



# Eaton Exponent Sensitivity in Sonic and Resistivity Log-Based Pore Pressure Prediction: Supporting Sustainable Energy Exploration in South Sembakung Field, Indonesia

Lucky Rinaldy<sup>1\*</sup>, Abdul Haris<sup>2</sup>

<sup>1</sup> Master Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok, Indonesia.

<sup>2</sup> Department of Physics, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Indonesia, Depok, Indonesia.

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Corresponding Author:

Lucky Rinaldy

[luckyriena@gmail.com](mailto:luckyriena@gmail.com)

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**Abstract:** Accurate pore pressure prediction is critical for safe drilling operations during early exploration when direct measurements are limited. The Eaton method is widely applied, yet the exponent ( $n$ ) is treated as a fixed constant without sensitivity evaluation under normal pore pressure regimes. This study quantifies the effect of exponent variation using sonic and resistivity logs from Well X, South Sembakung Field, Tarakan Basin. Normal Compaction Trends (NCTs) were constructed from shale intervals ( $GR \geq 75$  API). NCT quality differs substantially between log types with  $R^2 = 0.79$  for sonic versus  $R^2 = 0.076$  for resistivity, causing residual deviations amplified nonlinearly by  $n$ , making exponent selection consequential even under normal pressure. Systematic variation ( $n = 2.50$ – $3.50$  for sonic;  $n = 1.00$ – $2.00$  for resistivity) was validated against three DST measurements using Mean Absolute Error (MAE). Sonic predictions yielded MAE of 309.89–402.40 psi, outperforming resistivity predictions (584.50–995.85 psi), reflecting superior NCT stability. Resistivity errors reflect petrophysical heterogeneity including formation water salinity and clay mineral content. Lower  $n$  values mechanically converge predictions toward the hydrostatic baseline as a mathematical consequence of the Eaton formulation. The Eaton exponent must therefore be treated as a site-specific calibration parameter, not a universal constant.

**Keywords:** Eaton method; Exponent sensitivity; Normal pressure regime; Pore pressure prediction; Resistivity log; Sonic log

## Introduction

Accurate pore pressure prediction is critical for safe and efficient drilling operations, wellbore stability analysis, and geomechanical evaluations. In the early stages of exploration, where direct pressure measurements such as Repeat Formation Tester (RFT) or Drill Stem Test (DST) are sparse or unavailable, indirect methods based on well logs become the primary tools for estimating formation pore pressure. The theoretical foundation of pore pressure prediction rests on the principle of effective stress, whereby pore pressure is the difference between total stress and the stress carried by the rock framework (Terzaghi, 1943). Overpressure

mechanisms including disequilibrium compaction and fluid expansion have been documented across many sedimentary basins (Osborne & Swarbrick, 1998), making reliable prediction methods essential for drilling safety. Among these methods, the Eaton equation (Eaton, 1975) remains one of the most widely used empirical approaches due to its simplicity and practicality in utilizing conventional well-log data, particularly sonic transit time and resistivity logs.

The Eaton method is based on the Normal Compaction Trend (NCT), which describes the expected compaction behavior of shale under hydrostatic pressure conditions. Deviations from this trend are translated into pore pressure estimates using an

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exponent ( $n$ ) that controls the sensitivity of the model. Despite its popularity, the Eaton exponent is frequently assigned a default constant value (commonly  $n = 3$  for sonic and  $n = 1.20$ – $1.50$  for resistivity) without thorough calibration or sensitivity assessment. This practice is particularly problematic in normal pore pressure regimes, where formation pressures are close to hydrostatic and deviations from the NCT are typically subtle. In such conditions, small changes in the exponent can significantly influence the predicted pressure profile, yet this sensitivity is rarely examined systematically.

Most previous studies have focused on overpressured basins where pressure anomalies are pronounced. Consequently, limited attention has been given to the performance and behavior of the Eaton method under normal (hydrostatic) pressure regimes, where subtle deviations make the choice of exponent particularly critical. Furthermore, comparative sensitivity analyses between sonic and resistivity logs within the same well and geological setting remain scarce. Understanding these sensitivities is important because sonic and resistivity logs respond differently to changes in porosity, fluid content, and effective stress, which may lead to contrasting prediction behaviors even within identical formations. Studies comparing sonic and resistivity log performance for pore pressure prediction have demonstrated that sonic-based models generally yield more stable results in heterogeneous clastic formations, while resistivity responses are more sensitive to fluid salinity and clay content variations (Moghadam & Jahanbakhshi, 2022; Avasthi et al., 2022).

This study addresses these gaps through a detailed single-well sensitivity analysis in a normal pressure environment. The primary objectives are to quantify the impact of Eaton exponent variation on pore pressure prediction accuracy using sonic and resistivity logs, to compare the performance and sensitivity of both log types, and to provide recommendations for optimal exponent selection when the Eaton method is used as a baseline in normal pressure regimes.

## Method

### *Data and Study Area*

This study applies a well-based quantitative approach using log data from Well X, South Sembakung Field, Tarakan Basin, North Kalimantan, Indonesia. The dataset comprises Gamma Ray (GR), Sonic transit time (DT), Deep Resistivity (RIPD), and Bulk Density (RHOB) logs acquired over a total depth of approximately 8,500 ft at a sampling interval of 0.25 ft. Three Drill Stem Test (DST) measurements at 6,957 ft (2,980 psi), 7,340 ft (3,200 psi), and 7,620 ft (3,400 psi) served as reference pressure data for quantitative model validation. The South

Sembakung Field is an onshore field; therefore, no offshore air gap or water column correction was required. The overall research workflow is summarized in Figure 1.

### *Log Quality Control*

Quality control was performed in two stages. First, invalid log values flagged as  $-999.25$  were removed from all log curves. Second, a rolling median filter with a five-sample window was applied to each log for spike reduction only. This narrow window, equivalent to 1.25 ft at the 0.25 ft sampling interval, was intentionally selected for quality control purposes to eliminate localized acquisition artifacts while preserving the regional compaction signal. This QC filter was applied to raw log data only and was not used for Normal Compaction Trend construction, which followed a separate procedure described below. Log curve identification and quality assessment followed standard petrophysical interpretation protocols (Asquith & Krygowski, 2004; Rider & Kennedy, 2011).

### *Shale Identification*

Shale intervals were identified using a Gamma Ray cutoff of  $GR \geq 75$  API. This threshold falls within the commonly used industry range of 65–80 API for clastic sequences and is consistent with the lithological characteristics of the Tarakan Basin deltaic formation (O'Connor et al., 2023). Core descriptions from the South Sembakung Field indicate that the primary GR response in the analyzed interval is attributable to clay mineral content rather than detrital radioactive minerals such as K-feldspar or glauconite. No baseline correction was applied to the GR log as the well was drilled with water-based mud and borehole conditions were stable throughout the logged interval. A total of 19,052 data points were classified as shale from 33,624 total samples, representing 56.70% of the analyzed interval. Only shale intervals were used for NCT construction, following the theoretical requirement that the Eaton method is most applicable to mechanically compacting shale formations. The relationship between mechanical compaction and porosity reduction in shale sequences, which forms the basis for NCT construction, has been established in compaction and fluid migration studies (Magara, 1978).

### *Overburden Stress*

Vertical overburden stress ( $S_v$ ) was calculated by integrating bulk density log (RHOB) from surface to the depth of interest. For the shallow interval above the top of the RHOB log, a constant bulk density of  $1.8 \text{ g/cm}^3$  was assumed to represent near-surface unconsolidated sediment, consistent with common practice in overburden stress estimation for onshore wells in deltaic

sequences (Bourgoyne et al., 1991; Zhang, 2011; Bjørlykke, 2015).

$$S_v = \int_0^z \rho_b(z) \cdot g dz \tag{1}$$

where  $\rho_b$  is bulk density ( $g/cm^3$ ),  $g$  is gravitational acceleration, and  $z$  is depth. For the interval above the top of the RHOB log where density data are unavailable, typically the surface casing section, a surface bulk density of  $1.80 g/cm^3$  was assumed and increased linearly to the first valid log measurement, following the approach of Nelson & Miller (1992) for shallow unconsolidated sediment intervals. This interpolation ensures a physically consistent overburden profile from surface to total depth.

*Hydrostatic Pressure Calculation*

Hydrostatic pressure ( $P_h$ ) was calculated using a constant gradient as expressed in Equation 2.

$$P_h = 0.444 \times z \tag{2}$$

where  $z$  is depth in feet. The gradient of 0.444 psi/ft was selected to represent the moderately saline formation water characteristic of the Tarakan Basin, consistent with regional drilling reports from the South Sembakung Field confirming normal pressure gradients within the range of 0.433–0.465 psi/ft, and validated by DST measurements indicating near-hydrostatic formation pressures throughout the study interval. This drilling campaign was conducted onshore.

*Normal Compaction Trend (NCT) Construction*

Separate NCTs were constructed for sonic and resistivity logs using the identified shale intervals. For the sonic log, NCT was defined by linear regression of transit time ( $\Delta t$ ) against true vertical depth, yielding the equation  $\Delta t_{NCT} = 131.06 - 0.00658 \times Z$  with a coefficient of determination  $R^2 = 0.79$ . This strong fit confirms that sonic transit time in the study area is primarily controlled by mechanical compaction, consistent with effective stress theory and basin subsidence compaction models (Sclater & Christie, 1980; Bowers, 1995).

For the resistivity log, a global logarithmic regression on shale intervals yielded an extremely low  $R^2 = 0.076$ , reflecting the inherent characteristic of resistivity in this formation, which is simultaneously controlled by formation water salinity, pore connectivity, clay mineral content, and temperature gradients in addition to mechanical compaction (O'Connor et al., 2023; Shabangu et al., 2025). The coefficient of variation of resistivity data reached 32%, compared to only 16% for sonic data, further confirming the high heterogeneity of resistivity responses in the Tarakan Basin deltaic system. The petrophysical complexity of resistivity responses in deltaic shales

reflects the multi-parameter nature of rock-fluid interactions that extend beyond simple compaction mechanics (Fjaer et al., 2008). Given the inadequacy of global regression, the NCT for resistivity was instead constructed using an adaptive rolling median applied exclusively to shale-identified data points. Rather than a fixed window size, the window was adjusted locally to capture the regional compaction trend while preserving sensitivity to depth-dependent resistivity variations in the heterogeneous deltaic sequence. This approach produced a correlation of 0.776 with the actual compaction trend, significantly outperforming all global regression methods tested, and is consistent with practice reported by O'Connor et al. (2023) and Shabangu et al. (2025) in similar deltaic formations.

*Eaton Pore Pressure Prediction*

Pore pressure was estimated using Eaton’s method separately for sonic and resistivity logs.

For Sonic:

$$P_p = S_v - (S_v - P_h) \left( \frac{DT_{obs}}{DT_{NCT}} \right)^n \tag{3}$$

For resistivity log:

$$P_p = S_v - (S_v - P_h) \left( \frac{R_{obs}}{R_{NCT}} \right)^n \tag{4}$$

Where

$P_p$  = predicted pore pressure

$S_v$  = vertical stress

$P_h$  = hydrostatic pressure

( $DT_{obs}$  and  $R_{obs}$  = observed log values

$DT_{NCT}$  and  $R_{NCT}$  = NCT values

$n$  = Eaton exponent

In Equation 3, an observed transit time greater than the NCT value indicates under-compaction relative to normal conditions, yielding a ratio greater than 1.0 and a predicted pore pressure above hydrostatic. In Equation 4, overpressure reduces observed resistivity below the NCT value, yielding a ratio less than 1.0. When raised to the power  $n$  and multiplied by the effective stress differential ( $S_v - P_h$ ), this produces a smaller subtracted term, resulting in a correctly elevated predicted pore pressure consistent with the physics of overpressure detection (Eaton, 1975).

*Exponent Sensitivity Design*

The Eaton exponent  $n$  was treated as a tunable sensitivity parameter rather than a fixed constant. For the sonic log,  $n$  was systematically varied among 2.50, 3.00, and 3.50, bracketing the commonly cited reference value of  $n = 3.00$  (Eaton, 1975). For the resistivity log,  $n$  was varied among 1.00, 1.20, 1.50, and 2.00. The lower boundary of  $n = 1.00$  for resistivity, while below the

commonly cited standard value of  $n = 1.20$  (Eaton, 1975), was included based on the empirical evidence from this dataset. The inherently low NCT quality of the resistivity log ( $R^2 = 0.076$ ,  $CoV = 32\%$ ) in this heterogeneous deltaic formation means that higher exponent values disproportionately amplify NCT construction uncertainty rather than genuine subsurface pressure signals. Under these conditions,  $n = 1.00$  represents the practical lower sensitivity boundary for this dataset rather than a geological exception to compaction theory. This interpretation is supported by the finding that 92.4% of resistivity variability within the shale intervals cannot be explained by depth alone, indicating that the log response is dominated by petrophysical factors including formation water salinity and clay mineral conductivity rather than mechanical compaction alone. The inclusion of  $n = 1.00$  therefore serves to bracket the full sensitivity range observable

under the NCT quality constraints of this formation, consistent with the sensitivity analysis framework recommended by Asfha et al. (2024).

*Statistical Validation Against DST*

Model performance was evaluated against DST reference measurements using Mean Absolute Error as expressed in Equation 5.

Mean Absolute Error (MAE):

$$MAE = \frac{1}{N} \sum P_{pred} - P_{DST} \tag{5}$$

where  $N$  is the number of DST reference points ( $N = 3$ ),  $P_{pred}$  is the predicted pore pressure at each DST depth, and  $P_{DST}$  is the measured formation pressure. Pressure deviation was also calculated at each DST depth to assess systematic bias in prediction direction.

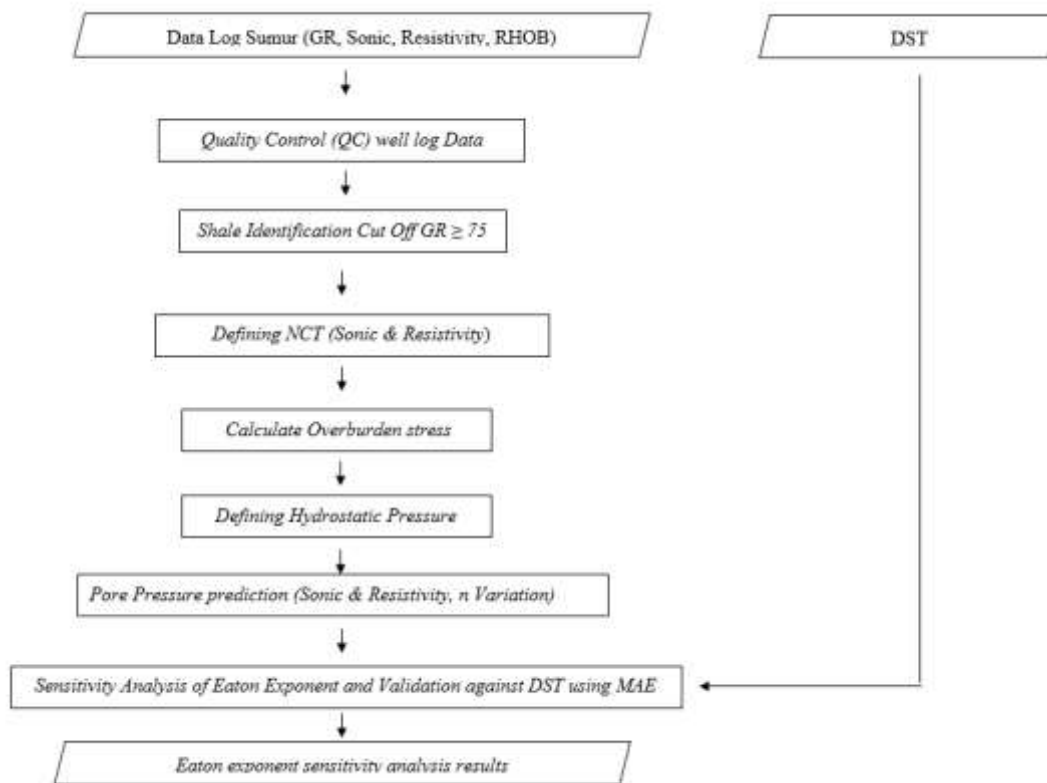


Figure 1. Research procedure

**Result and Discussion**

*Normal Compaction Trend Behavior*

Independent Normal Compaction Trends (NCTs) were established separately for the sonic transit time ( $\Delta t$ ) and deep resistivity ( $R_t$ ) logs using data from shale intervals ( $GR \geq 75$  API). For the sonic log at figure 2, linear regression of transit time against true vertical depth yielded a coefficient of determination of  $R^2 = 0.79$ ,

confirming that sonic transit time in the study area is primarily governed by mechanical compaction and effective stress. This strong fit indicates that the sonic NCT is a reliable reference baseline for the Eaton formulation in this formation.

For the resistivity log shown at figure 3, the global logarithmic regression yielded  $R^2 = 0.076$ , substantially lower than the sonic log. The coefficient of variation of resistivity data reached 32%, compared to only 16% for

sonic data. This disparity reflects the inherent characteristic of resistivity in heterogeneous deltaic formations, where the log response is simultaneously controlled by formation water salinity, pore connectivity, clay mineral content, and temperature gradients in addition to mechanical compaction (O'Connor et al., 2023; Shabangu et al., 2025). Consequently, the adaptive rolling median approach was adopted for resistivity NCT construction, producing a correlation of 0.776 with the actual compaction trend and significantly outperforming global regression. The fundamental difference in NCT quality between the two log types, with  $R^2 = 0.79$  for sonic and  $R^2 = 0.076$  for resistivity, is the primary factor controlling the contrasting prediction accuracies observed in the subsequent sensitivity analysis.

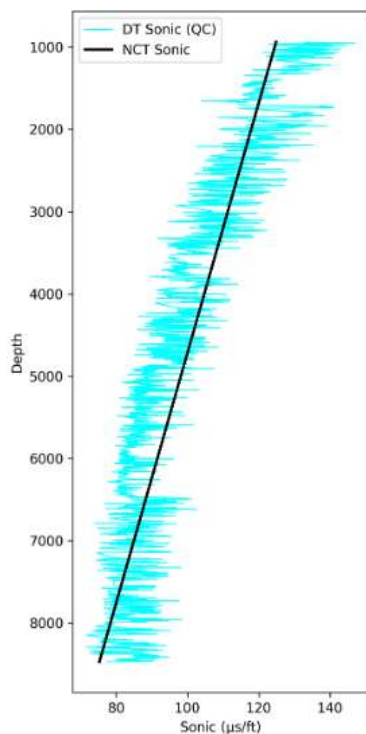


Figure 2. NCT sonic

*Sensitivity Analysis – Sonic Log*

Pore pressure predictions using the sonic log were generated by systematically varying the Eaton exponent among  $n = 2.50, 3.00,$  and  $3.50$ . Figure 4 presents the predicted pore pressure profiles for each exponent value together with the DST reference measurements.

The results indicate relatively stable prediction behavior across the tested exponent range, with MAE values of 309.89 psi at  $n = 2.50,$  356.61 psi at  $n = 3.00,$  and 402.40 psi at  $n = 3.50$ . The monotonic increase in MAE with increasing  $n$  reflects the nonlinear amplification of residual log-to-NCT deviations, which arise from lithological heterogeneity rather than true pressure anomalies. An important interpretive distinction must

be made here: the lower MAE at  $n = 2.50$  does not indicate superior physical accuracy. Rather, it reflects a mathematical convergence toward the hydrostatic baseline. As  $n$  decreases, the term  $(\Delta_t NCT / \Delta_t Obs)^n$  approaches 1.0 more rapidly for any ratio close to unity, causing the predicted pore pressure to approach the hydrostatic gradient. Since DST measurements confirm near-hydrostatic conditions, this convergence mechanically produces lower numerical errors without capturing genuine subsurface pressure dynamics. For this reason,  $n = 3.50$  is considered the most geophysically representative exponent for the sonic log in this study, as it provides greater sensitivity to subsurface variations while remaining consistent with the theoretical basis of the Eaton formulation for sonic logs. This interpretation aligns with sensitivity analyses showing that higher exponent values better capture genuine compaction deviations in well-constrained NCT environments (Ehsan et al., 2024; Gholami & Soltani, 2021; Zhang et al., 2021; Eaton, 1975).

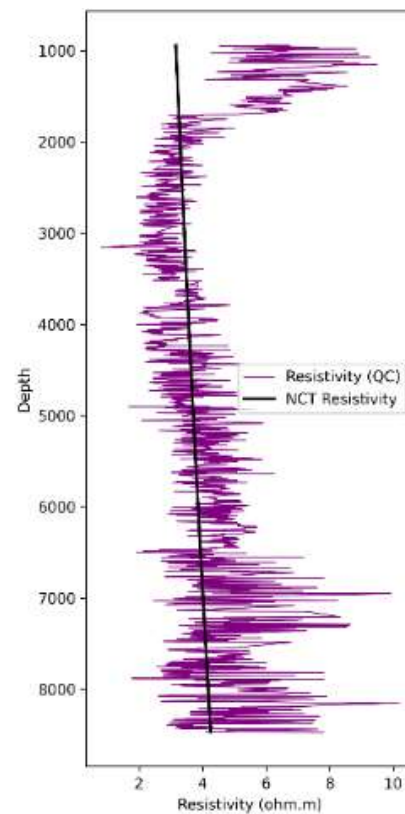


Figure 3. NCT resistivity

*Sensitivity Analysis – Resistivity Log*

For the resistivity log, the Eaton exponent was varied among  $n = 1.00, 1.20, 1.50,$  and  $2.00$ . In contrast to the sonic log, the resistivity-based model exhibited substantially higher sensitivity to exponent variation, with MAE values of 584.50 psi at  $n = 1.00,$  675.57 psi at  $n = 1.20,$  803.56 psi at  $n = 1.50,$  and 995.85 psi at  $n = 2.00$ .

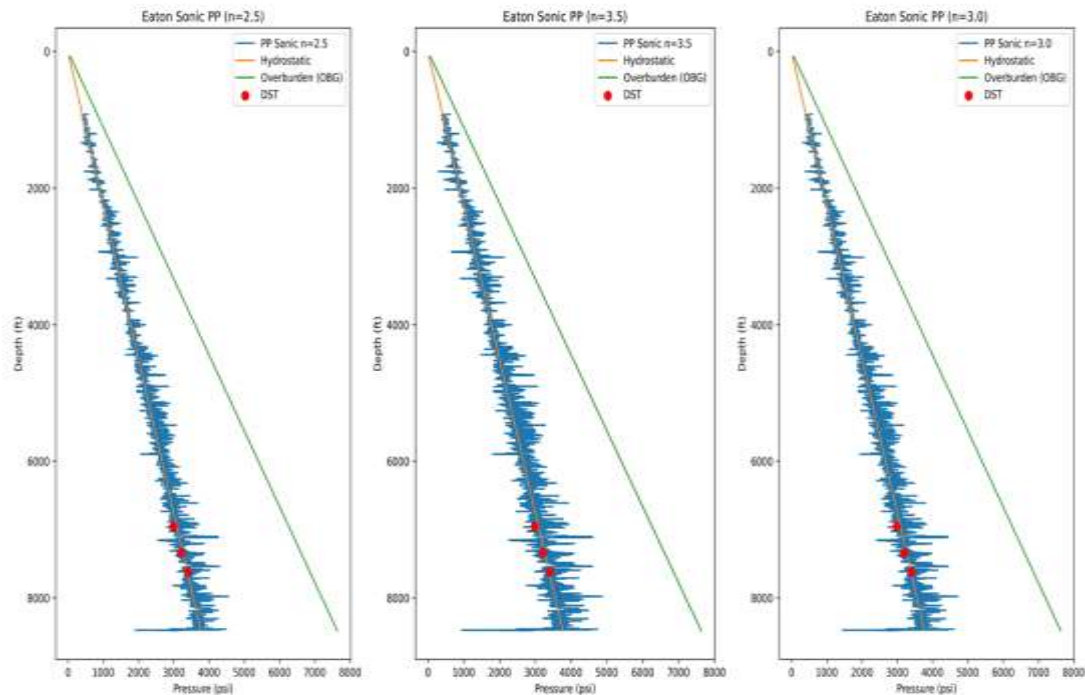


Figure 4. Eaton pore pressure sensitivity sonic

The substantially higher MAE values of resistivity-based predictions compared to sonic-based predictions reflect three compounding factors specific to the Tarakan Basin deltaic formation. First, the NCT quality differs fundamentally between log types:  $R^2 = 0.79$  for sonic versus  $R^2 = 0.076$  for resistivity, meaning that 92.40% of resistivity variability within shale intervals cannot be explained by depth alone. Second, the coefficient of variation of resistivity data (32%) is twice that of sonic (16%), confirming inherently higher data

heterogeneity. Third, formation water salinity, clay mineral conductivity, and pore geometry simultaneously influence the resistivity response independently of pore pressure (O'Connor et al., 2023; Shabangu et al., 2025). These three factors collectively explain why resistivity-based predictions are structurally less accurate than sonic-based predictions in this geological setting, independently of exponent selection.

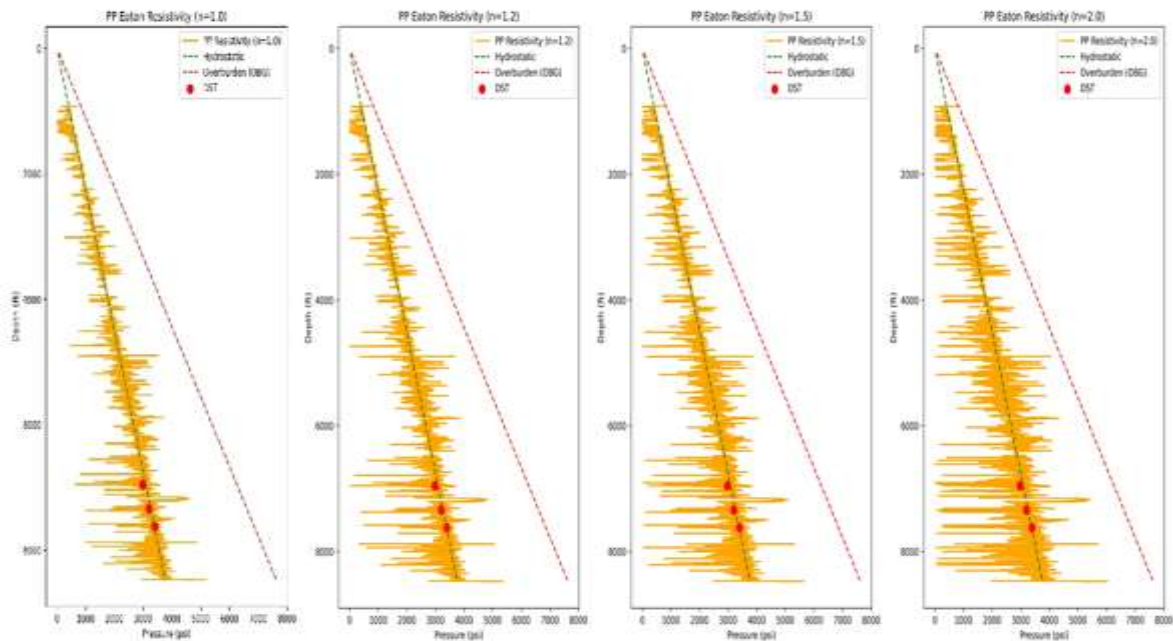


Figure 5. Eaton pore pressure sensitivity resistivity

The lowest within-group MAE was achieved at  $n = 1.00$  (584.50 psi). While this value is below the commonly cited standard of  $n = 1.20$  (Eaton, 1975), it represents the practical lower sensitivity boundary for this dataset given the inherently unstable NCT quality. Higher exponent values disproportionately amplify NCT construction uncertainty rather than genuine pressure signals under these conditions, making  $n = 1.00$  the methodologically appropriate lower boundary for this formation.

*Comparative Performance and Hydrostatic Bias*

Table 1 summarizes the MAE values for all tested exponents. Sonic-based predictions consistently yielded lower absolute errors of 309.89–402.40 psi than resistivity-based predictions of 584.50–995.85 psi, reflecting the superior NCT stability of the sonic log. The reliability of sonic transit time as a compaction indicator is further supported by its relatively low sensitivity to formation anisotropy in mechanically compacting shale sequences (Sayers, 2013), in contrast to resistivity which integrates fluid and mineralogical effects simultaneously. In practical drilling terms, the sonic MAE range of 309.89–402.40 psi corresponds to equivalent mud weight uncertainties of approximately 0.60–0.80 ppg at the DST depths, which falls within acceptable margins for normal pressure prediction in exploration contexts (Bourgoyne et al., 1991).

**Table 1.** Mean Absolute Error (MAE) of eaton-based pore pressure prediction using DST measurements

Method	Eaton Exponent (n)	MAE (psi)
Sonic	2.50	309.89
Sonic	3.00	356.61
Sonic	3.50	402.40
Resistivity	1.00	584.50
Resistivity	1.20	675.57
Resistivity	1.50	803.56
Resistivity	2.00	995.85

A systematic hydrostatic bias is inherent in the Eaton formulation under normal pressure conditions. As  $n$  decreases, the term  $(\text{ratio})^n$  converges toward 1.0 regardless of the actual log-to-NCT ratio, causing the predicted pore pressure to approach the hydrostatic baseline. This is a mathematical consequence of the formulation rather than an independent geophysical observation. The methodological implication, however, is significant: in normal pressure environments where DST measurements confirm near-hydrostatic conditions, a lower  $n$  will mechanically yield lower MAE values without necessarily providing a more physically accurate representation of subsurface pressure dynamics. This renders MAE minimization an insufficient criterion for exponent selection in normal

pressure regimes, and advocates instead for an integrated evaluation combining quantitative error assessment with geophysical sensitivity analysis (Asfha et al., 2024; Zhang, 2011).

*Implications for Eaton Method Application*

Default exponents of  $n = 3.00$  for sonic and  $n = 1.50$  for resistivity without sensitivity analysis introduces prediction errors of 356.61 psi and 803.56 psi respectively, substantially higher than the errors achievable through systematic calibration. These error magnitudes correspond to equivalent mud weight uncertainties of approximately 0.70–1.60 ppg, which are operationally significant in precision drilling contexts (Bourgoyne et al., 1991; Zoback, 2010).

Quantifying these uncertainties and propagating them into mud weight design is therefore an important practical consideration for well planning (Khaled et al., 2022; Khan & Ahmad, 2023). The results underscore that the Eaton exponent must be treated as a site-specific calibration parameter validated against direct pressure measurements. The single-well design of this study provides a controlled sensitivity framework that isolates the contribution of exponent selection without the confound of inter-well geological variability, enabling a physically interpretable comparison of sonic and resistivity log behaviors that is directly applicable to normal-pressure exploration wells in the Tarakan Basin (Li et al., 2025; Shatyrbayeva, 2024).

**Conclusion**

This study demonstrates that the Eaton exponent ( $n$ ) exerts a measurable influence on pore pressure prediction accuracy in normal pore pressure regimes, where residual log-to-NCT deviations persist due to NCT construction limitations rather than true pressure anomalies. In the present study, NCT quality was  $R^2 = 0.79$  for sonic and  $R^2 = 0.076$  for resistivity, confirming that substantial residual variability exists in both log types even within the normal pressure interval. These residual deviations are amplified nonlinearly by  $n$  in the Eaton formulation, making exponent selection methodologically consequential even in the absence of overpressure. Systematic sensitivity analysis using sonic and resistivity logs from Well X, South Sembakung Field revealed distinct prediction behaviors between the two log types. Sonic-based predictions were more stable across the tested exponent range of  $n = 2.50$ – $3.50$ , with MAE values of 309.89–402.40 psi, supported by a robust NCT ( $R^2 = 0.79$ ). The exponent  $n = 3.50$  is recommended for sonic in this formation as it provides greater geophysical sensitivity to subsurface variations while remaining consistent with the theoretical basis of the Eaton formulation. Resistivity-based predictions

exhibited substantially higher MAE values of 584.50–995.85 psi across  $n = 1.00$ – $2.00$ , directly attributable to the inherently low NCT quality of the resistivity log ( $R^2 = 0.076$ ,  $CoV = 32\%$ ), where petrophysical factors including formation water salinity and clay mineral conductivity dominate the log response beyond mechanical compaction. A systematic hydrostatic bias is inherent in the Eaton formulation under normal pressure conditions: as  $n$  decreases, the term  $(ratio)^n$  converges toward 1.0 regardless of the actual log-to-NCT ratio, causing predicted pore pressures to approach the hydrostatic baseline as a mathematical consequence rather than a geophysical finding. This behavior renders MAE minimization alone an insufficient criterion for exponent selection in normal pressure environments, as lower  $n$  values will mechanically yield lower numerical errors without necessarily providing a more physically accurate representation of subsurface pressure dynamics. An integrated evaluation combining quantitative error metrics with geophysical sensitivity assessment is therefore recommended. These findings underscore the importance of treating the Eaton exponent as a site-specific calibration parameter validated against direct pressure measurements, rather than a universal constant. The results are directly applicable to normal-pressure exploration wells in the South Sembakung Field and comparable deltaic formations within the Tarakan Basin. Extension of these findings to other Indonesian sedimentary basins with fundamentally different geological characteristics – including carbonate or volcanoclastic systems – requires independent validation against local pressure data. For future research, it is recommended to extend this sensitivity framework to multi-well datasets within the Tarakan Basin to evaluate the spatial consistency of optimal exponent values, to incorporate uncertainty quantification methods such as Monte Carlo simulation to propagate NCT construction uncertainty into prediction confidence intervals, to investigate the influence of formation water salinity correction on resistivity-based NCT quality and its downstream effect on exponent sensitivity, with reference to established petrophysical controls on resistivity in deltaic sedimentary systems, and to evaluate the integration of the Eaton method with the Bowers method for formations transitioning from normal to overpressure regimes in deeper intervals of the South Sembakung Field, and to explore the potential of machine learning approaches for automated exponent calibration using multi-well datasets.

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#### Author Contributions

L.R. and A.H.: conceptualization, L.R.: methodology, L.R.: software, L.R. and A.H.: validation, L.R.: formal analysis, L.R.: investigation, L.R.: resources, L.R.: data curation, L.R.: writing – original draft preparation, L.R. and A.H.: writing – review and editing, L.R.: visualization, A.H.: supervision. All authors have read and agreed to the published version of the manuscript.

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#### Conflicts of Interest

The authors hereby declare no conflicts of interest.

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