Oil and gas exploration hotspots in Asia Pacific: Data-driven opportunities in Malaysia, Indonesia, and India

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Exploration trends across Asia Pacific

Upstream exploration is making a strong comeback across Asia Pacific with recent successes sparking renewed industry enthusiasm. In 2023 material discoveries in Malaysia and Indonesia have reinvigorated interest in basins once thought mature, showing that significant upside potential remains. New significant discoveries continued to emerge across the region as recently as last year. Exploration drilling spanned from Sumatra to East Java in Indonesia and across Malaysia's offshore basins, yielding notable discoveries such as the Bekok Deep gas/condensate discovery in Malaysia's Malay Basin. These discoveries also highlight how modern seismic data, whether newly acquired or reprocessed, is allowing explorers to image and access deeper plays.

Government agencies are responding by promoting new licensing rounds and acreage offerings, opening overlooked established and frontier areas to investors. For example, Malaysia's latest bid round offered five exploration blocks across Malaysia and newly offered Technical Evaluation Assessment (TEA) blocks over the Layang Layang and Langkasuka basins. An industry-supported extensive new 2D seismic acquisition campaign in 2024 allowed Bangladesh to launch its first offshore licensing round in more than a decade, inviting bids on 24 blocks covering its largely unexplored offshore waters. India continues its Open Acreage Licensing Program (OALP X launched in Feb 2025), and Indonesia continues exploration activities through its Joint Study Agreement (JSA) blocks across all the basins coupled with regular tender blocks. This surge of opportunities reflects a clear regional strategy, boosting domestic reserves, increasing production and meeting rising energy demand, especially for natural gas. India, now the world's third-largest energy consumer, is pushing to increase natural gas from about 7% to 15% of its energy mix by 2030. This aggressive target shows strong government backing for new gas exploration. In parallel, companies are embracing advanced geoscience technologies to derisk these exploration opportunities. Modern multi-client seismic surveys, expansive well data libraries, and interpretation tools enable explorers to quickly explore and high-grade areas. Across Asia Pacific's diverse geology – from mature shallow provinces to high-potential deepwater frontiers – access to modern high-fidelity seismic data and access to acreage will help to unlock further hydrocarbon resources.

Malaysia: Revitalising mature and frontier basins with modern data

Malaysia offers exploration opportunities across established basins and frontier areas. In Peninsular Malaysia's mature Malay Basin, recent drilling based on reprocessed seismic data has

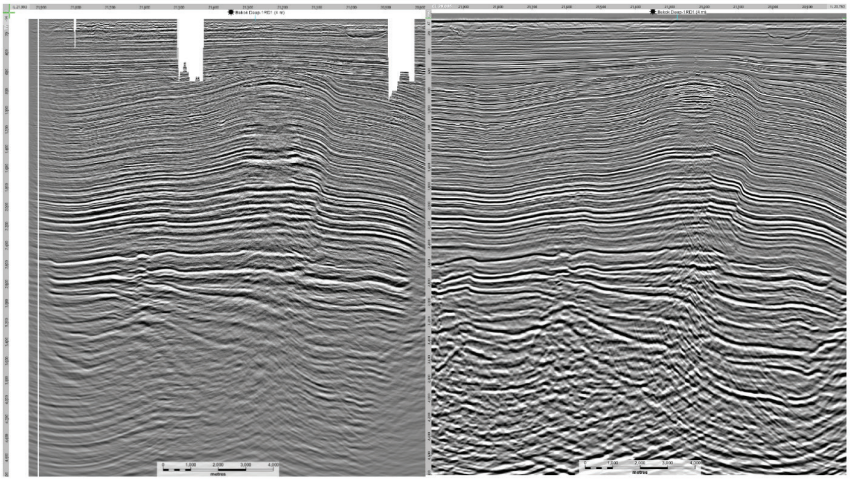

Figure 1 Legacy seismic showing attenuation below the existing Bekok discovery (left). PSDM reprocessing significantly improved imaging, allowing for drilling and discovery of Bekok Deep (right).

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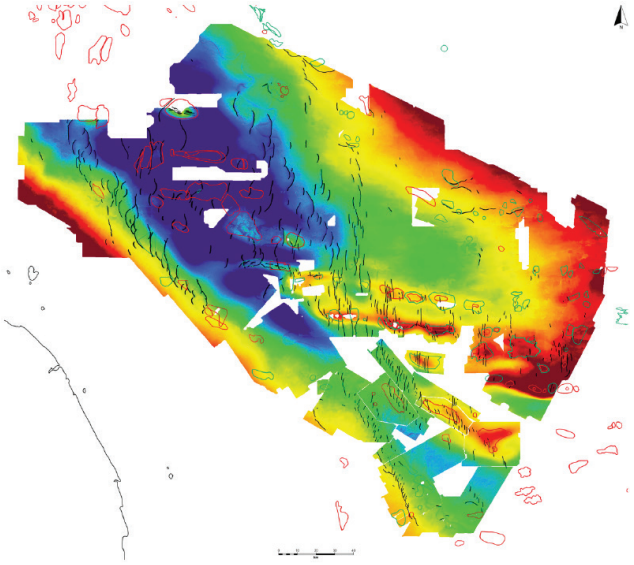

Figure 2 An example TWT structural map from the current PSDM reprocessed area of the Malay Basin.

confirmed a deeper play. In 2024 Petronas announced a significant discovery at the Bekok Deep-1 well (Figure 1), tapping new hydrocarbon reservoirs beneath an established field. This well encountered excellent flows from Middle Miocene Group I sands and importantly proved a new deeper play in the Malay Basin (Group M reservoirs) with significant upside potential. This success underscores that revisiting mature basins with newly enhanced data can yield sizable discoveries.

The Bekok-1 discovery was mapped and drilled on the TGS 3D MegaMerge seismic data, which integrates more than 70 vintage surveys (around 40,000 km² of coverage) into a single seamless volume using modern noise attenuation, multiple elimination, and updated velocity model-building technology (including Full Waveform Inversion and Q Tomography/Migration). The resulting time and depth migrated datasets provide consistent, high-resolution imaging of the Malay Basin's stratigraphy – a significant uplift over the legacy data. This 3D MegaMerge volume allows explorers to continuously map structures (Figure 2) and stratigraphic features across vintage surveys and block boundaries, identifying new leads and deeper plays beneath existing fields. Imaging of the deeper section has opened up new plays (including the Bekok-1 discovery) for further exploration drilling in a basin critical to Malaysia's domestic oil and gas supply.

In East Malaysia's Sabah province, focus is growing on the Sandakan Basin. This is a proven hydrocarbon basin with existing discoveries such as Mutiara Hitam-1, Kuda Terbang-1 and Nymph-1. Most of the basins in Sandakan are still considered frontier with limited seismic data, until now. TGS has embarked on a multi-phase 2D seismic acquisition and reprocessing campaign, with the latest phase (Phase 7, initiated in late 2023) having acquired 5000 km of new long-offset 2D seismic, reprocessed 2600 km of legacy lines and generated 2800 km² of 2D^{cubed} volume from the new 2D data. The aim of these datasets is to deliver a modern regional seismic dataset to unravel the complex geology and enable the mapping of further prospects in this frontier basin. The results of this new dataset show a clear resolution of the entire basin and enable tracking of the Miocene-Pliocene fan systems and deeper carbonate plays where the short offset legacy data had struggled to image below the shallow carbonate platforms and steep dips (Figure 3).

Indonesia: Unlocking deeper potential in East Java

Indonesia is another hotspot in Asia Pacific's exploration resurgence, where data-driven approaches are breathing new life into mature basins. A prime example is the East Java Basin, a geologically complex but hydrocarbon-rich province. Historically, exploration in East Java (both onshore and offshore Madura Strait) has centered on shallow carbonate pinnacle reef plays – notably the prolific Miocene Kujung Formation. However, deeper targets below the carbonates remained challenging due to the lack of imaging resolution of the legacy seismic data . The thick Wonocolo limestone platform and intricate channel systems in the shallow section generate strong velocity contrasts and imaging artifacts, blurring the deep section on vintage surveys. This left uncertainties regarding the potential of the Eocene petroleum system (Ngimbang Formation) and the pre-Tertiary section in East Java.

Today, modern seismic acquisition and processing workflows can clearly image the deeper Eocene system. New long-offset 2D and 3D data have been acquired in the East Java Basin. Modern processing flows now include high-resolution model-building with Full Waveform Inversion (FWI), allowing geophysicists to derive much more accurate velocity models in geologically complex zones. The impact has been dramatic: where legacy data struggled to image below the Kujung carbonates, the newly processed seismic data reveals clear imaging into the Eocene section. The deeper Ngimbang Formation and even the top of basement are now confidently interpretable across large areas. This breakthrough further opens up the Eocene section as a viable play in a basin long thought to be fully exploited at the shallower levels. The L-46-1 is an older oil discovery in the Ngimbang

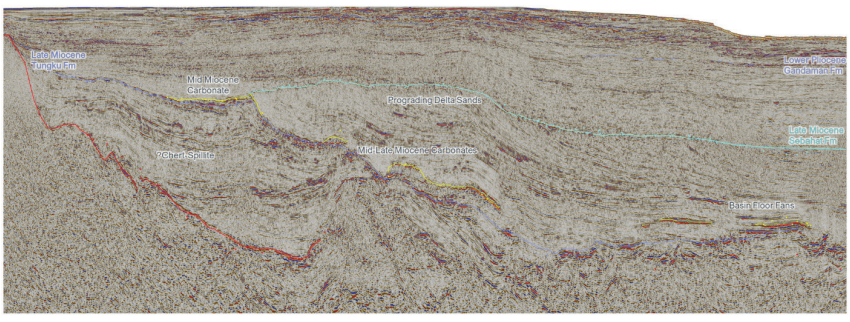

Figure 3 PSDM reprocessing has enhanced existing and revealed new plays in the Sandakan Basin.

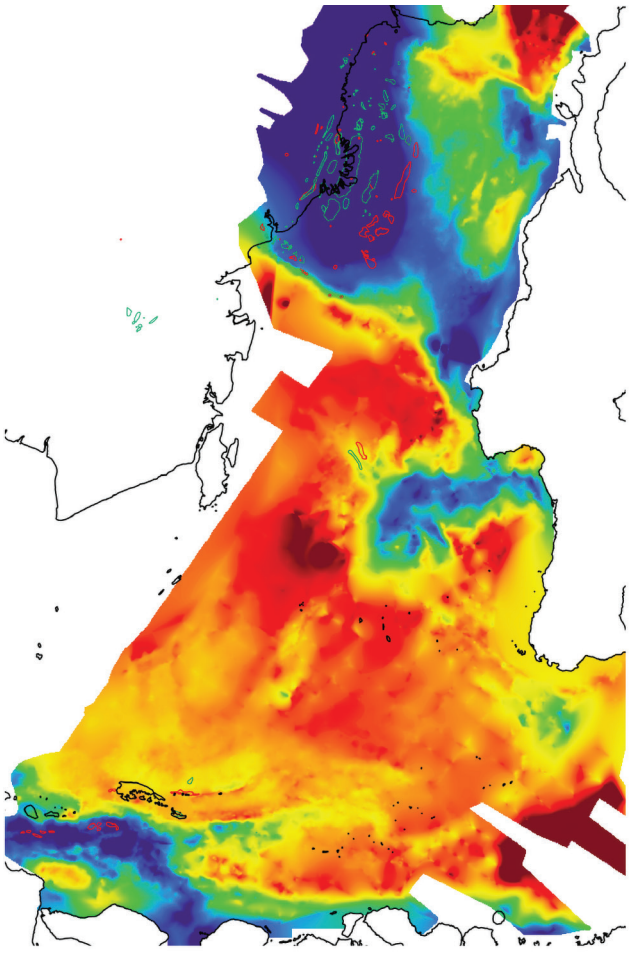

Figure 4 Extensive new 2D and 3D acquisition combined with reprocessing and 2D^{Cubed} now allows rapid local or regional structural evaluation with enhanced resolution, as demonstrated by this isochron map covering East Java, South Makassar and Kutei Basins.

formation and further discoveries can be anticipated from the new modern seismic data. The initial interpretation of the reprocessed seismic volume identified large gently folded structures and stratigraphic pinchouts in the deeper syn-rift sequences, which were invisible in legacy data.

New imaging technology-driven projects such as TGS' East Java Sea and Kutei 2D^{Cubed}, where thousands of kilometres of legacy 2D lines from multiple vintages have been phase, amplitude, and time-matched and interpolated into a 3D- volume. This 2D^{cubed} technology uses structurally conformable interpolation to infill the gaps between 2D lines, effectively creating a 3D seismic cube that can be sliced, visualised and interpreted as any other 3D volume. The motivation is to spur exploration in areas like the Madura Platform and the neighbouring Makassar Straits, where extensive 2D data exists, but few wells have tested deeper objectives. Harmonising these datasets creates a 'big picture' view of basin architecture and potential leads that cross individual block boundaries. This regional screening tool that covers multiple basins provides an extremely valuable insight into the wider regional structural development and play types.

The East Java and Kutei 2D^{cubed} (Figure 4) has already yielded tangible results. Seismic interpreters are now confidently mapping the Ngimbang Formation pinchouts and basin floor fan geometries, a feature previously unrecognised. If charged by Eocene source rocks, these deeper reservoir targets could add a new tier of exploration prospects below the established plays. Industry interest is indeed shifting to test these ideas – Indonesia's exploration in 2024 included wells targeting deeper or underexplored objectives in basins like East Java and North Sumatra. While the largest Indonesian discovery of 2024 was in North Sumatra (Mubadala's Tangkulo gas discovery in deep water, a new Oligocene syn-rift play), East Java and Kutei basins remain high in activity with continuing drilling and studies. The presence of a modern seismic dataset combined with available well data has been interpreted to produce GDE maps in a Facies Map Browser tool (FMB) which can help to derisk these new plays.

It is worth noting that Indonesia has strategic reasons to push exploration now. The country's oil production has been in decline, and it aims to boost output (with an ambitious target of 1 million barrels per day of oil and 12 Bcf/d of gas by 2030). Achieving this will require developing known discoveries and making new ones, especially gas for domestic use and LNG export. That imperative has the government and SKK Migas (the regulator) encouraging exploration in both proven core areas and high-risk, high-reward frontiers. Modern data has essentially become a catalyst for Indonesia's exploration drive, reducing geological uncertainty in a way that enables companies justify the risk of wildcat drilling in deeper or remote zones.

India: Data-driven exploration on the east coast

In the Indian subcontinent exploration attention is converging on offshore basins that promise substantial new reserves. India's east coast, bordering the Bay of Bengal, is a prime area of interest due to its multiple sedimentary basins (Cauvery, Krishna-Godavari, Mahanadi, and the Bengal Fan area) where discoveries in vast untested areas have been proven. India's government has prioritised increasing domestic hydrocarbon production – particularly natural gas – to fuel its growing economy. With India now the fourth-largest LNG importer, there is a strong impetus to find more gas at home, aligning with the target to raise natural gas to 15% of the energy mix by 2030. These policy initiatives are driving new offshore licensing rounds and increased exploratory drilling. However, one challenge for explorers has been the heterogeneous nature of data coverage on India's margins – historically, data quality and availability varied widely by basin. This is precisely where modern subsurface imaging technology makes a difference by combining disparate datasets into unified, modern products that can accelerate exploration activities.

A cornerstone of TGS's strategy in India has been the creation of a 2D^{cubed} seismic volume spanning the entire offshore India East Coast. This 2D^{cubed} project, completed in 2022, merged more than 250,000 kilometres of legacy 2D seismic data (from numerous vintages) across an area exceeding 500,000 km². This is a mega-scale project – it stretches from the Krishna-Godavari Basin in the central east coast, through the Cauvery Basin in the south, all the way to the Bengal Fan in the north east (Figure 5). By applying TGS's proprietary structurally conformable interpolation processes, these 2D lines were interpolated into a continuous 3D volume, enabling geoscientists to traverse the data from any orientation

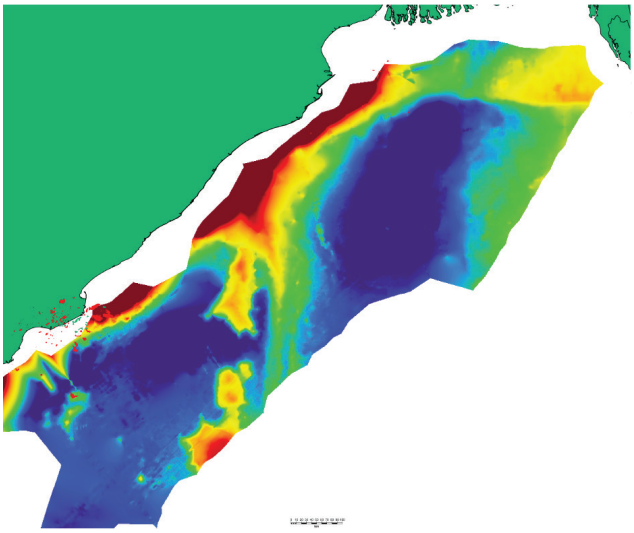

Figure 5 Regional near-basement structural map extending from the entire east coast of India to Bangladesh.

and perform rapid regional interpretations. This 2D^{Cubed} dataset is unrivalled in its coverage and consistency, effectively offering the first complete subsurface picture of the entire passive margin in one contiguous volume. Such a comprehensive view is invaluable for regional prospectivity analysis: it allows exploration teams to correlate stratigraphy and structure from one basin to the next, understand how major tectonic elements like shelf breaks or hinge zones extend along the margin, and pinpoint underexplored sectors that analogously resemble known productive areas.

To complement the seismic, TGS has deployed its powerful Facies Map Browser (FMB) tool for east coast India, marking the first application of this advanced geological interpretation

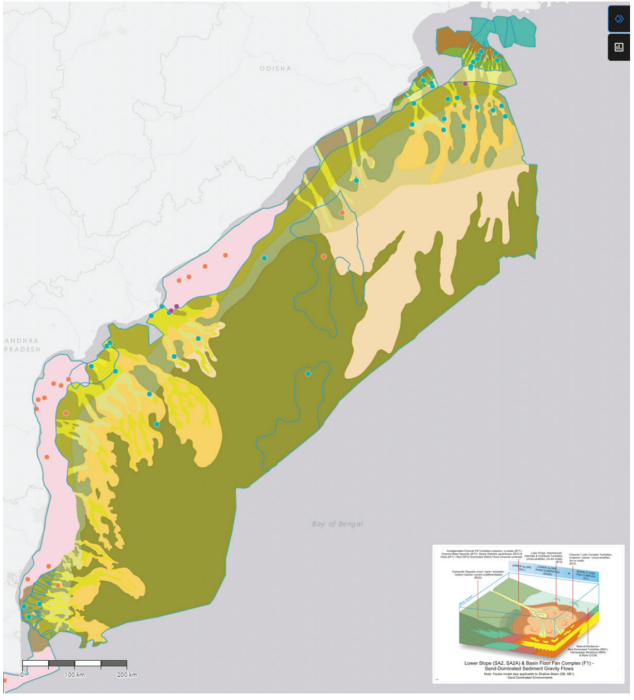

Figure 6 GDE map from the web-based facies map browser for one of the potential reservoir intervals with an inset block diagram highlighting the depositional environment.

product in the region. The east coast India FMB integrates an extensive library of well data (from exploration and appraisal wells that have been drilled offshore India over the decades) with the seismic interpretation in a sequence stratigraphic framework. Geoscientists have built a unified stratigraphic column for the east coast basins and mapped depositional facies for each sequence/age, leveraging well logs, biostratigraphy, core data, and regional seismic markers. The result is a series of Gross Depositional Environment (GDE) maps and facies distribution maps that are tied to actual well observations and constrained by seismic data (Figure 6). For example, the FMB can show the extent of Late Cretaceous fluvial-deltaic sands in the Cauvery Basin versus time-equivalent marine shales in the deeper Krishna-Godavari Basin, all in a consistent stratigraphic context. This gives explorers a head start in identifying where reservoir-quality sands or viable source rocks are likely to be present, even in areas with sparse drilling.

Such data-driven interpretation is supporting operators in derisking assets and identifying new prospects in India's offshore. For instance, consider the frontier deepwater areas of the Mahanadi Basin and the Bengal Fan (offshore Odisha and West Bengal). These areas have very few wells, but the regional 2D^{cubed} seismic and FMB work together to model the basin fill. Geoscientists can identify large submarine fan complexes on seismic and then use the FMB's calibration from wells to infer likely sand presence and reservoir quality. This helps in delineating leads for further 3D seismic or eventual drilling. In proven basins like Krishna-Godavari (KG), where major gas fields (e.g., the Dhirubhai deepwater fields) have been found in Miocene-Pliocene turbidites, the focus is shifting to both shallower plays (e.g., Pliocene channels in slope settings) and deeper plays (e.g., syn-rift Early Cretaceous prospects). TGS's Mega 3D reprocessing project in the KG Basin (announced in 2025) will reprocess ~16,900 km² of legacy 3D data with the latest PSTM/PSDM and FWI methods. The goal is to obtain contiguous, high-resolution images of both the main reservoir targets and the deeper basement-involved structures that could host secondary plays. When complete by 2026, this mega-merge volume will further enhance subsurface imaging in KG, analogous to the Malay Basin project in Malaysia. It is anticipated that such data will be crucial for companies to evaluate blocks on offer in future OALP bidding rounds and to plan appraisal campaigns on existing discoveries.

Overall, India's east coast exploration is being transformed. Instead of relying on an isolated patchwork of surveys or partial data, operators now have access to an integrated platform (seismic + wells + depositional models) covering the entire margin. This accelerates exploration and reduces uncertainty significantly – companies can make informed decisions on which play segments to chase and which to avoid. Bringing global best practices to India means the upcoming exploration campaigns can leverage decades of geoscience innovation, focusing the drill bit on the highest potential targets and helping India meet its energy ambitions.

The Critical role of modern subsurface data in derisking Asia Pacific exploration

Modern subsurface data is fundamental to successful exploration today. Enhanced seismic datasets and innovative geoscience

methodologies have dramatically improved exploration outcomes by reducing uncertainty and identifying viable targets. Key contributions include:

- **Regional context and play identification:** Comprehensive regional datasets (2D^{cubed} volumes, mega-merged reprocessed 3D seismic surveys and TGS' FMB databases) provide critical insights into basin architecture and petroleum systems. Examples include the seamless 3D seismic volumes in peninsular Malaysia, which revealed previously overlooked deep targets such as Bekok Deep, and the India East Coast 2D^{cubed}-volume, highlighting deltaic sequence continuity across block boundaries.
- **Improved imaging and new targets:** Advanced processing technologies, such as broadband acquisition, deghosting, high-density velocity analysis, and Full Waveform Inversion (FWI), significantly enhance seismic imaging. These methods have successfully identified deeper reservoir targets in East Java, improved imaging beneath complex carbonate overburden offshore Sabah, and delineated subtle stratigraphic traps in Malaysia's Malay Basin. Enhanced seismic imaging directly correlates to improved geological confidence and new exploration opportunities.
- **Data integration and accessibility:** Integrating seismic and well data into cohesive, user-friendly interpretation tools, such as Facies Map Browser (FMB), allows rapid analysis and geological prediction. This integrated approach accelerates the identification of high-quality reservoirs and source rock potential across large underexplored regions, significantly streamlining exploration decisions and collaborative analysis.
- **Risk mitigation and faster decision cycles:** High-quality subsurface data reduces exploration risk by improving geological certainty, allowing companies to prioritise prospects with higher potential and minimise futile exploration activities.
- **Cross-border insights:** Comprehensive datasets spanning national boundaries offer strategic advantages by providing a regional geological context across borders, enabling operators to reduce geological risks and avoid surprises. Cross-border seismic datasets, such as those covering the Bengal Fan from Bangladesh to India or those spanning Malaysia and Indonesia, support informed decision-making and enhance exploration efficiency.

Outlook: Data-shaped exploration ahead

The role of advanced seismic data in exploration will grow increasingly critical in Malaysia, Indonesia, India, and other Asia Pacific regions. In Malaysia, improved data coverage in Sabah and continuing seismic enhancements in the Malay Basin will continue to fuel exploration interest. Indonesia's exploration will increasingly target deeper plays and frontier basins, benefiting from enhanced data resolution and integration. Exploration of India's East Coast will leverage comprehensive seismic data and interpretation tools to meet ambitious hydrocarbon production targets. Similarly, Bangladesh's frontier exploration potential in the Bengal Fan will be increasingly realised through advanced seismic data applications, significantly reducing geological uncertainty.

In conclusion, the effective application of advanced subsurface data remains core to future exploration success in the Asia Pacific region. The combination of modern seismic acquisition, sophisticated data processing, and integrated interpretation platforms significantly enhances geological understanding and exploration success, reinforcing the essential role of data-driven approaches in uncovering new oil and gas resources.

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