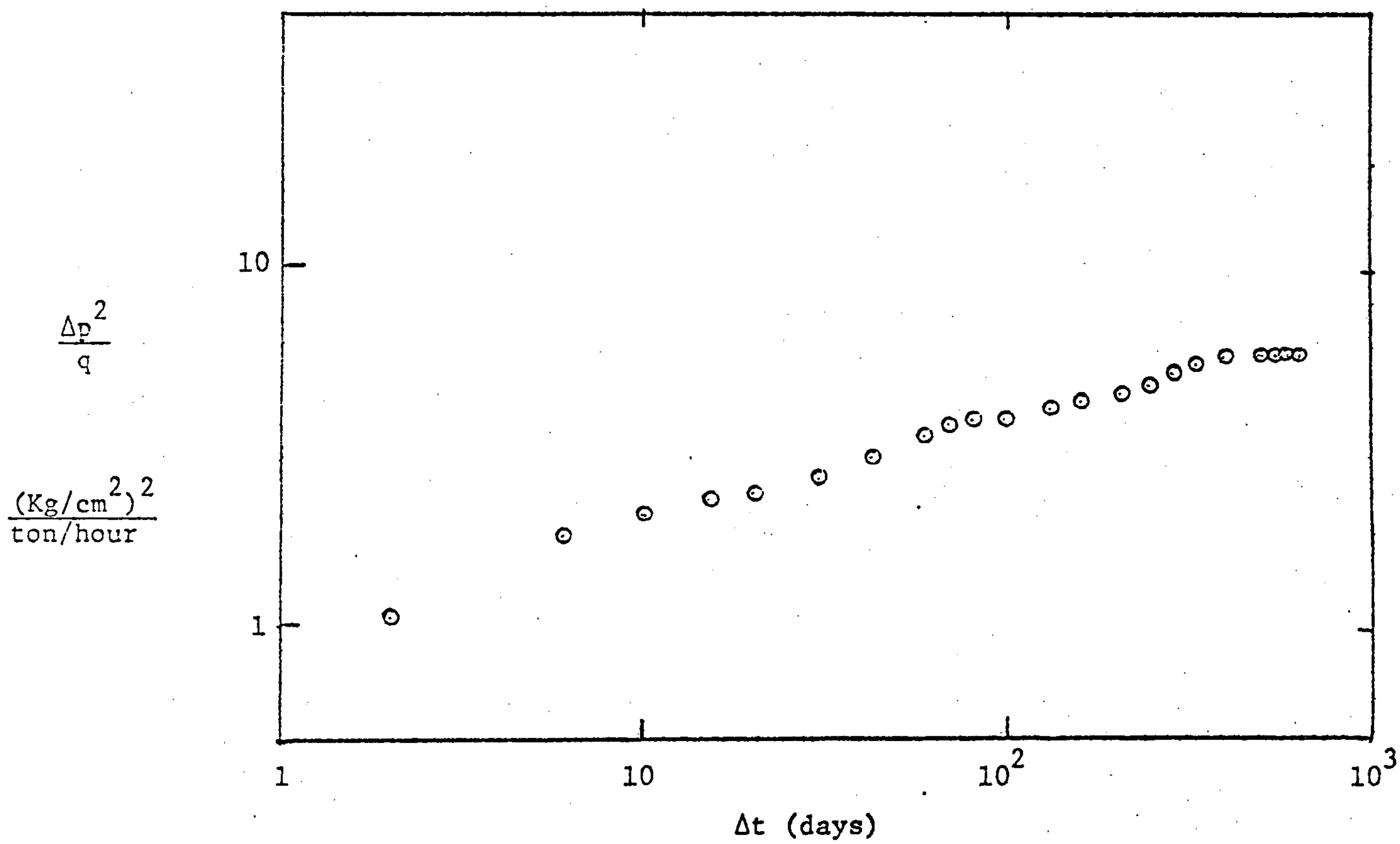

FIG. 7: LOG-LOG GRAPH OF DRAWDOWN DATA

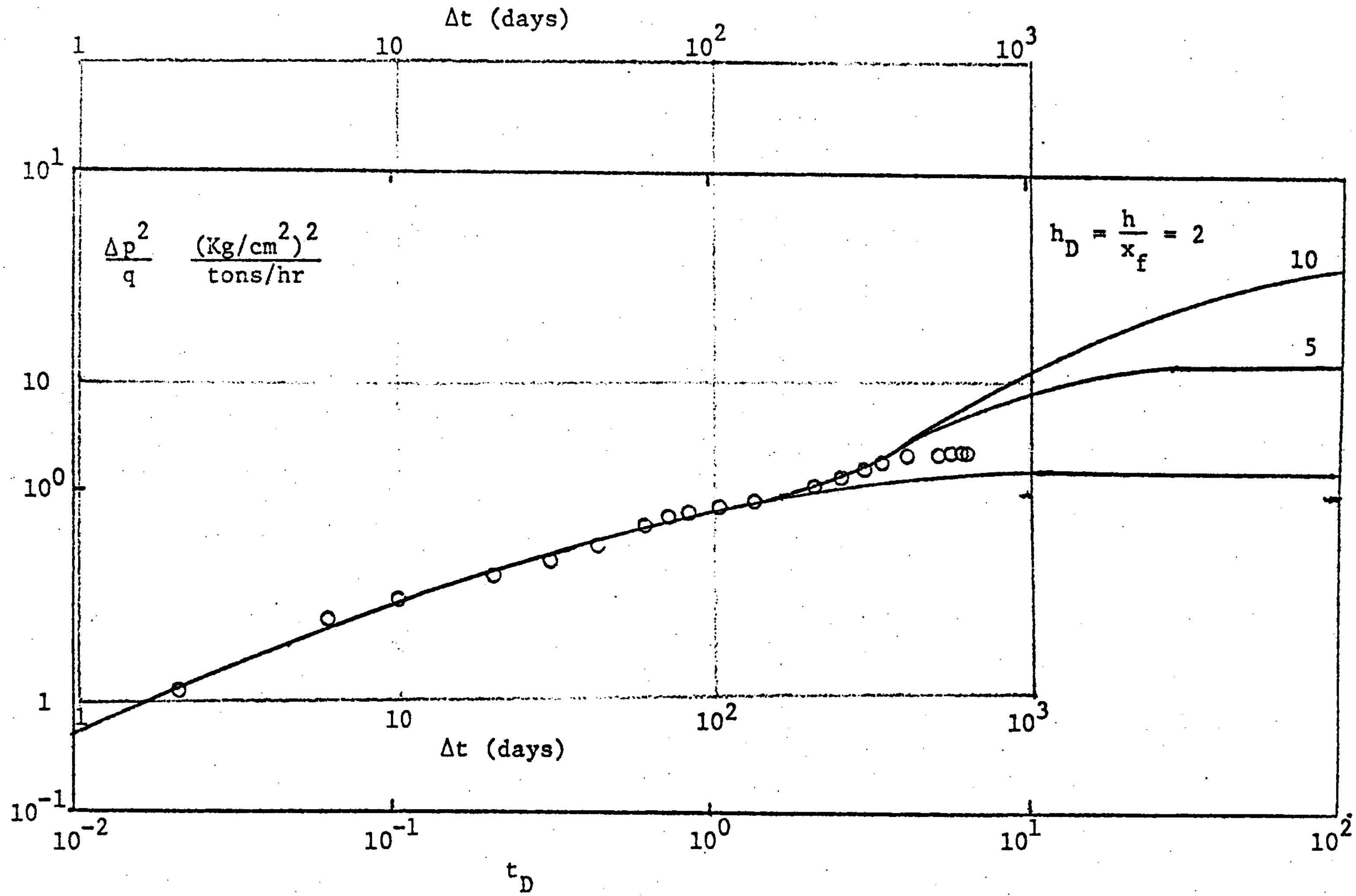

FIG. 8: TYPE-CURVE MATCHING WITH PARALLELEPIPED MODEL

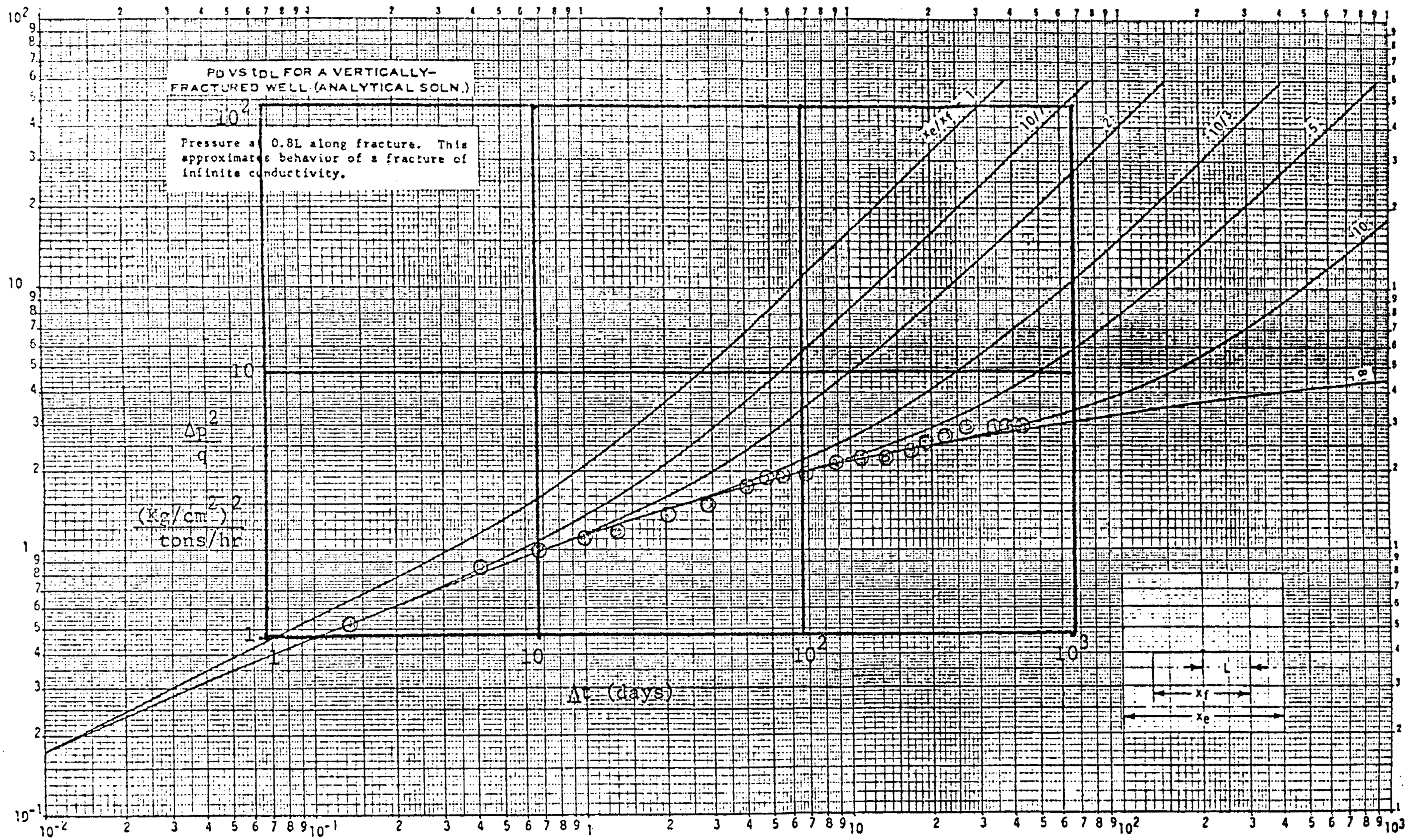

FIG. 9: TYPE-CURVE MATCH FOR THE DRAWDOWN DATA BY USING THE INFINITE CONDUCTIVITY VERTICAL FRACTURE SOLUTION