Log-guided parameterization in full waveform inversion: tuning a two-parameter case

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Summary

1.A) Eaid et al. (2021) proposed incorporating observations about strong parameter correlation from well-logs into FWI formulation using **a single parameter**.

1.B) We suggest **incorporating a second parameter** to the same formulation to include information omitted by (1A).

1.C) In applications like CO_2 sequestration, gas effects will **divert elastic parameters from an existing background trend** (see FIG. 3 and FIG. 4).

1.D) We are testing (1B) using proposed models for the Carbon Management Canada Newell County Facility after 1664 tons of CO_2 are injected in the reservoir (Macquet et al., 2019).

Method

2.A) Fit a trendline to the well-log data.
2.B) Parameterize (2A) in the **tangent direction** (Eaid et al., 2021).
2.C) Define a vicinity of interest along (2A).
2.D) Project values inside (2C) into a **normal plane**
2.E) Apply principal component analysis using (2D).

Now, the used model in full waveform inversion is:

$$\mathbf{P_{Log}} = \hat{\eta} + a\,\hat{\kappa}$$

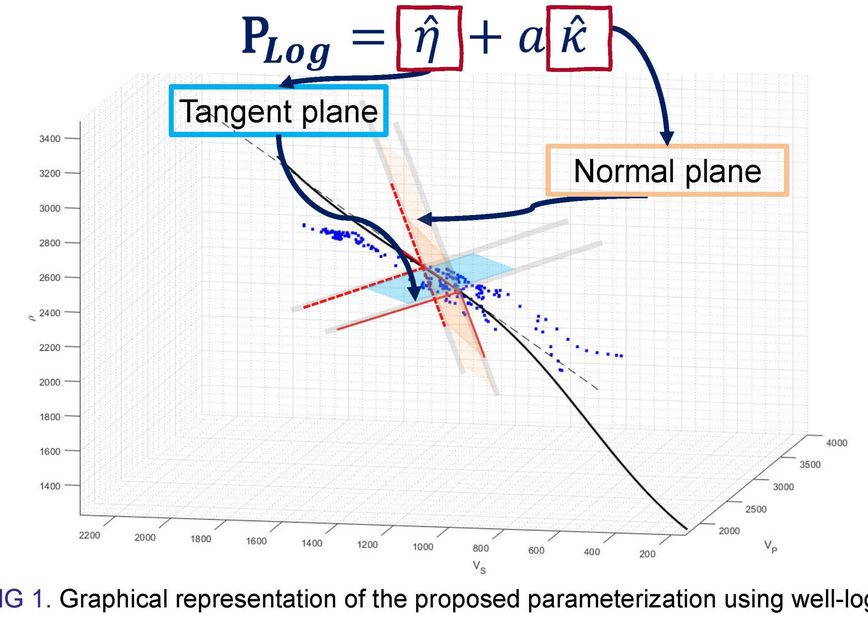

FIG 1. Graphical representation of the proposed parameterization using well-log information in V_P-V_S-ρ space.

Results in a time-lapse application

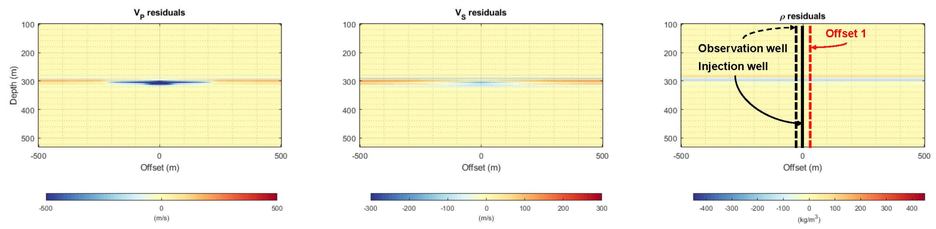

FIG 2. True model residuals from an advanced stage of CO_2 injection.

TEST 1

Using a small deviation from the trendline to estimate $\hat{\kappa}$

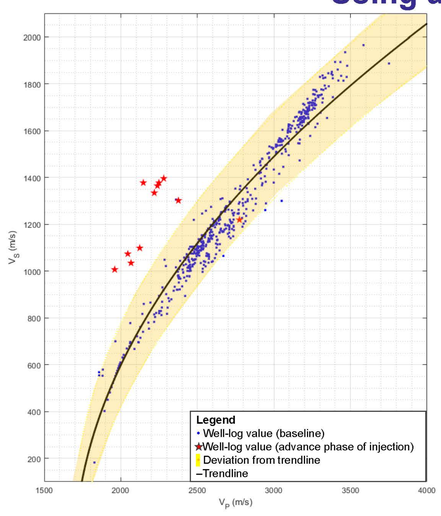

FIG 3. Example of the region considered along the trendline in test 1.

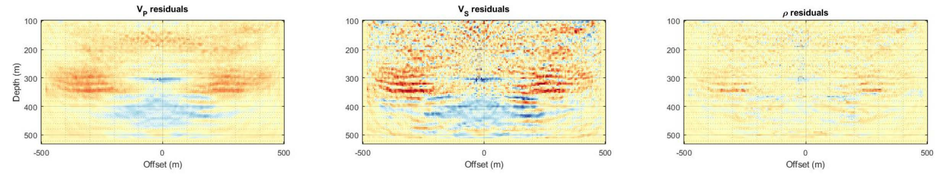

FIG 5. Inverted residuals from test 1 at an advanced stage of CO_2 injection.

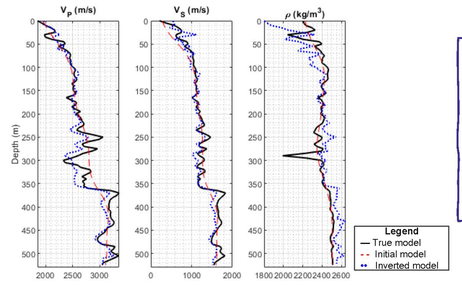

FIG 6. Model comparison for an advanced stage of CO_2 injection at offset 1 (see FIG 2).

Measured V_P reduction
[-3, - 394] m/s
(reservoir)

TEST 2

Using a large deviation from the trendline to estimate $\hat{\kappa}$

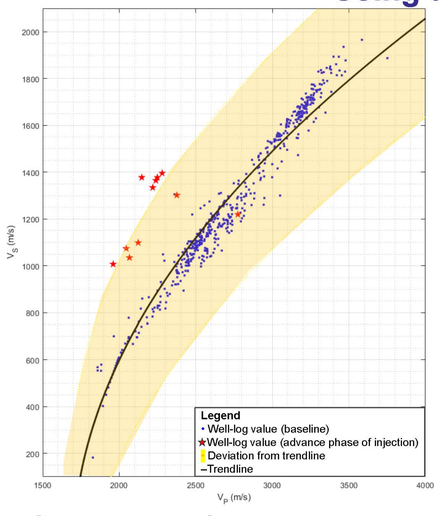

FIG 4. Example of the region considered along the trendline in test 2.

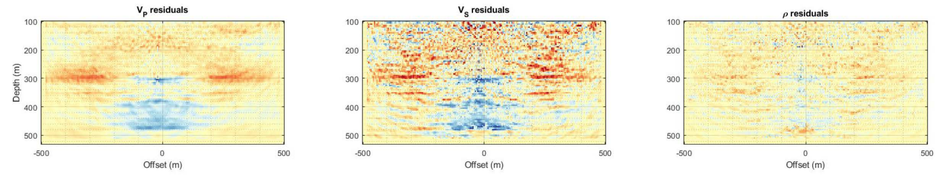

FIG 7. Inverted residuals from test 2 at an advanced stage of CO_2 injection.

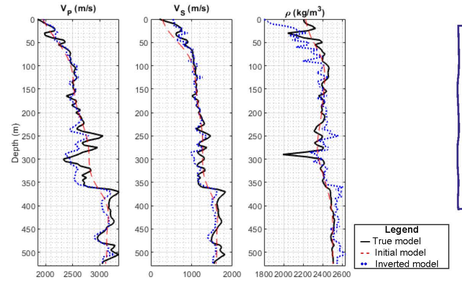

FIG 8. Model comparison for an advanced stage of CO_2 injection at offset 1 (see FIG 2).

Measured V_P reduction
[-1, - 410] m/s
(reservoir)

Acknowledgements

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References

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- Macquet, M., Lawton, D. C., Saeedfar, A., and Osadetz, K. G., 2019, A feasibility study for detection for detections thresholds of co2 at shallow depths at the Cami Field Research Station, Newell County, Alberta, Canada: Petroleum Geoscience, 25, No. 4, 509–518.

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