Submission code: RP07WBDQYQ

See this and other abstracts on our website: https://home.sbgf.org.br/Pages/resumos.php

Weighted-Average Time-lapse Full-waveform Inversion with Different Acquisition Methods

Paulo D. S. de. Lima (Federal University of Rio Grande do Norte), Mesay Geletu Gebre (Federal University of Rio Grande do Norte), Claudionor G. Bezerra (Federal University of Rio Grande do Norte), João Medeiros Araújo (Universidade Federal do Rio Grande do Norte), Mauro Ferreira (Trinity College Dublin)

SBGf Conference
18-20 NOV | Rio'25

Weighted-Average Time-lapse Full-waveform Inversion with Different Acquisition Methods

Introduction

Estimating accurate time-lapse images remains challenging due to nonrepeatability effects caused by differences in the acquisition geometry. Several time-lapse full-waveform inversion (TLFWI) strategies have been proposed to mitigate inconsistencies of different recording datums. A particular challenge arises when a streamer acquisition is used to collect baseline data and an ocean-bottom node (OBN) for subsequent monitoring. Therefore, it is essential to have a robust TLFWI strategy that can effectively address this issue, thereby enabling operational cost reduction. In this context, the recent weighted-averaged inversion (WA-TLFWI) has been investigated in some non-repeatable scenarios, providing accurate time-lapse images. However, it has never been explored considering different acquisition types. In this study, we analyze the robustness of this strategy in scenarios with different acquisition vintages.

Methods

Several time-lapse FWI schemes have been proposed to address these challenges in the context of reservoir monitoring. The parallel strategy estimates the baseline and monitors models separately using the same initial model. In contrast, the sequential strategy uses the result of the baseline inversion as the initial model in the monitor estimation. The central-difference approach uses four FWI workflows by combining two sequential inversions, which are averaged to obtain a final time-lapse estimate. The weighted-averaged inversion (WA-TLFWI) can provide accurate time-lapse images in non-repeatable scenarios using only three FWI workflows. These workflows give rise to two bootstrap time-lapse estimates, $\Delta\mathbf{m}^{+}$ and $\Delta\mathbf{m}^{-}$, which are averaged using a weight parameter β:

$$\Delta\mathbf{m}^{\mathrm{WA}} = \frac{\Delta\mathbf{m}^{+} + \beta\Delta\mathbf{m}^{-}}{1+\beta}\,, \tag{1}$$

where $-1 < \beta \leq 2$ compensates for artifacts with opposite signs appearing in the two bootstraps.

Results and Conclusion

To simulate a nonrepeatable scenario due to different acquisition types, we consider a subsurface model that exhibits typical Brazilian pre-salt field characteristics called Gato do Mato. The experimental acquisitions start with a streamer for the baseline, followed by an OBN acquisition for the monitor. Hydrophones spaced 20 m apart at the seawater surface were used in the first acquisition, while nodes spaced 1000 m apart at the seabed were employed in the monitor acquisition. We compare the accuracy of the time-lapse estimates using the WA-TLFWI with the other common TL strategies present in the literature.