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USE OF CORE ANALYSIS TO PREDICT RESERVOIR COMPACTION

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ABSTRACT

Changes in formation thickness may be estimated by well performance calculations that depend on knowing an approximate value of the elasticity modulus for the thickness. The objective of the present study is to estimate this modulus by use of data from core analysis.

Keywords: Compaction, Deformable aquifer, Core analysis,

1. Introduction

Changes in formation thickness may lead to reduced well integrity. I believe that use of data from core analysis is the most direct way to estimate compaction when little or no production data is available.

In a companion paper, I proposed a methodology to predict compaction from the combination of a deliverability plot, $p_w(q_{sc})$, and a plot of $p_w(h_n)$, Jelmert (2015). In this study, I use data provided by Raghavan *et al*. (1972) to estimate the elastic modulus of the thickness.

2. Determination of the elastic modulus

Raghavan *et al*. (1972) obtained the following formula for the thickness, $h(p)$.

$$h(p) = h_e \frac{1-\varphi_e}{1-\varphi(p)}$$

The basic assumption is that the volume of grains remain essentially constant while the bulk volume changes.

Suppose the thickness has a constant elasticity modulus, $\xi = 1/h \cdot dh/dp$. Then: $h_n = e^{-\xi(p_e - p)}$ where $h_n = h/h_e$.

Next, the objective is to enable estimation of ξ by linear regression. To reach this end I prepare a semi-log plot: $\ln(h_n(\Delta p)) = -\xi\Delta p$. This equation will show up as a straight line with intercept 0 and slope $-\xi$. Experimental data may be fit to the equation by linear regression. The quality of the fit may be judged by the correlation coefficient, R^2.

3. Calculations performed

Raghavan *et al*. (1972) provided the porosity data given in the two left columns of Table 1. The fit of the exponential model to the experimental data is shown in Fig. 1.

Suppose the data provided by Raghavan *et al*. are representative for a formation. From Table 1, we see that $h_n = 0.979$ for $\Delta p = 2000$ psi. Then, the normalized compaction is $\Delta h_n = 1 - h_n = 0.021$. A thickness at the external boundary of 100 ft leads to a compaction at the wellbore of 2.1 ft. In the same way, the normalized compaction calculated from the regression formula is: $h_n = 0.977$. As a consequence: $\Delta h_n = 1 - h_n = 0.023$ and a compaction of 2.3 ft.

Table 1: Calculation of Normalized thickness from porosity data.

p	φ	Δp	$1-\varphi$	$h_n = \dfrac{1-\varphi_e}{1-\varphi(p)}$	$\ln(\Delta p)$
500	0,285	2000	0,715	0,97902098	-0,0092
1000	0,287	1500	0,713	0,98176718	-0,0079
1500	0,29	1000	0,71	0,98591549	-0,0061
2000	0,293	500	0,707	0,9900990	-0,0043
2500	0,300	0	0,7	1	0

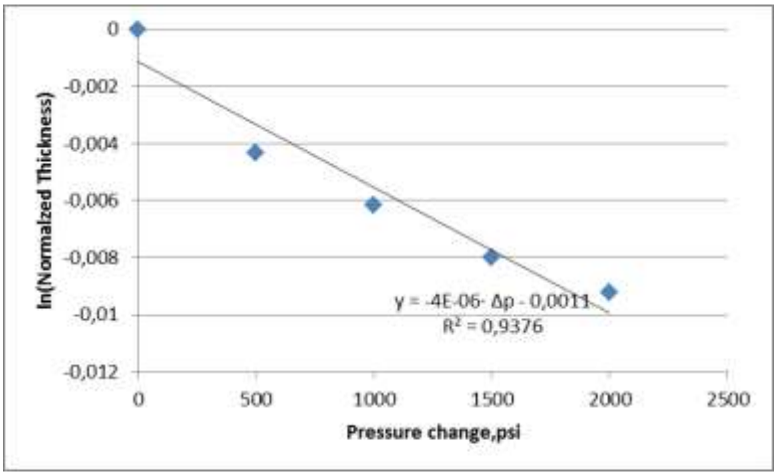

Figure 1: Core data and trendline.

4. Conclusions

The elastic modulus of thickness changes may be estimated with good accuracy for the present data set.

REFERENCES

1. Jelmert, T.A. (2015), A simplified model to predict thickness changes in a confined aquifer. Cest2015- Rhodes, Greece .
2. Raghavan, R., Scorer, J.D.T. and Miller (1972), An investigation by numerical methods of the effect of stress-sensitivity on the conductivity, porosity and permeability of sandstones. SPEJ June, 267-75, Trans AIME 253