GAUSSIAN WELLWORKS
RESERVOIR INTELLIGENCE

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DIGITAL RESERVOIR TWINS

Gaussian Wellworks delivers a calibrated reservoir digital twin that integrates rock properties, fluids, pressure behavior, well performance, and uncertainty into a single decision framework.

Unlike a static technical study, the twin is designed to be updated as new field data become available—supporting faster scenario testing, more credible forecasts, and clearer communication between technical, management, and commercial teams.

WHAT CHALLENGES THE TWIN SOLVES

FRAGMENTED DATA Connects discipline-owned datasets in one model basis.	**POROSITY-ONLY ESTIMATES** Uses broader calibration for flow capacity and connectivity.	**HIDDEN UNCERTAINTY** Carries input uncertainty through to forecast outcomes.
UNDERUSED FIELD HISTORY Calibrates against observed pressure and production behavior.	**OVERLOOKED ROCK EFFECTS** Tests when compaction and pressure sensitivity matter.	**UNEQUAL COMPARISONS** Screens undeveloped locations on a consistent basis.

ONE UPDATEABLE FRAMEWORK CONNECTS RESERVOIR BEHAVIOR, UNCERTAINTY AND BUSINESS DECISIONS.

CORE CAPABILITIES

1. INTEGRATED RESERVOIR UNDERSTANDING

Combines the data that most strongly control performance, including: petrophysical data, pressure and well-test data, PVT and fluid reports, geomechanics, core measurements, analog information, production history, and development context.

2. FLOW CAPACITY & CONNECTIVITY

Uses a broader calibration basis for permeability, transmissibility, tortuosity, and pressure response—rather than relying on porosity-only transforms.

3. UNCERTAINTY-AWARE FORECASTING

Produces P90/P50/P10 production and pressure forecasts, compares depletion/injection/EOR/storage scenarios, and supports risk-based option ranking.

4. PRESSURE & DIFFUSIVITY CALIBRATION

Estimates field-calibrated hydraulic diffusivity from production history and pressure behavior, matching how the reservoir actually responds.

5. GEOMECHANICAL BEHAVIOR

Identifies when poro-elastic and pressure-sensitive rock effects are negligible—and when they are large enough to change planning decisions.

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WHEN A RESERVOIR DIGITAL TWINS ADDS VALUE

Clients use a reservoir digital twin when they need to understand how the reservoir is likely to perform under different development strategies, how uncertainty affects forecast confidence, and which options should be prioritized. It is especially valuable when teams need more defensible forecasts, visible uncertainty through P90, P50, and P10 outcomes, faster screening of development or injection scenarios, better capital allocation, and clearer communication between subsurface specialists, management, and commercial decision-makers.

CLIENT DELIVERABLES

OPERATORS

- Updateable calibrated twin integrating petrophysical, core, PVT, pressure, well-test, production and geomechanical data.
- P90/P50/P10 production and pressure forecasts.
- Comparative screening of drilling, depletion, pressure support, injection, EOR and storage options.
- Diagnostics for flow capacity, connectivity, diffusivity and pressure response.
- Ranked development and field-life-extension options.

INVESTORS & LENDERS

- P90/P50/P10 production and pressure outlooks.
- Risk-ranked comparisons across drilling, pressure support, injection, EOR and storage scenarios.
- Capital-allocation guidance across competing options.
- Forecast-confidence analysis linking assumptions to production, reserves and field life.
- Mature-asset screening for pressure support, EOR, storage and field-life extension.

AUDITORS & REGULATORS

- Documented model basis covering source data, assumptions and reservoir interpretations.
- Calibration evidence linking modeled results to observed pressure and production behavior.
- Transparent propagation of input uncertainty into P90/P50/P10 outcomes.
- Physically grounded interpretation of permeability, compaction and pressure-sensitive behavior.
- Reviewable forecast basis linking data, calibration, scenarios and results.

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CASE STUDY— IMPROVING FORECAST RELIABILITY IN A MATURE GULF OF MEXICO RESERVOIR

Summary

A mature offshore sandstone reservoir in the Gulf of Mexico had already produced more than 100 million bbl and was being assessed for extended field life, including continued pressure support and possible CO2-EOR. The issue was not just decline forecasting. It was whether the reservoir model inputs being used for forecasting and reserves work were physically correct.

Objective

We re-examined earlier petrophysical interpretation that suggested porosity and permeability might increase as reservoir pressure declined. If accepted, that would imply improving reservoir quality during depletion. However, this interpretation conflicted with field evidence and with bulk-compressibility-based understanding that producing reservoirs compact as pressure falls. The main objective was therefore to test whether the apparent pore dilation seen in laboratory-style pore-volume compressibility data was real reservoir behavior or a misleading artifact.

Provided Solution

The reassessment integrated core-derived pore-volume compressibility data (**Figure 1**), reservoir fluid and PVT data, bottom-hole pressure history from nine producing wells, and analytical poro-elastic modeling. Key field evidence showed that initial reservoir pressure was about 13,000–14,000 psi. Over time, flowing bottom-hole pressures declined and later stabilized around 4,000 psi after early depletion and pressure-management actions (**Figure 2**).

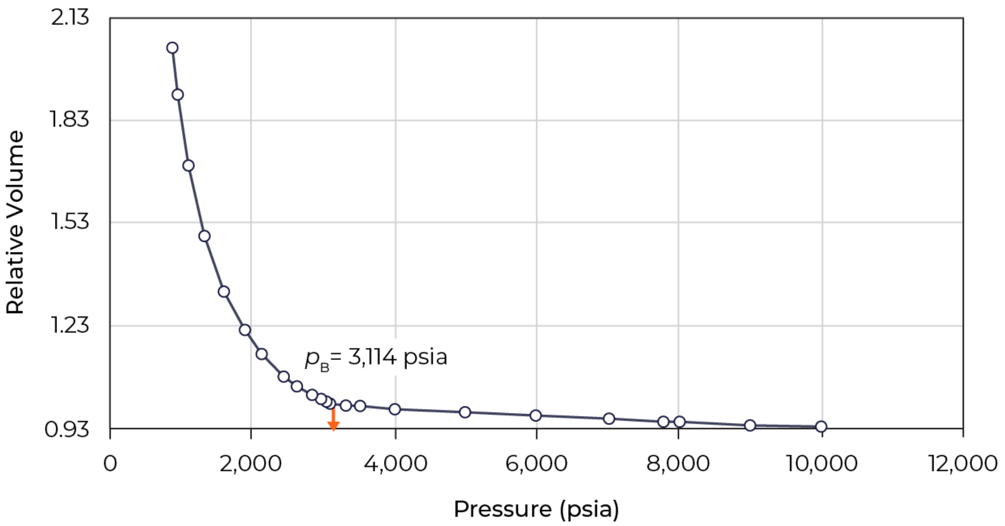

Figure 1 – Reservoir-fluid expansion response during the depletion

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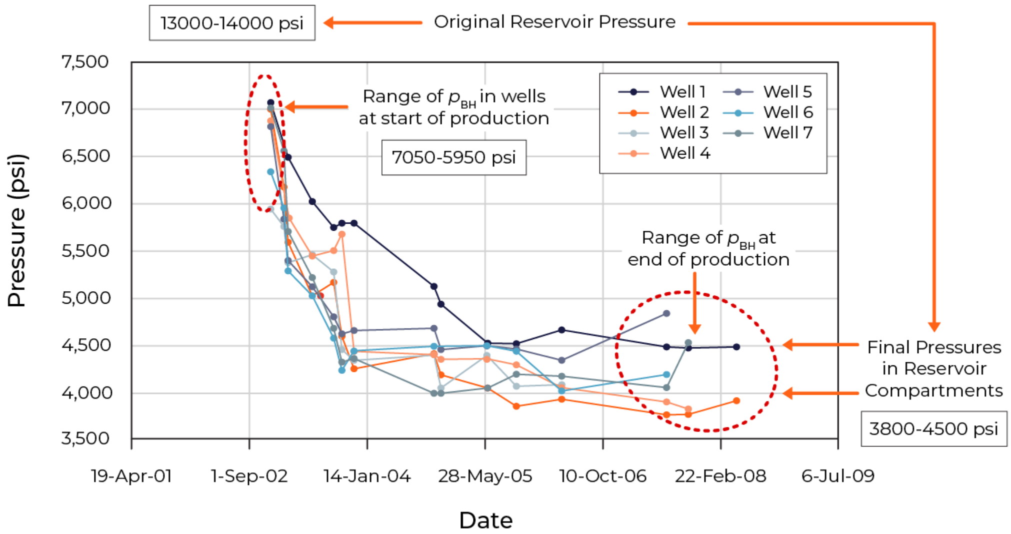

Figure 2 – Bottom-hole pressure decline history

Results and Findings

The PVT analysis showed that fluid compressibility increased as pressure declined, giving about 6.56% fluid-volume expansion from 10,000 psi down to the bubble-point pressure of 3,114 psi. This translates as roughly 6% recovery-factor support in the near-wellbore region from fluid expansion alone, before considering any poro-elastic contribution.

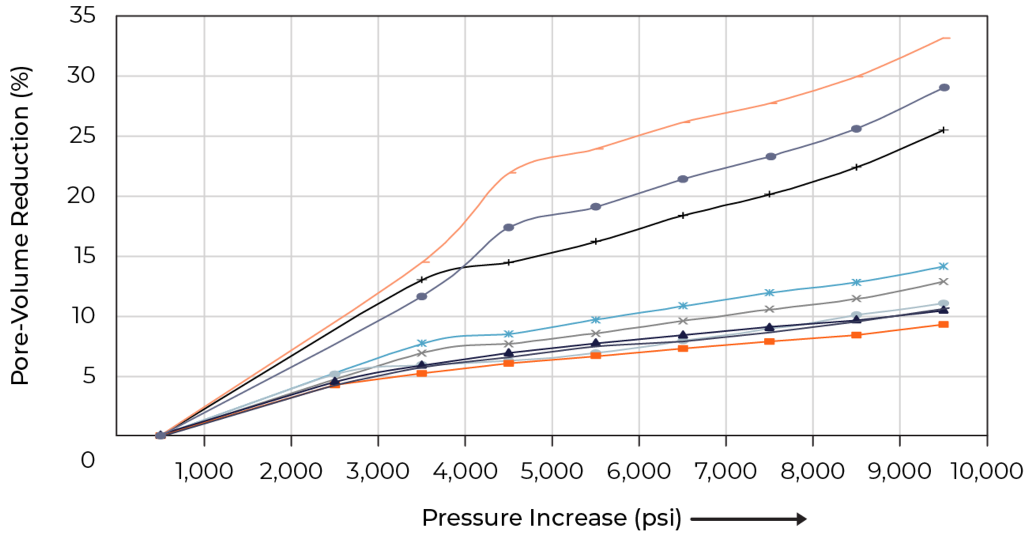

Figure 3 – Pore-volume reduction with pressure increase

The core finding of our investigation is that earlier laboratory pore-volume compressibility trends suggested that pore volume increases as pressure declines (**Figure 3**), implying that permeability might improve during depletion, as indicated in **Figure 4**. However, reinterpretation of pore-volume response suggested that this apparent dilation is not the correct reservoir interpretation. Instead, field evidence and analytical modeling indicate that pore compaction dominates during production depletion, not pore expansion. The misleading laboratory interpretation is attributed to a sign-reversal problem in how pore-volume compressibility is read

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and applied, with possible additional distortion from core handling damage during coring, unloading, drying, and re-pressurization.

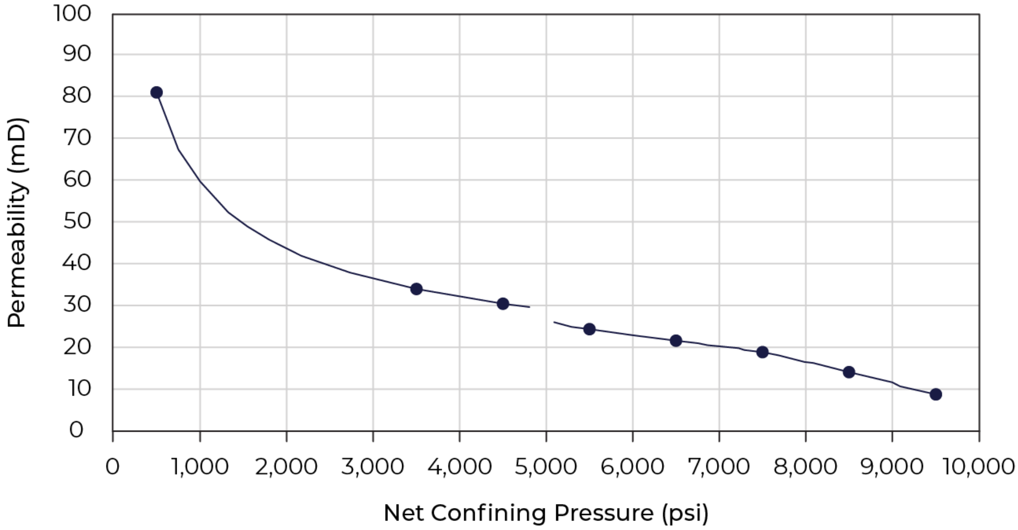

Figure 4 – Apparent permeability response from lab interpretation

The corrected interpretation is captured most clearly in **Figure 5**, which shows that pore-volume reduction corresponds to production depletion, while pressure increase during injection corresponds to pore-volume expansion. This matters because forecast models based on the incorrect interpretation could overstate permeability improvement and misrepresent pressure support behavior. For later-life development planning, that would affect reserves estimation, pressure-maintenance strategy, and screening of EOR or storage options.

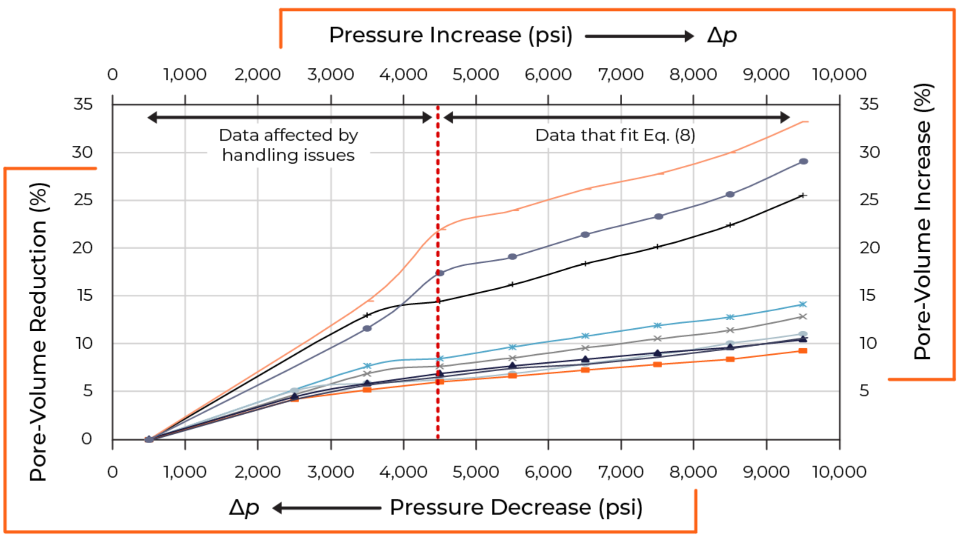

Figure 5 – Corrected pore-volume response interpretation

Our analysis shows that poro-elastic relaxation may enhance well rates in deep reservoirs by up to 25% in general. For the Gulf of Mexico sandstone case, it further estimates that if porosity falls from about 33% to about 23% as reservoir pressure declines from 9,500 psi to 4,500 psi, then pore-fluid expulsion associated with pore collapse could add up to about 30% to the production stream relative to Darcy-based forecasting alone.

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Overall, the analysis shows that improving forecast reliability in a mature reservoir may depend less on adding complexity and more on correcting the physical meaning of key inputs. In this case, the main improvement came from replacing a misleading depletion interpretation with one consistent with field pressure behavior, compaction mechanics, and poro-elastic response. That provides a stronger basis for production forecasting, reserves estimation, and later-life decisions on pressure support, EOR, and field-life extension.

READ THE FULL CASE STUDY

ADDITIONAL EVIDENCE

Peer-reviewed studies further demonstrating the reliability and technical validity of Gaussian technology in digital twinning.

[1]. Weijermars, R., and Williams, G., 2026. Ultra-fast reservoir characterization and well-performance evaluation enabled by digital permeability twins. First Break, March Issue, 44(33), 65-73. DOI

[2]. Toko, A.D.P., and Weijermars, R., 2025. Stiffening of Bulk Modulus in Poroelastic Medium with Rising Pore Pressure: A Comprehensive Sensitivity Study using a Closed-Form Solution Method. Computational Mathematical Modeling (2025). DOI

[3]. Toko, A.D.P., and Weijermars, R. 2025. Beyond Biot – Nonlinear stiffening of the bulk modulus in fluid-saturated porous media. Results in Engineering, Volume 26, 105019. DOI

[4]. Weijermars, R., 2025. Comprehensive Permeability-Transform Solutions for Shale and Sandstones using Data Sets from around the Globe. Petroleum Research. DOI

[5]. Tian, Y., Weijermars, R, Zhou, F., Sun, Z., and Liu, T., 2023. Advances in Stress-Strain Constitutive Models for Rock Failure: Review and New Dynamic Constitutive Failure (DCF) model using Core Data from the Tarim Basin (China). Earth-Science Reviews, Vol. 243 (2023) 104473. DOI

[6]. Weijermars, R. and Afagwu, C., 2022. Hydraulic Diffusivity Estimations for US Shale Gas Reservoirs with Gaussian Method: Implications for Pore-Scale Diffusion Processes in Underground Repositories. Journal of Natural Gas Science and Engineering 106, Article 104682. DOI

