From Velocity to Geology: Geologic Explanations of Anomalous Velocity from eFWI

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Summary

Since 2019, when multi-client OBN seismic surveys became a practical reality for the oil and gas industry, our understanding of the subsurface has advanced significantly. Interpreters have been learning how to fully utilize these new products to gain insights on their prospects and prospect inventory.

Recent OBN eFWI seismic data, in the Mississippi Canyon area of the Gulf of America (GOA), reveal notable velocity anomalies, expressed as alternating high- and low-velocity zones within the deep Mesozoic carapace section (Figure 1). This study aims to propose a geological interpretation of these anomalies by integrating newly available OBN-based eFWI seismic data with existing well information.

Method

The approach focuses on identifying deep velocity anomalies throughout the Amendment 1& 2 eFWI FWI Derived Reflectivity (FDR) and velocity models. These anomalies appear to be stratigraphically similar to features encountered in the Wrigley well (EW 922). To investigate this relationship, sonic logs from the Wrigley well are compared directly with eFWI velocities extracted along the wellbore trajectory.

The comparison demonstrates a consistent and geologically plausible match between the Wrigley sonic velocities and the eFWI velocity profile (Figure 2). Notably, the low-velocity intervals identified in the eFWI models align with known Jurassic source rock intervals, specifically the Cotton Valley–Bossier Formation, encountered in the well (Cunningham, 2016). This correlation provides compelling evidence that the deep eFWI anomalies represent genuine lithological and geochemical variations rather than inversion artifacts, thereby validating the interpretive value of the OBN-derived models.

Extrapolating away from well control, differences within the Mesozoic carapace can be observed (Figure 3). Gross interval thickness varies from ~500m thick to 0m. Some examples are welded to the basement whereas others are relatively shallow on salt highs. These observations can affect predictions on source presence, source maturity, and potential hydrocarbon yield for a given basin. This interpretation adds granularity to the source risk typically assigned to GOA prospects.

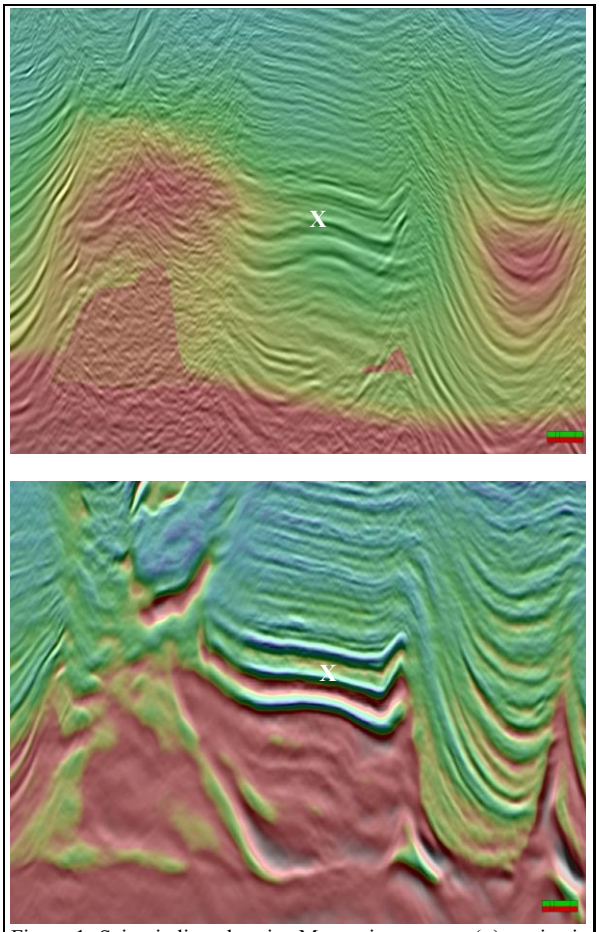

Figure 1: Seismic line showing Mesozoic carapace (x) section in legacy MWAZ RTM with velocity overlay(top) and Final eFWI FDR with velocity model overlay.

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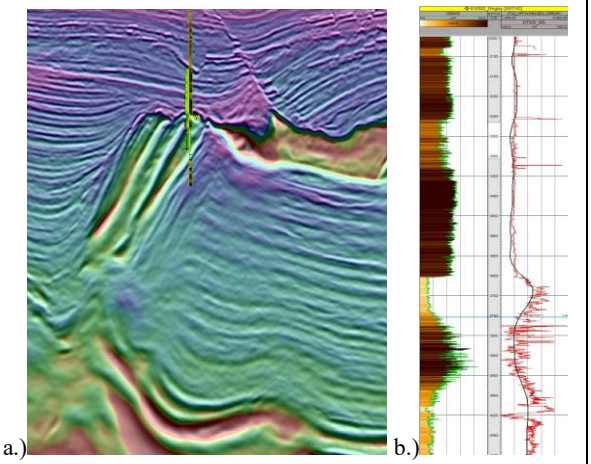

Figure 2: Wrigley well (EW 922) a.) Well traverse through mega-flap, inverted stratigraphy, eFWI FDR with Velocity Overlay. b.) Well logs GR with curve fill (left,green) and Velocity (right) with Velocity from Sonic log (red) and eFWI velocity (black).

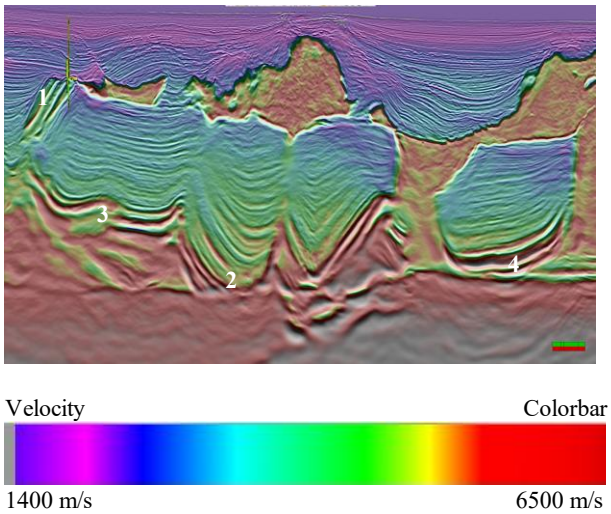

Figure 3: Arbitrary seismic traverse (FDR with eFWI velocity overlay) through Wrigley (EW 922) (1) showing inverted carapace section relative to surrounding basins. Observations include: Missing Mesozoic section (2), Relative high (3), Depositional thick (4)

Discussion

The results highlight the substantial uplift in subsurface resolution and depth penetration achieved through elastic FWI of long-offset OBN data relative to legacy WAZ/MWAZ seismic imaging in the Gulf of America. Interpreting deep velocity anomalies as potential indicators of mature source rock intervals offers a powerful new tool for reducing exploration uncertainty. By leveraging the enhanced fidelity of the Amendment 1 and 2 eFWI datasets, exploration teams can more confidently assess source rock presence, distribution, and maturity in frontier areas. Ultimately, this improved understanding of the deep subsurface supports more robust risk assessment and more informed decision-making for future exploration programs.