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Research Article

# Generation of Pseudo Velocity Logs from Resistivity Logs and an Applied Example from Thrace#

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**Keywords**
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sonic log,
pseudo velocity log

**Abstract:** This study used the well-log data belonging to two wells in the Thrace region drilled by the Turkish Petroleum Company (TPAO). A scale function was created from the correlation of sonic and resistivity logs in only one of these wells and the non-linear equation it defined was obtained to derive a pseudo velocity log. With the aid of this equation, a pseudo velocity log was derived for the second well drilled in the area using only resistivity log values. Additionally the % error values were calculated for both wells and the similarities between them investigated.
The true sonic logs and derived pseudo velocity logs from both wells were compared in the study. For both wells, the logs were observed to be similar. This study reveals that for any area with the aid of the non-linear equation based on the correlation between sonic and resistivity logs taken from one well, pseudo velocity logs can be derived using only resistivity log values for other wells in the region without requiring new sonic log measurements.

## 1. Introduction

It is possible to determine seismic velocity and resistivity from some physical parameters linked to the lithology of rocks. The most important common parameters in seismic velocity and resistivity variations are determined to be density and porosity and the correlation between them has been shown with a variety of equations [1-11]. In addition to seismic velocity and resistivity, the common equation for formation factor and porosity has been determined [1, 12, 13]. [9, 14] used the common "scale function" obtained by certain field studies related to the correlation between resistivity and sonic velocity to reveal a non-linear experimental equation. Using the relationships found by these researchers pseudo velocity logs were derived from resistivity log values in the field.

This study used the resistivity and sonic log values from only one well in a field with many wells drilled to obtain a scale function. The non-linear equation defined by this function was found. By applying this equation to only resistivity log values from other wells in the field, pseudo velocity logs were derived and drawn.

## 2. Material and Method

The details of the methodology and theoretical approaches followed in this study are based on the work he has done in Rudman (1982) [9].

Moving from the correlation of resistivity and seismic velocity, [7] adapted the generalized relationship [$TT' = A+(B)\ R_a^{-1/C}$] of Kim's (1964) scale function. Here TT′=pseudo-velocity log, $R_a$=apparent resistivity and A, B, C are coefficients. Obtaining the scale function from the resistivity (R=Ohm-m) and sonic (TT= μs/ft) log values for each data point read in a defined equal depth interval is schematically shown in Figure 1.

### 2.1 Research Findigs

This study used the resistivity and sonic logs from wells K-1 (Keşan) and P-1 (İpsala) drilled nearly 14 km apart by TPAO in the Thrace region of Turkey in 1995.

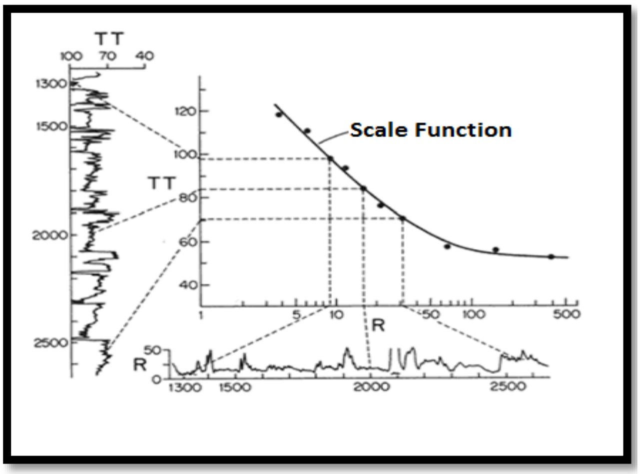


***Figure 1**: Sketch illustrating generation of scale function curve. Resistivity R(Ohm-m) and Transit-Time TT(µs/ft) or Sonic Logs from specific depth interval form a pair of values for each data point {Modified from [6]; [9]}.*

From the 2405-3340 meter interval of K-1 well, a scale function with semi-logarithmic resistivity (R) on the horizontal axis and sonic (TT) on the vertical axis was obtained from normalized digital resistivity and sonic log values (Figure 2).
Considering the area covered by this scale function in accordance with [9]'s technique,

$R_{min}$ =$R_1$ =5 Ohm-m and $R_{max}$=$R_3$ =2500 Ohm-m and **Q**=$(R_3/R_1)^{1/2}$ =22.36, $R_2$=Q.$R_1$=118.8 Ohm-m. On Figure 2 the values equivalent to $R_1$, $R_2$ and $R_3$ values of $TT_1$=80 µs/ft, $TT_2$=55.5 µs/ft and $TT_3$=54 s/ft were used in the general equation ;

$$TT'_i=A+(B).R_i^{-1/C} \qquad (1)$$

to find the C, B and A coefficients of

**C**= $\{\log_{10} Q/ \log_{10} [TT'_1-TT'_2 / TT'_2-TT'_3]\}$=1.11;
**B**=$(TT'_1-TT'_2).R_1^{1/C}$=104.44; and
**A**=$TT'_1-(B)/R_1^{-1/C}$=55.5.
In conclusion the scale function equation for K-1 well was found to be

$$\mathbf{TT'_i=55.5+(104.44).R_i^{-1/1.11}}.$$

By inserting all resistivity ($R_i$) values from K-1 well into the equation, pseudo velocity log ($TT'_i$) values were obtained. Finally the resistivity, true sonic log (TT) and pseudo velocity log (TT´) of K-1 well were drawn side-by-side (Figure 3).
The resistivity log values from the 1450-2100 meter interval of P-1 well, 14 km away from K-1, were inserted in the scale function from K-1 well and the pseudo velocity log for P-1 was obtained. The R, TT and TT´ logs are shown together in Figure 4. The measure of the similarity between the pseudo velocity logs and true sonic logs obtained for K-1 and P-1 wells was found using the % error ratio equation of

$$\%\text{Error Ratio}=(TT-TT'/TT)\text{x}100 \qquad (2)$$

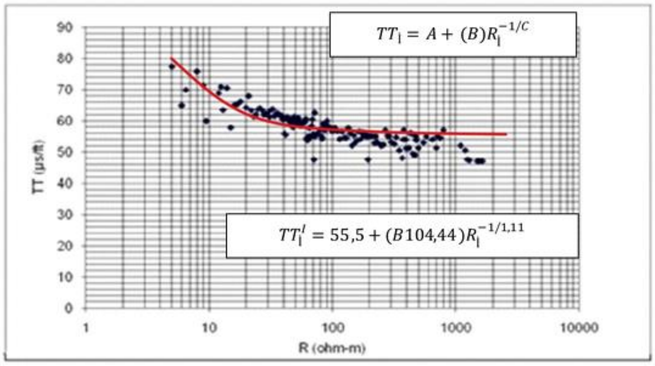


***Figure 2:** Plot of data point and scale function curve for K-1 well. Curve was fitted to data points by eye*

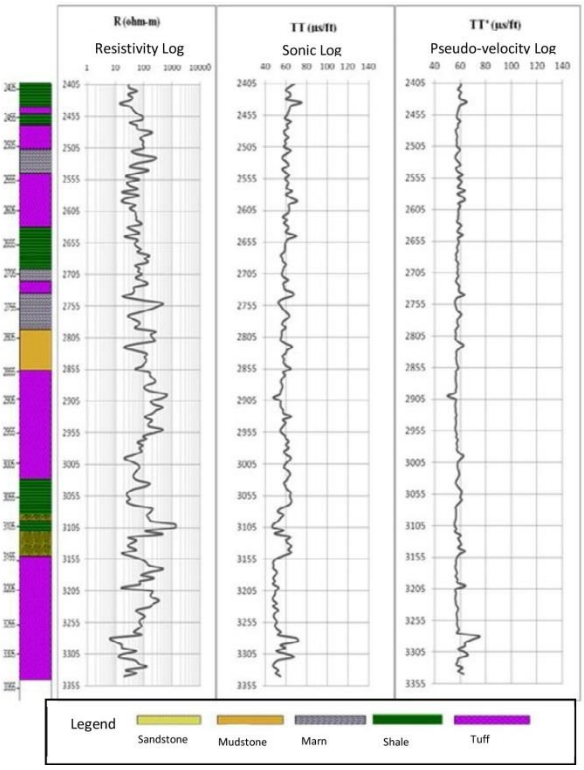


***Figure 3.** Graph of True Sonic Log (TT) and Pseudo-Velocity Log (TT´) for K-1 Well.*

## 3. Conclusions

The pseudo velocity logs (TT´) obtained for K-1 and P-1 wells were compared with true sonic logs (TT) and both logs had a high rate of similarity. The % error rate of the similarity between the two logs was calculated and was

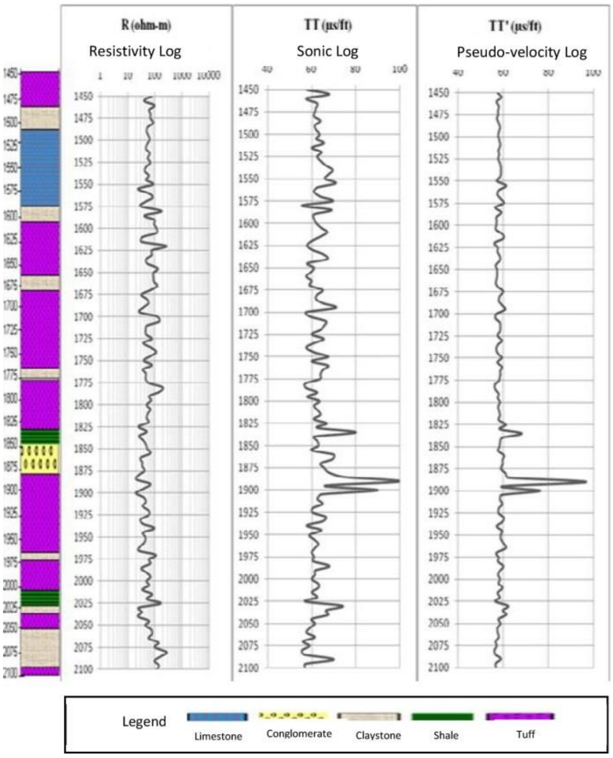


***Figure 4.*** *Graph of True Sonic Log (TT) and Pseudo-Velocity Log (TT′) for P-1 Well.*

found to have a mean of $\pm$15. Though the data intervals used in the two wells were not at the same depth, it is important that there appeared to be no great deviation in the % error rates between the TT and TT′ logs in each well. This situation indicates that if data was evaluated from the same depth, a lower % error rate may be obtained.

This study technique allows the possibility of deriving reliable pseudo sonic logs from only resistivity logs without obtaining sonic logs in a broad field area with tens of wells drilled. In conclusion, it is clear that this study will ensure great convenience and economic gains for petroleum and underground structural research in any region.

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