ENERGY GROUP

DEEPWATER SANDSTONES: NEW PARADIGMS, NEW FRONTIERS

23-24TH SEPTEMBER 2026

The Geological Society, Burlington House, Piccadilly, London

It has been 30 years since the publication of GSL Special Publication No. 94 'Characterisation of Deep Marine Clastic Systems'. At that time the move to explore and develop deepwater reservoirs in present day deepwater settings was beginning to gather pace, but many significant deepwater discoveries were still to be made. Prevailing paradigms about process and product were changing as workers in the field focused on developing an understanding that a wider range of processes beyond classical turbidity currents were responsible for depositing and shaping deepwater sandstone deposits.

30 years later depositional models and process understanding has evolved significantly, leading to the successful deployment of concepts that have driven exploration to integrate new ideas including the role of mass-transport complexes and a wider range of particulate sediment gravity flow processes. A much deeper understanding of post-depositional remobilisation and it's role in shaping subsurface architectures and influencing fluid flow and petroleum recovery has also emerged. Vast deep-water discoveries have been developed and now accumulated significant production history, providing a wealth of data sets that have dramatically improved characterisation of deep-water systems. Tertiary reservoirs have been extensively developed, and today the focus has shifted decisively to older Cretaceous systems around the circum Southern Atlantic margins. Continued advances in geophysical technology, seismic data acquisition and processing, including 'AI/ML' driven interpretation tools, have contributed to our ability to visualise, map and characterise these systems in the subsurface.

30 years on from this key Society publication new paradigms and frontiers are being explored in the field. This symposium aims to showcase developments, insights and case studies from the last three decades and bring together geoscientists and practitioners working on deepwater sandstones from across academia, industry and government organisations.

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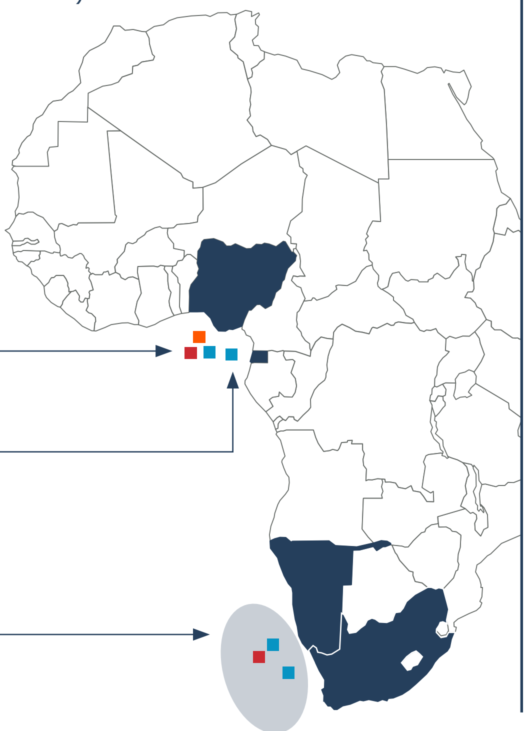

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Shareholder returns since 2022:
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Deepwater Sandstones: New paradigms, new frontiers

23-24 September

Burlington House, London

Final Programme

Workshops - 22 September *Both workshops require separate registration*	
09.00 – 12.00	**Advanced Interpretation of Deepwater Sedimentary Systems from 2D and 3D Seismic Data**
13.00 - 16.00	**Deep water reservoir architecture - a virtual field trip from around the World?**
Day One	
08.30	**REGISTRATION**
09.00	**Welcome**
09.15	**KEYNOTE** **After 20 Years and 700 High-Impact Exploration Wells: What Has Deepwater Sandstone Exploration Delivered** Andrew Jackson
	SESSION ONE New Frontiers: Emerging Basins and Giant Deepwater Systems
09.40	**Imaging an Emerging Deepwater Fairway: New 3D Seismic Insights into Stacked Channel and Fan Systems Offshore Sierra Leone** Peter Browning-Stamp
10.05	**Giant deepwater sandstones yet to be discovered in the world largest frontier province; the Bay of Bengal, offshore Bangladesh** Elisabeth Gillbard
10.30	**BREAK**
10.55	**Comparing Apples with Oranges – The depositional and structural styles of Block 1 CBK, Offshore South Africa** James White
11.20	**Hot Crust & Cryptic Elephants - Cretaceous deep-water systems of the Walvis Basin, Namibia** Niall Sayers
11.45	**Exploring Giant Upper Cretaceous Deepwater Turbidite Systems Offshore Equatorial Guinea: A New Frontier for Stratigraphic Trap Exploration** Chris Johnston
	SESSION TWO Insights: Advances in Deepwater Systems, Processes, and Architecture
12.10	**Transport Fairways and Reservoir Characterization of Deep Marine Sediments, Offshore Northern Borneo** Melissa Johansson
12.35	**LUNCH**

13.35	**Mass-transport complexes responding to tilt-block exhumation in deep-water settings: A new exploration paradigm** Tiago M. Alves
14.00	**3D Seismic Characterisation of Miocene–Quaternary Mass Transport Complexes in Offshore Southwestern Black Sea** Deniz Yağmur Kayhan
14.25	**Sedimentology with consequences. How deepwater studies affect the energy industry** Daniel Minisini
14.50	**BREAK**
15.15	**Deepwater Sandstones - Highlights from Modern 3D Seismic Observations** Neil Hodgson
15.40	**Contourite Sands: Character and Challenge** Dorrik Stow
16.05	**Evolving Understanding of Reservoir Connectivity in the Ntomme Deepwater Sandstone Reservoir, Offshore Ghana** Sydney Crentsil
16.30	**Closing**
17.00-18.00	**Drinks reception** ***Sponsored by***

Day Two	
08.30	**REGISTRATION**
09.00	**Hybrid gravity-bottom current (turbidite-contourite) systems in the subsurface: models for deep-water deposystems with predictive stacking patterns, geometries and reservoir distribution** Professor Bryan T Cronin
	SESSION THREE Insights: Advances in Deepwater Systems, Processes, and Architecture
09.25	**Sinkites and buoyancy-driven stratigraphic inversion in the northern North Sea** Jan Erik Rudjord
09.50	**Deep-Water Depositional Systems: Reservoir and Retention Styles** Rene Jonk
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	SESSION FOUR Surveillance, Connectivity and Recovery
10.40	**Connectivity & oil recovery within deepwater clastic reservoirs of the Schiehallion Field** Doug Watson

11.05	**Using spectral decomposition and 4D seismic to unlock bypassed oil and improve pressure support in vertically stacked reservoirs in Niger Delta** Romel Arellano
11.30	**Geophysical monitoring and novel data integration for the Ormen Lange field** Øystein Sømme
11.55	**Locating the remaining oil in the Buzzard field** Robert Webber
12.20	**LUNCH**
	SESSION FIVE Technology and Characterisation: Seismic, Modelling and Digital Outcrops
13.30	**Clear as Mud? Using Constrained Forward Modelling to Bring Rigour to Deepwater Turbidite Interpretation — An Antipodean View** Alex Wilson
13.55	**BREAK – Poster Session**
15.00 Virtual	**Digital outcrop models synthesize legacy and new outcrop data: An example from the Brushy Canyon Formation, Delaware Mountain Group, Permian Basin, Texas** Zane Jobe
15.25	**From Injectites to Sinkites: rethinking Paleogene remobilized sands in the Northern North Sea** Jan Erik Rudjord
15.50	**ForwArd STratigraphic (FAST) modelling of turbidite systems** Chris Stevenson
16.15	**Bridging the scale gap between well tests and petrophysics with ultra-fine sector models** Luke Johnson
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The Energy Group of the Geological Society would like to thank the following for their support for this conference:

Conference Sponsors:

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ORAL ABSTRACTS
(In Programme Order)

Session One: Geoscience for Cable Routing, Burial and Protection

KEYNOTE: After 20 Years and 700 High-Impact Exploration Wells: What Has Deepwater Sandstone Exploration Delivered

Andrew Jackson

Abstract

This presentation reviews the performance and outcomes of high impact1 deepwater sandstone exploration wells drilled in present day water depths >500m since 2007. Drilling activity and performance is reviewed with a focus on the key basins that have delivered the greatest success. The talk also highlights the most significant deepwater sandstone wells planned over the next 12 to 18 months that could shape the future of deepwater sandstone exploration.

Over the past 20 years, deepwater sandstones have been a major focus for high impact exploration drilling, being the primary target in two thirds of offshore high impact wells drilled in water depths greater than 500m. Of the 712 wells that targeted deep water sandstone reservoirs, 387 resulted in discoveries, including 171 potentially commercial finds, delivering a commercial success rate (CSR) of approximately 24% and a technical success rate (TSR) of 54%.

Deepwater sandstone exploration has contributed around 65bnboe of discovered commercial resources globally, including ~23 billion barrels of oil and 249 tcf of gas. The Atlantic Margins have been particularly significant, accounting for ~46% of deepwater sandstone tests and 39% of the commercial resources discovered, equivalent to around 23bnboe. It has also hosted several of the industry's most important frontier exploration successes and promises to play a key role in future exploration.

The Suriname-Guyana Cretaceous turbidite play, unlocked by the 2015 Liza discovery, is the largest oil play to have emerged in the period at >15bnboe and has reinvigorated the search for the next major Atlantic Margin play. While Namibia's Orange Basin has delivered promising discoveries, it appears at present unlikely to rival the scale of Suriname-Guyana, and reservoir deliverability and gas management remain key barriers to commercialisation.

Exploration has ventured into ever deeper waters but commercial success has been elusive with only eight of the 86 wells drilled in ultra deepwater (>2500m) resulting in commercial discoveries and only two of these currently in production. Commercialisation timelines are also lengthy in deep water exploration. Since 2007,

the median time from licence award to discovery was ~10 years and the median time from discovery to production ~8.6 years.

Imaging an Emerging Deepwater Fairway: New 3D Seismic Insights into Stacked Channel and Fan Systems Offshore Sierra Leone

Authors: Peter Browning-Stamp, Ian Bulley

Organisation(s): FA Oil

Abstract
The deepwater Sierra Leone–Guinea Basin remains one of the least explored segments of the Equatorial Atlantic margin despite proven petroleum systems, multiple hydrocarbon discoveries, and its geological affinity to several highly productive transform-margin basins. Historically, exploration has been constrained by sparse deep-well control and limited seismic imaging, resulting in significant uncertainty regarding reservoir distribution, quality, and deepwater depositional architecture.

A recently acquired 3D seismic survey offshore Sierra Leone provides the first opportunity to image the basin-scale organisation of deepwater sediment fairways across a large portion of the continental slope and basin floor. Interpretation of the new dataset reveals a basin-scale sediment-routing system comprising stacked Upper Cretaceous and Paleogene channels, fans, and mass-transport complexes, providing the first detailed view of the deepwater depositional architecture of the Sierra Leone margin. The data reveal multiple significant episodes of deepwater sediment delivery, the development of laterally extensive fan complexes, and vertically stacked reservoir fairways associated with long-lived sediment-routing systems.

These observations provide important new insights into the evolution of transform-margin deepwater systems and reveal depositional architectures comparable to hydrocarbon-bearing channel and fan complexes recognised elsewhere along the West African margin, including recent discoveries in Côte d'Ivoire and Liberia. The study highlights how modern 3D seismic data are redefining reservoir distribution, trap styles, and exploration potential within an emerging frontier basin, while offering broader lessons for the evaluation of underexplored deepwater sandstone plays worldwide.

Giant deepwater sandstones yet to be discovered in the world largest frontier province; the Bay of Bengal, offshore Bangladesh

Authors: Elisabeth Gillbard, Verity Agar

Organisation(s): TGS

Abstract
The Bay of Bengal is the receiving basin for the world's largest delta system, the Ganges-Brahmaputra-Meghna Delta. The immense sediment supply has constructed the largest submarine fan on Earth, yet the region remains almost entirely unexplored for petroleum. 12,000 line km of long-offset 2D seismic data, alongside historic well data and regional geological understanding has provided extensive insight into the reservoir characteristics and distribution of deepwater sandstones across the offshore Bangladesh margin.

Using high-resolution seismic data, we have mapped out the distribution of the evolving facies and reservoir architecture over time, from early distal deep-marine fans through to the prograding shelf and associated slope, mass transport and deep-marine sand systems. Depositional models of comparable settings allow for the identification of huge sediment redistribution systems since the Miocene. Large-scale canyons and channel complexes, with sand-rich cores supply sediment to the slope and deep basin whilst avulsion processes over time result in the lateral and vertical redistribution of the entire system. Regional lowstand events identified on the shelf can be directly associated with an increase in sediment volume to the slope and basin floor.

Predictable slope facies are identified, with large-scale aggrading channel systems often associated with mass-transport complexes acting as seal, intraformational source rocks and also reservoir facies and conduits.
Ultimately these slope systems provide sand material to the unconfined basin floor setting. Basin floor fans are readily identified within the data, characterised by gigantic thin or stacked, high-amplitude and lobe shaped bodies which can be traced for many km. Coarse-grained indicators such as sediment waves and channel cores have been identified within the fan bodies.

Predictive reservoir models and high-resolution seismic data allow for the identification of deep-marine sand systems within the frontier Bay of Bengal, opening up the region as a significant new petroleum province.

Comparing Apples with Oranges – The depositional and structural styles of Block 1 CBK, Offshore South Africa

Authors: James White, Jan Tomanek, Niall Sayers

Organisation(s): Eco Atlantic Oil & Gas

Abstract
Block 1 CBK is strategically located within the Orange Basin offshore South Africa and covers approximately 20,000 km² of highly prospective acreage. The licence lies within one of the world's most exciting emerging petroleum provinces, following a series of world-class oil discoveries offshore Namibia, including Venus, Graff, Mopane and Capricornus, which have confirmed the presence of a prolific regional petroleum system.

Unlike many frontier licences focused on a single play, Block 1 CBK encompasses an exceptional diversity of depositional environments and structural styles. The block extends from shallow-marine shelfal settings to deepwater basin-floor environments, capturing a broad spectrum of reservoir systems including fluvial-deltaic sandstones, slope channels, turbidite complexes and Albian-aged basin-floor fans. This geological diversity provides multiple independent exploration opportunities across several stratigraphic intervals.

Prospectivity is supported by a wide range of trapping styles, including structural, stratigraphic and combination traps. Fault-bounded closures, rollover anticlines, pinch-outs, channel-levee systems and basin-floor fan complexes are all recognised within the licence, creating a diverse portfolio of exploration targets and reducing dependence on any single play concept.

Although the Namibian discoveries demonstrate the effectiveness of the regional petroleum system, Block 1 CBK represents more than a direct analogue. Variations in sediment routing, source rock distribution, crustal architecture and structural evolution have generated multiple play fairways across the licence, each with its own exploration potential. This geological complexity provides opportunities to target hydrocarbons in several reservoir intervals and trapping styles rather than relying solely on Albian basin-floor fan plays.

With its large areal extent, multiple proven play concepts, diverse geological settings and proximity to recent world-class discoveries, Block 1 CBK represents a compelling exploration opportunity. Continued seismic reprocessing and integrated geological evaluation are expected to further refine prospectivity and identify a portfolio of drill-ready prospects capable of delivering material exploration success.

Hot Crust & Cryptic Elephants - Cretaceous deep-water systems of the Walvis Basin, Namibia

Authors: Niall Sayers, James White, Jan Tomanek

Organisation(s): Eco Atlantic Oil & Gas

Abstract
Situated over 600 km north of the Orange Basin discoveries, the Walvis Basin offshore Namibia features Cretaceous deep-water clastic plays which are every bit as compelling, revealed on 2D and 3D seismic data sets, with minimal well penetrations to date.

In the Albian, initial routing of gravity-driven depositional systems was influenced by both marginal subsidence and plume uplift from the Tristan-Gough mantle plume, resulting in many early channels running sub-parallel to the present margin. This influence decreases into the Late Cretaceous. The clastic sedimentary systems are more locally derived than the Orange Basin, sourced from multiple entry points along the margin, creating the potential for high along-strike variability in sediment composition. The provenance areas feature large regions of meta-sediments and granites in the present day, albeit with increasing presence/palaeo-thickness of Etendeka flood basalts towards the Walvis Ridge in the North.

Seismic data reveal prominent stacked and laterally migrating channel systems in the Upper Cretaceous, connecting to giant outboard fan complexes. These comprise a set of potential reservoir targets in the basin. Deeper in the stratigraphy a more subtle play holds great potential – Albian fans of comparable size to Venus or larger, fed by more subtle channel systems from a relatively proximal shelf-edge.

The prospectivity of these systems has been unlocked by recent advances in understanding of the heat flow underpinning oceanic crust in distal margin settings. Planned acquisition of new 3D seismic data is expected to cast further light on these plays.

Exploring Giant Upper Cretaceous Deepwater Turbidite Systems Offshore Equatorial Guinea: A New Frontier for Stratigraphic Trap Exploration

Authors: Chris Johnston, Lisa Fullarton

Organisation(s): Meren

Abstract
Recent exploration in offshore deepwater Equatorial Guinea/São Tomé & Príncipe area has renewed industry focus on this largely underexplored area in the Gulf of Guinea. Meren's deepwater Equatorial Guinea acreage (acquired in 2023) provides access to what is believed to be the sweet spot of an extensive Upper Cretaceous deepwater turbidite fairway, with the potential to host multiple giant stratigraphic hydrocarbon accumulations.

This presentation reviews the regional geological framework and petroleum system elements underpinning the opportunity, integrating seismic interpretation, well calibration from L-2, and basin modelling results tied to key exploration wells. The study demonstrates the presence of large-scale, lobe-dominated turbidite fan complexes deposited in a deepwater setting, offering significant reservoir development and extensive stratigraphic trapping potential. Conventional seismic mapping of these systems can be challenging due to their subtle seismic expression and complex geometries. Examples are presented showing how new technologies, including the PaleoScan seismic interpretation platform, enhance the visualization of fan architectures, improve reservoir mapping and geological understanding, and reveal fairway-scale exploration targets that may not be readily apparent using traditional interpretation methods alone.

The results highlight a compelling combination of proven hydrocarbon charge, short migration pathways, well-developed reservoirs, and significant yet underexplored trap potential. Together, these factors position offshore Equatorial Guinea as a strong candidate for the next major exploration hotspot in West Africa and a potential home to the next generation of giant deepwater discoveries.

Transport Fairways and Reservoir Characterization of Deep Marine Sediments, Offshore Northern Borneo

Authors: Melissa Johansson Dorrik Stow

Organisation(s): Geode-Energy Ltd, Herriot Watt University

Abstract
High-resolution seafloor mapping of the continental slope offshore NW Borneo is combined here with analogue studies of the West Crocker Formation exposed onshore. These case studies provide critical insight on the processes, deposits and likely architecture of the hydrocarbon-rich succession in the subsurface. Rapid uplift of the accretionary margin yielded the Crocker-Rajang Range, which reaches a height of over 2000 m. This has provided abundant sediment supply to form the Baram Delta and associated slope to basin sedimentary succession. The present-day shelf is 50-70 km wide, fed by a series of short-headed rivers and the broader Baram river delta system. The slope has a distinctive stepped profile comprising a series of slope-parallel elongate mini basins separated by shale-cored ridges. These ridges are breached by fault-controlled transport fairways. The North Borneo Trough reaches a depth of 3300 m. The sediment facies are characterised by large submarine slides (volume 1200 km3, area 5300 km2, thickness ~ 240m), complex mass transport deposits (MTDs), deep water massive sands (DWMS), and thick to thin-bedded turbidites. The same deepwater facies are observed within the West Crocker Formation in what we interpret as two principal facies associations: (a) an Transport Fairway facies association, dominated by slides, MTDs, DWMS and hybrid turbidite-debrites, in units up to 120 m thick; and (b) a quiescent Muddy Slope facies association, dominated by thin and very thin-bedded turbidites and rare hemipelagites, in units up to 80 m thick. The former represent focused downslope sedimentation along a tectonically active margin, whereas the latter represent periods of relative quiescence and slope-wide sedimentation. Both facies associations can provide reservoir prone facies

Mass-transport complexes responding to tilt-block exhumation in deep-water settings: A new exploration paradigm

Authors: Tiago M. Alves

Organisation(s): 3D Seismic Lab - Cardiff University, Department of Earth and Environmental Sciences

Abstract

Mass-transport complexes are often recognised in deep- and ultra-deep regions of continental margins where they comprise primary geological reservoirs. They can be part of thick sequences deposited near an evolving syn-rift topography, comprising coarse-grained intervals within otherwise fine, distal-margin sediment. This talk classifies and critically assesses the presence, and tectono-stratigraphic significance, of mass-transport complexes offshore West Iberia, where re-processed seismic data image strata near DSDP and ODP boreholes. A field analogue from SE Crete will be discussed, and geological maps, regional transects, lithological columns and outcrop photos compared with seismic data. On Crete, the exhumation of basement tilt-blocks was episodic and led to accumulation of discrete coarse-grained mass-wasting deposits in nearby depocentres; boulder-conglomerates and coarse-grained sandstones directly sourced from exhumed fault scarps. They form 10 to 25 m-thick crests of coarse-grained material within ‘background’ marine strata - sandy turbidites and fine-grained hemipelagites. In West Iberia, mass-transport complexes reveal a similar character to Crete, spanning the continental rifting stage (Jurassic-early Cretaceous) and the Continental Breakup stage (Aptian/Albian). As the outcrop data from Crete replicates the setting imaged on offshore West Iberia, we postulate that hyperextended blocks close to the loci of continental breakup have been completely exhumed and eroded under a shallow water column, if not at the surface. Our outcrop analogues are important as they reveal that mass-wasting facies are controlled by: a) the relative proximity to active faults and adjacent footwall blocks to basin depocentres, b) the relative position (depth and relative height above sea level) of footwall blocks, and c) the nature of the basement units eroded from adjacent footwall blocks. Importantly, the relative position of deep-water mass-transport complexes in Iberia stresses their potential as both geological reservoirs and mineral placers; mass-transport of sediment have eroded lower-crust and putative mantle rocks to deposit thick, broad coarse-grained intervals.

3D Seismic Characterisation of Miocene–Quaternary Mass Transport Complexes in Offshore Southwestern Black Sea

Authors: Deniz Yağmur Kayhan, Sevinç Altıner, N. Özgür Sipahioğlu

Organisation(s): General Directorate of Mineral Research and Exploration of Türkiye (MTA), Middle East Technical University, Turkish Petroleum Offshore Technology Center

Abstract
The SARIYER-3D seismic dataset, covering an area of 1575 km2, was used to characterise mass transport complexes (MTCs) in offshore southwestern Black Sea. The dataset was acquired using the ORUÇ REİS Seismic Research Vessel and processed by the General Directorate of Mineral Research and Exploration of Türkiye (MTA), Department of Marine Research.

Seismic interpretation was carried out on a series of key stratigraphic horizons, from which time-structure, isochron, RMS amplitude and variance maps were generated. MTCs were interpreted based on their dim, low-amplitude and chaotic seismic reflections, and their expression on attribute maps. A total of thirteen MTCs, ranging from 11.2 to 319 km2 in area and from 0.4 to 30 km3 in volume, were identified within three stratigraphic intervals. They were characterised following a systematic workflow, analysing their internal architecture, effects on surrounding sediments, possible roles in petroleum system, potential triggering mechanisms, and connections with gases and gas-related structures.

These MTCs were classified using a two-step approach. In the first step, they were categorised into Type 1 and Type 2 based on age, dimensional characteristics, effects on surrounding sediments, and whether they are attached or detached. Three Messinian and older MTCs were classified as Type 1, which have outliers in area-length plot, do not show noticeable impacts on surrounding sediments and are attached. In contrast, ten post-Messinian MTCs were classified as Type 2, which do not show outlier values in area-length plot, have effects on surrounding sediments and are detached. In the second step, Type 2 MTCs were further subdivided into Type 2-A and Type 2-B according to the observation of distinct internal structures and the presence of gases among potential triggering mechanisms. The findings indicate that Type 1 MTCs were primarily triggered by regional-scale processes, whereas Type 2 MTCs were associated with local-scale triggers.

Sedimentology with consequences. How deepwater studies affect the energy industry

Authors: Daniel Minisini

Organisation(s): Rice University, ExxonMobil

Abstract
In the great scheme, we researchers push the boundaries of knowledge to benefit humankind. Part of this "good" is solving problems that matter. Among the most critical is understanding the natural resources useful for the energy systems that feed Society At Large. In this view, researching deepwater sandstones, helps us develop datasets, methods and ideas to find, evaluate and produce from depositional systems capable of hosting fluids (oil, gas, brines) and elements (H, He) essential for cost-effective energy. Mainly, our datasets help calibrate the several models used to make predictions, and our ideas/theories reduce the uncertainty to make decisions.

The contribution explains with real cases how the single studies on deepwater find tangible applications in Industry. The examples aim to help the community to better determine key questions, methods, and scales of future research projects. Some of the examples of key applications include: (1) the influence of trace fossils on rock geomechanics, with implications for wellbore stability and drilling strategies; (2) early diagenetic processes that either preserve or destroy reservoir porosity, affecting storage capacity and flow behaviour; (3) the evolution of channels and lobes, which governs stratigraphic architectures and the efficiency with which these bodies drain hosted fluids; (4) sedimentary features that control fracture propagation under stress, informing stimulation approaches in tight sandstones; (5) mass transport–deposit scarps that generate localized mini basins where sand accumulates; (6) lateral facies variability, a critical element for constructing chronostratigraphic frameworks that integrate data and interpretations across disciplines.

Deepwater Sandstones – Highlights from Modern 3D Seismic Observations

Neil Hodgson

Pending

Contourite Sands: Character and Challenge

Authors Dorrik Stow, Alaister Shakerley

Organisation(s): Heriot Watt University, Larus Energy Limited

Abstract
The largest present-day, deepwater sandy deposits are contourite sand sheets. The best known is the Cadiz sand sheet on the Iberian margin. This covers an area of 4000km^2, with an estimated thickness of 800m, an inferred net-to-gross ratio in excess of 50% sand, and individual sands 1-40m thick. The sand sheet passes into three discrete contourite channels, the largest of which funnels sand alongslope and downslope to water depths exceeding 1200m. This channel is floored by a series of large active sand waves and gravel lag deposits. The Falkland sand sheet off southern Argentina extends over 30,000km^2 across the Falkland Terrace, comprising multiple sand sheets, ribbons, and scour and fill elements. Still larger in scale, the Ryukyu sand sheet south of Japan demonstrates a clear link between shelf sand supply and deepwater contourites.

Detailed analyses reveal clean, well-sorted sands that would yield excellent reservoir characteristics on burial. Sandy contourite facies models are markedly different from the bi-gradational model for finer-grained contourites and from those of turbidites. They show current-induced sedimentary structures (parallel and cross-lamination), together with large-scale bioturbation. Textural properties show fine and very fine sands controlled by normal bottom-current transport with increased winnowing and improved sorting as grain size increases. Medium and coarse-grained sandy contourites, by contrast, show the effects of intermittent bedload transport and winnowing. Porosity-depth relationships show a high initial porosity (50-60%) and a systematic decrease with depth to around 35-40% near 500m burial depth. Models of porosity with depth yield contourite porosity exceeding 10% at 2500 m burial depth.

These characteristics are also exemplified by outcrop examples: Miocene sandstones in the Moroccan Rifean Gateway, Oligo-Miocene calcarenite contourites on a slope terrace in Cyprus, Quaternary shallow-water contourites on Boso Peninsula of Japan, and probable spillover contourites in Okinawa. Subsurface examples are mostly of mixed or hybrid turbidite-contourite systems, with prolific hydrocarbon discoveries in the Coral and Mamba systems. Downslope sand supply and alongslope reworking are also well-documented in the Campos Basin off Brazil. Most recently, high-quality seismic data from offshore Papua New Guinea has demonstrated the presence of large-scale mid-Miocene turbidite fairways linked to active tectonism. They also reveal the synchronous interaction and subsequent reworking by strong bottom currents, which have generated a wide spectrum of features seen in modern contourite sand sheets – furrows, sub-circular depressions, channels, and sediment wave fields.

Evolving Understanding of Reservoir Connectivity in the Ntomme Deepwater Sandstone Reservoir, Offshore Ghana

Authors : Sydney Crentsil, D.Scott, A.Pearce

Organisation(s): Tullow Oil

Pending

Hybrid gravity-bottom current (turbidite-contourite) systems in the subsurface: models for deep-water deposystems with predictive stacking patterns, geometries and reservoir distribution

Authors: Professor Bryan T Cronin

Organisation(s): Deep Marine Ltd

Abstract
Recent studies demonstrate that bottom (contour) currents play a major role in shaping deep-water depositional systems by reworking fine-grained turbidite sediments and modifying seafloor morphology. These processes create asymmetric levees, sediment drifts, and sediment-wave fields that generate complex seafloor topography. This topography influences the pathways of downslope turbidity currents, controlling the formation of elongate trough fills, tabular lobes, and other sand bodies that are not adequately described by traditional terminology such as channels, lobes, or splays.

Examples from the Guyana-Suriname and Côte d'Ivoire-Ghana margins show that contour currents have strongly influenced slope and proximal basin-floor systems since the Late Lower Cretaceous. Unlike shelfal longshore currents, which transport sediment westward offshore Guyana-Suriname and eastward in the Gulf of Guinea, contour currents flow in the opposite direction at slope and basin-floor depths. These currents strip fine suspended sediment from turbidity currents and deposit it as drifts, enlarged levees, or sediment-wave fields.

The resulting asymmetrical levee development profoundly affects channel architecture. Levees become enlarged on the contour-current side and subdued on the opposite side, causing channel complexes to migrate and stack systematically toward the subdued levee. Reservoir channel elements display consistent high-angle lateral offsets in the same direction. Enhanced levee asymmetry also steepens local gradients, promoting channel-margin collapse, mass-transport deposits (MTDs), and large-scale slope failures, commonly occurring on the outer flanks of channel systems.

A further consequence is the progressive and mirrored shifting of lobe complexes both on intraslope terraces and basin floors. This suggests that contour-current influence, rather than accommodation space alone, can govern stacking patterns in deep-water systems.
These geological controls have important implications for hydrocarbon exploration and development. Understanding contourite-turbidite interactions improves prediction of reservoir geometry, guides optimal well design and placement, and informs subsea infrastructure planning, ultimately reducing development complexity and project costs.

Sinkites and buoyancy-driven stratigraphic inversion in the northern North Sea

Authors: Jan Erik Rudjord, Mads Huuse

Organisation(s): Aker BP, Manchester University

Abstract
Km-scale mounds and ridges, up to 200m high, along the mid-Miocene unconformity in the northern North Sea consist of sand underpinning Late Oligocene ooze-rich claystone rafts. They have been attributed to mud diapirism, differential compaction, injectites, or gravity slides, yet key observations are inconsistent with these models. The sands are intrusive, cross-cutting laminar ooze stratigraphy while apparent absence of parent sands, evacuation sags, and feeder dikes challenges an injectite origin. Serrated sand boundaries record vertical displacement of ooze blocks, segmented by polygonal faulting, rather than gravity sliding.

Using modern 3D broadband seismic of uniform quality and an extensive well database including drill-cuttings images and mineralogical analyses, we propose that younger sands liquefied at or near the seabed, forming dense pseudo-fluids that sank into polygonal fractures in underlying, early consolidated, low-density biosilicious ooze. The ooze was displaced upward as buoyant rafts while the sand sank. Comparable density inversions are known from load casts and ball-and-pillow structures, but not previously from partly consolidated sediments across major unconformities, at kilometer scale, or over basin-scale areas.

We therefore define sinkites as a new type of reservoir caused by a new depositional/remobilization process, termed buoyancy-driven stratigraphic inversion, explaining jack-up structures, sand-filled dikes and sills, and discontinuous high-porosity and blocky sands in the Tertiary northern North Sea. The model has implications for reservoir prediction, seal integrity, migration pathways, and subsurface storage assessment.
References:

Rudjord, J.E. & Huuse, M., 2025. Km-scale mounds and sinkites formed by buoyancy driven stratigraphic inversion. Communications Earth & Environment 6, 490. https://www.nature.com/articles/s43247-025-02398-8

Rudjord et al., 2024. Sinkites, More than a Theory? Observations from a Miocene Gas Discovery, East of the Sverdrup Field. Extended abstract EAGE Oslo

Deep-Water Depositional Systems: Reservoir and Retention Styles

Authors: Rene Jonk, Brandon Harper, Howard Feldman, Gwladys Gaillot, Gustavo Zvirtes, Andrew Hurst, Vitor Abreu

Organisation(s): ACT-Geo Consulting and Training, University of Aberdeen, Feldman Geosciences,

Abstract
Deep-water sandstone reservoirs are crucial for hydrocarbon extraction and the short- and long-term storage of hydrogen and carbon dioxide. Deepwater depositional models tend to be sandstone-centric even though sand-dominated facies represent a small fraction of the total volume of slope to basin floor deposits. Moreover, aspects of flow and retention of fluids are controlled by the architecture and distribution of mudstone facies. Predicting fluid flow and retention requires integrating the architecture of these associated volumetrically dominant fine-grained strata.

Mudstones are intimately associated with processes that deposit reservoirs through gravity and contour-current flows, and consist of detrital silt-sized grains and clay-mineral aggregates. These form levees, mass-transport deposits and the fringes of distributive depositional systems. Additional deposits of pelagic sediment mix directly with the turbidites, debrites and contourites leading to a more complex architecture and rock property assemblage.

Herein, we interpret deep water systems to be deposited beyond significant influence of coastal processes such as waves, tides, and sediment cascading from river mouths. Three key factors govern the trap-seal styles of deep-water systems:

- Characteristics of the sediment delivery system are defined by the size of the catchment area, provenance of the source terrane and weathering, importantly with respect to clay mineralogy.
- Depositional profile, width of the shelf, size of the basin, as well as the slope-to-basin profile, influence the short-lived versus long-lived nature of feeder systems and the style of deposition of both reservoir and non-reservoir facies.
- Modification of reservoirs by syn- and post-depositional processes, include liquefaction and sand fluidization. These processes modify petrophysical characteristics in sandstones and mudstones, and create complex reservoir architectures, including heavily remobilized depositional sandstones and sandstone intrusions within encasing mudstone facies.

By integrating outcrop analogues, high-resolution and near-seafloor seismic data, subsurface models are produced that provide insights in predicting subsurface fluid flow and retention.

Connectivity & oil recovery within deepwater clastic reservoirs of the Schiehallion Field

Authors: Doug Watson, Noah Jaffey

Organisation(s): BP, Adura

Abstract
The Schiehallion, Alligin and Loyal fields are located 130km west of the Shetland Islands. They have produced oil through 76 currently active wells, via the largest subsea oil production infrastructure in the UK. These fields produce oil from a variety of Palaeocene submarine gravity flow deposits, using a waterflood recovery mechanism. The size of these fields (covering an area of ~300 km2), relatively high density of wells, and almost 30-year production history and regular surveillance data acquisition (including nine 4D seismic monitors) have built a unique understanding of the reservoir architecture, fluid connectivity and of how recovery efficiency variability.

In-field examples of connectivity and recovery efficiency are shown from sub-environments including peripheral lobe, proximal lobe, channel-lobe transition zone, erosionally confined channel complex, weakly confined channel complex and final channel fill. Encountered recovery issues are discussed. Examples are shown of how different well types and configurations (injector-producer placements) have been designed to optimise waterflood recovery, adapting to the reservoir architecture within each depositional environment.

Using spectral decomposition and 4D seismic to unlock bypassed oil and improve pressure support in vertically stacked reservoirs in Niger Delta

Authors: Romel Arellano, Lisa Fullarton, Sebastian McDonald

Organisation(s): Meren Energy

Abstract
Deep water, structurally complex reservoirs in the Niger Delta present continual challenges for reservoir management, particularly when compartmentalization creates multiple fluid segments within vertically stacked reservoir intervals. This article integrates spectral decomposition, 4D seismic interpretation, and water injection optimization to characterize reservoir architecture, diagnose injection inefficiency, and recover bypassed oil in a highly faulted four-way dip anticline setting in the Niger Delta.

Spectral decomposition interpretation identified stratigraphic separation between two reservoirs intervals, revealing the risk of vertical disconnection between injector and producer completions planned before production. The water injector was accordingly completed with mechanical sleeves enabling independent injection into individual reservoir intervals. During field production, 4D seismic interpretation identified depletion in the upper reservoir and active water encroachment in the lower reservoir, confirming that the injector was not effectively supporting the upper compartment.

A targeted well intervention activated the previously isolated upper modular screen sleeves in the water injector. This resulted in a 33% increase in injection rate and a 270% improvement in injectivity index, confirmed by pressure transient analysis. The offset producer responded within two months, achieving a 17% increase in oil rate accompanied by a reduction in water cut. This integrated workflow demonstrates the value of combining advanced seismic interpretation with reservoir monitoring to unlock bypassed oil and improve pressure support in structurally complex, faulted reservoirs.

Geophysical monitoring and novel data integration for the Ormen Lange field

Authors: Øystein Sømme

Organisation(s): Shell

Abstract

Ormen Lange is Norway's second largest gas field, located in the southern Norwegian Sea. Discovered in 1997 and on production since 2007, the field produces dry gas with minor condensate from the high-quality Egga turbidite sandstone reservoir, with production transported approximately 120 km to the Nyhamna onshore facilities. A key subsurface and business challenge is predicting aquifer influx and water breakthrough, as water-handling capacity at Nyhamna is limited and directly influences long-term production and development decisions.
To manage this risk, Ormen Lange has a mature geophysical surveillance program that integrates pressure monitoring transducers (PMT), 4D seismic and time lapse gravity. The 2025 gravity survey represents a significant operational milestone: Reach Subsea's Reach Remote 1, an uncrewed surface vessel with an integrated work-class ROV, completed the acquisition unassisted. The survey met the required data-quality standards while reducing offshore personnel exposure compared with conventional campaigns.

This talk describes the surveillance strategy, acquisition approach, and integration workflow used to convert measurements into reservoir insight. Time-lapse seismic-derived water saturation changes are forward modelled as gravity responses and compared directly with measured gravity data. This enables independent seismic and gravity observations to be assessed in a common domain, highlighting where they agree and where spatial discrepancies remain.

The resulting constraints are incorporated into Assisted History Matching and dynamic model updates, improving confidence in aquifer movement forecasts and water-breakthrough predictions. By combining the spatial sensitivity of 4D seismic with the mass-change sensitivity of gravity, the workflow strengthens reservoir understanding and supports more robust decisions for future Ormen Lange field development.

Locating the remaining oil in the Buzzard field

Authors: Robert Webber, Murdo Paterson, Ben Tomsett

Organisation(s): CNOOC International

Abstract
The Buzzard Field, a UK North Sea deepwater reservoir with more than 850 MMbbl of cumulative oil production, is in post plateau decline having accumulated significant production history. The reservoir is a stratigraphic trap formed of stacked Upper Jurassic turbidite reservoirs, that pinch out within Kimmeridge Clay Formation mudstones. These reservoirs are formed by thick units of high reservoir quality sandstone, that dip to the East with >1000ft of relief within the oil column.

A comprehensive subsurface re evaluation that has been undertaken to identify remaining oil volumes and refresh the opportunity portfolio. Rather than using a reservoir simulation modelling workflow as the basis of the work, this study applies a geological and surveillance driven approach, integrating a world class production dataset with classical reservoir engineering methods.
A Surveillance Atlas was constructed to consolidate geological and production surveillance information into a unified, quality controlled framework, to facilitate effective visualisation and multi-disciplinary interpretation.

The integrated subsurface work commenced by establishing the geological controls on production, characterising the pore system to understand the rock types present and reviewing production surveillance datasets to characterise the 'style of sweep' in the reservoir and the types of opportunities in play.

The field was subdivided into drainage cells, enabling localised assessment of sweep behaviour, connectivity, and remaining oil distribution. Geological controls—including reservoir architecture, hydraulic units, stratigraphic pinchouts, and fault juxtapositions—were synthesised with surveillance observations to map baffles, barriers, and flow pathways.

Remaining oil volumes were estimated with an LTRO workflow that balanced STOIIP based recovery expectations against historical and forecast production, supported by flood front analysis and unit level production allocation. Alternative geological and connectivity scenarios were rapidly tested to constrain uncertainty.
This case study demonstrates the critical role of reservoir surveillance in characterising the geological controls on production in a deepwater depositional environment and in supporting the generation of future development opportunities.

Clear as Mud? Using Constrained Forward Modelling to Bring Rigour to Deepwater Turbidite Interpretation — An Antipodean View

Authors: Alex Wilson

Organisation(s): Eliis

Abstract
Constrained stratigraphic forward modelling (C-FSM) of deepwater turbidite systems offers a practical path to improving the rigour of subsurface interpretation workflows. Unlike conventional basin-scale approaches, C-FSM operates at seismic interpretation scale, with scenario-based depositional models tied to seismic and well lithofacies interpretations. This brings stratigraphic forward modelling within reach as a routine interpretive tool rather than a specialist research exercise.

A central contribution of C-FSM is interpretive discipline. Building a forward model requires explicit, upfront commitment to choices that conventional workflows leave implicit: the net-to-gross derived from seismic expression, the base topography controlling turbidite flow routing and deposit geometry, and critically, the sequencing of individual depositional events. In standard practice, stratigraphic intervals correlated between wells as a single formation may represent multiple discrete turbidite events — spatially separated, temporally diachronous, or sourced from distinct entry points. C-FSM makes these ambiguities visible and forces the interpreter to resolve them before the model yields internally consistent outputs.

Case studies from the Carnarvon Basin (NW Australia) and Sabah (NW Borneo, Malaysia) illustrate this workflow across contrasting settings — a drowned passive margin shelf system and a tectonically confined slope environment respectively. In both cases, scenario comparison reveals significant sensitivity of predicted sand distribution and connectivity to interpreter choices about event sequencing and net-to-gross — choices routinely under-constrained in conventional interpretation. Probability outputs from ensemble model runs provide a basis for ranking scenarios and communicating geological uncertainty to reservoir and commercial teams.

Near-term development priorities include AI-assisted matching of forward seismic models to observed seismic data to condition and rank C-FSM scenarios, alongside HPC-enabled ensemble runs at scale. Together these will substantially extend the predictive reach of the workflow.

Current C-FSM capabilities already deliver interpretive value at the scenario-building stage. This work argues that constrained stratigraphic forward modelling deserves consideration not only as a predictive tool but as a means of raising stratigraphic rigour across deepwater turbidite interpretation workflows.

Digital outcrop models synthesize legacy and new outcrop data: An example from the Brushy Canyon Formation, Delaware Mountain Group, Permian Basin, Texas

Authors: Zane Jobe, Brian S. Burnham, Christine Rossen, R.T. (Rick) Beaubouef

Organisation(s): Colorado School of Mines, VRGeoscience Limited, Sante Fe, NM, USA, RTB Geoscience

Abstract
The future of the energy industry relies on understanding increasingly complex geological settings, and geoscientists must be able to think in three (and sometimes four) dimensions to better interrogate the subsurface. While nothing replaces learning from real outcrops, digital outcrop models offer a powerful solution that provides immersive and accessible 3D geological data and enhanced context that help build spatial-reasoning and critical-thinking skills necessary to interpret sparse subsurface data. Where these models truly excel is that they provide a spatial and geological bridge between small-scale (i.e., thin section, individual beds) and large-scale (i.e. seismic) data that are hard to visualize in the field alone.

This study focuses on world-class outcrop and subsurface data from the Delaware Mountain Group of the Permian Basin, Texas that is highly relevant for conventional and unconventional reservoirs, saltwater disposal, and emerging industry applications (e.g., CCUS). Legacy data from extensive outcrop-based fieldwork documents the Brushy Canyon Formation in exceptional detail, including hundreds of measured sections (many with outcrop gamma-ray logs), photopanels, correlated cross-sections, and submarine channel- and lobe-complex mapping. We are migrating this legacy material into georeferenced and modern digital frameworks (e.g., VRGS, Petrel). In addition, we are integrating newly-collected drone-based photogrammetry and lidar, with targeted fieldwork, paleocurrent analysis, and sample geochemistry in areas not previously studied in detail. An area of particular focus is the updip paleo-slope position, where thick successions of laminated (and sometimes organic-rich) siltstones are laterally adjacent to stacked, turbidite-dominated submarine channel fills. Detailed mapping and petrographic/geochemical characterization of these siltstone intervals will improve understanding of depositional processes of these volumetrically significant slope and base-of-slope deposits.

The integrated dataset enables improved stratigraphic correlation between localities, refinement of existing facies mapping, and quantitative characterization of stratigraphic architecture at scales ranging from individual beds to channel complexes to entire submarine-fan systems. Future work is focused on extending this digital-outcrop framework both onto the platform (i.e., co-eval shelf) and into the subsurface of the Delaware Basin, and (2) developing geospatially-informed

machine-learning approaches for improved reservoir-modelling of these deep-marine systems.

From Injectites to Sinkites: rethinking Paleogene remobilized sands in the Northern North Sea

Authors: Jan Erik Rudjord, Brit Thyberg, Mads Huuse

Organisation(s): Aker BP, University of Oslo, University of Manchester

Abstract

The prospective Paleogene succession of the northern North Sea consists of polygonally faulted mudrock interbedded with turbidite sand derived mainly from the East Shetland Platform, and to a lesser extent sourced from Norway. These sands are commonly remobilized and occur abruptly as clean, high-porosity, locally forming thick bodies within dykes and beneath jack-up structures. Thin dikes are traditionally interpreted as overpressure-driven sand injectites sourced from deeper parent sands. The spatial association of thick blocky high-porosity sand below the jack-up structures with dykes and wings has likewise supported an injectite interpretation. However, the frequent absence of required underlying parent sands, together with the difficulty of generating adequate overpressure to move 100-meters-thick sand vertically, over large areas, have motivated alternative interpretations as in-situ re-mobilized depositional sand. Such interpretations, however, have yet to provide convincing depositional models for their abrupt occurrence.

We suggest that the deeper Paleogene jack-up structures formed by the process described in a recently proposed model for Miocene mounds in the region (Rudjord and Huuse, 2025). This model interprets comparable features as sinkites formed by buoyancy-driven stratigraphic inversion. In this model, liquefied seabed sand, triggered by earthquakes or water expulsion, sank into polygonal fractures in early consolidated, low-density biosiliceous ooze, thereby forcing the ooze upwards as buoyant rafts. The original biosiliceous composition (opal-A) and required inverse density contrast were subsequently obscured during burial by silica diagenesis and compaction.

This interpretation provides a common genetic model for enigmatic remobilization structures throughout the Cenozoic succession of the northern North Sea, and has important implications for Paleogene stratigraphy, reservoir prediction, and subsurface fluid-flow and seal quality assessments.

References:

Rudjord, J.E. & Huuse, M., 2025. Km-scale mounds and sinkites formed by buoyancy driven stratigraphic inversion. Communications Earth & Environment 6, 490. https://www.nature.com/articles/s43247-025-02398-8

Km-scale ooze evacuation craters formed by buoyancy-driven stratigraphic inversion in deep-water Norwegian and North seas

Abstract

Large craters, tens of kilometres wide and two hundred meters deep, occur in consolidated, polygonally faulted Brygge Formation siliceous ooze along the Mid-Miocene Unconformity in the distal deep-water Norwegian Sea. Comparable volumes of similar aged low-density ooze occur as mounds and rafts hundreds of meters above, but often downdip of their source craters, at present seabed or buried below younger sediments.

Earlier interpretations invoked diapiric ascent, gravity-slide excavation, or overpressure-driven eruptions. However, craters lacking slide evidence, together with observed 100-meter thick and several hundred-meter-wide coherent blocks of excavated ooze, are difficult to reconcile with these. Mapping the Mid-Miocene Unconformity in the Snorre area of the North Sea identifies near-closed craters of similar scale, unrelated to gravity slides but associated with giant jack-up structures of consolidated low-density biosilicious ooze underpinned by mounds of reservoir quality sand (sinkites).

We propose that the craters formed during earthquakes when early consolidated low-density siliceous ooze, buried beneath denser sediments, rose buoyantly while overlying liquefied sediment sank, producing stratigraphic inversion.
Other previously discussed mechanisms likely played a role. Hydrothermal vents from Paleogene volcanic intrusions and the regional-scale Miocene doming likely influenced the localization of the craters. Loading by thick glacial sand and clay is a prerequisite creating the density instability towards the underlying deep-water ooze and not because it induces overpressure and eruption. Diapiric ascent is a directly related process, only opposite with a ductile low-density sediment piercing its way upwards. Gravity slides are often obviously involved but we suggest the slides were triggered by the buoyancy-driven inversion and not causing it.

This mechanism links ooze evacuation craters with mounds, jack-up structures, sill/dikes, and discontinuous clean sands observed in the Northern North Sea as related expressions of large-scale buoyancy-driven remobilization in biosiliceous Tertiary strata with considerable regional implications for the distribution of reservoir sand and seal.

ForwArd STratigraphic (FAST) modelling of turbidite systems

Authors: Dr Chris Stevenson and Prof. Pete Burgess

Organisation(s): University of Liverpool

Abstract
Understanding stratal architecture in deep-water systems is a long-standing challenge in the energy sector. Current approaches apply sequence stratigraphic principles alongside analogue data to extrapolate 3D architectures from 1/2D vertical sequences. This approach is limited to subjective or at best semi-quantitative assessment due to insufficient analogue outcrop and subsurface data to adequately define and test uncertainty ranges, human reluctance to consider alternative stratigraphic interpretations, and difficulty linking results directly to available subsurface data.

Here, we present process-based numerical ForwArd STratigraphic modelling (FAST). This is a powerful tool to rapidly predict, test, and explore deep-water fan stratigraphy. A critical advantage of this approach is that modelled stratigraphy is fully quantified in 3D and explicitly linked to specific input controls, uncertainty can be assessed statistically, and synthetic seismic images can be generated for robust comparison with data used in subsurface evaluation workflows.

Our FAST model Lobyte 3D simulates deep-water fan architecture across slope and basin floor settings. Quick computation times allow multiple model runs to constrain how basin-floor topography, sediment supply, and flow magnitude and frequency parameters control strata. Model architectures can be visualised and quantitatively analysed, for example to calculate stacking patterns, connectivity, and connected volumes, which can be linked back to controlling processes to extract predictive relationships.

Bridging the scale gap between well tests and petrophysics with ultra-fine sector models

Authors: Luke Johnson, Mykyta Hladylchenko, Rebecca Maguire, Steve Wybar, Piers Johnson

Organisation(s): Oilfield Production Consultants (OPC) Ltd

Abstract

Permeability is the most ethereal of concepts of the subsurface. Measured from core plugs at the centimetre scale, correlated to logs at the decimetre, and averaged over hundreds of metres by well tests – it is difficult to produce a coherent representation in a flow simulation. We present an integrated workflow that fills this gap by combining core, log, well test and outcrop analogue data in a common model, with the outcrop providing the ground truth for three-dimensional architecture that well data alone cannot resolve.

An ultra-fine geological sector model is built around the tested well out to approximately the radius of investigation of the test, with cells typically 1 to 10 cm vertically and 1 to 10 m horizontally, adjusted to the scale of heterogeneity seen in core and analogous outcrops. The models reproduce the key characteristics of the analogue as appropriate to the setting with petrophysical properties distributed within that framework. The well test is then simulated on each model and compared against the full measured pressure derivative, rather than the interpreted kH alone. The intent is not to produce a single, precisely wrong answer, but to test a reasonable range of depositional, diagenetic and structural concepts and retain those that replicate the lower-frequency signal of the well test.

We have applied this workflow on several field cases covering a range of depositional settings and fluid types. In each case, the geological concepts were refined to reproduce the pressure derivative. Retained models are upscaled using flow-based methods to full-field grid cell dimensions, yielding effective kH and kV that honour both the petrophysical and the dynamic data. The outcome is non-unique by intention: subsurface data are never sufficient to characterise a field perfectly. Instead, the deliverable becomes a suite of viable, coherent subsurface representations, each honouring core, log, test and analogue observations, together with the range of kH and kV they imply.

The workflow offers a step improvement for teams seeking to understand why petrophysical and well test permeabilities frequently disagree, replacing an empirical correction with a geologically explicit and auditable explanation. A persistent mismatch between datasets is treated as a signal that the current understanding may be flawed, rather than as noise to be multiplied away.

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