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Streamer to Streamer 4D Seismic in the Gulf of America

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Introduction

This work presents a successful application of streamer-on-streamer 4D seismic acquisition in a Gulf of America (GOA) oil field. The technique offers a cost-effective method for reservoir monitoring and identifying remaining hydrocarbons in mid-sized fields. Field A has been producing for over 20 years from a complex turbidite reservoir with a gas cap and oil rim. The key uncertainty of the field for future development is the shape and timing of the water front; history matching the contact movement proved difficult. Earlier attempts at 4D interpretation of legacy non dedicated streamer datasets could not highlight even the original oil-water contact (OWC). To address this key uncertainty additional data acquisition was necessary.

Method and/or Theory

Indications of early water encroachment in a producer sparked the drive for 4D seismic data. In 2023, a monitor streamer acquisiton was shot attempting to repeat a preproduction with significant acquisition challenges. This was the first dedicated 4D streamer repeat survey in Shell's Gulf of America portfolio since 2006. OBN is typically preferred because of the high risk of non-repeatability from loop currents prevalent in GOA and associated streamer feathering differences. The effects of the loop current were quite prevalent during the baseline survey which resulted in extreme feathers of 40+ degrees. To compensate during the monitor, a slide in acquisition technique was applied to induce high feather over selected target areas. The acquisition vendor PXGeo achieved high geometric repeatability, resulting in excellent 4D data quality. To manage expected 4D interpretation complexity given the unique production history and fluid properties of field A, the processing project also included a legacy non-dedicated streamer survey with different acquisition specs, splitting the total production period into two episodes of approximately 10 years each. Dedicated reprocessing from field tapes by SLB followed by in-house imaging resulted in a very good quality products including 3 time stamps.

Results and Conclusions

Results of the fast track dataset alone were good enough to highlight the original OWC and the direction of water encroachment into the oil leg, resulting in relocating a producer target prior to drilling.The contact was found to be non-flat, dipping 200–300 feet deeper in the East. Despite extensive time-depth conversion efforts, flattening the contact was not feasible and resulted in a new understanding of compartmentalization and fluid history in the field along with additional volumes. The full track dataset was able to illuminate fluid changes within the original gas cap, something that we had lower confidence in achieving during feasibility studies given assumptions on residual gas saturations. We mapped water pathways to upcoming wells and refined the volume and shape of the remaining gas cap. The inclusion of a non-dedicated streamer survey as a midpoint step, though lower in S/N than the dedicated 4D, was critical for identifying multi-fluid zones and understanding water encroachment rates. This high-effort joint Vendor/Shell processing approach shows that useful 4D data can be obtained from legacy data, something that had never before been achieved in Field A.

The 2023 Field A 4D streamer seismic survey marked Shell's first dedicated 4D repeat in the Gulf of America since 2006, yielding high-quality data thanks to a unique approach with acquisition and processing. By integrating legacy data and existing contracts, with this workflow the team delivered a strong 4D interpretation revealing a non-flat OWC, complex fluid migration, and key insights that optimized well planning, reduced exploration risk, and prevented uneconomic drilling.