SEISMIC FOLDOUT

SEISMIC IMAGING-LED SEDIMENTOLOGY INSIGHT REVEALS EXTRAORDINARY NEW POTENTIAL IN THE GULF OF PAPUA

Searcher

LARUS ENERGY

The Papuan Plateau and Eastern Aure Moresby Fold–Thrust Belt is a frontier petroleum exploration province with no wells drilled to date. Regional, high resolution, broadband, PSDM multi-client 2D from Searcher and proprietary seismic data has transformed the understanding of the tectonostratigraphic evolution of the region and has uncovered a new Mid-Miocene turbidite play for Papua New Guinea (PNG). The remarkable imaging yields seismic facies characterising weakly to unconfined, laterally migrating, channel complexes at the base of slope and basin-floor lobe systems. The proximal fan reservoir units are overlain by thick intervals of hemipelagic shale and involved in thrust anticline traps which post-date deposition. High quality seismic data, outcrops, geochemical hydrocarbon seep analysis and challenging conventional wisdom have been keys to unlocking the huge potential of this frontier basin.

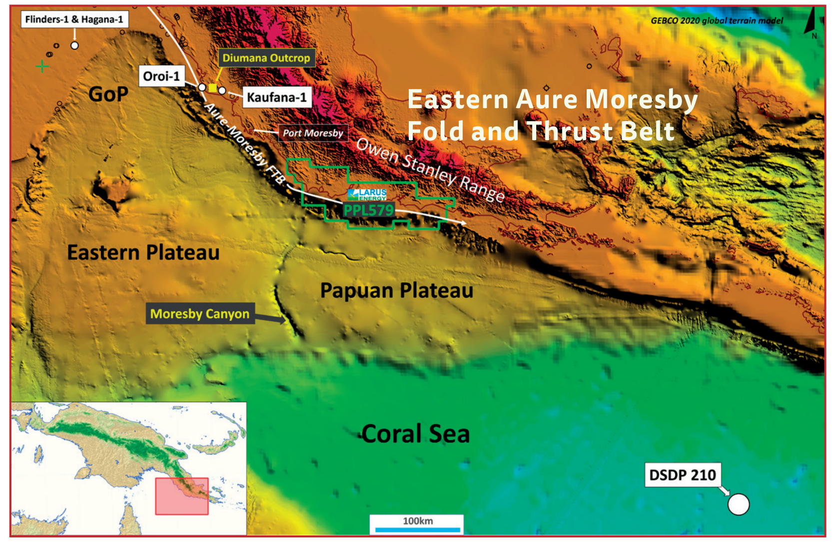

Figure 2: Location map and information. Foldout seismic line is located within PPL579.

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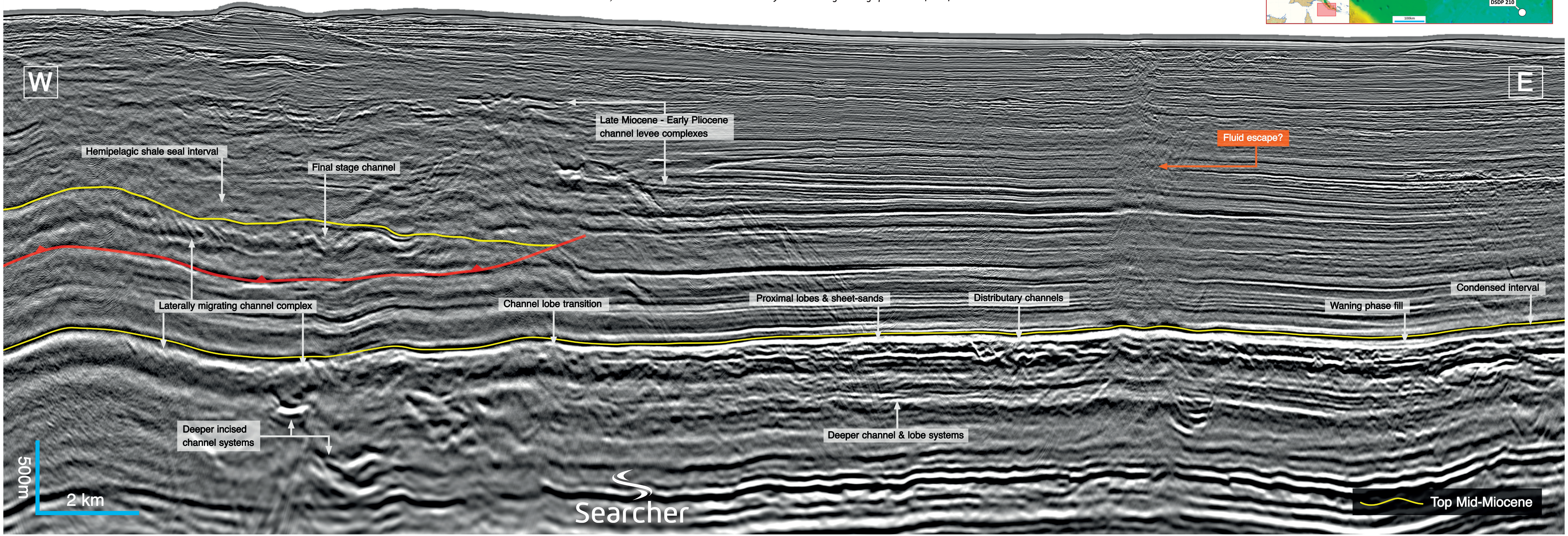

Figure 1: Showing Mid-Miocene channel complexes transitioning into lobe systems.

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STUNNING UNEXPLORED TURBIDITE PLAY REVEALED OFFSHORE PAPUA NEW GUINEA

Exceptional imaging from modern multi-client PSDM 2D seismic data in south-east PNG has uncovered exciting new reservoir potential within large-scale Neogene channel-fan turbidite complexes.

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Submarine fans and turbidite systems are important targets for oil and gas exploration and form prolific petroleum reservoirs in many sedimentary basins worldwide. Remarkable imaging from modern proprietary and multi-client PSDM 2D seismic data in south-eastern Papua New Guinea (PNG), has uncovered exciting new reservoir potential within large-scale Neogene channel-fan turbidite complexes.

Historic exploration in PNG has primarily focused on plays associated with the Jurassic Toro Formation and Miocene reef carbonates. Turbidites sourced from the north in the Late Pliocene from the Fly River Delta have been targeted in the Gulf of Papua (GoP), which led to the Flinders and Hagana discoveries in 2013. Yet despite the margin of the Aure Moresby Fold and Thrust Belt (AMFTB) stretching for over 800 km, and clear evidence for large sedimentary basins, exploration drilling has been limited to only the north-west AMFTB. Here the identification onshore of Mid-Miocene outcrops of fine–coarse, quartz, 'greywacke' sandstones, up to 122m thick in the Diamana village area, offered evidence for the presence of turbidite depositional fairways and the transport of quartz-rich material into deep water.

These encouraging outcrops and field mapping led to the drilling of two onshore wildcat wells: Oroi-1 in 1949 and Kaufana-1 in 1958 (see map inset on foldout). The wells were drilled on surface anticlines, without the benefits of modern seismic data and encountered off-axis turbidite systems, with limited reservoir potential. And yet, despite advances in our understanding of turbidite reservoirs, as well as advances in seismic acquisition and processing technology, in addition to the advent of new insights into basin modelling and charge effectiveness, there has been no exploration of the Aure Moresby Fold and Thrust Belt since the 1980s.

Indications of medial to distal turbidites and deepwater, nested, channel-levee complexes, have previously been recognised on deepwater seismic data. Indeed, a Mid-Miocene to Pliocene submarine fan system has also been cored on the abyssal plain of the Coral Sea (DSDP well 210) where fine-grained turbidites have been transported long distances (>400 km), from the fold belt via plateau-traversing deep water conduits, such as the Moresby Canyon. They represent the terminal lobes and mega-distal remnants of large-scale turbidite systems.

The presence of Mid-Miocene quartz-rich, turbidite sandstones onshore and terminal fans over 400 km from their provenance, indicates that major deepwater systems existed in the Neogene. This raised a question to PNG explorers: Where are the proximal turbidite plays located?

Shining the Light on Turbidite Reservoirs

Regional PSDM multi-client 2D seismic data acquired by Searcher in 2015–2016, has revolutionised the understanding of the Papuan Plateau and the offshore AMFTB, and has driven recent exploration efforts. The remarkable imaging from high resolution, broadband seismic data has enabled the division of the Miocene to recent interval into multiple sequences, which embody the evolution of a Neogene foreland basin to a fold–thrust belt and its cessation. Reservoir potential has been recognised within multiple, high-reflectivity turbidite pulses.

A distinctive Mid-Miocene system has now been identified, exhibiting impressive seismic facies that differ greatly from subsequent transverse and long-ranging axial systems. Large-scale channel and lobe complexes are observed, which are involved in thrusted anticlines and overlain by a thick, seismically transparent interval, which is interpreted to be hemipelagic marine shale, deposited during a period of relative tectonic quiescence (*Figure 3*).

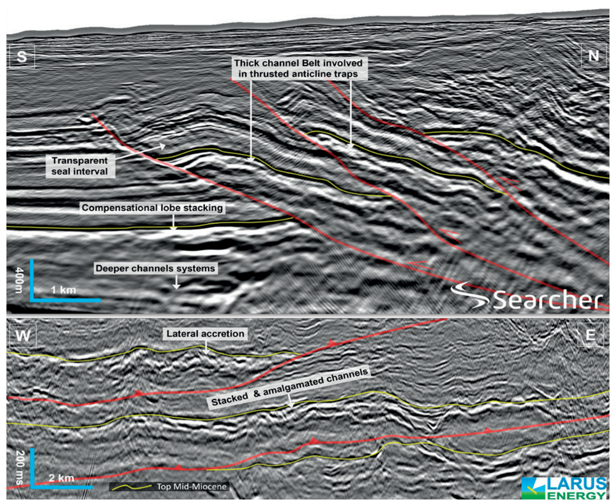

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Figure 3: Dip and strike sections located towards the base of the slope. Laterally extensive and thick, semi-confined to unconfined channel complexes can be observed, characterised by stacked and amalgamated channel bodies within a broad valley. The channel complex system is structurally repeated by thrusts which provide anticline traps.

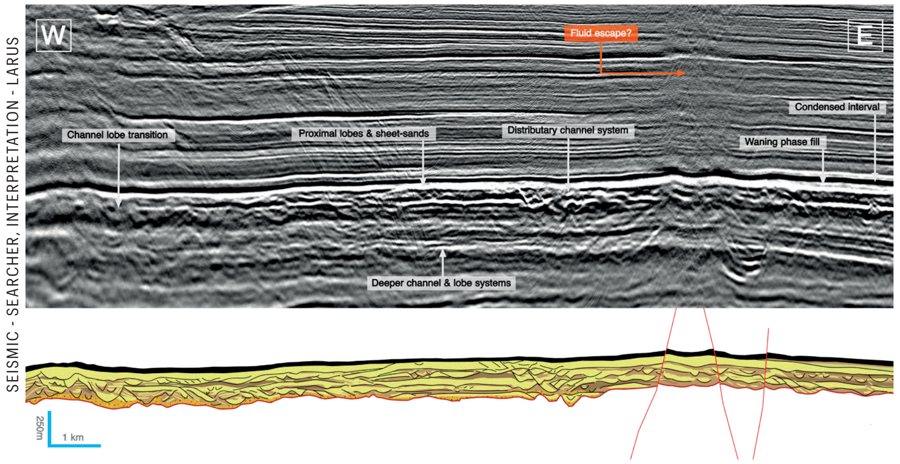

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Figure 4: Strike section of the proximal fan, showing wel- imaged stratigraphic detail, with interpretation. In the central axis, we can see high-amplitude, high-frequency shingled peak-trough pairs, indicating lateral reworking. Is this the missing section chased by pioneering explorers nearly a century ago? Line Length 16 km.

The major Mid-Miocene pulse of sediment transport into deep water can be subdivided into four phases, marking the initial incision and erosion, followed by the backfill, waning and abandonment phases. At the base of slope, weakly confined to unconfined channel complexes are observed, which are captured within a broad canyon or basal scour. A thick, gross reservoir interval can be characterised by laterally extensive, stacked, amalgamated channels and shingled reflector pairs. The shingled seismic reflectors dip towards a final stage channel and are indicative of active, lateral channel migration, within a meandering channel belt. Constructional levee systems appear to be absent, indicating that there was an abundant supply and deposition of flow-stripped, coarse-grained material to the proximal fan area.

The unconfined channel complexes transition on the basin floor into laterally extensive, amalgamated, stacked sheet sands and lobe systems. These are characterised by two, thick, High Amplitude Continuous (HAC) packages, interspersed with more discontinuous events which are interpreted to be distributary channels (*Figure 4*).

Basement highs form prominent bathymetric high-grounds during the Mid-Miocene, which ponded and diverted the course of the depositional fairway to the east. The switch in orientation resulted in the depositional axis of the proximal fan to parallel the strike of the advancing AMFTB. This configuration is favourable for reservoir continuity within E–W striking frontal thrust anticlines, which post-date reservoir deposition.

The AMFTB foreland depocentre effectively represents a very large and elongated perched basin. Bathymetric lows following inter-plateau depressions and interconnected graben systems, situate deepwater canyons and channels (*Figure 5*). These provide transport pathways for Mid-Miocene to recent, low density, fine-grained turbidites, to traverse the Papuan Plateau and form the terminal lobes in the ultimate sink, on the abyssal plain of the oceanic Coral Sea Basin.

Huge Potential

Integrating sedimentological insight with modern high-fidelity seismic has allowed the locality of a sand-rich proximal turbidite complex where it is held in thrusted structural closures of globally significant scale. The continuation of this study combined time-based structural reconstruction of the fold belt with basin modelling to show that the proven source rocks in this basin are in the oil-charge generative stage during and after structure formation. This innovative new modelling, combined with onshore light oil seeps and Searcher's offshore drop core geochemistry dataset, all point to an active thermogenic petroleum system.

Seated as it is in the new era of seismic imaging, the large scale of the thrusting and structuring in this area, has been integrated with a sophisticated hydrocarbon basin-model and the detailed analysis of a newly recognised sand rich proximal turbidite play fairway. The exciting opportunity presented by integrating these elements in an unexplored frontier basin, is that it generates the opportunity for the size of material discoveries that will make a difference on a globally significant scale.

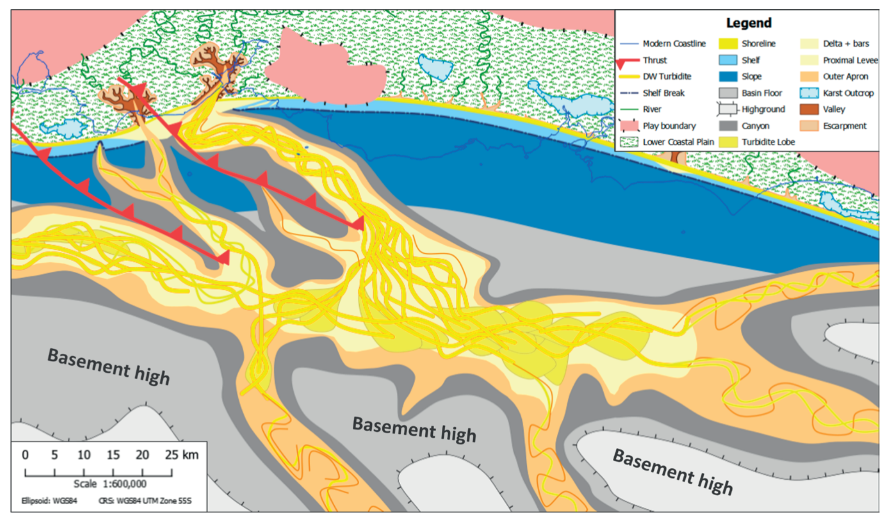

Figure 5: Mid-Miocene backfill phase GDE map showing diversion of depositional axis due to 'back-stop' basement high systems.