AAPG

5 - 7 March 2024
Al Khobar, Saudi Arabia

4TH EDITION: AAPG GEOSCIENCES TECHNOLOGY WORKSHOP
STRATIGRAPHIC TRAPS OF THE MIDDLE EAST

TECHNICAL PROGRAM COMMITTEE

Wafa Salmi (Co-Chair)
PDO

Ammar Balila (Co-Chair)
Saudi Aramco

Ahmed Taher
ADNOC

Ezdeen Ibrahim
BAPCO Upstream

Nicolas Hawie
Halliburton

Thomas Jewell
Halliburton

John Humphrey
KFUPM

Luca De Vincenzi
OCRE Geoscience Services

Elias Kharusi
Petrogas E&P

Kenri Pomar
Saudi Aramco

Alex Yeadon
Saudi Aramco

Aimen Amer
SLB

Friso Veenstra
TNO

WORKSHOP OUTLINE

Workshop Overview

The Stratigraphic Traps of the Middle East workshop hosted by AAPG is inviting all professionals to the upcoming 4th edition. This workshop aims to continue the success of proving a platform for industry professionals to share recent knowledge through case studies, new technologies, and latest collaborations to unlock the full potential of stratigraphic traps and deal with upcoming associated challenges.

The past 10 years have seen a natural shift to more complex trapping mechanisms in the mature basins of the Middle East. With previous plateauing creaming curves, the recent stratigraphic discoveries were able to change the game and introduce steeper curves. Missing hydrocarbons predicted by basin models have now been realized providing better predictive outcomes. Each individual stratigraphic discovery made has positive dependencies and implications that open the door to more potential across multiple stratigraphic units. With such incremental success, stratigraphic traps have proven their immense future value for the industry.

The mature basins of the Middle East are leading the industry in identifying complex trapping configurations to all sized traps unlocking the significant value they presented a decade ago. Successful exploration and production in stratigraphic traps often require advanced techniques and technologies to accurately locate and extract hydrocarbon resources. Therefore, the rise in collaboration between all industry professionals and academia is commended to have been a great enabler to overcome the challenges and move the industry closer to the comforts of knowledge and discovery replication.

This workshop will showcase new technologies and best practices that further enhance stratigraphic traps evaluation and associated decision-making processes. In addition, new developments in seismic data focusing on illuminating stratigraphic traps, such as high-resolution seismic data, new processing techniques, new developments of interpretation models and workflows that have unraveled some of the latest discoveries in the area.

Benefits of Attending

The workshop will continue to provide opportunity for attendees to receive up-to-date knowledge about stratigraphic trap exploration of the Middle East covering the prolific Gulf region and surrounding areas, exposure to regional and global stratigraphic case studies. It is also an opportunity for all professionals to share state of the art-technologies utilized to detect and produce these complex-yet-rewarding traps. It is a great networking experience-sharing opportunity. The participants will receive a summary of the breakout sessions and discussions, lessons learned, and the abstracts of papers presented in the workshop.

WORKSHOP GUIDELINES

FORMAT
The workshop will be 3 days, consisting of oral presentations, poster presentations and breakout sessions where participants can discuss and investigate a specific theme that is of mutual interest. The first day will feature an inaugural keynote speech by a high-profile professional from the industry.

ATTENDANCE
Registrations are invited from all relevant disciplines with experience and/or knowledge of the subject areas being addressed in the workshop. Registrations will be accepted on a first-come, first-served basis.

CALL FOR ABSTRACTS
You are invited to prepare a poster for presentation at the workshop. If you are interested in participating, please send a short abstract to cnavarro@aapg.org by 5 February 2024. All posters will be produced as pull-up banners and delivered by AAPG. There will not be any other format available for poster display.

REGISTRATION TYPES & FEES
Fees are inclusive of onsite documentation, coffee breaks and luncheons.

> $1,850 AAPG Non-Member Fee
> $1,850 Join and Save
> $1,650 AAPG Member Fee
> $1,550 Committee/Presenter
> $850 AAPG Young Professional Non-Member Fee
> $750 AAPG Young Professional Member Fee
> $500 Academia Fee
> $350 AAPG Student Non-Member (Masters)
> $250 AAPG Student Member (Masters)

*To avail a Member rate you must be an active member of AAPG.
**To register as a Young Professional you must be under the age of 35 with less than 10 years of work experience.

REGISTRATION DEADLINE
To guarantee your seat, please make sure to register by 27 February 2024.

CANCELLATION POLICY
AAPG will refund the tuition, less a $100 processing fee, if the request is received no later than 30 days prior to the workshop. Cancellations must be made in writing. The registrar will accept cancellation notices by telephone, but all such notices must be followed up by fax or e-mail. No refund will be made for cancellations received less than 30 days prior to a workshop being given. Nonpayment of tuition does not constitute automatic cancellation. If no cancellation notice is received by 30 days prior to a workshop, participants are liable for full tuition. AAPG reserves the right to cancel a workshop if enrollment is insufficient to ensure proper effectiveness. Substitutions for individuals can be made at any time. A paid enrollment may be transferred one time to a future workshop if the request is received prior to the 30-day cut-off date.

DAY 1: TUESDAY, 5 MARCH 2024

SESSION 1: ADVANCES IN STRATIGRAPHIC TRAPPING CHARACTERIZATION

This session focuses on the latest technical advancements in defining stratigraphic traps characteristics. It explores the leading-edge techniques that revolutionized the characterization of stratigraphic trapping for efficient resource extraction and better reservoirs predictions in stratigraphically complex environments, to enhanced drilling decision-making in the oil and gas industry.

The talks presented at this session could involve the latest techniques and methodologies utilized to understand the complexities associated with stratigraphic traps. Key elements to demonstrate how high-resolution seismic data helps to reveal complex stratigraphic traps, advanced well logging techniques to better understand lithological, and fluid evaluations. Furthermore, talks can also address the integration of geophysical and geological knowledge for accurate trap identification, and the application of reservoir modeling to better predict reservoir properties and trap geometries that were previously difficult to distinguish. Additionally, presenting break-throughs and analogues highlighting successful applications of these advancements in exploration and production phases, emphasizing the enhancement in hydrocarbon recovery, and maximizing exploration success rates.

SESSION 2: NOVEL WORKFLOWS TO IDENTIFY STRATIGRAPHIC TRAPPING CONCEPT

This session is dedicated to showcasing new and/or innovative workflows in the field of geology to enhance the identification stratigraphic traps. These distinctive workflows serve as the required foundation for the comprehensive insights gathered by the energy industry and involve a combination of well log analysis, advanced seismic imaging and geological modelling techniques.

For many decades these applications served the conventional structural traps but current repurposed to unravel the intricacies that complement the extensive datasets provided by seismic analysis. This proves to be especially advantageous in the well-established basins of the Middle East, characterized by abundant well data and a prolific petroleum system.

Potential workflow discussion points can encompass a wide spectrum of themes, including but not limited to:

- **Stratigraphy:** The characterization and correlation of architectures and geometries using a variety of techniques to enhance our ability to identify various types of trap concepts. This leads to the recognition of potential geographical areas that are worthy of further investigation for example pinchouts, onlaps and subscrops.
- **Sedimentology:** The pivotal role of sedimentology in bolstering geological comprehension is underscored through diverse methodologies. Techniques such as core studies, chemostratigraphy and heavy mineral analysis, contribute to unraveling depositional environment and sediment provenance. This, in turn, facilitates the construction of geological models pertaining to reservoir and seal pinch-outs, truncations and diagenesis within the correlating facies.
- **Geochemistry:** Exploration of gas indications and identification of hydrocarbon presence using Fluid Inclusion Stratigraphy (FIS) and Isotopic data. These findings hold the potential to enhance basin models and refine predictions of migration pathways and subsequent accumulation locations.
- **Geomechanics:** Examination of stress patterns and pressure zones, shedding light on areas of aquifer connectivity between fields. Additionally, insights into hydrocarbon pathways between wells and predictions regarding reservoir formations are derived from geomechanical data.
- **Structural Frameworks:** In basins with active tectonics and ductile halokinesis, intricate stratigraphic deposits emerge as a result. These syn-depositional formations linked to the basin's structural evolution have created various size traps and are worthy subjects of exploration and analysis.

By delving into these workflows, we illuminate new dimensions of geological investigation, enriching our understanding of intricate geological processes in mature basins like those found in the Middle East.

DAY 2: WEDNESDAY, 6 MARCH 2024

SESSION 3: INTEGRATED CASE STUDIES: OVERCOMING CHALLENGES IN EXPLORING FOR STRATIGRAPHIC TRAPS WITHIN SILICICLASTIC DEPOSITIONAL SYSTEMS

Siliciclastic depositional systems comprise an expansive range of environments with distinctive facies and facies associations spread over the long sediment transport route from the mountains sourcing terrestrial materials to the final resting place of sediment on the basin floor. The distribution of facies within such systems is governed by a combination of key factors such as sediment influx and relative sea level, the interplay of which creates a framework of architectural packages – or sequences – that can be predicted using outcrop and subsurface data in conjunction with modern depositional analogs.

Sequence stratigraphic models of siliciclastic systems can therefore determine the distribution of sandstone reservoir facies and adjacent mudstone or siltstone sealing facies within a specific formation and thus help map stratigraphic traps in the subsurface, aided by seismic attributes and geomorphological analysis.

Advances in subsurface data processing and integration combined with geological ingenuity over the past decade have led to testing several siliciclastic stratigraphic trap concepts, some of which have seen great success. These include – but are not limited to –: aeolian dune reservoir sandstones surrounded by playa lake and interdune tight facies, braided fluvial sandstone valley fill incising into older marine shales, transgressive shoreface and strand plain sandstones surrounded by tighter marine facies, detached deltaic mouth bar reservoirs trapped between prodelta and overbank muddy facies, and deep marine channel complexes encased in marine shales.

This session aims to showcase some of these cases from conception to drilling, highlighting the geological models behind them and how they reconcile with drilling results in addition to the lessons learned.

SESSION 4: INTEGRATED CASE STUDIES: COMPLEXITIES IN CARBONATE DEPOSITIONAL SYSTEMS – OPPORTUNITIES AND CHALLENGES FOR EXPLORING FOR STRATIGRAPHIC TRAPS

Different types of carbonate depositional systems, combined with diagenetic overprinting, offer numerous potential stratigraphic traps in carbonate strata. Complexities can be found in ramp, rimmed shelf, and isolated platform settings. These can include platform-top facies mosaics, peri-platform (slope to basin) carbonate debris, lateral facies changes within prograding clinoforms, isolated carbonate build-ups and mud mounds, and lateral facies changes within carbonate ramp systems, among many others. Accordingly, exploration for stratigraphic traps in carbonate systems requires a comprehensive and integrated approach involving evaluation of seismic, cores, well logs, pressure and fluid data, as well as outcrop analogs.

A thorough evaluation of seismic data, using seismic sequence stratigraphic analysis combined with seismic attribute and seismic inversion analyses, often provides a good framework to characterize geometrical aspects of carbonate depositional systems, and can often provide insight into lateral facies distributions. However, to gain further understanding, comprehensive analyses of cores, thin sections, geochemistry, well logs, and pressure and fluid data can provide high-resolution stratigraphic identification and correlation of different facies and potential flow units. Such studies can yield the depositional setting, related diagenesis, potential connectivity, and identification of petroleum system elements (source, reservoir, seal). Furthermore, detailed outcrop analog studies are essential for validating the interpreted depositional systems, including the distribution and geometrical relationship of different depositional facies.

The purpose of this session is to review recent stratigraphic trap exploration efforts in carbonates (for both successful and non-successful cases), to learn the evolving understanding of carbonate depositional models, to raise awareness of recent technological advancements, and to suggest workflows for identifying carbonate stratigraphic traps. All the lessons learned from this session will be extremely valuable for reducing the risk uncertainty of future exploration for carbonate stratigraphic traps in the region.
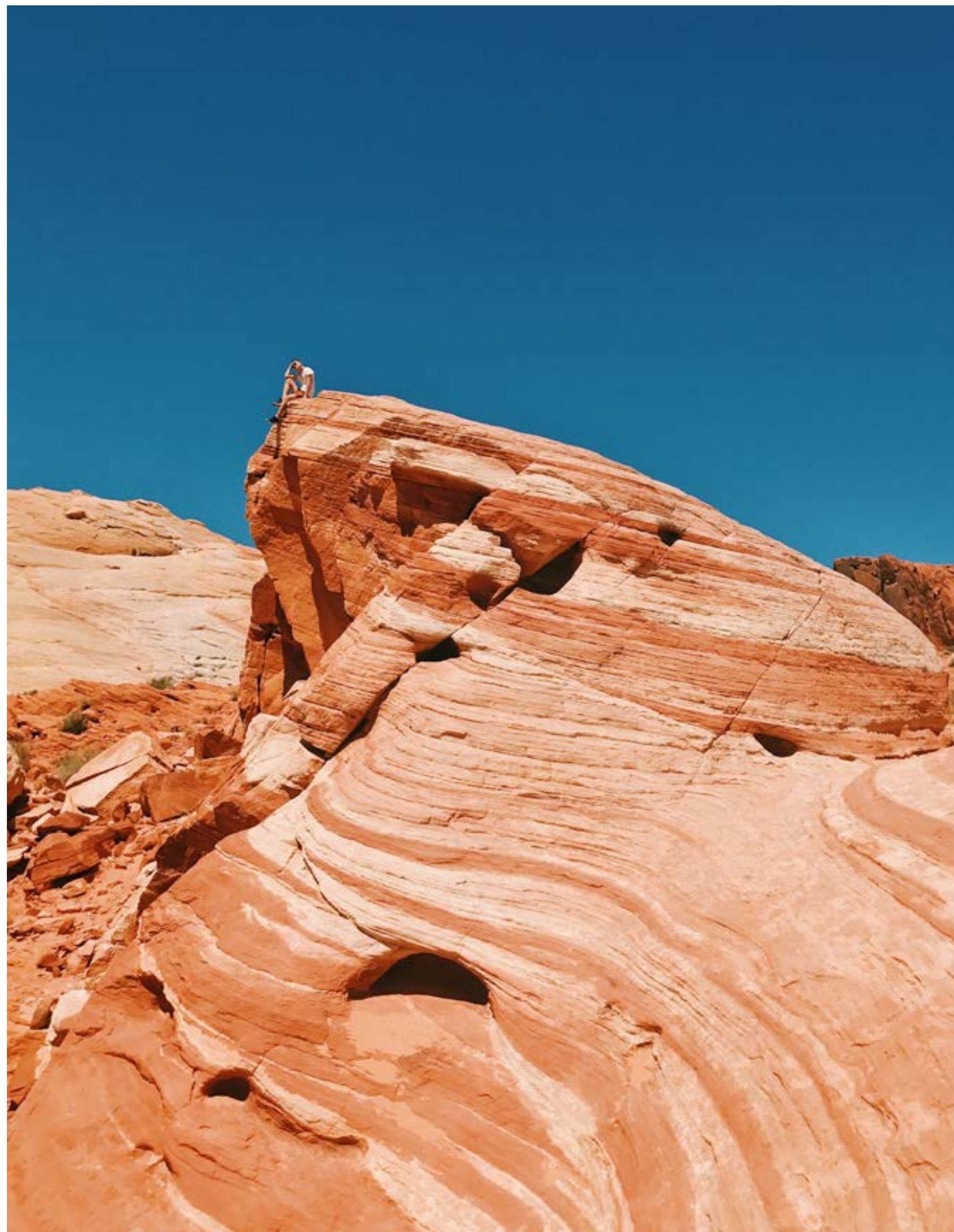
DAY 3:   THURSDAY, 7 MARCH 2024

SESSION 5: DE-RISKING STRATIGRAPHIC TRAPPING MECHANISMS USING INNOVATIVE NUMERICAL APPROACHES DRIVEN BY AI AND MACHINE LEARNING

Since the 1970's the oil and gas industry supported by the scientific community has benefited from major advances in the fields of sedimentology and stratigraphy. Conceptual models have been proposed for various depositional settings from continental to transitional and marine systems. These models attempted to reconstruct the vertical and lateral architecture and associated geobodies and to predict petroleum systems elements properties as reservoir and stratigraphic trapping mechanisms. The rapid exploration of complex stratigraphic trapping mechanisms has strongly been backed by novel geophysical techniques, amongst them: seismic stratigraphy, multi-attribute assessment and seismic inversion and characterization - and their integration in sequence stratigraphical workflows.

Since then, a growing interest in correlating subsurface sedimentary architecture and facies in carbonate, siliciclastic and evaporitic environments with surface analogues was evidenced. However, the latter interest was affected by challenges and obstacles related to (1) the restricted availability of G&G datasets (2) their associated vertical and lateral resolution, (3) the lack of integrative multidisciplinary numerical/software platforms that handle vast amounts of datasets and finally (4) consistent 3D/ 4D workflows that allow to achieve this complex task.

In this session we aim to discuss the recent innovative and state of the art workflows utilized to de-risk complex stratigraphic trapping mechanisms in carbonate and siliciclastic successions. We highlight the importance of using integrated 3D/4D Shared Earth Approaches that combine multi-disciplinary (i.e., geology, petrophysics, geophysics, engineering) and multiscale datasets and their associated interpretation and stratigraphic numerical modelling techniques supported by artificial intelligence and machine learning applications. Those techniques allow to bridge the scale gap resulting from the multi-disciplinary integration and attempt to evaluate seismic and sub-seismic architectures and facies of sedimentary systems and associated stratigraphic trapping mechanisms using a combination of process based, deterministic and/ or geostatistical applications.

SESSION 6: THE ROLE OF STRATIGRAPHIC TRAPS, SUSTAINABILITY AND RESILIENCE

This session focuses on the role that stratigraphic traps can play in the effective containment of carbon dioxide (CO_2) and hydrogen and their likely future contributions to increasing sustainability throughout the energy transition in the Middle East. These traps are geological formations that have a pure stratigraphic or partial combination of structural and stratigraphic features that can prevent the upward migration of fluids and gases, making them suitable for long-term storage solutions.

Discussion topics could include, but are not limited to:
- **Understanding sealing units:** Stratigraphic traps include formations with impermeable rocks preventing the upward and lateral migration and leakage of stored CO_2, ensuring that the gas remains trapped and isolated underground.
- **Complex reservoirs:** Stratigraphic traps are often characterized by high heterogeneity and layered geological formations. These reservoirs may provide ample storage capacity for the captured CO_2, but also complex geometries may make fluid injection points and flow prediction challenging.
- **Repurposing depleted gas fields:** Once fields have been depleted of their natural gas resources, they can potentially be repurposed for CO_2 storage. The existing geological features that trapped natural gas can similarly retain stored CO_2. Understanding which existing stratigraphic fields can be utilized will be critical.
- **Hydrogen exploration and storage:** Similar to CO_2 storage, exploring for and storing hydrogen in geological formations can support the transition to a clean energy economy. Hydrogen's properties and behavior in geological formations are different from hydrocarbons and CO_2, but the geological characteristics that make stratigraphic traps suitable for one could potentially be leveraged for the other.

In this session we aim to focus on the selection of suitable stratigraphic traps for CO_2 storage or hydrogen exploration and storage involving a comprehensive assessment of the geological, engineering, environmental, and regulatory factors.