

## The Impact of Seismic Geometry on Facies-Based Inversion

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### Summary

The energy industry's role in the new zero-carbon emission era is of paramount importance. This study focuses on the potential of new technologies and innovative ideas to significantly reduce the environmental impact associated with seismic acquisitions (Figure 1). Building on the work of Naghizadeh et al. (2023), who demonstrated the efficacy of alternative acquisition geometries in mitigating environmental footprint, our study delves into the effects of different acquisition geometries on pre-stack gather amplitudes. In this research we employ a comparative analysis of a series of Joint Impedance & Facies Inversion (JI-FI) outputs (Kemper and Gunning, 2014) over the same acreage.

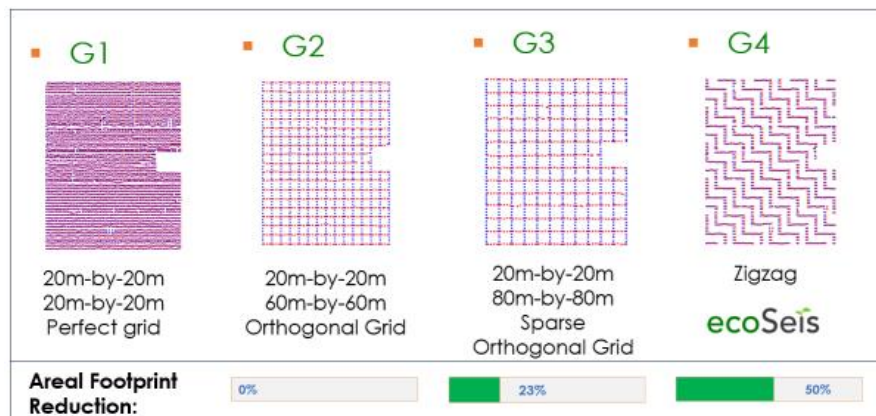


Figure 1 This figure illustrates the acquisition geometry of the analyzed surveys, along with the corresponding areal footprint reduction.

### Theory / Method / Workflow

To evaluate the effect of alternative acquisition geometries on seismic amplitudes, we used an existing high-density dataset acquired using an orthogonal grid, with a 20m-by-20m source-receiver grid. This dataset was decimated to create alternative geometries: an orthogonal with 60m line intervals and a zigzag geometry with similar trace density (Figure 1). The target zone within the Athabasca oil sands in Canada is shallow at approximately 200m depth. The generated seismic geometries were fully processed using anisotropic prestack time migration and then inverted to get an understanding of the impact of trace density effect on Ji-Fi outputs.

There are numerous quantitative interpretation solutions, but a Ji-Fi was selected as the most suitable algorithm for this situation. The inversion uses Bayesian theory and rock physics-driven low-frequency information to produce unbiased results without relying on well interpolation, variogram models, or simplistic rock physics relationships. Instead, well inputs are divided into elastic facies based on observable petrophysical contrasts. These inputs are then modeled into depth-varying compressional velocity trends and individual facies-based rock physics models are computed, relating compressional velocity to shear velocity and bulk density for each elastic facies. Combined with a Markov-random field process, this allows for the construction of a low-frequency model without direct interpolation from well inputs. Ji-Fi empowers the utilization of all wells in the field as 'blind tests,' thereby enhancing confidence in both the inversion's result and parameterization.

## **Results, Observations, Conclusions**

The result of Ji - Fi inversion has shown comparable quality to the original dataset without compromising the elastic properties within the target zone indicating that alternative geometries can help reduce environmental impact and acquisition costs. However, the line and station distribution should be considered to ensure the trace density of remains sufficient for accurate target resolution.

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## **References**

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