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# Abstracts Poster Presentations

# PROVENANCE OF THE OTI AND TAMALE GROUP, VOLTAIAN SUPERGROUP, GHANA

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The Neoproterozoic Voltaian Supergroup (VS) is constituted by three Groups: the Kwahu, Oti and the Tamale Groups. In Ghana, the Voltaian Supergroup occupies an approximate area of ~115,000 km2 with depth of up to 5–7 km, occupying the southeastern part of the West African Craton. This study investigated the provenance of the sediments of the Oti and Tamale Groups by studying the detrital framework grain compositions of the sandstones constituting the Oti and Tamale Groups. Field samples were collected from the most accessible units of the main formations and thin sections produced from the sandstone samples. Modal analysis of the framework grains was carried out by making 500 counts of the quartz (Q), feldspar (F) and lithic (L) grains. Analyzing the modes on the ternary plots, plutonic rocks (granites) and metamorphic sources (gneisses) are suggested as the source lithologies for the sandstone samples of the Oti and Tamale Groups. To ascertain the provenance of the finer sediments, geochemical studies was carried out in addition to the sandstone studies. Binary and ternary plots of some trace element proxies such as Cr/V vs Y/Ni, La/Th vs Hf, La-Th-Sc proposes granitic and mixed felsic/basic source of the Oti and Tamale Groups. In addition to that, Th-Hf-Co ternary plots also suggest the mudstone and sandstones to be similar in composition to the Post Archean Australian Shales (PAAS) and the Upper Continental Crust (UCC). Calculated Sm-Nd and Rb-Sr model ages place the age of the source of the sediments between 720 Ma to 1.58 Ga. The isotopic data also suggests a continental crustal source. A composite of the detrital framework analysis, geochemical and isotopic studies suggest the older Kwahu Group, the adjacent Pan African gneissic-granitic rocks and the amazonian craton to be the possible sources of the Oti and Tamale Groups.

# Changes in the benthic foraminiferal assemblage within the Middle Eocene Bassein B Formation, Bombay Offshore Basin, Western India

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The Eocene Epoch is punctuated by climatic perturbations and their consequent biotic reorganizations and turnover events. Our present study is based on samples of core-well sections of the Bassein B Formation from the Bombay Offshore Basin, Western India belonging to the Shallow Benthic Zone (SBZ) 14-17 (mid-Lutetian to Bartonian age; Cotton et al., 2019). Our study documents the benthic foraminiferal distributions across the Bassein B Formation and aims to understand the cause of these reorganizations. The Bassein B Formation a shallow-water carbonate sequence, is sub-divided into lower (SBZ 14-15) and upper (SBZ 16-17) units. The Lower Bassein B Formation is dominated by larger benthic foraminifera (LBF) orthophragminidae (Discocyclina-Asterocyclina)- Nummulites assemblage in a wackestone lithology which suggests an outer ramp depositional environment. The first appearance of Palaeonummulites spp is also recorded within the Lower Bassein B formation. In the Upper Bassein B Formation (SBZ 16-17), we witness; dominant occurrences of smaller benthic foraminifers Rotaliids, Bulimina sp., Nonion sp., Quinqueloculina sp. Amongst the LBFs we document common occurrences of Idalina sp., Austrotrillina sp., Rhabdorites sp., Medocia sp., Borelis sp., Nummulites sp., Fabulariids, and Peneroplids; along with several conical taxa Dictyoconus sp., Coskinolina sp., and Fallotella sp. The first appearance of Orbitolites sp. is documented within this unit. The major change in foraminiferal assemblage showcasing deposition within an outer ramp (open marine environment) setting in SBZ14/15 to an inner ramp (restricted marine environment) setting of SBZ16/17 along with local appearances and disappearances (Orthophragminids) of taxa can be attributed to regional depositional history. The global scale warming event Middle Eocene Climatic Optimum which spans the SBZ 17 biozone may have further caused an increase in hypersaline conditions which led to the dominance of Miliolids, conical LBFs, textularids, triserial and biserial smaller benthic foraminifera as observed from sections within Kutch onshore Basin in Western India.

# Cyclicity in Early Anisian fluvial to shallow-marine transition in NW Bulgaria

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The Early Anisian (Aegean) transition from continental fluvial to shallow marine carbonate settings in NW Bulgaria, comprise set of nineteen mixed terrigenous-carbonate parasequences, is studied in ten detailed lithofacies sections along the Iskar River gorge. The time range of the individual parasequences, marked by traceable flooding surfaces, corresponds to a cyclicity of 21 Ky, and the entire interval represents a mesoscale sequence unit comprising about 400 Ky. The terrestrial lithofacieses are represented by four psammitic, four fine-grained and two paleosol related, while the marine ones are related by two limestone, three dolomite and three hyporock types. The data obtained are subjected to Markov Chain Analysis (MCA) with over 220 transitions in every section, used for intersection correlation purposes.
The sections are divided into four intervals, representing the passage of sedimentation processes through three distinct depositional settings. The lowermost four parasequences are dominated by terrestrial fluvial processes, but their base demonstrate evidence of inner-coastal to supratidal-plain setting. The channel erosion, local slump induced synsedimentary deformations, and in-situ and allochthonous paleosol products are typical. The parasequence's MCA chi-square is ranging between 110-130. Upwards, in the next six parasequences, presented lithofacieses associated with inner coastal to supratidal plain prevails. The share of dolomite and marl, together with wave ripple, flaser and lenticular structures, and intensive bioturbation, increasing. MCA chi-square decreases to 85-100.
The third interval demonstrates features of inter- to subtidal plain settings. Here, in three relatively thin parasequences, where bioclastic and clayey limestones associate with the dominant dolomites and marls, the maximum flooding zone is recognized. MCA chi-square demonstrates lowest levels - 50-70. Uppermost interval, spanning a set of six parasequences, demonstrates a relative return of settings back to inter- to supratidal plain conditions, where marls and hyporocks alternate with often enriched by crinoid dolomite. MCA chi-square value again raised to 120-140.

# Detrital zircon U-Pb ages in the estimation of sediment provenance of late Permian to early Triassic Rustler and Dewey Lake Formations in northern Delaware Basin, New Mexico, USA.

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Detrital zircon provenance studies on Permian formations in the Delaware Basin (westernmost sub-unit of the Permian Basin in Southwest United States) have been mainly focused on middle Permian deposits. Information on late Permian sediment provenance for this area is rare and based on inferences, if not non-existent. We are presenting new detrital zircon U-Pb ages to estimate sediment provenance of late Permian and early Triassic Rustler and Dewey Lake Formations, with a first-ever provenance study on the Rustler and an overall continuity of sediment source studies in the Delaware Basin.

As the last two of four late Permian-early Triassic formations (in ascending order: Castile, Salado, Rustler, and Dewey Lake), the Rustler and the Dewey Lake mark the end of thick evaporite sequences in the Delaware Basin and the beginning of transgression/regression deposits and continental redbeds. Previous studies on middle-Permian deposits revealed various potential sediments sources from Laurentia (mainly North America) and from peri-Gondwanan terranes now in Central America, with primary source shifts from Laurentia to Gondwana and back to Laurentia between late Carboniferous and middle Permian. Current data from this study on sandstones from the Rustler and the Dewey Lake in northern Delaware Basin, show similar sources with major inputs from Laurentia compared to peri-Gondwanan terranes, confirming the observed pattern in older sediments up until middle Permian.

This study provides new data on the geochronology of the Rustler and the Dewey Lake in northern Delaware Basin and furthers the understanding on the sediment dispersal dynamics at the time of the complete formation of Pangea and on the role of geographic locations regarding zircon signatures.

# Deep Learning in Reservoir Characterization: A GAN-based Approach

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Effective reservoir characterization is vital for optimizing oil and gas production and minimizing exploration risks. This study explores the use of Generative Adversarial Networks (GANs) to address the limitations of traditional machine learning in handling complex geological patterns and generating high-resolution data representations.

Recent advancements in deep learning, particularly GANs, have shown promise in delivering accurate reservoir property models. This research presents an innovative approach that integrates seismic data and well logs to create high-fidelity 3D geological models of subsurface reservoirs.

The study follows a systematic workflow, focusing on data collection and preparation, reservoir modeling with GANs, evaluation of results, and integration with other data sources. The North Sea and Netherlands field data are used, with an emphasis on data preprocessing to ensure quality and consistency.

A deep convolutional GAN (DCGAN) model is employed to capture intricate spatial distribution of critical reservoir properties. Quantitative metrics and visual analysis are used to evaluate the accuracy of the generated synthetic reservoir models.

Integration with diverse data sources enriches the understanding of reservoir properties and behavior. This approach combines GAN technology with traditional reservoir characterization methodologies to provide more accurate models.

Preliminary results show promise, with the methodology offering a robust and reliable tool for subsurface modeling. It represents a significant step forward in the domain of reservoir characterization, offering a more sustainable and efficient future for the oil and gas industry.

In conclusion, this research presents an innovative and advanced approach to multi-dimensional reservoir characterization using GANs, with the potential to revolutionize the oil and gas industry and broader geoscience applications.

# Understanding Potential of Punjab Platform with reference to the Infra-Cambrian reservoir (Bilara Dolomite) Pakistan

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The Bilara dolomite in the Baghewala-1, Kalrewala-2, and Tarriwala-1 wells of the Bikaner-Nagaur Basin of India are proven reservoirs. This article investigates the facies and hydrocarbon potential of the Bilara Dolomite Formation in the Punjab Platform, Pakistan. The Punjab Platform Basin is still in the frontier exploration stage due to lack to data and few wells. The dataset available for this study includes the GR (Gamma-Ray) logs of 6 wells namely, Fort Abbas-1, Marot-1, Karampur-1, Bahawalpur East-1, Bahawalpur X-1, and Suji-1. This paper adds significant insights into the depositional settings and evolution of the Bilara Dolomite by integrating well data, electric facies and GR trends. Well logs trends of facies assist in identifying probable reservoirs and tight zones. The isopach maps help in deciphering the thickness of Bilara in various parts of the Punjab Platform and underlying horst and graben structures. The Bilara carbonates were deposited in coastal marine environments, particularly in supratidal to intertidal zones to lagoonal environment. On the Punjab Platform, the average porosity distribution pattern shows good reservoir characteristics, with an increase in average porosity towards the west. The findings of this study not only shed light on the Bilara Dolomite's petroleum potential, but they also provide useful information for regional geological models and exploration tactics and decision-making.

# Sedimentology and Stratigraphic Evolution of the Early Cambrian Ambar Formation and Implications for Paleo-environmental reconstruction along the southern margin of Tethys, Peshawar Basin, Pakistan.

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The 88 to150 m-thick Early Cambrian Ambar Formation of the Peshawar Basin, Pakistan is predominantly a sandy dolomite, massive dolomite, dolomitic limestone, calcareous quartzite, subordinate phyllite/argillite and minor shale succession within which variety of lithofacies recognized including; Massive dolomite, Sandy dolomite, Thin-bedded sandy dolomite, Laminated sandy dolomite, Dolomitic limestone, Quartzite and Argillite/Phyllite. Common sedimentary structures in the conglomerates and sandstones include planar and trough cross-bedding, planar lamination, soft sediment deformed bedding, compound cosets of strata with low angle-inclined bounding surfaces and lags of imbricated pebbles.The microfacies analysis identified seven major microfacies including; Aphanocrystalline to very finely crystalline dolomites, Fine to medium crystalline dolomites, Fenestral dolomite, Siliceous dolomites, Algal laminated dolomite, Gypseous dolomite and Dolomitic Limestone.The diagenetic alterations and generation of secondary porosity with various diagenetic processes supported by petrographic analysis suggest potential of the Ambar Formation as a reservoir. Based on facies and the widespread occurrence of dolomite indcates deposition in shallow subtidal to lower supratidal through intertidal system. Although the regional and temporal distribution of the Ambar Formation is complex, in broad terms the paleogeographic analysis reveals that North or northwesterly parts of Indian Plate occupied low latitudes of warm conditions under $15^{o}$ South of the equator during deposition of the Ambar Formation. During the Early Cambrian a shallow marine mix siliciclastic and carbonate sedimentation of the Ambar Formation was developed in the southeastern margin of the Tethys.

# Evaluating the Rise of Land Plants in a Thalassocratic World: Sedimentological Characteristics of Ordovician Fluvial Systems from Source to Sink

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The Early Paleozoic witnessed a unidirectional shift in fluvial systems as recorded by sedimentary deposits, which is believed to have arisen from vegetation-induced changes to alluvial landscapes. Global database surveys suggest that these changes in sedimentary architecture as well as a global increase in mudrock content originated during the Ordovician. These sedimentological shifts are apparently synchronous with the appearance of the earliest fossil evidence for land plants in the Middle Ordovician, suggesting that even shallow-rooting vegetation was able to markedly change the fluvial landscape. However, due to high global sea-level during the Ordovician, fluvial sedimentary sequences have been argued to be rare compared to other geological periods, and detailed facies analyses of units of this age are less abundant than for fully 'pre-vegetation' or 'syn-vegetated' successions.

This poster presents initial results from a widespread survey that qualifies the facies recorded in several Middle Ordovician to early Silurian fluvial sequences and complements these observations with analyses of littoral and shallow marine facies. New field data from sites including the Late Ordovician sequence in southwestern Sardinia, described by previous authors as representing a transgression from a braid plain to a deep marine environment, are revisited using structural, petrographical, and geochemical methods. Comparisons are made with other putative Ordovician fluvial sequences, as well as the littoral to non-marine facies of the Silurian Coralliferous and Gray Sandstone groups of Pembrokeshire, Wales. These observations are synthesized to isolate facies characteristics that are archetypal of Ordovician fluvial systems and evaluate the non-marine landscapes in which the first land plants took root.

# Patterns of re-sedimentation in Pre-Salt lacustrine carbonates, Santos Basin, Brazil

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South Atlantic Pre-Salt giant oil accumulations stimulated extensive research aimed at understanding the origin and evolution of these extensive reservoirs. The Búzios Field, which main reservoirs correspond to carbonate intraclastic lacustrine deposits, has some of the wells with the highest daily production in the world. However, due to the complexity of the Pre-Salt deposits, lack of representative analogues and the scarcity of specific studies, many controversies still persist in the interpretation of their depositional models. In the rift Itapema Formation, bioclastic accumulations show many signs of reworking, including abrasion, fragmentation and disarticulation of the bivalve bioclasts. Besides, the bioclasts occur commonly within intraclasts and as nuclei of ooids, an indication of multicycle redeposition. The predominant massive structure, chaotic orientation of the bivalve bioclasts and mixing with stevensite grains, points to gravitational redeposition triggered by intense tectonic activity during the rift phase. In contrast, the sag Barra Velha Formation deposits comprise intraclasts eroded from the characteristic in situ spherulites and shrubs. These deposits display characteristics of dynamic, multicyclic reworking, and are often interspersed with the in situ deposits, even at a thin section scale. This aspect, together with the widespread occurrence of the resedimented deposits in many Pre-Salt areas, suggest that models involving redeposition by gravitational, wave, and current processes may not represent properly many of the Pre-Salt intraclastic deposits. We propose that internal waves, resulting from disturbances in the chemocline of the alkaline, stratified lacustrine system, promoted recurrent reworking of the in situ deposits, generating multicycle redeposition and intercalation with the in situ deposits. Understanding the genesis of these deposits is vital for decreasing exploration risks and optimizing the production from the Pre-Salt intraclastic reservoirs.

# Revealing the origin of Cretaceous and Paleogene fluvial deposits from eastern Amazonia through quartz luminescence

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The Cretaceous and potentially Paleogene strata, originally grouped as the Alter do Chão Formation, cover a large extent of the Amazonas Basin in the northern region of Brazil. Comprehending the sediment provenance not only contributes to paleogeographic reconstructions but also holds implications for understanding the origin and evolution of the Amazonian rivers and their related biotic environments. Thirteen riverbank outcrops distributed along a basin-transverse profile that exposed the entire stratigraphic succession were described using the method of Facies analysis and pure quartz aliquots from forty-five samples were analyzed by optically stimulated luminescence sensitivity (OSL), measured using blue OSL (BOSL). Two different lithological units can be identified in the studied profile with distinct BOSL responses: i) Lower unit: composed of medium cross-stratified sandstone that crops out in the Aveiro municipality area, possibly equivalent to the Jazida da Fazendinha Formation, with lower BOSL sensitivities; ii) Upper unir: composed primarily of coarse to pebbly sandstone that crops out in the Alter do Chão to Óbidos municipality region, equivalent to the Alter do Chão Formation, with higher BOSL sensitivities. Seven sedimentary facies were characterized, indicating associations interpreted as fluvial deposits dominated by sandy bars. The low sensitivity of the Lower unit may have as its source an area with high erosion and low sediment recycling in the basin, while the Upper unit, with high sensitivity, may be associated with a cratonic source. To deepen our understanding of the factors behind this shift in sediment source areas drained by fluvial systems, luminescence data will be cross-referenced with Nd isotopic data.

# Variation of fractional transport rates with relative particle size

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The nonuniformity of bed material significantly complicates the prediction of sediment transport rates. One method to predict the transport rate of size fractions is to use empirical relations in fractional transport rates, normalised relative to that of the median particle size, d50b. Previous analysis has shown that relative fractional transport rate declines with particle size. Transport data show a predictable decrease in transport rate for particle sizes di≲d50b, however, this relation is not supported for coarser particles, di≳d50b, that show significant scatter in fractional transport rates. Hitherto the reason for this distribution in fractional transport rates and why it breaks down at coarser sediment sizes has not been explained. In this study, flume experiments have been conducted to estimate the fractional transport rates of noncohesive sand- and silt-sized, bed material carried by flows in the upper-stage plane bed regime. The same overall pattern in relative transport rates, to those described previously, is seen for relatively fine particles (di≲d50b). This decline in transport rates can be explained in terms of the vertical suspended-sediment concentration profile as described by the Rouse Equation. Relatively coarse bed material (di,≳d50b) depart from the transport relation observed for finer particle sizes: since these size fractions, carried as mixed load or bedload, are poorly described by the Rouse relation. In our data enhanced fractional transport rates, compared to the Rouse-controlled relation for finer material, are observed for di≳d50b. This positive deviation in transport rates for larger material is consistent with the expected effect of hiding-exposure effects: that enhance the transport of coarse material, due to their greater exposure to the flow, compared to finer grains. The study reinforces the importance of accounting for particle size nonuniformity in transport models and validates the use of a Rouse-based fractional (polydisperse) modelling approach for suspended-load dominated sediment transport.

# Antalya Travertine Plateau Düden Stream Hydrogeology

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The Antalya Travertine Plateau and Düden Stream, which is the world's largest freshwater travertine and where the drinking water and irrigation water of the city of Antalya is provided, have been investigated from a hydrogeological point of view. In the study area, where the Mediterranean climate is effective, the average temperature was determined as 18.7 °C and the annual average rainfall was determined as 1085.3 mm. In the research, the sources in the study area and its surroundings are classified as the sources discharged from the Mesozoic aged limestones and the sources discharged from the travertine, and it is seen that the travertine is fed by precipitation and Mesozoic limestones.To evaluate the waters from the sampling points in the study area, Schoeller, Piper, and circular diagrams covering the May and September 2016 periods were drawn and it was observed that the groundwater was Ca-CO3-HCO3 rich. In the budget calculation made for the study area, the annual average recharge of the travertine aquifer is 185 million m^3 and the annual discharge from the travertine resources is calculated as 702 million m^3 and the discharge into the sea of the travertine aquifer is 1.5 Mm3 per year. With the groundwater level values in November, a groundwater elevation map was created on the Arc Map, and it was observed that there was no groundwater flow from the travertine aquifer to the creek.

# MID-CRETACEOUS ANOXIC EVENTS IN THE EASTERN CARPATHIANS: SEDIMENTOLOGICAL, GEOCHEMICAL AND BIOTICAL CHANGES INSIGHTS

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This study focuses on the Albian-Turonian depositional interval of the outer thin-skinned thrust belt of the Eastern Carpathians, in order to point out the overprint of mid-Cretaceous Oceanic Anoxic Events (OAE).

Two lithological units are cropping out in the studied area: (i)The Lower Cretaceous Streiu Formation (300-350m in thickness) that consists of alternating black and dark-grey shales, grey marls, and convolute calcareous sandstones; (ii) The Upper Cretaceous Tisaru Formation (100-110m in thickness) which is divided in two members: the Lower Member, dominated by couplets of greenish-black shales and radiolarites, and the Upper Member, composed mainly of variegated (greenish and red) shales. Based on calcareous nannofossil investigations, the age of the whole studied succession is late Albian - early Turonian (UC0 up to UC7 biozones). The Albian-Cenomanian interval has been thoroughly sampled (4 samples/m) for geochemistry and biostratigraphy analysis based on calcareous nannofossils.

In this section, in addition to the fluctuations of total organic carbon (TOC), two positive excursions of δ13Corg have been identified. The first is placed in the upper Albian, probably corresponding to the OAE1d, below the LO (last occurrence) of the nannofossil Hayesites albiensis. The second positive excursion of δ13Corg is situated in the mid-Cenomanian, slightly above the FO (first occurrence) of the nannofossil Lithraphidites acutus, and might be assigned to the mid-Cenomanian Event (MCE). Additional biostratigraphic analyses and more δ13Corg data are further requested for a more rigorous age control and to better highlight these anoxic events.

# Lateral facies transition in a lower Aptian shallow platform: from siliciclastics to rudist-coral carbonate factory (northwestern Maestrat basin, Spain)

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Lower Cretaceous sedimentation in the Maestrat rifting basin (eastern Spain) occurred in subbasins separated by low subsident seaways. The uppermost Barremian-lower Aptian stratigraphy and facies evolution from marginal to open marine areas in the central part of the basin is reviewed here. New lithostratigraphic, isotopic and ammonite data of the poorly explored northern part of the Morella subbasin allow the correlation to the nearby sedimentary domains, documenting the transition between the northern protected terrigenous-dominated areas (Oliete subbasin), to the southern open marine carbonate-dominated areas (Salzedella subbasin). Two T-R sequences are identified across the studied subbasins. The lower sequence includes partly restricted skeletal facies rich in oysters (Alacón Fm), which grades laterally to the oolitic-orbitolid rich successions of the Xert and lower-middle Forcall Fm in the southern Morella subbasin. Skeletal to oolitic large-scale subtidal dunes are frequently developed in the upper regressive part of the sequence. The overlying discontinuity (early Aptian, intra-forbesi biozone) is very prominent in the marginal Oliete subbasin (top of the Alacón Fm), and is coeval to the abrupt facies change documented basinwards.  The upper T-R sequence is bounded by the major discontinuity at the upper part of the early Aptian (i.e. intra-furcata biozone). The analysis of the late regressive deposits of this sequence allow to document in detail the lateral transition from the terrigenous and bioclastic successions of the Oliete subbasin (upper Josa Fm) to the open marine coral-rudist dominated carbonate facies (Villarroya Fm), with an intermediate facies belt dominated by oolitic grainstones.

# Effects of meandering fluvial system superposition behaviour on sand bodies structure

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The sedimentary architecture of sand bodies developed by meandering rivers and their preserved successions are highly variable. Where architectural elements representing channel segments evolved at different times overlap, different forms of superimposition can occur. This study delves into the arrangement of sedimentary architectural elements within meadering river deposits of the Permian Shanxi Formation in Fugu City, China. The objectives encompass identifying the lithological organization and palaeoenvironmental, relating deposits to sedimentary processes, explaining the architectural elements in terms of river evolution, illustrating the characterize meandering fluvial successions, and reconstructing the evolutionary migratory behavior of the formative fluvial system. Utilizing 15 photomontages and analyzing 20 sediment bodies, the study provides a detailed stratigraphic relationship of the outcrops, including a 3D palaeoenvironmental reconstruction. The conglomeratic and sandstone bodies, up to 1.6m thick and 25m wide, forming four vertically stacked channel storeys that are partially laterally offset, exhibit bases with up to 2 meters of incision. Internally, these bodies consist of cosets of cross-strata, each set measuring 0.2-0.3 meters in thickness. The bounding surfaces defining each set dip downward at angles of 8-10 degrees, while foresets of cross-beds dip at 20-25 degrees, oriented obliquely to the dips of the set bounding surfaces. The vertical and laterally offset stacking of the bodies records channel avulsions and the aggradation of a channel belt over a longer time period. The partial incision of older bodies by younger ones indicates the gradual generation of accommodation during a relatively slow rate of basin subsidence. The study sheds light on the meandering river system evolution by revealing the intricacies of architectural elements, their internal characteristics, and the palaeoenvironmental context. This contributes significantly to our understanding of meandering river depositional processes and aids in reconstructing the dynamic evolution of meandering river systems from preserved deposits.

# Origin of high H2S concentration in the silicate-gypsum-shale depositional setting: A case study from the Bonan Sag of Jiyang Depression, Bohai Bay Basin

Mr Changjia Bao[1,2], Origin of high H2S concentration in the silicate-gypsum-shale depositional setting: A case study from the Bonan Sag of Jiyang Depression, Bohai Bay Basin Chengyan Lin[1,2], Origin of high H2S concentration in the silicate-gypsum-shale depositional setting: A case study from the Bonan Sag of Jiyang Depression, Bohai Bay Basin Chunmei Dong[1,2], Origin of high H2S concentration in the silicate-gypsum-shale depositional setting: A case study from the Bonan Sag of Jiyang Depression, Bohai Bay Basin pengjie Ma[3], Origin of high H2S concentration in the silicate-gypsum-shale depositional setting: A case study from the Bonan Sag of Jiyang Depression, Bohai Bay Basin Lihua Ren[1,2]
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The Bonan Sag, located in the central Jiyang Depression of the Bohai Bay Basin, is a half-graben depression that exhibits a steep gradient in the northwest and a gentler slope in the southeast. This study focuses on the Shahejie Formation, which is the primary oil-bearing system in the area. The lower Es3 to upper Es4 Sub-members in the sag, in ascending order, consist of delta front and lacustrine turbidites, gypsum mudstones and organic-rich shales, primarily controlled by several northwest-trending stepped faults which significantly influence the migration and accumulation of oil and gas reservoirs in the area. Hydrocarbon extraction shows that several wells in the fault belt of the sag contain high levels of H2S (up to 17000ppm), which always accompanied by CO2 production. Meanwhile, the crude oil fractions commonly contain sulfur, which increases the exploration risks. According to the tectonic evolution and thermal history, a suite of petrologic and chemical methods, including core description, optical observation with cathodeluminescence, handheld XRF elemental detector, infrared carbon-sulfur analyzer, EPMA and stable isotopes of sulfur, were carried out, and the formation mechanism of H2S-containing oil and gas reservoirs in the lower Es3 to upper Es4 Sub-members were explored. The results indicate a gradual decrease of sulfur content from gypsum mudstones to organic-rich shales. High levels of H2S concentration were mainly detected at the interface of gypsum mudstones and organic-rich shales. The studied intervals were dominantly obtain the burial depth between 3200 and 4200 m, with an average geothermal gradient of 35℃/km and burial temperature between 120 and 180℃, within the appropriate thermal zone for thermochemical sulfate reduction, and faulting events facilitate the connection between source rocks to reservoirs. The gypsum-to-anhydrite transformation process could provide free SO42--rich fluid, resulting in an open thermochemical sulfate reduction system (Δδ34Anhydrite-Pyrite=14.2‰) sulfur-rich oil accumulation.

# Paleo-oxygenation of the West Equatorial Atlantic using pore analysis in Cibicides pachyderma tests over the last 30 kyrs B.P.

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The West Equatorial Atlantic (WEA) comprises part of the AMOC (Atlantic Meridional Overturning Circulation), which is an important component in ocean heat distribution and maintenance of the climate on the planet. During the Heinrich Stadials (H) the formation of NADW (North Atlantic Deep Water) was weakened and the AMOC was disturbed. Weakening in the ocean circulation leads to a decrease in the O2 content in the bottom waters, which influences foraminifera test pores showing that where O2 is low, the foraminifera have larger pores and vice versa. The present work aims to evaluate the oxygenation in the WEA over the last 30 thousand years through pore analysis of Cibicides pachyderma (Rzehak, 1886), especially during Heinrich 1-H1 stadial when the AMOC was weakened. The sedimentary core MD09-3243CQ was collected on the WEA on board of R/V Marion Dufresne I73/Retro III Cruise. As a result, during the interglacial increase in the photosynthetic rates caused higher concentration of O2 and lower mean area of the tests pores. During the H1 two phases were observed, one representing the weakening of the AMOC showed an increase in average area of the pores. The second phase with the AMOC resumption the oxygenation of deep water increased, and the pores of the tests decreased. During glacial, smaller photosynthetic rates induced increasing the average area of the pores. In addition, the porosity of tests was correlated to the 231Pa / 230Th ancillary data to verify the correspondence between the low AMOC intensity and the increase in the porosity in the C. pachyderma tests, this relationship was established, and it was evident around 16.000 years BP.

# Microbial role in rhodolith formation around volcanic islands: an example from South Korea

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Modern and actively growing rhodolith beds are common features of the wide channel between the volcanic Jeju and Udo islands in South Korea. Living and non-living rhodoliths dominate the seabed topography and contribute to the formation of mixed carbonate/volcaniclastic tidally -influenced beaches.
Using traditional and novel tools, a multi-disciplinary and multi-scale methodology was applied to explore the role of microbes in rhodolite formation. The subspherical to ellipsoidal rhodoliths, nucleating around volcanic fragments, form biogenic matrices characterized by a complex three-dimensional architecture that harbour distinctive high diversity microbial communities. Our investigations indicate the existence of a direct link between rhodolith microbial constituents, degradation of organic matter and authigenic minerals precipitation. Microbial cells and extracellular polymeric substances (EPS) are the main sites where Mg-rich calcite and aragonite nucleate and grow. The authigenic precipitation is mainly driven by biotic processes (biologically induced by microbial metabolic process or simply influenced by nucleation on microbial biofilm substrate). The mutual presence of organic compounds and calcium carbonate minerals reveals that the associated rhodolite microbial communities play a fundamental role in biomineralization.

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# Facies variability and depositional controls on reservoir heterogeneity of lacustrine carbonates from the Brazilian Pre-salt

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Aptian lacustrine carbonates, formed by a range of unusual calcite morphologies associated with Mg-silicate matrices, form the most prolific hydrocarbon reservoirs from offshore Santos and Campos basins (SE Brazil). In the last decade many studies were published targeting the many geological challenges associated with these deposits, ranging from the contrasting depositional models to the complex diagenetic and hydrothermal evolution. Although relatively monotonous in terms of basic constituents (i.e. calcite fascicular shrubs and spherulites, Mg-silicate mud and intraclasts), the Pre-salt facies lateral and vertical variability has not been completely understood, adding substantial uncertainty to geological models. Part of this challenge comes from the difficulty to integrate the multiscale data coming from direct and indirect sources (e.g., seismic, well log, core, micro-scale analysis). Another part of the challenge resides in the fact that every Brazilian Pre-salt is somehow unique due to variations in the local geological context, basement configuration, and structural settings. Within this context, this work explores facies variability of the Barra Velha Formation in a target pre-salt field in the Santos Basin by integrating petrography, borehole image log interpretation, and 3D seismic data. The results showed significant faciological differences between the three Barra Velha Formation stratigraphic units, namely BVE 100, 200, and 300, and also differences associated with the distinct structural/topographic domains of the field. Additionally, the configuration of the faulted blocks of the Camboriú Formation basaltic basement exerted major control on the facies belts and on the distribution of depositional energy within the system. Some of the most prolific wells occur in the eastern (open) margin of the field, where the mapped marginal mound geometries and slope deposits are commonly related to thick accumulation of resedimented carbonates.

# PALAEOSOLS, FACIES, AND STRATIGRAPHIC ARCHITECTURE IN CONTINENTAL SEQUENCES OF THE SANFRANCISCANA BASIN (CENTRAL-EAST OF BRAZIL)

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During the Cretaceous, the Brazilian Sanfranciscana Basin was the scenario of fluvial and aeolian environments, whose facies, palaeosols, and stratigraphic architecture indicate significant changes in tectonics and climate. This work proposes an independent sequence stratigraphic model, using the facies and palaeosols distribution as the stratigraphic proxy for identifying variations in the accommodation space, sediment supply, and their relationship with the tectonic and climatic events. The palaeopedological analysis was performed on thirty-eight profiles of the palaeosols in the field according to the procedure of the Field Book for Describing and Sampling Soils. In the southern basin, Pedotype P1 profiles occur in the upper part of the Três Barras Formation (wet draa facies association). During the Upper Campanian, from south to north, the drier aeolian system was replaced by the fluvial-aeolian depositional system (Sequence SF2B – Serra das Araras Formation), indicating the increase in water availability. This change, associated with uplifts, generated the Unconformity U-2, on which hydromorphic palaeosol profiles (Pedotype P2) presented reddish to purple colours, clay minerals in bioturbation, oxide-to-hydroxide coats in the Bg horizons, iron reduction process, indicate poor-drained soils profiles in wetlands conditions. The unconformity U-0 was generated by the extensional tectonic processes during the Gondwana breakup in the Early Cretaceous and marked the initial continental sedimentation. The Lower Cretaceous Sequence SF1 overlies this unconformity, constituted by fluvial and lacustrine deposits. Overlaying unconformity U-1 are the Upper Cretaceous volcanic rocks, fluvial, and aeolian deposits of the Sequence SF2A and SF2B. The evolution of sequences records changes in tectonic and climatic detected in South America during the late Cretaceous. (Supported by FAPESP 2020/07997-4 and CNPq 310734/2020–7).

# Shelf sand ridge or incised shoreface? – tracing an isolated sand body in the lowermost Triassic of the eastern part of the Central European Basin (western Poland)

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The Drawsko Sandstone Member (Triassic, Middle Buntsandstein) forms an isolated sandstone-carbonate complex within a uniform clay-siltstone succession of the lowermost Triassic of northwestern Poland. A detailed interpretation of its architecture and depositional processes is lacking. The literature provides varied general interpretations. The aim of the current project is to conduct a detailed lithological analysis and mapping interpretation of this horizon in western Poland in order to reconstruct its large-scale depositional architecture. Because of the scarcity of Triassic core material in numerous boreholes, regional lithological data coverage is provided by wireline logs. In the first stage of the project, 191 boreholes in the Gorzów Block area were analysed. On this basis, the Drawsko Sandstone Member, with a thickness of 15–25 m on average, was subdivided into five lithological elements, which were analysed in terms of their thickness patterns and lateral distribution. The thickness of the entire horizon decreases from S to N. The horizon forms finger-like linear bodies, while its highest lithological element forms an island in the central part of the area. Additional data were provided by sedimentological investigations on cores from the Gorzów Wielkopolski IG 1 borehole. Fine-grained non-calcareous sandstones, going upwards into fine-grained calcareous sandstones with ooids and finally into oolitic limestones, are present. The rocks form repeated cyclothems several meters high, in which parallel- or cross-laminated sandstones go into flaser or wavy laminated muddy sandstones. Occasional mudstone interbeds up to 10 cm thick, intraclasts and clay flakes, as well as clay drapes are present. Two possible interpretations are considered: shelf sand ridge or incised shoreface. It is possible that the investigated sand body has a more complex structure.

# 3D CHARACTERISATION OF SEDIMENTARY HETEROGENEITY AND ITS IMPACT ON RESERVOIR PROPERTIES IN AMALGAMATED FLUVIAL SHEET-SANDSTONES: MONTLLOBAR FORMATION (YPRESIAN, TREMP-GRAUS BASIN, SPAIN)

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In tectonically active basins, axial and transverse depositional systems interaction can result in complex sedimentary architectures, affecting the morphology and internal heterogeneities of sandstone bodies. Here we present a detailed study in the lower Eocene Montllobar Formation (Tremp-Graus Basin, South-Pyrenean Foreland Basin), based on sedimentary logging, facies and paleocurrent analysis, fluvial architecture and correlation from UAV imagery interpretation, together with 3D facies modelling. The study focuses on characterizing the sedimentary heterogeneities of an example of axial fluvial system influenced by a coeval transverse alluvial fan.
Sedimentary data suggests that the study area up-north, closer to the basin margin, is dominated by channelized and amalgamated coarse-grained alluvial fan deposits, while farther south-westwards (basinwards), the succession is dominated by an alternation of finer-grained amalgamated fluvial-sheet sandstones with isolated high-sinuosity channel fills and floodplain deposits of the Montllobar Formation. In between these two areas, the studied amalgamated sandstone unit vertically displays up to three multilateral multichannel stories, with conglomerate-rich channel bases, composed by fine- to medium-grained and coarse-grained sandstones. These sandstones stack and amalgamate to form dominantly downstream-migrating mid and lateral-channel bars, interlayered by thin-elongated mudstone lenses and occasionally interbedded or partially eroded by conglomerate-rich alluvial fan facies. These sedimentological and architectural characteristics, together with bar dimensions, are consistent with the interpretation of a braided meandering river system, deposited during low accommodation and/or high sediment supply conditions.
3D modelling of the studied sandstone unit characterizes internal facies variability, porosity, vertical and horizontal permeability. The presence of thin-elongated mudstone lenses results in local baffles and poorly connected vertical permeability, affecting the upward movement of the injected $CO_2$. However, the lateral spread and stack of channel barforms facies would facilitate lateral connectivity for $CO_2$ migration. The studied case shows a potential for $CO_2$ storage despite 5% of the reservoir is characterized by non-connected seepage barriers.

# Land Loss in the Mississippi River Delta from Subsidence, Reduced Sediment Dispersal, Global Sea-Level Rise, and Coupled Atmospheric and Oceanographic Processes

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The Mississippi River Delta (MRD) in Louisiana has suffered large-scale land loss during the last few centuries and is representative of other low-elevation deltaic coasts that are at risk because of disrupted sediment supply and accelerated global sea-level rise. Most MRD land loss actually occurred after individual late Holocene deltaic headlands were abandoned, but before 1932 when air photos made land loss measurements possible. An additional land loss of ~5000 km2 has been recorded from 1932 to 2016 at a mean rate of ~57 km2 yr-1.

We use LiDAR to hindcast land-area changes for 1950-2010 by incrementally restoring elevation lost from subsidence and global sea-level rise. Our results indicate the magnitude and spatial distribution of 20th century land loss can be explained by ongoing subsidence, greatly reduced sediment supply and dispersal due to dam and levee construction, and acceleration of global sea-level rise. Other factors contributed on local scales, but the land loss that has occurred was inevitable due to the drivers listed above.

Multidecadal accelerations and decelerations in land loss in the MRD have generally been attributed to non-linear subsidence from subsurface fluid withdrawals. We propose an alternative view that non-linear land loss represents multidecadal sea-level anomalies that reflect the Atlantic Multidecadal Oscillation (AMO), which is related to flux of water in and out of the Gulf of Mexico from the Atlantic, and is associated with changes in atmospheric circulation that produce precipitation anomalies in the Mississippi River watershed, anomalies in Mississippi River discharge to the Gulf, and changes in wind directions that either trap water along the coast and elevate coastal sea level, or advect water away to lower coastal sea level. Positive and negative sea-level anomalies amplify or suppress global sea-level rise and its impacts on the MRD, but cancel each other over decadal time scales.

# EXCEPTIONALLY LARGE BOULDERS IN GRAVELLY SUBMARINE SLOPE CHANNELS: TRANSPORT BY CONCENTRATED BASAL LAYER IN TURBIDITY CURRENTS, OR DEBRIS FLOW ORIGIN?

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Large boulders have long been described in deep water, both in ancient turbidite systems and modern submarine fans. However, hitherto they have neither been described in detail nor the interpretation of their transport mechanism has been supported by field data. Here we present a study of large to very large boulders of volcanic mafic rocks and matrix-supported (packstone to wackestone) rudist limestone, up to 5 metres or more in diameter, which occur within submarine slope channel fills of the Campanian to Maastrichtian Rosario Formation, Mexico. The diameter of these exceptionally large extrabasinal clasts is typically of the same order as the thickness of the channel fill within which they occur. The adjacent sediments include organised and disorganised clast-supported conglomerates of pebble to cobble grade, matrix-rich to matrix-supported conglomerates, and lesser sandstones. Many of these deposits are characterised by structures interpreted to represent tractional transport by turbidity currents. In close association with the boulders, generally forming a basal/marginal rim, are more poorly-sorted matrix-supported conglomerates and mud-matrix debrites. The composition of the boulders indicates derivation from the contemporaneous shoreline. We suggest that the boulders were transported within cohesive debris flows which deposited en-masse, but due to subsequent erosion by gravel-transporting turbidity currents the debris flows deposits were largely eroded, leaving winnowed boulders scattered across the palaeo-channel belt. Over time the same process happened repeatedly, as the boulders are encountered in different stratigraphic levels across the system. Understanding these sediment transport processes and how they respond to seabed morphology and topography has important implications for deep-water sediment transport processes, and potentially for subsea infrastructure placement.

# Facies Zonation and Heterogeneity of Carbonate Formation

# Case Study – East Siberian Basin

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The goal of the study was to define the facies zonation of the carbonate layer I of the Eastern Siberia field based on a joint analysis of the core data and geophysical data. Layer I belongs to the Osinsky horizon of the Early Cambrian and is composed mainly of calcareous dolomites, which were formed under conditions of basin transgression throughout the platform; the rocks were subject to secondary transformations (shallow-marine platform setting). In this period tectonic differentiation occurs on the territory of the platform, with division into zones of shallow and depressional sedimentation zones, with the formation of organogenic structures (limestones) of various types.
The study area has 48 wells, 11 of which contain core data, and it's covered by 60% of 3D seismic. Most of the wells were drilled in the 2010s and they contain a good set of wireline logs.
At the stage of early diagenesis, the rocks of layer I underwent processes such as dolomitization and leaching, as well as partial silicification. The first had a positive effect on reservoir properties, but silicification did the opposite. The anhydritization process took place in the voids and matrix, which also negatively affected the filtration and capacitance properties of the rocks.
During the subaerial exposure, in the layer I process of karstization developed and the process of halitization, which began at the end of the diagenesis stage, continued.
In the stage of late diagenesis and catagenesis, the processes of halitization and stylolitization were actively developed and had a negative impact on the reservoir quality.
Using a series of seismic attributes and well data, it was possible to divide the study area into facies zones with better and poorer reservoir properties. The results of this study formed the basis for constructing a 3D geological model and development planning.

# The Oligo-Miocene Carbonate ramp succession of Maiella Mtn. to reconstruct changing oceanographic conditions in the Central Mediterranean

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This work presents a detailed stratigraphy on the Oligo-Miocene ramp carbonate succession cropping out in Majella, the northern extension of the large Apulian Platform placed in the Mediterranean area. The performed stratigraphic analysis included a detailed facies analysis integrated by biostratigraphic analysis based on calcareous nannofossils. Six new stratigraphic sections were measured in the southern and eastern sectors of the Majella and correlated with 9 previously published sections. This analysis not only facilitates the reconstruction of the stratigraphic architecture but also enables insights into the evolution of oceanographic conditions. In the time interval between Rupelian and Chattian, a ramp developed and was characterized by a large field of dunes in the middle ramp, testifying to the presence of strong currents that transported sediment towards the basin from south-east to north-west direction. Subsequently, between Chattian and Aquitanian, there was a transition to more siliceous facies, featuring deposits rich in planktonic and spicule evidence that indicate a shift to deeper depositional environments and a decline in carbonate production, followed by further deepening. During Burdigalian time, a resurgence of north-directed currents is observed, giving rise to a new dune field in the middle ramp. Successively, at the end of Burdigalian up to the middle Serravallian, a renewed deepening phase occurred, marked by the deposition of outer ramp facies with a pronounced increase in the terrigenous component. A significant sea level drop resulted in an erosive surface that delimited the lower boundary of the subsequent lower Tortonian to upper Messinian carbonate deposits. These deposited on a large ramp where the carbonate production was dominated by red algae in the middle ramp and by the epiphytic component in the inner ramp. Upwards a new drowning is recorded and it is linked to the progressive deterioration of environmental conditions due to the closure of the Mediterranean

# Mediterranean Heteostegina levels as proxies for oceanographic conditions

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Different Heterostegina-rich levels characterize the Miocene carbonate ramp sequences in the western and central Mediterranean regions. This study focuses on three levels situated in different areas of the Mediterranean. One occurrence is located on Menorca Island (Balearic Islands), marking the transition between the lower Tortonian Migjorn carbonate ramp and the Upper Tortonian-Lower Messinian Reef Complex. The second, coeval, level is found in the Upper Miocene succession of the northern Apula ramp, exposed in Majella (Eastern Central Apennines), indicating the base of the Tortonian to lower Messinian Lithothamnion carbonate ramp. The oldest analyzed Heterostegina level is situated in the lower Burdigalian portion of the Latium-Abruzzi carbonate ramp succession (Western Central Apennines).

These Heterostegina units have in common that they consist of uniform tabular beds measuring some 0.5–1 m in thickness, and that they are characterized by a high concentration of Heterostegina specimens (H. gomez-angulensis in Menorca, H. papyracea in the Apennines ramps). The texture of the coarse, rudite, fraction is generally matrix-supported, although layers a few centimeters in thickness may exhibit a grain-supported texture. Locally, the upper part of the layers contains an increased amount of fine fraction in the matrix, displaying a packstone texture with components such as Elphidium, discorbids, bryozoans, and planktonic foraminifera. In all study cases, there is an evident association between phosphatic-rich intervals and Heterostegina-rich deposits.

This study aims to explore the correlation between oceanographic conditions, phosphogenesis events, and levels of Heterostegina. It endeavours to unveil the reasons behind the substitution of extensive Heterostegina accumulations by spots where phosphogenesis occurred, likely linked to localized upwelling phenomena. The Heterostegina levels appear to be a consequence of restoring conditions the conclusion of the oceanographic conditions that promoted the upwelling phases and coinciding with a change in accommodation space.

# LATE PLEISTOCENE SEDIMENTATION PROCCESES FROM THE NW BLACK SEA

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The Black Sea is a semi-enclosed marginal basin, which connects with the Mediterranean Sea through the Bosphorus Strait, Marmara Sea and Dardanelles Strait. Throughout the last glacial period the Black Sea basin became isolated due to the sea-level dropping, leading to the disconnection with the Mediterranean. During the Late Pleistocene, the melting of the Fennoscandian Ice Sheet has delivered in the Black Sea basin a high deglacial sediment load that contain large amounts of red-brown clays. Former studies suggested that these clays entered the Black Sea through Manych Depression from the Caspian Sea, but more recent studies link their origin to the proglacial Lake Disna, located near the Fennoscandian Ice Sheet southern termination. The red-brown clays contain thin silt and grey clay laminae with few fine sand intercalations, interpreted as episodic turbidites. These sediments occur only on the north-western part of the Black Sea basin. In this study we present the results of 12 gravity cores collected from the NW Black Sea shelf, from water depths ranging between 166 and 1315 meters water depth. All the studied cores contain the red-brown clay sediments intercalated with green-grayish clays, rich in black specks of organic matter. The thickness of red-brown clays varies between 50 and 160 cm. Some cores contain two distinct red-brown subunits, mainly made of clays, separated by gray-greenish clays. This study aims to provide new insights into the Late Pleistocene Black Sea sedimentary record. New data on the red-brown clays deposition during the Last Glacial Maximum, along with paleoenvironmental and paleoecological reconstructions, are also presented herein.

# Variations in deep-water depositional systems across icehouse and greenhouse climates: a comparative analysis

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Deep-water clastic depositional systems are sensitive to environmental factors that varied during the evolution of the Earth. One such factor is global climate, manifested over long timescales in the alternation between icehouse and greenhouse phases. Icehouse phases are characterized by low eustatic sea levels that may have promoted sediment bypass on continental shelves and sediment accumulation in deeper water. However, submarine-fan successions deposited under greenhouse highstand phases suggest that sustained sediment influx to the deep sea may exist over a range of climatic conditions.

This study investigates how the sedimentary architecture of deep-water siliciclastic successions is influenced by the alternation of icehouse and greenhouse phases, and tries to elucidate the effect of global climate on deposition across geographic (e.g., latitude) and geologic contexts (e.g., tectonic setting, landplant evolution). To answer these questions, data on >200 turbidite systems of Proterozoic to Quaternary age were collected and analysed using the DMAKS database. The dataset includes >8,000 architectural elements (e.g., channel bodies, lobes) and >40,000 facies entries. The results show that, on average, both channel and terminal deposits accumulated under greenhouse periods are built by thicker sand beds and separated by much thicker mud intervals; they are thus characterized by a lower average sand fraction compared to icehouse examples. This observation can be explained by higher weathering rates combined with changes in weathering type and thus an increase in mud content reaching the oceans. Furthermore, a lower sea level can increase slope instability, thereby increasing the frequency of turbidity flows, giving rise to the thinner turbidite beds of icehouse systems.

Determining the importance of climatic controls on mechanisms of sediment delivery to the deep-sea has implications for predicting subsurface stratigraphic architectures of deep-water

reservoirs, used for energy extraction and carbon capture and storage, which accumulated under different climates.

# Facies Outcrop Analogue and Borehole Image Analysis for Reservoir Geometry Prediction: Case Study for a Sand-Meandering Reservoir in Lembak Oil Field, South Sumatera Basin, Indonesia

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The Structures of Talang Akar Formation in Lembak Field, South Sumatera Basin have not been developed intensively due to wide variations in the reservoir geometry. The recent 2D seismic interpretation results in the area is not good enough to provide information to re-evaluate this prospect. Integrated interpretation between facies outcrop analogue, borehole image analysis and the result from PBU analysis ensured the identification of new hydrocarbon pool reservoir geometry with the virgin pressure indication.

The study highlights the value of borehole imaging in characterizing a meandering channel reservoir, especially the paleo flow analysis then integrated with thickness width ratio from outcrop analogue. We define techniques of borehole image facies analysis, four borehole image facies associations were identified in Gritsand Member, Talang Akar Formation. Geological concept with outcrop analogue is really important to predict the reservoir paleo flow. From outcrop, sand thickness-width relationship gives better perspective to define the geometry. Despite of the complexity sinuosity from paleo meandering channel, integrated evaluation from borehole imaging then PBU surveillance and geological concept from outcrop give this research valuable and challenging. In the practice, co-rendered maps of isopach map and GDE map were generated to highlight the several realization channel patterns as well as to resolve the favorable reservoirs which were interpreted as shoreface shaly sand and channel sand meander from borehole images.

The significantly enhanced data from this evaluation detected detailed variations in sand geometry, accurately picking up formation top markers while drilling. The pressure data delineated various zones of interest and gave the new pool hydrocarbon reservoir so will increase the realization for production target. This non-intrusive, cost-effective methodology proved reliable in this petroleum setting to maximize pay-sand reserves. It optimizes new drilling campaign funneling and improves the success ratio for production and EUR target by helping with the best subsurface practices.

# Facies Architecture and Palaeogeographic Distribution of a Permian Dryland System (Utah, USA) - The Organ Rock Formation with application to ground-truthed facies modelling

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The Permian-aged Organ Rock Formation of the Cutler Group (Utah, USA) has been selected as an analogue for the Slochteren Formation of the Rotliegend Group (Dutch Sector, SNS). In this study, detailed sedimentary logging was conducted across an outcrop profile representing a ~200km-long dryland distributive fluvial system (DFS). Where the formation lies below the surface, onshore well data was used. A series of correlation panels were constructed and flattened upon a regional marker. This poster presents the first detailed facies association distribution map for the Organ Rock Formation (~280 Ma).

Sourced from the basaltic Uncompahgre Uplift, conglomeratic alluvial facies of the Undifferentiated Cutler pinch SW-downstream into amalgamated, poorly sinuous channel-fill. Overlying the aeolian-dominated Cedar Mesa Formation, medial multi- and single-storey fluvial channel-fill elements of the Organ Rock Formation are interdigitated by overbank splays and reworked aeolian sediment. Sheetflood processes dominate the terminal pinch-out zone, where unconfined fluvial splays interact with a laterally traceable dune field (>85x55km2) or terminate into the Blanding Basin palaeo-lake (>125x130km2).

Many proven fields of the Rotliegend Group are now at the mature stage of their life cycle. In recent years, this stemmed interest for CCS, geothermal, and exploration for overlooked play concepts (e.g., the ‘Dutch Havel’). With this study, a common facies scheme can be used to interpret virtual outcrops for proximal, medial, and distal zones of a dryland DFS. The ground-truthed facies models are then populated with real petrophysical data from the subsurface and translated into reservoir models for simulating fluid flow and/or storage.

# The characteristics and mechanisms of early marine cementation in carbonate sediments: A case study from recent sabkha carbonate deposits in Abu Dhabi

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As a typical modern low-angle homoclinal carbonate ramp sedimentary system, the Abu Dhabi coastline is regarded as a “natural laboratory” to study the carbonate diagenetic processes. Diverse early-diagenetic processes can impact the highly reactive carbonate sediments. Meanwhile, the coastal area in Abu Dhabi, especially in sabkha, is one of the few places around the world where the interaction between carbonate and evaporite deposits can be studied. Early marine cementation is widely distributed in various sedimentary settings, which plays a critical role in the diagenetic evolution of recent carbonate sediments. Through the data from cores, thin sections,cathodoluminescence, and scanning electron microscopy, the features and mechanisms of early marine cementation from sabkha sediments in Abu Dhabi have been studied. The main mineral compositions of sediments in sabkhas are carbonate, gypsum, anhydrite, aeolian quartz, and feldspar. The carbonate allochems are composed of various bioclasts and peloids. There are gypsum, aragonite, halite, and pyrite cements in the sabkha deposits, which indicates the cementation is related to various chemical and biological processes. The evaporation and CO2 degassing process are the main abiotic factors that control early cementation. The metabolism of microbes and some secretions from organisms also have a great influence on cementation.

# Spatial variation in the sedimentary architecture of a vast Cretaceous desert in Northern China

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Deserts are characterized by their profound aridity and often share in common features. Studies on palaeo-desert deposition systems can promote the reconstruction of palaeoclimate, palaeoenvironment and palaeogeography. Desert depositional systems display a wide range of sub-environments. However, due to the deformed and fragmentary state of preservation in outcropping successions, many studies on palaeo-deserts have tended to focus on specific sub-environments rather than comprehensively exploring the entire desert system. The Lower Cretaceous The Lower Cretaceous Luohe Formation represents a widespread aeolian sandstone unit that extends across the entire Ordos Basin, from its margins to its center, with correlative deposits in northern China. Its widespread distribution and thickness make it one of the most expressive occurrences of continental deposits globally, covering an area exceeding 370,000 km$^2$----larger even than the largest modern desert in China, the Taklimakan Desert (337,000 km$^2$). The Luohe Formation was deposited as an extensive sand sea with distinctive desert-margin and central-desert aeolian-fluvial-alluvial stratigraphy. This characteristic transforms the formation into an exemplary subject for studies, illustrating the transition from a wet aeolian system to a dry aeolian system within the palaeo-desert. The objective of this study is to develop a comprehensive model that captures the spatial and temporal evolution of an aeolian-fluvial-alluvial succession from palaeo-desert margin to the centre. Additionally, we aim to discuss paleoclimate and paleogeography corresponding to the Early Cretaceous large paleo-desert system in the Ordos Basin.

# Paleogeographical constraints of the Ediacaran dolomite-phosphorite sequences of Bocaina Formation (Southwestern Brazil – Corumbá Group)

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The Bocaina Formation, a shallow marine carbonate sequence within the Ediacaran Corumbá Group, predates the emergence of macroscopic skeletal metazoans. Extending over 450 km in two regions of Mato Grosso do Sul, Brazil - the northwestern Corumbá Region and the southeastern Serra da Bodoquena Region - establishing a correlation between these regions is challenging due to facies variations and distinct underlying rocks. Previous age assessments indicate 555 Ma in the Corumbá Region and 580 Ma in the Serra da Bodoquena Region. The Bocaina Formation, hosting economic phosphorite deposits and crucial microfossils, lacks well-constrained paleogeography. This study reconstructs paleogeographical models by compiling existing data with new outcrops. Employing hand sample analysis, optical microscopy, and stable isotopes, we delve into understanding the depositional environments and stratigraphic framework of the Bocaina Formation. Geographical information system software was used to compile outcrops, maps, and aerogeophysical data. Our observations suggest the Bocaina Formation likely originated as a tide-dominated carbonate platform in a passive margin context in the Serra da Bodoquena region, with restricted teepee structures, small-ooid shoals, mudstone-microbial lagoons, and a phosphatic microbial barrier-reef complex, influenced by east-side upwelling currents. The deposition of a meter-thick shale succession in the Serra da Bodoquena region marks a marine transgression, followed by the establishment of a phosphatic-rich carbonate ramp in the region. This led to a marine incursion in the Corumbá region, creating an extensive shallow peritidal carbonate sequence in the area, with abundant teepee structures, intertidal microbial mats, giant-ooid and intraclastic shoals, smaller microbial barrier-reefs, and rare phosphorites. These findings not only offer insights into the Bocaina Formation's depositional history but also potentially explain both ages, implying a broader time interval for the deposition of the geological unit. Also, these paleogeographical and stratigraphical results may have implications with the formation of the Gondwana paleocontinent.

# From shallow to deep marine coarse-grained deposits: sedimentary systems during the late Eocene, Colombian Caribbean

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Coarse-grained clastic successions may be deposited in various sedimentary environments including alluvial, fluvial, transitional and deep marine. However, their detailed characterization is given the complexity of discerning the sedimentary environment in which they were deposited, as their transport from shallow to deep settings may even be interconnected.

This research from coarse-grained deposits of the upper Eocene in the San Jacinto Fold Belt (Colombian Caribbean) integrates sedimentological and ichnological information from outcrops and well-cores, to decipher paleoenvironmental conditions and characterize depositional settings.

Metric sequences of poorly sorted, immature, subtly horizontal laminated conglomerates interbedded with rhizolite-bearing clays vary laterally to conglomeratic sandstones and sandstones with massive structure and sporadic occurrence of Ophiomorpha revealing the arrival of continental sediments to the coastline. Poor-maturity coarse-grained deposits reflect short transport from the source area, with no fluvial or coastal buffering, via sediment-gravity flows with laminar rheology. These deposits suggest mouth-bar-type deltas, which are commonly linked to stable fluvial distributaries with recurrent periods of torrential rainfall.

Meter-thick beds of sigmoidal and lenticular conglomerates; planar cross-bedding (foreset and backset) pebbly sandstones; and undulated-stratified granule- and coarse-grained sandstones filling gently scours. Net contacts with centimetric-thick layers of horizontal bedded mudstones with abundant benthic foraminifera (shelf break to upper slope deeps) have been identified. The aforementioned deposits are overlain by thin beds of highly bioturbated fine to medium-grained graded sandstones, with Ophiomorpha and Thalassinoides, and mudstones, with Nereites, Phycosiphon, and Teichichnus, associated with low-density turbidites in a levee/terrace system. These features can be related to coarse-grained mouth-bar migration, that combined with the antidunes record, suggest supercritical flow deposition and transition to subcritical flows in deep marine environments.

This study reveals the occurrence of contemporaneous coarse-grained deposits accumulated in two different sedimentary environments, allowing an assessment of the dominant depositional processes acting on each of the deposits.

# Morphodynamics of intertidal linear sand ridges on muddy tidal flats, semi-enclosed Hamhae Bay, SW Korea

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Intertidal sand ridges are wave-reworked sand bodies consisting of sands and shells that normally occur on intertidal flats. It overlies a muddy substrate and shows often a linear feature parallel to the coastline. It has been generally known to be migrated landward by storm waves, welding into beach ridges and eventually forming cheniers. However, the shore-normal orientation of linear ridges occur rarely in muddy macrotidal flat in Hamhae Bay, Korea. For this reason, a linear sand ridge oriented perpendicular to the shoreline was investigated to understand how does it form under wave and tidal conditions, and to finally infer the source of coarse sands surrounded by mud substrate. About 500-m long, shore-normal linear ridge is located ca. 600 m away from the coastline and topographically situated near the mean sea-level. It is strongly asymmetrical in cross-section. Tidal currents on intertidal flat recorded maximum velocity of about 90 cm $sec^{-1}$ with ebb-dominance. Interesting feature is the seaward-directed sediment transport on the ridge inferred from the analysis of bedform orientation and time-series profiling survey using a VRS-GPS system and drone. Can-core sedimentary facies show a various scale of 2D-dunes deposited possibly by washover processes. Substantial transport of sands take places when high water levels coincides with high waves. Consequently, the ridge is migrating seaward during calm condition, while storm condition results in a landward migration. The coarse-grained sands might essentially come from highly-weathered coastal cliffs via tidal creeks, rather than the subtidal area. This study thus showcases how waves and tides are shaping and maintaining the linear intertidal ridge on embayed mud-flats.

# Thin-interbedded reservoirs detection and application based on seismic sedimentology

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[1]1, [2]2, [3]3

Thin-interbedded reservoirs are important exploration targets for lithologic reservoirs. However, it is difficult to be predicted by seismic data because of the limit of seismic resolution. In this paper, we propose a new thin-interbedded prediction process based on seismic sedimentology taking Ordos Basin in China as an example. Braided river delta deposits are developed in this work area, and the underwater distributary channels are the main reservoir. The thickness of a single reservoir is generally less than 10 meters, with rapid lateral changes and multiple sets of thin interbedded reservoirs are developed vertically. The seismic data cannot meet the requirements of thin reservoir identification. How to improve the ability of thin reservoirs identification and predict the distribution of sand bodies from seismic data is the key to improve the success rate of exploration. Firstly, a numerical model is created by typical wells to analyze the seismic response characteristics and the thin interbedded interference by forward modeling. Through numerical simulation, it has been clarified that the strong reflection from coal seam and the adjacent response from sand body are the main factors that make the target sand body difficult to be identified. Then, the strong reflection event is separated from the original seismic data by matching tracing method to weaken the coal influence to the target sand. The dominant frequency is appropriately increased by superposition sampling method to improve the seismic resolution. Finally, we extracted stratal slices of the target layer and the adjacent layers from processed seismic data, and used superimposed slicing method to suppress the interference from adjacent layer. The result shows that the plane distribution is consistent with the geological pattern, and the description of the details is clear, and it is consistent with the drilled results.

# A new model of early oblique sediment provenance in the steep slope zone of rift basin: A case study of the Upper Fourth Member of Formation Shahejie in the northern Bonan sag w in Eastern China

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Sedimentary provenance analysis in the early stage of faulted basins is crucial for classifying sedimentary systems and predicting favorable hydrocarbon zones. Previous research has indicated that the steep slope zone of faulted basins mainly develops nearshore submarine fans, small fan deltas and sublacustrine fans by short-axis provenance perpendicular to the border fault. However, the early faulted basins are characterized by complex topography and intense tectonic activity, and whether the existence of other provenance directions remains unclear. This research focuses on the sedimentary provenance of the Upper Fourth Member of Formation Shahejie, located in the eastern steep slope belt of the northern Bonan sag within the Jiyang Depression in Eastern China, Using high-resolution 3D seismic data, in conjunction with core samples, and well logging data. The main findings are as follows: (1) A large-scale progradational-channel-filled seismic facies combination oblique to the border fault is observed in the seismic profile, along with a tongue-shaped strong amplitude anomaly, indicating a large-scale oblique provenance in the early stage of the faulted basin steep slope zone;(2) The core data shows the phenomenon of gravel orientation arrangement, and the logging curve characteristics and lithofacies combinations reveal antirhythmic characteristics. Based on these observations and the seismic facies and seismic attribute identification results, it is comprehensively inferred that the large-scale oblique source is fan delta sedimentation;(3) A new sedimentation model for the early stage of rift lacustrine basin steep slope zone is proposed, which includes both nearshore submarine fans by short-axis provenance and fan deltas by oblique provenance. The fan delta in the early stage of rifting steep slope zone has good reservoir physical properties and excellent reservoir conditions, which can be a promising exploration direction for the next step. This study reveals a new reservoir research direction for deep exploration in fault basin’s steep slope zone.

# Shelf to basin-floor sediment transport: outcrop analysis of a fluvial-deltaic-slope succession, northern England

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Sedimentary successions preserved with sufficient detail to demonstrate convincing evidence of coeval processes operating from shoreline, to shelf, to marine slope and basin-floor remain relatively poorly documented. Well-exposed outcrops of the Carboniferous Millstone Grit Group in and adjacent to the Askrigg Block of North Yorkshire, England, record deposition from a fluvial plain, to deltaic, to a slope and basin-floor environments. Twenty-four sedimentary logs (with a cumulative length of ~450 m) cover accessible and well-exposed parts of the Carboniferous Nidderdale Shale, Red Scar Grit and Scar House Sandstone in Upper Nidderdale. The lithology, grain size, thickness, structure, contacts and fossil assemblages of each bed were recorded. The locations of each log were tied to georeferenced photos and recorded on 1:10,000 scale base maps. Photo panoramas and 3D models of the outcrops were created from photographs with metadata locations; panoramas were used for further analysis and stratigraphic correlation. Twenty-two facies are classified. These occur in eight distinct facies associations, each recording evidence for a suite of depositional processes in a range of settings.
From analyses of logs and architectural panels, a series of depositional environments have been interpreted: fluvial floodplain and splay, fluvio-deltaic plain, a delta-edge distributary channel system, interdistributary bay and lagoon, overbank, delta-front, and distal slope to basin-floor. The interrelationships of architectural elements of different depositional environments have enabled regional 3D depositional models to be established based on geometrical relationships. The models are constrained within a sequence stratigraphic framework for which marine maximum flood surfaces with diagnostic palaeo-fauna provide a chronostratigraphic framework. Collectively, the integrated results demonstrate mechanisms of sediment transport and delivery from fluvial systems developed across a shelf edge delta to a submarine slope and basin-floor setting. Results enhance our understanding of dynamic source-to-sink systems from land, via shelf, to slope and basin floor.

# Mid-deep circulation depositional mode in the northwestern South China Sea and the impacts of complex topography

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As a natural laboratory for studying energy and material exchange at water-rock interfaces, the northern slope area of the South China Sea (SCS) possesses complex geomorphology, such as uplifted seamounts, flat terraces, and depressed canyons. It also develops various types of deep-water depositional processes, including gravity flow slides/slumps, turbidity currents, and contouritic currents, which have profound impacts on shaping continental margins.

Based on high-resolution bathymetry and seismic reflection data, CTD data, numerical simulation results as well as published data from marine sedimentology and physical oceanic numerical simulations, this study focuses on analyzing the sedimentary combination under intermediate and deep circulation bottom currents in the Central Canyon at the SCS northerwestn corner.  We (i) investigates the main features of mid-deep circulation currents passing through a large submarine canyon  (extending hundreds of km); (ii) explore how atmospheric forcing (winds), mesoscale oceanic processes such as eddies, and sub-mesoscale current-topography interactions modulate the mid-deep circulation patterns.

Comprehensive data results suggest that the convergence of different water masses and current-topography interactions  take primary responsibility for generating local instability and energy dissipation, which in further determines the sediment particle distribution. These findings emphasize the intensification and bifurcation of local circulation specifically induced by a large canyon morphology, which can provide innovative insights for better understanding mid-deep circulation structures and sedimentary patterns at the western boundary of ocean basins such as the SCS.

# Estimating paleo-tidal constituents from Pliocene “tidal gauges”-an example of paleo-Orinoco Delta, Trinidad

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The Neogene Orinoco Delta is one of the typical river deltas where both the records of modern and ancient tidal processes can be studied. A ca. 5 My/>10 km thick succession on the island of Trinidad contains remnants of paleo-Orinoco deltaic deposition preserving both tide- and wave-influenced delta lobes within the same time intervals, just like the modern Orinoco Delta. The tide-influenced delta lobes and estuaries preserve spectacular tidal bedding signals, including tidal rhythmites. The tidal record encoded within the tidal rhythmites is preserved well enough that the primary tidal constituents responsible for the tidal currents can be inferred.

Lower to Upper Pliocene tidal rhythmites have been examined in two main paleo-Orinoco sub-environments: (1) estuary and delta lobe deposits of Morne L’Enfer Fm. at Erin Bay and (2) abandoned tidal channels associated with tide-influenced delta-front deposits from Telemaque Sandstone Member of Manzanilla Formation at Matura Bay. Both wave- and river-current signals are also present in most study areas.

Tidal constituent analysis of unusually well-preserved paleo-Orinoco tidal rhythmites reveals a hierarchy of tidal signals that include semidiurnal, diurnal, fortnightly (neap-spring), monthly (perigee-apogee), semi-yearly, and possibly seasonal and yearly cycles that span thickness intervals ranging from mm to meters.

The tidal constituents were dominated by, in decreasing importance, M2, S2, and likely K1 rather than O1. The modern tide data clearly show that K1 is more important in terms of tide-generating potential than O1, as was likely so in the Pliocene. The comparison between the constituent analysis of the ancient tidal record and the modern tide measurements reveals their similarities in tidal patterns and constituent types. From this, we deduce that the tidal constituents responsible for the Pliocene Orinoco Delta tides were mixed semidiurnal tidal cycles similar to those found today in Trinidad (Atlantic type-synodically dominated) rather than Caribbean (tropically-dominated) type.

# The origin of carbonate minerals in shale of the Qingshankou Formation in the Sanzhao Sag, Songliao Basin: Implications for paleoenvironment and shale oil exploration

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Lacustrine carbonates are widely distributed in the Qingshankou Formation, which is the primary hydrocarbon source rock in the Songliao Basin. However, the origins of lacustrine carbonate deposition and their implications for shale oil exploration and paleoenvironment are not well understood. In this study, thin section observation, X-ray diffraction (XRD), stable carbon and oxygen isotope and trace element analyses were utilized to determine the types and origins of lacustrine carbonates in the Qingshankou Formation. Three types of calcite (biological detritus, mud crystal calcite, and sparry calcite) and two types of dolomites (mud crystal dolomite and fine crystal dolomite) were developed in the studied shale. The carbonates of the Qingshankou Formation were mainly formed in saline, stratification, anoxic water conditions with medium to high primary productivity. The biological detritus is elongated and curved which was formed by biochemical processes on the biological shells in paleolakes. Mud crystal calcites were formed laminations in laminated shales and mixed with clays without laminar structures in massive marlstones. Sparry calcite has a larger particle size and a clean surface. It was formed by organic acids generated from organic matter that dissolve and recrystallize the original calcite. Mud crystal dolomite is a product of sulfate reducing bacteria participating in biochemical reactions, appearing in the form of lenses and waves. Fine crystal dolomite is a product of recrystallization, appearing in a flat rhombic or sub rhombic shape. The carbonates developed in the Qingshankou Formation are associated with the intervals with high TOC contents and within the thermally mature zone of hydrocarbon generation. In addition, intergranular pores and dissolution pores are widely developed within carbonate minerals, providing storage space for the enrichment of shale oil.

# Shallow-water onlap sedimentary model of black organic-rich shale in the Longmaxi Formation, Sichuan Basin, China

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Fine-grained sedimentation determines the material basis of shale reservoir and plays an important role in the formation of high-quality shale. It is generally believed that the shale of Longmaxi Formation was formed in deep water environment in the Sichuan Basin in China, but this study has obtained a new understanding. Based on drilling cores, outcrops, thin sections and seismic data, the sedimentary model of the Longmaxi black shale of the Sichuan Basin was studied. The results show that: (1) siltstone interbedded with shale, bioturbation, cross laminae, wavy laminae, graded laminae, orientation of mud gravel and basal erosion occurred in the black organic-rich shale of the Longmaxi Formation , which reveals obvious shallow water sedimentary characteristics. (2) The reverse graded sequence of shale-silty shale-siltstone formed by wave action is developed in the black shale, which indicates that wave action has an important influence on the formation of black shale in the Longmaxi Formation. (3) The storm has a certain influence on the formation of black shale in the Longmaxi Formation, which shows the normal graded sequence of siltstone to black shale formed on the irregular erosion surface. (4) Seismic profile and regional stratigraphic well correlation show that the black shale of the Longmaxi Formation shows obvious onlap characteristics. With the rise of sea level, the shale migrated to the margin of paleo-uplift. In general, the black shale of the Longmaxi Formation in the Sichuan Basin was formed in a sedimentary environment with limited water depth and is vulnerable to waves and storms. As the sea level continues to rise, the shale is characterized by continuous overlapping migration. The shallow-water onlap sedimentary model of the Longmaxi Formation organic-rich shales has important guiding significance for the search of organic-rich shales in the Sichuan Basin.

# Effect of pore structure and CO2-oil-rock interactions on sweep efficiency of CO2 EOR in tight sandstone reservoirs

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CO2-oil-rock interactions and complex pore structure affect the sweep efficiency (ES) and wettability, thus have a significant impact on CO2 enhanced oil recovery in tight oil reservoirs. In this study, we selected 10 rock plugs from the Yanchang Formation, Ordos Basin in China. First, casting thin section and mercury intrusion capillary pressure were performed to investigate the microscopic pore structure characteristics of the tight rock samples. The results show that pore structure can be divided into three types (RT-I, RT-II, and RT-III) from good to poor qualities. On this basis, CO2 floodings using the Nuclear Magnetic Resonance technique were performed to investigate the influence of pore structure on the ES in large (PL) and small (PS) pore throat intervals. With the increase of displacement pressure, the oil recovery of RT-I, RT-II and RT-III are about 70.9%, 67.8% and 10.16%, respectively. The ES of PL of all samples are similar, while the ES of PS decrease subsequently for the three types. Pressure, mineral composition and the complex pore structure are attribute to the differences. On one hand, higher displacement pressure leads to lower interfacial tension and viscosity, resulting higher oil recovery. On the other hand, CO2 is more likely to vaporize the light oil components, resulting in the asphaltene precipitation. Quartz with smooth surface is not easy to precipitate, while most clay minerals are easier to absorb asphaltene and are likely to alter the wettability of pore surfaces. Thus, in comparison to RT-III, the ES of RT-I with higher quartz content is higher in PS. In addition, the worse the relationship between pore structure configurations, the greater the capillary pressure, causing the different ES between RT-I and RT-II. The findings in this study shed a light on the understanding of complex mechanisms for CO2 EOR in tight oil reservoirs.

# The impact of grain size and shape on porosity and permeability: a digital image analysis approach

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An accurate and reliable description of the porosity-permeability relationship in geological materials is valuable in understanding subsurface fluid movement. This is important for reservoir characterisation, energy exploitation, carbon capture and storage (CCS), and groundwater contamination and remediation. Whilst a significant amount of work has been done to understand the relationship between the pore structure and the porosity-permeability relationship, further investigation of the impact of the grains on this relationship may be beneficial. This work aims to use grain characteristics such as shape (sphericity) and size (Feret diameter) to better constrain the porosity-permeability relationship. We demonstrate the implementation of a fully digital workflow based upon micro X-ray computed tomography (µCT), through which individual grain identification and measurement in 3D is automated. This technique was used to investigate sandstone samples from the Brae Formation sandstone (North Sea, UK), Wilmslow Sandstone Formation (Sellafield, UK) and Minard Formation (Porcupine Basin, N. Atlantic). Using this novel digital approach, we find that sphericity and porosity exhibit a positive relationship according to φ= 〖1.22φ〗_s-0.42 whereas no such relationship exists with grain size. These measurements are applied to calculate a Kozeny-Carman (K-C) porosity-permeability fit where it was found that excluding grain size results in a poorer quality fit, despite showing no relationship with porosity or permeability. Inclusion of both grain sphericity and size was found to produce an unsatisfactory fit, possibly due to significant deviation from the K-C assumption that grains are spherical. A simpler fit of the form K= 10^5.54 φ^3.7, excluding any influence of grain characteristics, is most suitable for the studied materials, showing that grain shape and size is not influential on the porosity-permeability relationship in a K-C paradigm. This highlights the need for a model capable of considering a range of grain shapes to further constrain the porosity-permeability relationship.

# Along-strike architectural variability of normal fault-controlled deltaic systems (Crati Basin, Italy)

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Deltaic systems can be classified into: (i) base-of-scarp, (ii) Gilbert-, and (iii) shelf-type based on the depth of water in the receiving basin and the gradient of the depositional slope, which in turn control the stratal architecture and facies types distribution within each delta type. This study aims to address the along-strike architectural variability of Pliocene-Pleistocene deltaic systems deposited in the eastern margin of the Crati Basin (southern Italy), which is characterised by an array of major N-S striking normal faults, and a secondary fault network composed of NE-SW and NW-SE-striking faults, developed since the Pliocene-Early Pleistocene. To assess it we had the following objectives: (i) construct strike and dip logs along the basin margin to determine facies and sourcing areas, (ii) establish outcrop-based internal geometry and architectural variability, and (iii) build correlation panels to assess lateral geometry and facies changes. We divided the eastern margin into three sectors (i.e., southern, central, and northern), with throw greatest in the northern sector and decreasing southwards. Log correlation shows the dominance of coarse-grained material (i.e., conglomerates) near the faulted margin, thinning and fining westwards into siltstone. Results indicate that in the early phase shelf-type deltas developed above the basement along the entire length of the subsided hangingwall. Stratigraphically above, the northern and central sectors are characterised by the formation of Gilbert-type deltas, whereas in the southern area, shelf-type deltas continued to develop. This suggests that the growth of the margin was characterised by initial low-gradient depositional slopes and the formation of shelf-type deltas. Continued syn-sedimentary growth of the margin resulted in steeper depositional slopes along the central and northern sectors and the related development of Gilbert-type deltas.

# Correlation of diagenetic processes and mineralogy with high productive zones: An example of lacustrine Brazilian pre-salt carbonates of the Barra Velha Formation, Santos Basin

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The Brazilian pre-salt lacustrine carbonate reservoirs are the most prolific oil play in the country. Therefore, understanding their depositional and diagenetic processes is extremely important for the exploration and production of the reservoirs. In this work, a combination of petrographic and core description with X-Ray Diffraction (XRD) and the interpretation of conventional and special well logs, such as Nuclear Magnetic Resonance (NMR) and Borehole Image Logs (BHI) allowed the characterization of main depositional, mineralogical, diagenetic and petrophysical features along a key well. In an attempt to correlate the mineralogical distribution from well logs with the core characterization, mineralogical inversion was performed by using conventional logs which were validate with XDR results. In this way, the main mineralogical distribution of Barra Velha Formation deposits was determined. The results showed a preferential correlation between mineralogical distribution with highly productive zones, as observed in Production Testing (PLT). These productive zones are mainly correlated with high concentration of dolomite (>30%), which exhibit a high concentration of vuggy pores as observed in BHI, whereas the low productive zones are associated with high concentration of calcite and absence of vugs. The core and thin sections description attest the high dolomite concentration in these high productive zones with the presence of vugs, which are mainly related with the diagenetic dolomitization process combined with dissolution. Despite the petrofacies exhibit some influence of depositional porosity, the imprint of diagenetic dolomitization and dissolution processes are the main controls on the porosity and permeability of these high productive intervals.

# Are there limitations in dating fossils subjected to volcanic influence?

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The volcanic Island of Santa Maria (Azores, Portugal) was chosen to test the impact of volcanic fluids and heat on isotope proxy data (δ13C, δ18O values and 87Sr/86Sr ratios) from skeletal carbonates. The main goal is to establish the potential and limitations of these materials for paleoenvironmental reconstruction and age dating in Neogene to Mesozoic volcanic settings.
At Santa Maria, an extraordinary coquina of international relevance—Pedra-que-pica—is interbedded in volcanic deposits, providing the ideal context to test the influence of volcanic activity during biomineralisation. Two Pliocene outcrops (4.78 to 4.13 Ma based on adjacent basalts) were selected: Pedra-que-pica and Figueiral (Touril Complex). Shell fragments and encasing sediment were analysed for their elemental (Ca, Mg, Sr, Fe, Mn) and C and O-isotope composition. Shell powder samples were also used for dating purposes via 87Sr/86Sr. X-ray diffraction (XRD) analysis of encasing sediments was also performed.
The elemental composition of the shells shows expected low-magnesium calcite composition, with Mn and Fe concentrations below 50 and 480 ppm, respectively. In contrast, the encasing matrix presents significant Mn and Fe enrichment (386 and 21.280 ppm), probably related to detecting magnetite and dolomite under XRD (23 and 42%).
Stable C and O-isotope composition provided two clear data clusters: one comprising all shells (except one) and another comprising all sediment samples and one shell sample, which probably was contaminated during sampling. Shell samples plot along positive C and O-values from 1 to 2 ‰ whilst sediment samples show depleted values for both proxies (δ13C from -2.5 to -8 ‰; δ18O ca. 0‰). Strontium-isotope dating of the best-preserved shells provided ages ranging from 6.9 to 5.9 Myr, which confirms previous interpretations based on Sr-dating. Mineralogical stabilization or later interaction of these shells with encasing sediment and/or burial fluids did not affect their potential as palaeoecological and dating tools.

# Stratigraphy of reworked phosphatic levels reveal Oligo-Miocene Central Mediterranean paleoceanography: insights from the Hyblean sedimentary succession (Sicily, Italy)

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Phosphatic levels, whether in the form of in situ crusts or reworked phosphatic pebbles, frequently occur in the Oligo-Miocene record of Mediterranean carbonate successions, marking moments of condensation or depositional hiatuses.
This work focuses on revising the stratigraphy of the Lower Miocene portion of the Ragusa Formation (Southeastern Sicily, Italy), with the aim to identify and constraint the hiatuses associated with phosphogenesis, framing this process within the context of global climatic changes and regional paleoceanographic evolution.
Through Sr isotope analyses, coupled with detailed nannofossil assemblages' analyses, we identified two distinct intervals of phosphogenesis and sedimentary condensation. Previously thought as one long-lasting phase, these hiatuses occur at the base of the Aquitanian (23-22 Ma) and at the base of the Burdigalian (20 Ma), coinciding with two global cooling events and glacial maxima (Mi-1 and Mi-1a Events). Thus, these hardgrounds are interpreted as the result of the upwelling of nutrient-rich deep waters, increased weathering and phosphorous availability triggered by global cooling and enhanced circulation in the Mediterranean basin.
Coeval phosphatic hardgrounds also occur in the Oligo-Miocene succession of the Malta Island, lining up from South to North. This correlation supports the interpretation of increased bottom-water currents, which, originating in the deep Eastern Mediterranean basin, rose up to the eastern sides of the Central Mediterranean carbonate platforms during abrupt climate shifts.

# Facies association analysis of a Toarcian siliciclastic-carbonate lacustrine system, Sichuan Basin, China

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Considerable coverage has been devoted to hydrologic and biological feedbacks in marine environments, with scant attention paid to lacustrine system during the Jenkyns Event. The fossiliferous carbonate and clay-rich mudstone samples of the Da’anzhai Member (J1dn), palaeo-Sichuan lacustrine basin, offers an exceptional opportunity to evaluate lacustrine environment evolution contemporaneous with the Jenkyns Event during the Toarcian. In this study, we have undertaken an investigation of J1dn mainly from a petrological perspective (hand-sample observations and multiple micro-analytical techniques), and supplemented extant studies with new geochemical analyses and validations. Unique sedimentological and petrological features were used to identify five principal facies associations (FA) and depositional environments, including the distal delta front, accretionary bioclastic shoals, proximal bioclastic shoal ramp, distal bioclastic shoal ramp and (semi-)deep lacustrine environment. The vertical transitions of FA reveal that J1dn forms a complete lacustrine transgressive-regressive sedimentary system during the Toarcian, which can be further divided into 3 stages controlled by lacustrine-level fluctuation: Stage A (mainly an accretionary bioclastic shoal environment in warm, well-oxygenated fresh water, but accompanied by frequent lake-level fluctuations); Stage B (mainly a deep lacustrine environment at the relative lake-level highstand, occasionally affected by storm-induced waves, coinciding with the initiation of the Jenkyns Event); and Stage C (recovering the depositional environment dominated by bioclastic shoals at the relative lakelevel lowstand, contemporaneous with the end of the Jenkyns Event). At different stages, storm and hurricane events would induce the remobilised, resuspended and redeposit of unconsolidated sediments, allowing the mixing of fossiliferous carbonate and clay-rich mudstone in the lacustrine system. Finally, the proposed depositional evolution model at the lake-level highstand stage and lowstand stage of the palaeo-Sichuan lacustrine basin provides new insights and understanding on the changing palaeolimnological history of the Toarcian lacustrine system.

# Revising the control factors of tight sandstone reservoirs: A case study on Member 8 of Permian Shihezi Formation in Longdong area, Ordos Basin

Influence of diagenesis on reservoir in He 8 member of the Permian Shihezi Formation in Longdong Area, Ordos Basin Gaixia Cui[1], Influence of diagenesis on reservoir in He 8 member of the Permian Shihezi Formation in Longdong Area, Ordos Basin Shouyu Xu[1], Influence of diagenesis on reservoir in He 8 member of the Permian Shihezi Formation in Longdong Area, Ordos Basin Qinlian Wei[2]
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Abstract: Tight sandstone gas reservoirs, as a representative of unconventional gas reservoirs, possess significant reserves and abundant oil and gas resources. Consequently, they have become a crucial focus for governments and enterprises in terms of exploration and development. In the Longdong area located in the southwest of the Ordos Basin, a relatively complete set of dense thick sandstones with multiple layers rich in oil and gas has been continuously deposited due to sedimentary environment and structural factors. As exploration into tight sandstone oil and gas deepens, this area is gradually emerging as a new development replacement zone. This research area conducted experiments such as casting thin sections, scanning electron microscopy, high-pressure mercury injection tests, physical property analysis etc., to study parameters including reservoir properties, lithology characteristics, and pore structure features. The results revealed that lithic quartz sandstone (61.6%) and lithic sandstone (15.06%) were the main rock types in Box 8 section. The overall grain size was coarse with medium sorting while intragranular dissolution pores dominated followed by intergranular pores or crystallographic micro-pores. The thickness range of storage layer exhibited significant variation along with strong heterogeneity in rock type distribution within it. Reservoir properties are jointly controlled by sedimentary facies and diagenesis processes where sedimentary facies fundamentally determine reservoir property conditions; Sand body structure plays an important role on reservoir properties where cutting-type single-sand-body storage exhibits better physical properties than spliced-sand-body storage while isolated single-sand-body is inferior to both; Compaction is the primary reason for densification whereby water mica serves as the primary factor causing cementation-induced densification while low degree dissolution has limited effect on improving reservoir quality.

# Characterization of Proterozoic Tidal Deposits: Insights from Virtual Outcrop Models

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The overall configuration of Morro do Chapéu Formation, part of the Espinhaço Supergroup, shows basal conglomerates covered by fine grained sandstones and heterolithic strata, This assemblage indicates an environment predominantly influenced by wave dynamics. The tidal influence is observed in the middle interval of the deposit, due to changes in shoreline morphology. This study was intended to characterize these tidal deposits based on Virtual Outcrop Models acquired from a quarry within  the study area. In this context, five architectural elements were characterized through their internal and external geometry: i) accretionary climbing dunes; ii) erosive climbing dunes; iii) simple macroforms; iv) compound macroforms; and v) sand ridges. These deposits are not homogeneous, but mainly exhibit fine to medium-grained, well-sorted, low-angle and trough cross-stratified sandstones. Sets with regular or undulating bounding surfaces with internal planes dipping in the same direction as the dominant current, are interpreted as accretionary climbing dunes. Erosive climbing dunes show amalgamated sets with reactivation surfaces. Setsof truncated and regularly spaced cross-bedding are interpreted as compound macroforms formed by the stacking of simple macroforms, which consist in a set of cross-strata derived from a single and dominant tidal cycle, with mud drapes characterizing periods of slack water. Co-sets with thicknesses of up to 70 cm are associated with these bedforms, and are interpreted as tidal sand ridges, which gather cross strata with opposite dipping when compared to the flat and sigmoidal boundary surfaces. Such sand ridges show lateral accretion, abundant reactivation surfaces and double mud drapes. The architectural elements were interpreted as a tidal sand-sheet with dominant paleocurrent to NW, indicating a dominance of ebb tide over flood tide. The scale and morphology of such tidal bedforms closely resemble those in modern environments, despite differences in the Earth-Moon orbital dynamics.

# A standard procedure for monitoring the evolution of Sabellaria spinulosa reefs: the case of Torre Mileto.

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The largest bioconstruction currently known in the Mediterranean built by the polychaet annelid Sabellaria spinulosa Leuckart, 1849, is located along the northern coast of the Gargano promontory (Apulia, Southern Italy). The bioconstruction, which exhibits all the characteristics to be considered a reef, is configured through large bodies occuring near the locality of Torre Mileto, and small but continuous bioconstructions are distributed along a 50 km stretch of coast between the neighboring localities of Rodi Garganico and Vieste. Due to the impressive extent of the structure, its role in increasing biodiversity, and its influence on coastal dynamics, the procedure for the establishment of a Site of Community Importance (SCI) for the Natura 2000 Network has been started in order to protect the bioconstruction of the Torre Mileto area. The biogenic reefs built by Sabellaria spinulosa play a fundamental role in the evolution of adjacent sandy coasts, acting as natural breakwaters, mitigating coastal erosion, and serving as a sand reservoir that feeds the beaches. Through seasonal monitoring of abiotic and biotic parameters including changes in dimensions and morphology, as well as conducting observations at micro scales, we have successfully evaluated the well-being of the bioconstruction, its associated taxa, and its seasonal development. Furthermore, we propose a monitoring model for the environmental and health status of Sabellaria spinulosa bioconstructions applicable to the whole Mediterranean basin.

# 3-D OUTCROP MODELS APPLIED TO HIGH-RESOLUTION SEQUENCE STRATIGRAPHY: CASE STUDY OF DELTAIC DEPOSITS OF LAJAS FORMATION, JURASSIC OF NEUQUÉN BASIN, AT THE CERRO MELLIZO REGION (ZAPALA, ARGENTINA)

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The Neuquén Basin records Mesozoic stratigraphic successions of international relevance for hydrocarbon reservoir analogs studies. Presenting a complex structural arrangement, the Huincul Arch area in the basin's southern portion is the main region of occurrence of the Bajocian-Bathonian Lajas Formation, deposited in coastal environments included in the overall progradational Cuyo Group. Overlying the shelfal to shallow marine Los Molles Formation, these coastal deposits exhibit fluvial and deltaic architecture, eventually reworked by waves and tides. The study area outcrops in the Picún Leufú Creek, which displays nearly 300 meters of piled-up strata. The studies available for this region suggest that the deposits are influenced by tidal currents, with uncertain wave reworking. To determine the vertical and lateral distribution of facies and their stratigraphic implications and to understand the coastal dynamics of these fluvial, wave- and tide-dominated deposits, a detailed analysis of photofacies and photohorizons is made based on 3-D outcrop models built by aerial LiDAR and photogrammetric surveys. 3-D outcrop models are photorealistic, georeferenced representations of outcrops as point clouds and textured meshes, usually displaying thousands of points per square meter and centimeter-to-millimeter spatial resolution over large areas. Such characteristics allow the definition of the different photofacies, analogously to seismic facies, based on the stratal terminations, internal configuration, and external geometry of rock bodies. Unlike seismic facies, photofacies' internal configuration includes color, sedimentary structures and may be defined by texture when the grain size is larger than the spatial resolution. The extraction and classification of photofacies is achieved through remote sensing. The available published data is integrated in 3-D whenever possible with the new geological-geophysical-geochemical data. The present study addresses the stratigraphic heterogeneity by defining facies associations, systems tracts, and sequences of high to medium frequency, namely 5th and 4th orders.

# Microbial mat and microbially induced structures in interdune deposits, Mangabeira Formation, Mesoproterozoic (NE-Brazil)

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The Proterozoic-Phanerozoic transition represents the shift from a period with a large predominance of microscopic single-celled autotrophic organisms to a period dominated by metazoans with predatory feeding tendencies. The strong evolution of these organisms has consequently resulted in a decline in the record of Microbially Induced Sedimentary Structures (MISS). This study focus in to relate the influence of the Proterozoic on the MISS of the aeolian deposits of the Mangabeira Formation (Espinhaço Supergroup). The analytical techniques and approaches used consisted of the facies interpretation linked to optical microscopy analysis of the features on petrographic sections. In the interpretation of the petrographic thin section, different structures were described as characteristic features of microbial activities: i) in the form of mud drapes; ii) concave; iii) forming ripples; iv) with dispersive tails; v) bifurcated and crenulated and vi) arranged in spaced sub-horizontal sheets. The predominance of wrinkle structures (which are the most abundant of the Proterozoic) alternating with layers of fine sediments, reflecting repetitive cycles of microbial growth, sedimentary deposition, subsequent burial and new growth. Flame structures were also observed, which occur when grains of higher density are superimposed on grains of lower density, forming pillow-type features. In the case of microbial mats, the muddy level has greater resistance, generating slight depressions. It was also possible to observe laminations associated with authigenic minerals, which reflect the decay of organic matter. These minerals have a convoluted and diffuse structure, indicating erosion and depositional processes. These characteristics helped to identify MISS in the siliciclastic rocks studied, which contributed to the paleoenvironmental reconstruction and understanding of the conditions that characterized these aeolian deposits. The next steps of the study will consist of the Raman Spectroscopy performing, which is a tool capable of determining the chemical composition of microbial mats based on their unique spectral signatures.

# Looking at Subsurface Through Deep Learning: an Artificial Intelligence Approach to Sediment Core Analysis

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Accurate sedimentary facies analysis is crucial for building subsurface stratigraphic models that may impact environmental, economic, and societal decisions. Subsurface stratigraphic investigations, however, require specialized sedimentological knowledge and skills in core analysis. In this context, artificial intelligence methods can support researchers and professionals in performing subsurface characterization. Here, we propose a novel Deep-Learning-based approach to perform automatic semantic segmentation on images from continuous sediment cores of Holocene age, based on the identification of six sedimentary facies associations. To train the model, we produced a robust segmentation dataset of high-resolution digital images from continuous sediment cores reflecting a wide spectrum of continental to shallow-marine depositional systems. The proposed model provides high-resolution sedimentological interpretation, mimicking the researcher interpretation process. We tested several model architectures, ranging from standard Convolutional Neural Networks to more advanced Transformers models. We performed a thorough evaluation of the models using numerous standard segmentation metrics, including Intersection-over-Union, F1-score, balanced accuracy, and Confusion Matrices. Moreover, visual maps showing model errors and confidence were produced to improve model interpretability. As a further contribution, we made all the data and code developed in this study publicly available, allowing a straightforward reproduction of the results and providing a method for immediate guidance in stratigraphic correlation and subsurface reconstruction.

# FROM GRAVEL RIVERS TO SANDY SHORES: SEDIMENTOLOGICAL ANALYSIS OF A GEOTHERMAL AQUIFER BASED ON OUTCROPS (TIEN SHAN FORELAND, SE KAZAKHSTAN)

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The Ili Basin is an active retro-wedge basin in southeast Kazakhstan, with a present-day structural architecture inherited from the ongoing uplift of the Tien Shan mountains since the Oligocene. The basin has been regarded as an intermountain basin since the Triassic with sedimentation combining coarser-grained alluvial deposition and finer-grained lacustrine conditions, not much unlike the modern landscape. The well-sorted, sandstone-rich Cretaceous interval has been recently identified as a prospective hot sedimentary aquifer, with temperatures reaching as much as 103°C at depths of 2850 m, making it a strong candidate for a geothermal energy source. Despite their economic and societal importance, little is known on the origin, extent, and lateral variability of Cretaceous strata, nor their tectonic context. A field campaign undertaken on the southern margin of the basin allowed for the examination of the sparse Cretaceous outcrops, and offers a first facies-based analysis of the sedimentary strata. One specific location exhibits exquisitely exposed polymictic conglomerates occupying large channels that were cut into highly weathered Paleozoic igneous basement. Conglomeratic facies gradationally transition over a few hundreds of meters northward (basinward) into intensely bioturbated, cross-stratified and well-sorted sandstone facies, reminiscent of sandstone found at the production interval of geothermal wells located tens of kilometers to the north. Sandstone facies are interpreted as nearshore deposits of a well-oxygenated marine environment and, for the first time, reveal the existence of a Cretaceous endorheic sea in the region. The paleoshoreline was likely affected by strong cross-shore currents and fed by alluvial fans, carving wave-cut platforms and valleys on the tectonically active southern margin of the basin. This newly proposed depositional model may better explain the characteristics of the deep Cretaceous aquifer, including its lateral extent, tabular geometry, well-sorted fabrics, and carbonate coatings, and open new avenues for its exploitation.

# CLAY-CARBONATE INTERACTIONS IN PRE-SALT IN SITU ROCKS

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Most of Brazil oil production comes from the huge Pre-salt reservoirs. The in-situ Aptian Pre-salt deposits were formed by a distinctive and complex combination of fascicular and spherulitic calcite aggregates and magnesian clays in a unique hyper-alkaline lacustrine system in a sag basin. Despite their critical role on the origin and quality of the reservoirs, the genesis and interactions among clays and carbonates remain unclear. To address this knowledge gap, an extensive analysis was conducted on 812 thin sections from five wells in the Barra Velha Formation (Santos Basin), through systematic petrography, cathodoluminescence, UV epifluorescence, and X-ray diffraction analyses. The identified syngenetic processes encompassed the deposition of Mg-clays as finely-laminated matrix, peloids and ooids, as well as the precipitation of fascicular calcite crusts on the sediment-water interface. Frequently, syngenetic materials were eroded and resedimented as intraclastic deposits. The common presence of clay peloids within the syngenetic shrubs indicate concurrent calcite and clay precipitation, albeit at variable rates. The eodiagenetic phases included the precipitation of matrix-replacive and displacive spherulites and fascicular shrubs, of matrix-replacive blocky calcite and dolomite, lamellar carbonates filling matrix shrinkage pores, and of microcrystalline calcite, dolomite, and silica replacing the Mg-clay matrix. The preferential dolomitization and calcitization of peloidal layers were most likely linked to their higher permeability and specific surface. Mesodiagenetic or hydrothermal phases, such as matrix-replacive saddle dolomite, macrocrystalline calcite, and dawsonite, were precipitated following significant matrix dissolution. Understanding the intricate processes governing the formation and alteration of carbonates and clays in the Pre-salt deposits is of utmost importance for constraining their unique depositional and diagenetic conditions and environments, but also for reducing exploration risks and enhancing the production from these extraordinary reservoirs.

# Hyperpycnal flow linking fluvial-deltaic and lacustrine depositional process and implication for sedimentary interpretation in lacustrine basin.

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Hyperpycnal flow was considered as extrabasinal turbidity flow during river floods period. Previous studies have interpreted and discussed hyperpycnal flow related deposits formed in deep water sedimentary environment in lacustrine basin. The formation and transport of those extrabasinal turbidity flows begin at river mouth position. And, hyperpycnites in shallow lakes settings were also interpreted in sedimentary records in recent years. Compared to the research about hyperpycnal flow in deep lacustrine settings, hyperpycnites from river mouth to lake settings are not well understood. This may also relate to the "subaqueous distributary channels" debate in lacustrine sedimentology. In this work, we discussed the typical sedimentary characteristics of shallow lacustrine hyperpycnal flow deposits in outcrops and cores in lacustrine basin. Seismic reflection characteristics were also interpreted. Based on the sedimentary architecture and analysis of the facies associations of subaqueous channels formed by hyperpycnal flows, we could get new sedimentary interpretation about the incised sandy deposits in delta front sedimentary environments. The sedimentary process of the river mouth to shallow lacustrine hyperpycnal flows shows obvious response to periodic flood events in geological history. The delta-fed hyperpycnal flow deposits are characterized by sinuous channels and lobe deposits associated with channel extension in the down-dip direction. Those delta-fed subaqueous channels have different depositional process compared to the distributary channels in delta plain environments. Flood discharge and hyperpycnal flow process is the main reason for the observed sedimentary architecture in the delta front to shallow lacustrine hyperpycnal flow deposits. The delta-fed hyperpycnal flows linked fluvial-deltaic and lacustrine depositional process. This study can aid understanding of the depositional processes of delta front and lacustrine and the facies interpretation in lacustrine basins.
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# Controls on heavy mineral composition on a continental scale

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Heavy mineral analysis is a well-established approach used in reconstructing sediment routing systems and can address a range of Earth science questions. To understand the geological significance of heavy mineral compositions, it is critical to distinguish original provenance signals from modifications of the heavy mineral cargo during transport and deposition. Importantly, studies of modern sedimentary systems provide a framework for interpreting heavy mineral composition in the depositional record. Although an extensive record of published work on modern sediments exists, most studies use conventional petrographic analysis and are limited in spatial extent. High-throughput techniques, such as automated mineralogy, are becoming more widespread and are more efficient, but generate data of different quality and quantity. Here, we use a continental-scale heavy mineral dataset of 1315 samples derived from EDX-SEM-based automated mineralogy to elucidate geological and climatic controls on heavy mineral composition across the Australian continent. Samples are floodplain sediments draining ~80% of Australia and are contextualised in their climatic and tectonic setting. Results suggest a broad climatic control on heavy mineral composition, but also retain provenance fingerprints from the underlying crystalline basement. Moreover, we use Australia's largest drainage basin, the Murray-Darling system, to better quantify transport-associated heavy mineral composition modification. Sediments in this vast ~1,000,000 km² drainage basin record stark changes during sediment transport. Near source areas, highly variable heavy mineral compositions are observed, interpreted to reflect source rock heterogeneity. In contrast, more uniform but significantly modified compositions are observed on increasing transport distance, which is best explained by processes associated with transient sediment storage and recycling in the unconsolidated sedimentary cover. Ultimately, understanding the geological processes controlling heavy mineral composition is expected to prove useful for the interpretation of heavy mineral analysis in comparable tectonic settings (i.e., passive and rift margins) in the depositional record and elemental flux between Earth reservoirs.

# The impact of the Kuroshio Current on the continental shelf and slope of Taiwan

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Ocean bottom currents are capable of transporting and depositing large volumes of sediment across the deep sea. Additionally, they can also deeply erode continental slopes, resulting in changes to slope morphology and stratigraphic architecture of continental margins.

The Kuroshio Current (KC) is a major western boundary current controlled by the North Pacific Gyre. It begins east of the Philippines and then flows in a north-eastward direction along Taiwan and Japan, bringing warm subtropical waters from the Indo-Pacific Warm Pool to mid-latitudes, being a key control on Asian climate. Taiwan is located in a complex tectonic area, at the boundary between the Philippine Sea Plate to the east and the Eurasian Plate to the west. Thus, it is an ideal area to investigate the interaction of bottom currents with the seabed in an active tectonic setting. Such settings are often characterised by complex and rough bathymetry, that can impact bottom current pathways and strength. In this study, we document the impact of the KC on the continental shelf, slope and tectonic ridges offshore Taiwan. We focus on three areas that are investigated using an 2D seismic data and multibeam bathymetry: i) the Luzon Arc, ii) the Ryukyu Arc and iii) the Penghu Channel/Taiwan Strait.

Our initial findings suggest that the KC interacts with bathymetric reliefs (e.g., tectonic ridges), that constrain and accelerate the current, resulting in pronounced seabed erosion. Although well-developed contourite drifts are rare, likely because of deformation or remobilisation by gravity-driven processes, we identified candidate sheeted drifts between tectonic ridges, that could form important archives of Earth’s past climate and oceanographic conditions.

# Ichnological evidence for changing water depths during deposition of trackbearing layers in the Maastrichtian El Molino Formation, Bolivia

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The Maastrichtian El Molino Formation in the Torotoro National Park (TTNP), Bolivia, is well known for its abundance of sauropod, theropod, ornithopod and bird tracks in predominantly clastic layers of ostracods, ooids and fine sand grains. Trackbearing layers in the middle member of the formation are interbedded with thick to very thick burgundy siltstone and fine to very fine green and red mudstone layers. Paleontological evidence, including charophytes, lacustrine ostracods, freshwater gastropods and fish, as well as negative $\delta$18O isotope values, suggest a freshwater environment for the deposition of the succession with vertebrate tracks. In our study, we have found twenty-one levels with dinosaur tracks, some also containing avian tracks. The upper surfaces of the tracked sandstones show mudcracks and wave ripples and are abruptly overlain with clay-rich mudstones. Alternation of the very fine sediment and trackbearing layers with evidence of freshwater further suggest significant fluctuations in base level in an ephemeral lacustrine basin. These fluctuations are confirmed by the occurrence of true theropod, ornithopod and bird tracks with theropod swim traces, which are very abundant in the Carreras Pampa tracksite and but also in other tracksites within the TTNP. Some individual swim traces cut through individual theropod tracks, indicating that the former were impressed on the substrate after the true tracks were printed. Preservation of tracks through water level changes requires some type of rapid substrate stabilization. The estimated size of the theropods based on the length of the tracks is 1.2–1.8 m in height to the hip; therefore, a relatively rapid rise of the water level of at least that depth of water must have occurred between the time of track formation and swim trace formation. Thus, the vertebrate ichnological record provides important clues to unravel the depositional history of the basin.

# Research progress of volcano- lake basin sedimentation: A case study of Dehui Fault Depression, Songliao Basin

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Volcanic eruption can produce a large amount of pyroclastic material, change the local structural characteristics, and affect the lake basin sedimentation in different degrees. Taking the Cretaceous Huoshiling Formation in Dehui Fault Depression, Songliao Basin as an example, the effects of volcanic activity on lake basin deposition were studied by using drilling core, cast thin section and scanning electron microscopy. The results show that the volcano erupted in the lake basin, forming a unique sedimentary characteristics. When the volcano erupted, the pyroclastic flow moved along the volcanic slope, and massive volcanic breccia and coarse-grained tuff are formed on the volcanic slope; above is fine-grained tuff with good stratification; at the top is a pyroclastic sedimentary rock composed mainly of stratified tuffaceous mudstone and sandstone, which is formed by fine-grained pyroclastic material plus terrigenous debris. The pyroclastic material with finer grain size migrates farther away under hydrodynamic action, and the content of pyroclastic material is lower at the farther distance, extending outward from the volcanic slope, and the lithology gradually changes from volcaniclastic rock to sed volcanic pyroclastic rock and pyroclastic sedimentary rock.

# Occurrence Characteristics of Chang 7 Shale Oil from the Longdong Area in the Ordos Basin, NW China : Insights from Petrology and Pore Structure

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rganic geochemistry experiments, X-ray diffraction (XRD), field emission scanning electron mi-croscopy (FE-SEM), N2 adsorption, CO2 adsorption, and two-dimensional nuclear magnetic resonance (2D NMR) were performed on ten Chang 7 shale samples (Longdong area, Ordos Basin) to elucidate their pore structure and characteristics of oil occurrence. Moreover, the factors influ-encing free oil were discussed, and an occurrence model was established. FE-SEM analysis re-veals that the pore types include interparticle pores, intraplatelet pores within clay aggregates, rare fracture pores and organic matter (OM) pores. The pores are predominantly slit-shaped. The development of micropores was mainly contributed by OM. Quartz and clay minerals influence the development of macropores and mesopores, feldspar mainly control macropores develop-ment, and pyrite most strongly affects micropore development. Micropores and mesopores con-tribute the main total pore specific surface area, while mesopores and macropores are the main contributors to the total pore volume. Pores >2 nm are the main storage spaces for shale oil, and free oil mainly occurs in pores >20 nm. Adsorbed oil and free oil were assessed by NMR T1-T2 mapping. The adsorbed oil signal intensities range from 7.5-23.4 a.u. per g rock, and the free oil signal intensities range from 4.4-23.2 a.u. per g rock. The free oil proportions are 15.9-70.6% (av-erage of 44.2%). The free oil proportion is negatively correlated with the clay mineral content and total organic carbon (TOC) content but positively correlated with the saturated hydrocarbon content and volume of pores > 20 nm. The results of this study could help optimize favorable shale oil target areas.

# Tectonic controls on braided-river delta sedimentary system: a case study of the Paleogene in Maxian area, Qaidam Basin

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Few studies on sequence stratigraphy of the Paleogene in the Maxian area of the Qaidam Basin. we integrate seismic data, well-logging data and integrated cores to study the sequence stratigraphy and the depositional system. Our study shows that:(1) Two major depositional facies, including braided-river delta in Lulehe Formation, braided-river delta and lacustrine in Xiaganchaigou Formation, were identified based on the analysis of lithofacies and facies associations. (2) Three third-order sequences(SSQ1 in lulehe Formation, SSQ2 in Lower section of Xiaganchaigou Formation, SSQ3 in Upper section of Xiaganchaigou Formation) bounded by depositional cycle are recognized in the deposits. Each third-order sequence can be classified into Lowstand (LST) + Transgression (TST) and Highstand (HST) systems tracts based on recognition of regressive-transgressive cycle. (3)The Qilian Mountains uplifts at the early deposition of the Paleogene caused the overcompensation of sediments, and formed a wide braided-river delta depositional system. The sag subsidence caused by the tectonic uplifts made the relative rise of lake level. The downthrown side of Maxian fault, Xiannan fault and Mabei fault provides accommodation space for sand bodies from ancient channels, and limits the lateral input channel of provenance, which makes the study area form a typical ' bird-foot ' delta deposition.

# LATE HOLOCENE SEA LEVEL AND CLIMATE CHANGES RECORDED BY INTERTIDAL RED ALGAL RIMS

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The calcareous red algae Lithophyllum byssoides colonizes the intertidal zone of vertical cliffs, developing thick bioconstructions on the tidal notch base. Due to their high sensitivity to sea level change, these bioconstructions are powerful sea level marker frequently used to model precise eustatic curves. Two algal rims were sampled around the Capo Caccia Mesozoic limestone peninsula (NW Sardinia, Italy) to define late Holocene high-frequency Sea level fluctuations for Western Mediterranean Sea. The internal pattern of both rims is characterized by an in situ superposition of several generations of L. byssoides thalli binding sand-sized clasts composed of shell fragments along with quartz and feldspar grains. Thin sections and SEM analysis confirm L. byssoides is the dominant framework builder with minor Corallina elongate and Serpulidae worm encrusters, competing with bioeroders as L. lithophaga. The internal macrostructure combined with AMS radiocarbon ages selected along the algal growth directions reveal two accretion phases separated by a marked erosive surface. This analysis constrains the rims formation in the last 500 years and during two different sea level rises. The first accretion phase took place during the Little Ice Age between Maunder (1645–1715 AD) and Dalton (1790–1830 AD) solar Minima. The second occurred during the modern warming pulse (post 1850 AD). The erosive surface indicates a hiatus in rim growth related to a sea-level drop of, at least, 30 cm possibly associated to the latest stages of the LIA. This work estimates a growth rate for the L. byssoides build-ups of about 2 mm/yr and reveals the ability of intertidal red algal rims to record, also minimal, Sea level fluctuations occurred in the last centuries.

# Unraveling Deep-Sea Facies and Processes : Insights into the Turonian-Campanian Chalk of Flamborough Head, UK

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The cliffs of Flamborough Head in Yorkshire, UK, provide a comprehensive view of the Upper Cretaceous period. These cliffs expose deep-sea chalks that were uplifted during the Tertiary inversion. They are likely to be analogous to the chalk deposits of the North Sea, where the depositional facies are inferred from seismic images and a few published core descriptions.

A detailed sedimentological study was conducted on the Turonian to Campanian sections, which included macroscopic and microscopic observations. The sedimentary features are well-preserved, allowing for the identification of depositional processes.

Three main facies associations were identified:

1. Turbidites facies are massive beds, several decimeters thick, with sharp bases. The base is coarser with sand-sized bioclasts and grades upward to finer grained, even laminated deposits. These beds correspond to the classical ab terms of the Bouma sequence. The terminal terms (Tcde) are typically absent. They are usually not bioturbated, except at their top.

2. Bottom-current related facies are abundant but do not correspond to the ideal contourite facies model. They are frequently several meters thick and composed of thinly laminated beds. Planar and undulating laminations are frequent. Current ripples occur. At a larger scale, bed packages show internal organization with compensation. These facies are likely to be deposited within large contourite drifts as seen on offshore seismic profiles nearby.

3. Hemipelagites are intensely bioturbated mudstones with rare faunas (few sponges and inoceramids) which do not show any evidence of currents reworking.

Turbidites and contourites facies are frequently associated, with the former likely being reworked by bottom currents. This study provides criteria to recognize different deep-sea chalk facies, applicable both on outcrops and cores. It offers insights to refine our understanding of the paleogeography, slope processes, and bottom currents dynamic of the North Sea chalk deposits and associated potential reservoirs.

# Mineralogical and Geochemical Baseline Study for Underground Hydrogen Storage in Porous Media: Implications in Reservoir and Caprock Integrity

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The storage of energy from renewable energy sources in the form of hydrogen (H2) is seen as a promising way to balance seasonal fluctuations in supply and demand. Hydrogen can be produced using excess electricity and stored temporarily in geological formations. Salt caverns, depleted oil and gas reservoirs and deep saline aquifers have been proposed for underground hydrogen storage (UHS). Despite its large storage capacity, UHS in porous media is associated with several geological and operational uncertainties.
The Ketzin site (Northeast German Basin, Brandenburg, Germany) is being evaluated as a potential location for a hydrogen pilot demonstrator in a saline aquifer. Therefore, the Triassic Stuttgart Formation is considered to serve as H2 reservoir and was successfully tested for CO2 storage (years 2004-2017). The unit is lithologically heterogeneous and consists of sandstones, claystones, evaporites (anhydrite) lenses and thin coal beds. Sandstones are partially cemented by anhydrite and analcime, showing variable porosity. The Middle Triassic Weser Formation is the top seal of the Stuttgart Formation, comprised of claystones, anhydrite and marls.
Studies of abiotic hydrogen reactions in porous media are rare and do not sufficiently describe the reactions that might be expected during UHS. This study aims to contribute to this field by performing batch experiments on core samples from the Ketzin site to detect possible textural, mineralogical, geochemical and petrophysical changes in the reservoir and caprock due to H2 exposure. The workflow includes a baseline characterization of the samples before and after H2 injection, using petrographic and mineralogical methods. Based on the mineralogical composition of these units, redox reactions involving iron-bearing minerals and dissolution of anhydrite and calcite cements would be expected. Such responses can lead to changes in porosity and mechanical properties of the formations. Results obtained contribute to decrease uncertainties related to the reservoir and caprock integrity during UHS.

# Methane-derived authigenic dolomite associated with upper Miocene channel-levee turbidites from NE Morocco (Taza-Guercif Basin)

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Methane-derived authigenic carbonates (MDAC) form at methane seeps in a range of marine environments as a by-product of microbial anaerobic oxidation of methane.
We report on MDAC from deep-water deposits of late Tortonian-early Messinian age, which accumulated onto the south-bounding slope of the Taza-Guercif Basin (NE Morocco). The studied MDAC are associated with marlstones and channel levee turbidites, which alternate to form a deepening-upward section about 600 m-thick. Optical and scanning electron microscopy and XRD data indicate that all of the sampled carbonates are structureless dolomicrites and are accompanied with fracture-filling jarosite and gypsum. Their methane-derived origin is confirmed by C and O stable isotope analyses, with most of the samples showing highly negative δ13C values (up to ~-39‰) and δ18O values up to ~2‰. Three MDAC types were recognized: i) tubular pipe-like MDAC (a few metres long and several centimetres across) occurring within the marlstones and thin-bedded levee turbidites; ii) bedding-parallel cm-thick MDAC intercalating channel-fill sandstones iii) MDAC occurring as intensely bioturbated patches embedding detrital and skeletal grains in columnar-like bodies (a few metres long and several tens of centimetres across) within channel fills. MDAC first occur ~150 m from base and are relatively more abundant in the marlstone immediately above thick turbidite units. However, there is no obvious geographic clustering of MDAC, suggesting that the methane venting was relatively diffuse, rather that channeled through major discrete pathways.
Current efforts are towards understanding of the factors that controlled MDAC intermittent formation, including the interplay with turbidite deposition.

# Characteristics of thrust nappe structure in Pinghu slope of Xihu Depression and its hydrocarbon geological significance

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The Xihu depression has experienced multiple tectonic movements since Cenozoic, forming complex and variable structural features. With the deepening of exploration, deep bedrock reservoirs have been paid more and more attention. In recent years, a new breakthrough has been achieved in the exploration of buried hill gas reservoirs in Baoyunting area, which proves the prospecting potential of gas reservoirs in Pinghu structural belt of Xihu depression. However, the formation factors of Pinghu slope are controversial, and the formation process of bedrock buried hill gas reservoir is still unclear. Therefore, in this paper, the activity characteristics of thrust nappe structure in the study area and its hydrocarbon geological significance are discussed through 3D seismic data, well logging and well logging data. The results show that: (1) the Pinghu slope area is formed by the activation and uplift of the reverse faults in the bedrock under the action of thrust and nappe, and a large number of normal faults are formed by the rupture along the weak zone of the tectonic stress in the late tectonic movement, and are not the main factors for the formation of the slope; (2) The reservoir formation conditions of the bedrock gas reservoir in the study area are very favorable, with large trap size and complete shape, large cap thickness and wide development area, and good physical properties of the reservoir. The reservoir formation model is formed under the source rocks of Gem Formation and near side reservoir with the source rocks of Pinghu Formation. (3) The bedrock in the upper part of Pinghu slope zone has the potential to develop large and medium-sized gas reservoirs, which is a new oil and gas field worthy of attention and can be used as a favorable target for the next deep-sea oil and gas exploration.

# Palaeodynamics and depositional architecture of Precambrian linear mega-dunes: Galho do Miguel Formation, Espinhaço Supergroup, SE Brazil

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Linear mega-dune deposits are often misrecognised in aeolian successions unless their original topography is preserved. Thus, this work aims to reconstruct linear mega-bedforms based on the depositional architecture and to elucidate the palaeodynamics of Precambrian draas through the sedimentological study in an interval of c. 80m of the Mesoproterozoic Galho do Miguel Formation. Three architectural elements were documented representing different parts of a complex draa system: compound cross-bedded sets, produced by the dune superimposition at the central draa region; low-angle cross-stratification sets, originated from the sedimentation in draa plinth areas; and planar-parallel sandstone strata, interpreted as subcritically climbing translatent strata deposited over the dry-interdune flats. The extensive lateral exposure and unusual thickness of the low-angle sets (up to 5.5 m) are likely linked to well-developed plinth areas, influenced by either the plinth deposition of a draa scale-bedform or by low rates of the bedform migration, resulting in its high vertical accretion rate. Both processes can coexist in the linear draa systems, which unfold through two key-stages: vertical accretion and lateral migration. This interpretation is further supported by the geometric relationship between the bounding surfaces, originated by dune elongation and superimposition during the vertical accretion process, and the interstratified relationship of plinth strata with compound dune deposits formed during later lateral migration. The existence of interbedded dry-interdune deposits (up to 4m thick) suggests the construction of large and well-developed interdune corridors between the mega-dunes under dry conditions. However, the enhanced accumulation of these deposits, compared to their Phanerozoic counterparts, may be attributed to factors such as: the higher sediment supply in Precambrian continents, favouring an overgrown of the dry-interdune packages, and the low rates of lateral migration of linear bedforms, preventing the entire erosion of the interdune strata. Consequently, the dune and interdune climb coevally over time, unlike the present-day examples.

# Application of Source-to-Sink Scaling Relationships to Reconstruct the Upper Triassic Shinarump Sediment Routing System, Colorado Plateau, USA

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The Upper Triassic Shinarump Member of the Chinle Formation is interpreted as the deposits of a continental-scale fluvial system that traversed southern Laurentia from the Ouachita Mountains of the southcentral USA to the Auld Lang Syne marine basin of the western Great Basin. Despite numerous studies focused on the Shinarump Member, none have presented quantitative estimates of the morphological segments that comprise this source-to-sink system. This study uses fluvial scaling relationships developed from modern river systems to estimate drainage-basin area and reconstruct submarine fan dimensions of the Shinarump sediment-routing system.

The presence and scale of inclined-strata sets suggest Shinarump fluvial deposits were deposited by large meandering rivers with bankfull depths that averaged approximately 23 m. Paleoslope estimates using data from median grain size and paleochannel bankfull depth produced a best estimate of 4.7x10$^{-5}$. Shinarump channels with paleodepths that average about 23 m are interpreted to represent a contributing drainage area of approximately 5.2x10$^{5}$ km$^{2}$ with a maximum drainage-basin length of 1,575 km. The length of the longest Shinarump river, represented by the estimated drainage-basin length, yields a backwater length of about 157 km. Sediment delivery to the basin floor from a fluvial system of this scale yields a submarine fan area of 4.2x10$^{4}$ km$^{2}$ and a maximum fan runout length of 281 km. Taken together, the scale of the entire Shinarump sediment routing system would place it within range of the top 100 largest systems of the modern world. These estimates provide a new avenue for comparison of the Shinarump with modern-day sediment routing systems.

# The mesofacies of fluvio-tidal translating point bars, McMurray Formation, Alberta, Canada

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Fluvio-tidal translating point bars, although common in modern environments, have only rarely been described sedimentologically and ichnologically in the literature. This study applies the mesofacies approach to provide detailed sedimentological and ichnological data on three fluvio-tidal translating point bars of the McMurray Formation in Alberta, Canada. Twenty-three mesofacies are defined based on recurring sedimentological and ichnological expressions at the lamina and lamina-set scale. These mesofacies are stacked into beds and bedsets of two depositional facies. Facies F1 occurs at the landward apex of the translating point bars and is dominated by sand- and mud-rich dune deposits, abundant soft sediment deformation, and rare bioturbated beds. F1 reflects high rates of sedimentation and unstable substrates that are challenging for infaunal colonization. Facies F2, found in the center to seaward positions of the translating point bars, is characterized by sand and sandy mud beds alternating with mud beds. The sand and sandy mud beds display variable degrees of bioturbation, featuring ichnological suites typical of brackish-water conditions. Sand and sandy mud beds are interpreted to reflect variable deposition rates, variable mud concentrations in the water column and persistent brackish-water conditions during tidal dominance. Unburrowed mud beds are deposited during elevated river discharge, whereas elevated bioturbation intensities in mud beds indicate slow deposition rates during tidal dominance. The association of F1 and F2 within a single translating point bar highlights the complex lateral facies changes that occur on a bar scale due to locally varying hydrodynamic conditions.
This detailed study of the sedimentology and ichnology of three translating point bars contributes to a better understanding of the physical, chemical and biological processes that affect fluvio-tidal environments. The mesofacies approach proved to be a powerful tool for delivering precise and concise sedimentological and ichnological descriptions, enabling highly refined facies interpretations.

# Characterization of tight oil reservoir in porcellanites, a proposed workflow

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The Barmer Basin (Rajasthan, India) is a hydrocarbon rich province sourced by the Barmer Hill formation. In the Northern part of the basin, this formation is divided into a lower shaly part and a cleaner upper part. The shale-dominated interval represents the source rock itself, while the upper part consists of microcrystalline clastic deposits interbedded with shale. These siliciclastics deposits are porcellanites made of silt-sized quartz and diatom shells. Porcellanites represent a very uncommon tight oil play. Therefore, its characterisation requires specific workflow.
Porcellanites have commonly a wide range of porosity, from very good to null, but an overall low to very low permeability. This is directly linked to the diagenetic state of this rock. Indeed, depositional mineralogy of porcellanite, under the form of diatomite, is in opal-A and is characterized by a high porosity ranging 60%-80%. With increasing burial and temperature, opal-A transforms into opal-CT and ultimately into chalcedony. This transformation is followed by a drastic drop of porosity, down to 10%. Besides, the decrease of porosity is correlated with an increase in the fracability of the rock.
We propose a multiscale workflow that relies on (1) integrating SEM and XRD measurements with core and BHI facies for the definition of diagenetic facies for porcellanites in cored intervals, (2) computing petro acoustic logs (such as Poisson's ratio, Young's modulus or unconfined compressive strength) to quantify brittleness and VSH to quantify shaliness, and (3) using a supervised approach to propagate diagenetic facies in uncored intervals or even in seismic. This diagenetic study could also be enhanced using 1D thermobarometric modeling to model the temperature and burial evolution at well location. The expected result of such workflow is the definition of "Goldilocks" intervals where the fracability of the flow units is sufficient to produce the more porous units.

# Sedimentary facies and architecture of Lower Pleistocene tidal-strait deposits from Calabria, Southern Italy

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The Messina Strait is a narrow marine passage that separates the Italian Peninsula and the island of Sicily in the Central Mediterranean Sea. During the Lower Pleistocene, a combination of extensional tectonism and marine depositional processes led to the development of diverse sedimentary features in an ancient expression of this strait. The paleo-strait deposits are currently located on both flanks of the modern strait and allow to reconstruct past hydrodynamic conditions.

In this study, the deposits located on the Calabrian side of the modern strait were studied in detail near the town of Cataforio using sedimentological logging, facies and paleocurrent analyses, interpretation of panoramic photographs, and 3D outcrop models reconstructed from drone imagery.

The targeted deposits consist of a mixture of siliciclastic and biocalcarenitic sediments. Four distinct facies were recognized based on their architecture: tangential cross-bedded (A) tabular cross-bedded (B), low-angle cross-bedded (C) and planar bedded (D). The thicknesses of these facies vary throughout the outcrop area, but typically range from 1 to 5 m. The different cross-bedded facies (A–C) also form compound bedforms with thicknesses up to 30 m and lateral continuity up to 100s of meters. Their main paleocurrent is unidirectional towards the west. These compound layers are occasionally interrupted by 1-2 m thick layers of facies D.

The presence of these complex sedimentary bedforms leads to the interpretation of ancient tidal-strait dunes with a predominant westward paleocurrent direction. The findings presented herein contribute to the broader knowledge of the region's geological history and enhance our understanding of similar tidal strait settings worldwide.

# Sediment Dating of Fluvial, Lacustrine and Aeolian Systems in the Basin of the great Lakes, Western Mongolia

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Luminescence and radiocarbon dating methods are mandatory to set up reliable chronological frameworks for sedimentary systems to reconstruct climate and environmental changes quantitatively through time. Our study area, the Basin of the Great Lakes in Western Mongolia is a key area to investigate sediment archives and sediment pathways under variable climates in this region including extreme continental climatic conditions. Alluvial fans, beach bars and dune fields, partly interacting with each other, were sampled for luminescence dating in detail. In this study, a total of thirty-four samples were taken from a beach ridge sequence of Khyargas Nuur and tested using K-feldspar single aliquot (2.5 mm) pIRIR dating to overcome the problem of the dim signal of quartz. Furthermore, single grain dating was also conducted to address the problem of insufficient bleaching of the pIRIR signals. The preliminary established chronological framework indicates that the studied samples were mostly deposited during the Holocene and the results yielded a continuous decline of the lake level for most of the Holocene period.

# Ship-Based Epoxy Impregnation of Unconsolidated Marine Sediment Cores: a Detailed Methodology

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Since the early 1900s, piston, gravity, vibro- or IODP sediment cores have been a keystone asset in multiple research and industry fields, such as global climate change, sedimentology, stratigraphy, palaeoceanography, hazard assessment and petroleum exploration. However, these cores are often collected, processed and stored rapidly to preserve their character, with minimal time allocated for records (images, core logs) to be created. This can lead to low quality image collection and rushed interpretations. Additionally, accessing the primary cores after storage can be difficult. Many additional techniques have been developed for the non-destructive analysis of cores (imaging, physical properties, X-rays, core description, XRF) however the same challenges apply. These techniques are limited by the instrument's ability and calibration and produces only a digital record for future investigations. Here, we present an integrated method for epoxy impregnation of sediment cores that enhances textural characteristics of the cores and allows for long-term preservation of part of the cores at room temperature. This method creates a 3D visual record that can be easily transported and stored for future observations, 3D scanned, and/or displayed for education purposes. Importantly, our method enhances sedimentary textures that may be otherwise obscured from the naked eye and from photography/other imaging techniques and preserves most of the core for conventional refrigerated storage. The epoxy impregnation method is simple and robust and can be applied to various clast types and grain sizes, although it is most applicable on sand and gravel. This versatile method can be performed on wet or dry cores, immediately after collection on the ship or in long-term core repositories and can be used on the full length or a small section of a core.

# Large-Scale Single-Event Sediment Waves; Insights into Cyclic Step/Antidune Deposition and Eruption-Fed Density Currents

Ms. Shannon Frey, Dr. Martin Jutzeler[1], Dr. Matthieu Cartigny[2], Dr. Rebec Carey[1]
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High magnitude, shallow marine or coastal volcanic explosive eruptions and their associated subaqueous density current can have substantial global impacts. These density currents can be fast and destructive, damaging underwater infrastructure, benthic ecosystems, and creating tsunamis that impact distant coastal communities. However, despite their potential damaging effect subaqueous density currents associated with volcanic eruptions remain poorly understood. Fields of large-scale sediment waves on volcanic flanks are commonly attributed to syn-eruptive volcanic density currents, depositing upstream-migrating bedforms known as cyclic steps and anti-dunes. However, these bedforms are known primarily from bathymetry and other remote techniques (sonar, seismic), and more detailed observations of internal structures and sedimentary characteristics cannot be acquired. Here, we present data from two sediment cores collected from a large sediment wave field offshore Macauley island, in the Kermadec arc. We show that the geochemical signature of the cores is consistent with the 5.7 ka, >30 km3 caldera-forming eruption of the now submarine Macauley volcano. The facies characteristics of the cores is consistent with models for deposition from high-concentration density currents under supercritical flow and are interpreted to be the product of syn-eruptive pyroclastic density currents that deposited cyclic steps and anti-dunes. Numerical modelling of previously published seismic data constrains speed, duration and flow depth of the density currents. Two distinct stages can be recognized; initial flows were fast (~ 40 km/hr) and short-lived, while the subsequent flows were prolonged and slower. We compare these results with observations and sediment waves associated with the Jan 15th, 2022, Hunga Tonga-Hunga Ha'apai volcanic eruption.

# Turbidities architectures evolution pattern in the slope-parallel submarine canyon head area, an implication for the Central Canyon Area, Qiongdongnan Basin, South China Sea

Dr. Chao Fu[1], Prof. Yuhong XIE[2], Mrss. Hui WANG[1]
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High sediment volumes deposited in deep-sea canyons play a crucial role in the source-to-sink system, creating various sand body stack patterns due to complex sedimentary processes like erosion, incision, and sedimentation. The turbidity's architecture in the canyon head area remains poorly understood due to the extremely fast-changing topography. This study focuses on the Central Canyon Area in the Qiongdongnan Basin, examining turbidities flow patterns and architecture resulting from volcanic activity, slumping, and canyon wall collapse. Using high-resolution 3D seismic data, we quantitatively identify turbidities architecture characteristics such as static aspect ratio, cross-sectional asymmetry, channel-complex-growth trajectories angle, and stratigraphic mobility number. Additionally, based on an empirical formula, we classify flow patterns into erosion, equilibrium, and depositional flows by calculating Froude numbers and flow thickness.Upstream, a mass of sediments is injected into an unconfined canyon area, while downstream features high-angle slopes and volcanic regions, leading to confined canyon areas with fewer developed channel levees and sharp infilling by lateral accretion turbidity channels. We find that upstream sections are primarily infilled by vertical or lateral accretion channels with wide levees, while downstream is dominated by lateral accretion or isolated channels without levees. This results in a sharp increase in U and Fr between the two sections, leading to the development of bypass sections with fewer sediments bearing. Finally, we use a bubble chart to identify dominant factors contributing to the turbidities stack pattern in various canyon sections at different stages in a quantitative manner.

# Reservoir Architecture of Uranium Bearing Ikansk (Eocene) Formation, South Tortkuduk, Southern Kazakhstan

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[1]Nazarbayev University, [2]Recherche, Orano, , [3]Katko JV LLP, [4]University of Lorraine
The uranium-bearing Ikansk (Eocene) Formation in South Tortkuduk (Chu-Sarysu Basin, Southern Kazakhstan) is commonly subdivided into the lower, sand-dominated and the upper, mud-dominated sub-units. The erosional base of this 30m thick formation is recently interpreted as a regionally extensive sequence boundary, while its top is marked by transgressive lag deposits of Intymak formation (middle Eocene Lutetian transgression). Facies analysis and well-to-well correlations show significant intra-formational reservoir architecture complexity characterized by variable scale vertical and lateral compartmentalization. Non-reservoir facies associations include multi-meter thick laterally extensive alluvial floodplain and delta-plain deposits and up to 10m thick and 500m wide curvilinear mud-plug deposits. Reservoir facies associations are dominated by ~15m thick upward fining and coarsening intervals interpreted as point bar and delta-front deposits respectively. The cross-cutting relationship of mapped architectural elements suggests rare preservations of thin (<4m thick) transgressive sand deposits at the base, which are overlain by a maximum-flooding surface and ~15m thick deltaic deposits formed when sediment supply became dominant, resulting in basin infilling and sediment progradation. These deltaic deposits were subsequently largely reworked by the advancing ~15m deep meandering channel-belt. The overlying sedimentary packages include remnants of multiple stacked cut-and-fill deposits, which are largely cannibalized by another ~15m thick meander belt. Poor preservation of lateral and vertical point bar continuities is likely a result of frequent and dramatic seasonal (monsoonal?) floods which caused chute incisions and cut-offs, point bar reorientations, and avulsions. The top unit is likely a shallow brackish bay-fill formed during slow sea-level rise ahead of the main transgression. Observed architecture is indicative of a dynamic interplay of sediment supply and sea-level changes in an overall low-accommodation setting. The mapping of architectural elements, although challenging in terms of workflow and resource management, significantly improves the accuracy of inputs for static reservoir models built for in-situ recovery uranium extractions.

# Study on the Extinction History and Evolution Model of Cretaceous Lake Basin in the West of Tabei Uplift, Tarim Basin

Dr Xiaoyang Gao[1], Dr Yong Hu[1], Dr Luxing Dou[1]
[1]Yangtze University

In recent years, the Cretaceous oil and gas reservoirs in the western part of the Tabei Uplift have become a hot exploration area, but the study of their structural sedimentary evolution characteristics is still shallow, which restricts the progress of exploration. On the basis of core observation, this study combines well logging and 3D seismic data to analyze the evolution history of lake basins in the study area, and establishes a lake basin evolution model under complex structural backgrounds. Research has shown that under complex tectonic backgrounds, the Cretaceous lake basin in the western part of the Tabei Uplift has undergone multiple processes of expansion, migration, and extinction. The Shushanhe Formation is the expansion period of the lake basin, where the early formed distributary channels and estuarine bars are transformed into beach bars far from the source area. During the lower stage of the Baxigai Formation, the southeast strata were uplifted, and the sediment source was deposited towards the northwest. Thick layers of mudstone were developed at the top, and the lake basin continued to expand. During the middle section of the Baxigai Formation, the uplift of the northwest strata led to forced lake retreat, and the center of the lake basin migrated southeast. The sedimentary period of the upper part of the Baxigai Formation is mainly characterized by onshore sedimentation, and the southeast strata rapidly uplift, leading to the delta filling the original lake and advancing forward. When encountering depression areas, local lakes are formed. After the lakes are filled with debris, the delta continues to accumulate forward, causing the lake basin to migrate and shrink. During the sedimentation period of the Bashjiqike Formation, the southeastern strata continued to rise, and the lake basin was filled and disappeared, developing a floodplain sedimentary system under arid climate conditions.

# Reunderstanding of organic matter enrichment law of fine grained sedimentary rock in saline lacustrine facies

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The composition and content of organic matter in saline lacustrine fine-grained sedimentary rocks vary greatly. Previous studies have been conducted on the source, organic matter type and hydrocarbon formation potential of brackish lacustrine organic matter, but the specific relationship between the composition content, source, organic matter abundance and hydrocarbon-gerating potential of typical parent material and sedimentary water conditions such as salinity has been less discussed. In this paper, the characteristics of typical hydrocarbon-generating organic matter in saline water environment were studied in detail. The two typical algaes of lamalginite and telalginite in aquatic organic matter have different degrees of development with different salinity. The longitudinal section of the telalginite showed long wavy and lenticular shapes, and the fluorescence characteristics showed that the internal brown and the outer yellow were yellow, and the body cavity and outer wall were visible, and the cross-section showed a pear-shaped shape, and the characteristics of the biomarkers were high in phytane and β-carotene and low in ααα-20R-C28 sterane. The lamalginite can secrete silicon dioxide with main symbiotic minerals of fine-grained feldspar and quartz. On the cross-section, it shows continuous layered stacking and the strong fluorescenc; on the section inside the parallel layer, it shows continuous distribution with the characteristics of banded silk. The characteristics of the biomarkers are low in Ph, β-carotene and gammacerane and high in ααα-20R-C28 sterane. The lalmalginite has photosynthesis to absorb orange light and is located in the bottom of the water body with a broad salinity range, but they more thrived in relatively low salinity. To saline lacustrine, with the increase of salinity, the relative contents of aquatic organic matter and telalginite increased, the contents of terrigenous organic matter, lemalginite and total organic matter decreased, and the oil-producing capacity per unit of organic matter increased.

# Re-Os geochronology of black shales from the Mesoproterozoic Hongshuizhuang Formation, North China

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In North China Craton, the Mesoproterozoic Hongshuizhuang Formation is dominated by a set of marine sediments including dolomite and black shale. The black shale is considered to be one of the oldest organic-rich sediment and source rocks in China. However, radiometric time constraints is lacking for this formation, and its age was only limited by zircon U-Pb dating of the strata above and below it (1,353±14 to 1316±37 Ma). In order to obtain Re–Os ages and initial $^{187}Os/^{188}Os$ (Osi) data, black shale samples from the Hongshuizhuang Formation were analyzed using the HCl-HNO3 digestion technique. A Re–Os date of 1392±107 Ma (Osi = 0.36±1.07, MSWD = 1.4, n = 5) was obtained from preliminary data of outcrop black shale samples from Liaoning Province, North China. We interpret the relatively large uncertainties in age and Osi to reflect heterogeneity of the Osi of samples related to temporal change of $^{187}Os/^{188}Os$ ratio of seawater when the sedimentary rocks were deposited. Further examination of core samples may provide better constraints on the age and variation of and Osi of Hongshuizhuang black shale.

# Reunderstanding of organic matter enrichment law of fine grained sedimentary rock in saline lacustrine facies

Dr Gang Gao[1,2], Dr Shiju Liu[1,2]
[1]China University Of Petroleum (beijing), [2]State Key Laboratory of Petroleum Resource and Prospecting, China University of Petroleum

The composition and content of organic matter in saline lacustrine fine-grained sedimentary rocks vary greatly. Previous studies have been conducted on the source, organic matter type and hydrocarbon formation potential of brackish lacustrine organic matter, but the specific relationship between the composition content, source, organic matter abundance and hydrocarbon-gerating potential of typical parent material and sedimentary water conditions such as salinity has been less discussed. In this paper, the characteristics of typical hydrocarbon-generating organic matter in saline water environment were studied in detail. The two typical algaes of lamalginite and telalginite in aquatic organic matter have different degrees of development with different salinity. The longitudinal section of the telalginite showed long wavy and lenticular shapes, and the fluorescence characteristics showed that the internal brown and the outer yellow were yellow, and the body cavity and outer wall were visible, and the cross-section showed a pear-shaped shape, and the characteristics of the biomarkers were high in phytane and β-carotene and low in ααα-20R-C28 sterane. The lamalginite can secrete silicon dioxide with main symbiotic minerals of fine-grained feldspar and quartz. On the cross-section, it shows continuous layered stacking and the strong fluorescenc; on the section inside the parallel layer, it shows continuous distribution with the characteristics of banded silk. The characteristics of the biomarkers are low in Ph, β-carotene and gammacerane and high in ααα-20R-C28 sterane. The lalmalginite has photosynthesis to absorb orange light and is located in the bottom of the water body with a broad salinity range, but they more thrived in relatively low salinity. To saline lacustrine, with the increase of salinity, the relative contents of aquatic organic matter and telalginite increased, the contents of terrigenous organic matter, lemalginite and total organic matter decreased, and the oil-producing capacity per unit of organic matter increased.

# An overlooked intrabasin synsedimentary fault system unveiled through detailed tectono-sedimentary analysis: the case of the early stages of the infill of the easternmost Cameros Basin (Late Jurassic-Early Cretaceous, N Spain)

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[1]Universidad Rey Juan Carlos, [2]Universidad de Oviedo, [3]Universidad Complutense de Madrid, [4]Instituto de Geociencias IGEO

The Cameros Basin developed in northern Spain from the Late Jurassic to the Early Cretaceous as a consequence of the opening of the Western Tethys and North-Atlantic domains, and it was filled by siliciclastic, carbonate and carbonate-evaporite deposits formed in alluvial, lacustrine and coastal environments. Although different tectonic models have been proposed for the reconstruction of its extensional structure, they all interpreted that intra-basin synsedimentary faults had minor or no significance in controlling sedimentation of the different units of the basin.

However, detailed stratigraphic and structural analysis, geological mapping, and cross-sections reveal a noticeable control on the sedimentation of the lowermost units of the Cameros Basin by subvertical faults striking N110-130º within the easternmost areas of the basin, which produced a significant increase in thickness south-westwards. One of this faults, the Peña Cofrades fault, produced a thickness increase which goes from 1,530 m at the less subsiding block (north-eastwards) to 3,610 m at the most subsiding block (south-westwards). These findings have important implications for the reconstruction of the extensional structure of the basin.

Despite the large thickness changes, very similar sedimentary facies and palaeoenvironments were developed in adjacent blocks of each fault. This fact makes difficult to identify the synsedimentary faults in the field and complicates the mapping and the evaluation of their relevance on generating subsidence. This facies similarity occurred because the large subsidence rates produced by the synsedimentary faults were compensated by high sedimentation rates allowing the development of similar sedimentary environments throughout the studied area within each studied stratigraphic unit.

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# Homogeneous sedimentary facies masking intra-basin synsedimentary normal faults: the interplay between accommodation generation and sedimentation rates

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[1]Universidad de Oviedo, [2]Universidad Complutense de Madrid, [3]Instituto de Geociencias IGEO, [4]Universidad Rey Juan Carlos

The presence of intrabasin synsedimentary normal faults commonly leaves an imprint in the sedimentary record of extensional basins, such as deeper-water facies in the hangingwall or the occurrence of alluvial-fan deposits attached to fault escarpments. Nevertheless, here we show the case of the eastern Cameros Basin (Late Jurassic-Early Cretaceous, N Spain), in which the presence of highly active intrabasin faults did not result in significant sedimentological changes, but show laterally homogeneous facies.

To comprehend the causes of such facies homogeneity, the sedimentary record of the Berriasian Oncala Group has been analysed in detail in the easternmost Cameros Basin, where thickness changes of more than 1000m related to the movement of synsedimentary faults have been recently demonstrated. These faults had not been identified before because there were no sedimentological clues pointing to their presence, since the Oncala Group consists of homogeneous carbonate-gypsum laminated sediments deposited in shallow coastal salinas all along the area. This can only be explained if the accommodation was created by successive fault pulses that did not significantly modify depositional depths and if, in addition, the accommodation generation was continuously compensated by high sedimentation rates. This process prevented the development of larger depositional depths in the hangingwall or significant fault escarpments.

The compensation of subsidence by sedimentation promoted only subtle sedimentological differences between the most subsident and less subsident areas, such as: 1) the abundance and thickness of gypsum layers increases northeastwards, suggesting higher evaporation/water input rates in the less subsident blocks; 2) mudcracks are more abundant to the northeast of the faults, indicating longer and more frequent subaerial exposure in the footwall; 3) stromatolites are more abundant in the less subsident blocks, suggesting that favourable conditions for their growth were developed in those areas, possibly due to higher agitation and/or oxygenation.

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# Poor Man's Line Scan – a simple tool for the acquisition of high-resolution, undistorted drill core photos

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The analysis and presentation of drill cores, an essential part of geoscientific research, requires the acquisition of high-quality core photos. Typically, core photos are either taken by hand, which often results in poor and inconsistent image quality and perspective distortions, or with large, heavy, and thus inflexible as well as expensive line scan setups. We present a simple, portable "Poor Man's Line Scan" setup that turns a customary smartphone into a semi-automatic core scanner utilising its panoramic photo function while guided on a rail in order to record undistorted core photographs at high resolution. The resulting images, although affected by some minor artefacts, are clearly superior in quality and resolution to single photos taken by hand and are comparable to images taken with commercial line scan cameras. The low cost (~EUR 100) and high flexibility, including the potential for modifications, of our tool make it an interesting alternative to the classical line scan setup.

# Coral reef development in the Holocene of Bermuda, northern Atlantic

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At a latitude of 32°N, Bermuda is among the northernmost atoll-like, tropical carbonate platforms. Fast-growing acroporids are lacking, and, hence, the reefs of Bermuda may be utilized as models of 'reefs of the future' that likely accrete at slower rates as compared to their lower-latitude counterparts. In order to investigate variations in accretion rate and coral community structure during the Holocene, we collected four rotary drill cores from an open, high-energy environment near the platform margin (North Rock) and from a protected, low-energy inshore-water site (Castle Harbor). First results indicate that Holocene reef growth started during 6.27 - 6.98 kyrs BP. Pleistocene eolianite, peat, and gyttja act as reef pedestals. Holocene reef thickness reaches some 16 m. Based on limited age data, it appears as if reef-accretion rate is indeed lower as compared to lower-latitude sites, e.g., in the Caribbean: accretion rates in Bermuda range from 1.11 - 2.93 m/kyr and average 2.03 m/kyr. Additional AMS-dates are currently being measured and will be used to verify these numbers. Reef facies include coral-rich boundstone, coralline algal bindstone, and unconsolidated sand and rubble. Microbialite crusts occur in coral-rich facies; in older core parts of the marginal site and throughout the successions of the protected sites. The coral community is dominated by stress-tolerant taxa: species of Diploria predominate and Orbicella spp. occurs in moderate abundance; Siderastrea spp. is rare. Other occasionally occurring corals include weedy taxa such as Porites spp., Agaricia spp, and Isophyllia spp. Millepora spp., as the only representative of the competitive life-history strategy group, is also rare. While the majority of the investigated reefs probably grew in a keep-up mode, one of the inshore-water reefs likely accreted in a catch-up mode as indicated by the occurrence of the ivory coral Oculina spp. in the lower core part.

# Sedimentary Sequence of a Sandy Conglomerate Reservoir in Qie12 Block, Qaidam Basin, Northwest China and its Influence on hydrocarbon enrichment

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Qaidam Basin is one of the most important oil and gas production basin. The thick sandy conglomerate reservoir of KunBei oilfield within Qaidam Basin is one of the main oil and gas producing reservoir. However, there still lacks the comprehensive understanding about the sedimentary sequence and architecture of the sandy conglomerate reservoir.
By comprehensively geology, wireline logging data, seismic and production dynamic data, the genetic type, distribution law of sandy conglomerate and its controlling effect on hydrocarbon enrichment are systematically studied under the control of the isochronal stratigraphic framework.
The analysis indicates that the depostional environment of the target lower part of the Ganchaigou Formation is an alluvial fan. We defined eight lithofacies according to the core analysis and five sedimentary microfacies by integrating the core and petrophysical data. We next propose four sedimentary architectural models by integrating the lithofacies result, microfacies analysis, and high frequency sequence models. The four architecture models include the extensively connecting body sandwiched with intermittent channels, the composite channel formed by the overlapping and separation of stable channels, the lateral alternated braided channel and sheet flow sediment, and the runoff channel inlaid in flood plain mudstone. We finally build an architecture model for the alluvial fan. The model of the alluvial fan overall shows an upward-fining grain-size features and this feature indicates that the alluvial fan belongs to a retrograding sequence. The built model consists of six alluvial fan bodies that migrates from north.
The sedimentary facies belt has obvious control effect on oil and gas distribution, the sedimentary structure units control the vertical enrichment of oil and gas, and the fan body evolution controls hydrocarbon plane aggregation.

# Progradation characteristics of Sinian Dengying Formation in central Sichuan Basin， China

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In Sinian period, intra-platform rift developed in the middle Sichuan Basin, and microbial mounds and shoals developed on both sides of the rift, which overlaps the karst transformation of Tongwan Movement in the late Sinian period to form high-quality pore and cavity type reservoirs. According to the 3D seismic data interpretation, multiple periods of progradational reflection developed in the Fourth Member of Dengying Formation, the scale and direction of progradation in each period are quantitatively described through the tracing and comparative interpretation of the progradation interface. It is concluded that: 1) the sediments of the Fourth Member of Dengying Formation were mainly controlled by the slow decline of the relative sea level in the high period, dominated by the transverse f progradation, and the platform edge continuously migrated to the north. 2) The progradation direction is approximately parallel to the intra-platform rift trend, indicating that except for the intra-platform rift margin, high-energy facies are still developed inside the platform, which can be an important field for further exploration.

# Features of Deep Sandy Debris Flow Reservoir in PG2 Block of Nanpu Sag

Gao Guangliang[1], Features of Deep Sandy Debris Flow Reservoir in PG2 Block of Nanpu Sag ZHANG Xianguo
[1]China University Of Petroleum-east China
Guided by the deposition theory of the sandy debris flow, the geological characteristics of the Sha1 Member reservoir in PG2 Block of Nanpu Sag was studied to clearly put forward the depositional pattern of sandy debris flow, reservoir characteristics,and meticulous depiction of the distribution of the interlayers using the rock cores, detection logging, seismic, analysis assay and production test data. The research results show that: the sandy debris flow mainly performs as domal deposition; it is thick in the middle and thin on the flanks; vertically it is usually overlapped by multi-cycles of sandbodies and blanket distribution in plane, the single sand body is thick and has good connectivity; the reservoir lithology is mainly sandy conglomerate and coarse sandstone,mainly belongs to low porosity and middle-low permeability reservoir and has strong intra-layer heterogeneity; the reservoir space is predominantly secondary solution pores with subordinate primary porosity and crevice; reservoir physical property is mainly controlled by sedimentary micro-facies, lithofacies and reservoir diagenesis; the reservoir interlayer mainly includes lithologic and physical property interlayers and discontinuously distributes on the sides of main water channel and outer fan and has low division ability; the sandbodies unite and overlay in the vertical and the reservoir is the thick massive reservoir with some layered characteristics. The research results have important guiding significance for the development of future reservoir development technology policy and the research of similar reservoirs.

# A data-driven seismic quantitative prediction method for gas bearing properties of thin tight sand layers

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The terrestrial tight sandstone gas reservoirs in the Sichuan Basin of China hold significant exploration potential. These reservoirs often exhibit characteristics such as thin thickness, low porosity, low permeability, and high water saturation, influenced by complex sedimentary diagenesis. In this study, a data-driven approach utilizing deep learning algorithms was employed to train a seismic prediction model for key reservoir parameters, including porosity, permeability, and gas saturation. The objective was to enhance the quantitative prediction capability of seismic information for gas-bearing properties in thin layers. The research findings revealed limitations of the deep learning method in seismic sedimentology interpretation. To address the problem of overfitting caused by severely lacking labeled data, this study proposes a strategy based on statistical rock physics and geological statistics to automatically generate and expand labels. Additionally, favorable reservoirs often develop thinly within a large set of background lithologies, resulting in an imbalanced distribution of reservoir parameter values. By leveraging the boundary synthetic minority class oversampling technique, the training bias caused by the imbalance of thin-layer samples can be addressed. Finally, by constructing a physics-guided multi-modal closed-loop network architecture and reinforcing the collaborative strategy of deep learning across multiple tasks, it is possible to effectively mitigate the ambiguity in data mapping and enhance the resolution of prediction results. The model and empirical data testing demonstrate that this method exhibits a high level of accuracy in quantitatively predicting the gas bearing properties, and can meet the interpretive requirements of seismic sedimentology for thin tight sandstone layers.

# Lithofacies characteristics and genetic mechanism of lacustrine hybrid sedimentary rocks in Sichuan Basin, Southern China

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The Jurassic Da’anzhai Member in the Sichuan Basin is a stratigraphic unit characterized by widespread mudstone and hybrid sedimentation. It comprises various lithofacies types and rich sedimentary structures, including massive structure, laminated structure, mud rip-up clasts and erosion surfaces. By means of detailed analysis of core, logging, thin sections, scanning electron microscope, XRD and XRF data, six lithofacies types are identified in the Da’anzhai Member, and the genetic mechanisms of these lithofacies such as sandy debris flow, turbidity current, bioclastic flow and still water sedimentation are analyzed based on the characteristics of lithofacies. A complete third-order cycle and three fourth-order cycles was identified the Da’anzhai Member based on the variation in the value of gamma ray, bioclastic content and geochemical trace elements. The influence of lake level on lithofacies is discussed according to stratigraphic cycle and distribution characteristics of different lithofacies. Finally, the comprehensive sedimentary model of the study area is completed.

# The formation and destruction causes of Shale Roof, Floor Sealing, and Shale Self-Sealing for marine shales and relevant influence

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In studying shale gas preservation conditions, the causes of formation and destruction of shale roof, floor sealing, and shale self-sealing for marine shales and the relevant influences have been major issues to be explored. Based on previous studies, this study first collects the drilling and logging data from representative wells in shale gas blocks in the Yangtze region, southern China, and then conducts a series of experimental analyses.The analyses on the lithology, average porosity and breakthrough pressure showed that the roof and floor provide sealing of shales due to physical property differences. According to the petrophysical porosity model, the joint characterization experiment, and N2, CH4 and CO2 gas permeability determination, it is found that self-sealing is caused by the pore structure differences of varied pore types and the gas sliding effect. According to the nitrogen isotope analysis, sealing can be damaged by the slippage, faulting and volcanic activity, causing a large amount of nitrogen coming from the atmosphere and upper mantle to be stored in the shale gas. Experiments on carbon isotope, gas component, and the FIB-HIM and FIB-SEM showed that: strong sealing can cause much liquid hydrocarbons to be retained in the shale formation system, with much liquid hydrocarbon cracked gas being generated in addition to the kerogen cracked gas. The carbon isotope inversion in the shale gas is stronger, and the organic matter pores are mainly pyrobitumen pores with larger pores and good connectivity. When the sealing capacities are weak, the amount of liquid hydrocarbons discharged from the shale are high. The shale gas is mainly kerogen cracked gas with weak or no carbon isotope inversion, and the kerogen pores with small pores and poor connectivity. The findings are significant and practical for improving relevant theories and guiding the selection of shale gas sweet spot.

# Response of the middle Eocene Bohai Bay Basin lake (E China) to the ENSO and to solar activity

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The behavior of the global climate system on scales from years to centuries is related to several mechanisms, including solar forcing and the El Niño-Southern Oscillation (ENSO). Pre-Quaternary archives are rare, however, due to limited stratigraphic resolution and the accuracy of datings. A middle Eocene lacustrine shale in the Bohai Bay Basin (E China) shows annual laminae that allow establishing its astronomical and varve chronology. Principal component analysis of the sediments in the cored material, their magnetic susceptibility and grayscale scans as well as analysis of the varve thickness in thin sections jointly reveal variations between a warm/dry and a cold/wet climate on the scale of centuries (~200–240 years, ~350 years), probably corresponding with cycles in solar activity. In situ δ13C and δ18O values of the light carbonate laminae show, in combination with varve-thickness data, that algal blooming and carbonate production show ~2.1–8.7 year cycles that could be ascribed to ENSO activity. The data also suggest that solar forcing controlled the ENSO intensity in the area of the Bohai Bay Basin during the middle Eocene.

# Influence of Organic Matter on Gas-Bearing Properties and Analysis of Sedimentary Mechanism of Organic Matter Enrichment: A Case Study on the Yangtze Region of Southern China during the Early Cambrian

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Shale gasexploration requires studies on the enrichmentmechanism of sedimentary organic matter.TeLower Cambrian shale is taken as a study object to analyze the effect of organic matter on gas content using TOC content and porosity analyses, isothermal adsorption experiments, and FIB-HIM scanning electron microscopy observations. Ten, we selected typical wells to determine the presence of excessive silica in the siliceous minerals by quantitative calculations. Besides, we analyzed the genesis of excessive siliceous minerals using elements including Al, Fe, and Mn, thus speculating the controlling factors of the redox environment and biological productivity. Results show that total organic carbon content controls the content of free and adsorbed gas, while shale gas mainly exists in organic pores and is developed in large numbers and with high roundness, showing the characteristics of “small pores inside big pores.” In the Lower Yangtze region during the Early Cambrian, the excessive siliceous minerals were of hydrothermal origin, and there were frequent hydrothermal activities due to its closeness to plate boundaries. Tese activities can intensify the reducibility of the waterbody’s bottom and improve the biological productivity on its surface, resulting in the enrichmentofthis matter.Mostexcessive siliconinthisregionisbiogenic,whileonlyasmallpart isofhydrothermalandbiogenic mixed origin. Te enclosed waterbody of the Upper Yangtze region was far from plate boundaries and close to the semiclosed “gulf,” resulting in its delamination. Te waterbody’s surface was abundant with oxygen, thus increasing the biological pro-ductivity, while the high reducibility at the waterbody’s bottom was conducive to preserving sedimentary organic matter.

# Water depth–terrigenous input dynamic equilibrium controls the Eocene lacustrine shale laminae records in Jiyang depression, Bohai Bay Basin, East China

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Lacustrine organic-rich Eocene shales are well developed within the faulted lake basin in the Bohai Bay Basin in eastern China. It is crucial to comprehend the sedimentation of these shales for the study of depositional processes, paleoenvironment reconstruction, and shale oil exploration. This research investigates the sedimentary characteristics and formation mechanisms of lacustrine shales in the Eocene Shahejie Formation (Es4s–Es3x), based on thin sections and scanning electron microscopy observations of cores, with x-ray diffraction analysis, electron probe microanalysis, and geochemical elements analysis. The Es4s–Es3x shale is deposited in a hypoxic saline lake with laminated, massive, and lenticular sedimentary structures, wherein laminated shale is the dominant lithofacies. Eight laminae units have been identified: micritic calcite laminae (MCAL), sparry calcite laminae (SCAL), quartz–feldspar–clay mixed laminae (QFCL), organic-rich clay laminae (OCL), clay laminae (CL), organic matter laminae (OL), dolomite laminae (DL), and anhydrite laminae (AL). They form seven lamina couplets: MCAL+OL+CL, QFCL+OCL, SCAL+OCL, SCAL+OL, MCAL+QFCL, DL+OCL, and DL+AL. Moreover, three massive lithofacies and three types of calcite lenticular laminae have also been identified. The Sr/Ba, S/total organic carbon, and Th/U ratios and other geochemical elements show that Es4s–Es3x shale is deposited in the hypoxic saline lake. Factors such as lake water, salinity, oxidation reduction, and water depth all vary with episodic high frequency. The halocline in the lake is a key factor controlling the lacustrine laminae deposition and the lamina couplet distribution in the lake basin. The halocline location fluctuations are controlled by the dynamic equilibrium of the water depth and terrigenous input, which further control the development of different laminae and lamina couplets. Massive mudstone formed due to turbidity, debris flows, and evaporation. The MCALmayhavebeendeposited due to breakdown and resuspension under strong hydrodynamics. Additionally, erosion, deposition, and compaction of water-rich muds and biodisturbance control the formation of the three lenses.

# PATTERNS OF X-RAY DIFFRACTION, PETROGRAPHIC AND GEOCHEMICAL VARIATION, AND THEIR GENETIC IMPLICATIONS FOR SANTOS BASIN PRE-SALT DEPOSITS

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Pre-salt deposits constitute important hydrocarbon reservoirs in the Santos Basin, eastern Brazilian margin. These lacustrine carbonate-Mg-clay rocks show a complex porosity and permeability distribution due to high-frequency intercalations of different facies. The geochemical and environmental conditions responsible for the origin and modifications of these deposits are still widely discussed. The current work aims to identify chemical and mineralogical patterns in a 48 m core of the Barra Velha Formation, through the correlation of X-ray Fluorescence (XRF), X-ray Diffraction (XRD), and petrographic analyses. Petrographic analysis recognized five in situ classes (shrubstone; shrub-spherulstone; mudstone; muddy spherulstone and muddy shrubstone) and two reworked classes (calcarenite and rudaceous calcarenite). The relation of $SiO2$ with $MgO$ ($R^2$=0.44) and $Na2O$ ($R^2$=0.33) is related to matrix preservation in the in situ classes. The slightly larger $K2O$ amount of reworked classes (avg. = 0.35 %wt) than the in situ samples (avg.= 0.21 %wt) is owing to detrital micas and feldspars, identified in XRD. CaO and SrO display a positive correlation (R2=0.73) in all samples, related to high Sr content in calcite. The preserved matrix of in situ rocks is composed of kerolite and smectite (stevensite), with rare smectite-kerolite mixed layers. Only smectite is found in silicified and dolomitized in situ samples, while illite-smectite mixed layers were only identified in reworked rocks. The observed Na+Mg+Si pattern is able to identify the preservation clay matrix, one of the main controls on reservoir quality. Furthermore, the chemical and XRD patterns indicate that kerolite is usually removed during diagenesis and that detrital material is preferentially incorporated during reworking.

# Analysis of the Enrichment Mechanism of Sedimentary Organic Matter under the Background of Tectonic Tension and Tectonic Compression ： A case study of the Lower Cambrian and the Upper Ordovician-Lower Silurian, in Yangtze region

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In order to meet the demand of shale oil and gas exploration, it is more and more important to study the controlling effect of sedimentary environment on the enrichment of organic matter. In this paper, the Lower Cambrian and Upper Ordovician-Lower Silurian shales in the Yangtze region are studied.The Early Cambrian in the Yangtze region was a tectonic extension background, while the Late Ordovician Early Silurian was a tectonic compression background.Firstly, according to the content of Mo and TOC, the water closure property of the shale depositional period is judged. Then this study selected typical wells, and calculated quantitatively whether there was excess siliceous minerals in shale and the content of it. The origin of excess siliceous minerals is determined by Al, Fe and Mn element. The results show that the Lower Cambrian shale is deposited in a weak to moderate restricted water environment, and the Upper Ordovician and Lower Silurian shales are deposited in a strong restricted water environment in the Yangtze region. Excess siliceous minerals in the Lower Cambrian shale is of hydrothermal origin. Tectonic tension leads to more developed hydrothermal activity.On the one hand, hydrothermal activity can enhance the reductivity of the water bottom. On the other hand, it can improve the biological productivity, so that the sedimentary organic matter can be enriched. Excess siliceous minerals in Upper Ordovician and Lower Silurian shale is biogenic. The tectonic compression has led to an increase in the sealing of water bodies.The strong restriction of the water leads to stratification. The oxygen content in the upper layer makes the biological productivity higher and the lower layer more reductive, which is beneficial to the preservation of sedimentary organic matter.

# Study on high-quality reservoir characteristics and main controlling factors of Paleogene Pinghu Formation in Xihu Sag

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The Paleogene Pinghu Formation in the Xihu Sag is a typical deep and ultra-deep exploration target layer in the East China Sea Basin., characterized by complex lithology and mineral composition, diverse types of diagenesis, strong reservoir heterogeneity. Therefore, it is imperative to clarify the development characteristics and controlling factors of high-quality reservoirs. This study, based on experimental data from core samples, thin sections, scanning electron microscopy, X-ray diffraction quantitative mineral analysis, and mercury injection analysis, elucidates the development characteristics of high-quality reservoirs in the Pinghu Formation from sedimentological and diagenetic perspectives. The research indicates that subaqueous distributary channels microfacies and tidal channels microfacies with strong hydrodynamic conditions, characterized by coarse-grained, pure sand bodies with good sorting and rounding, and high content of rigid particles such as quartz and feldspar, provide the material basis and prerequisite conditions for the development of high-quality reservoirs. The dissolution of feldspar and rock fragments by organic acids released during two phases of oil and gas charging is key to improving reservoir properties. Different depositional and diagenetic backgrounds lead to distinct micro-pore structures that control the reservoir's storage and permeability capabilities. By combining depositional, diagenetic, and pore structure factors, the reservoirs of the Pinghu Formation are classified into four types, with high-quality reservoirs primarily developing in coarse sandstones within subaqueous distributary channels and tidal channels microfacies. These reservoirs have undergone dissolution processes that enhance their properties, with the development of grain dissolution and interconnected pore structures with large pore throats and throat diameters, which enhance permeability. Combining the reservoir quality index (RQI), RQI > 1.5 is indicative of high-quality reservoirs, enabling quantitative prediction of high-quality reservoirs. The study clarifies the geological characteristics and controlling factors of high-quality reservoirs in the Pinghu Formation, which is of significant importance for increasing the success rate of exploration and evaluation.

# Origins of the dolomite and main controls of the development of dolomite reservoirs

# in the Lower Ordovician,Tarim Basin,NW China

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The Ordovician in the Tarim Basin, NW China is rich in oil and gas resources. Limestone and related reservoirs are mainly developed in the Middle and Upper Ordovician, and a large amount of oil and gas has been proved and produced. However, a massive dolomite occurred in the Lower Ordovician (including the Penglaiba Formation and the third and fourth member of the Yingshan Formation (collectively referred to as the Lower Yingshan Member), which have been confirmed by exploration to be able to form large-scale reservoirs, but no massive oil and gas discoveries have been made. In order to further clarify the origin of the Lower Ordovician dolomite and the main controlling factors of the development of the dolomite reservoirs, a systematic petrological and geochemical analysis was made. The results show that the Lower Ordovician dolomites are mostly distributed in thick layers and blocks in a large area, and vertically the lower strata are mostly dolomite, while the proportion of dolomite in the upper strata decreases; the lithology is mainly medium fine crystalline dolomite, a small amount of very fine crystalline dolomite and grain dolomite. The residual grain structures or phantoms are usually observed in the medium-fine crystalline dolomite and very fine crystalline dolomite; combined with geochemical parameters such as carbon and oxygen isotopes, strontium isotopes, trace elements, rare earth elements, fluid inclusion measurements, and cathodoluminescence, it is believed that the Lower Ordovician dolomite in the Tarim Basin was formed in the early diagenetic period, and the middle and late diagenetic periods were superimposed with buried dolomitization; the development of the dolomite reservoirs is mainly controlled by high-energy facies, exposure dissolution and dolomitization.

# Unraveling the enigmatic origin of Ediacaran-hosted calcite veins in the Arabian Plate: Insights from in-situ LA-ICP-MS and clumped isotopes thermometry

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Ediacaran outcrops in Saudi Arabia were preserved in half-grabens linked to the Najd strike-slip fault system and later on affected by the Red Sea Rifting. This complex fault system manifested, particularly in the study area, as intensive calcite veins with a distinctive crack-seal morphology. However, previous studies have yet to focus on different structural-controlled diagenetic processes in the Neoproterozoic sequences across the Arabian Plate. Therefore, this study aims to focus on the structural diagenesis of the Ediacaran strata in order to understand the fluid flow and tectonic evolutions.

Here, we apply a novel in-situ LA-ICP-MS and clumped isotope thermometry to investigate veins and host rocks. In-situ LA-ICP-MS provides accurate REE compositions for micro-scale veins, while the clumped isotope method provides the precipitation temperature and isotopic composition. The δ18O and δ13C of the carbonate host rocks vary from -11.79 to -7.83‰ and -0.58‰ to 1.1‰, respectively. The clumped isotope-derived paleotemperature of the host rock is 47-60°C. Meanwhile, the δ18O and δ13C of the crack-seal veins vary between -11.2 to -7.8 ‰ and -2.9 to 1.9‰, respectively. The estimated clumped-derived paleotemperature of this vein is 95°C. On the other hand, the later cross-cut veins indicate an isotopic composition of -10.9 to -10.6‰ for δ18O and -18.2 to -15‰ for δ13C, with the calculated paleotemperature of 74-84°C. Therefore, the positive Eu anomaly in all vein samples indicates the hydrothermal fluid as a remnant memory of the high-temperature water-rock interaction.

The study area has undergone multiple tectonic events and fluid circulation members along fractures associated with different stages of basin evolution. Our research provides new insight into paleo fluid circulation and demonstrates the potential of in-situ LA-ICP-MS trace element analysis and clumped isotope thermometry for investigating the structural diagenesis of calcite veins in the Ediacaran host rock in Arabia.

# The search for "Jenyon's Channel": The missing link between the Permian basins in the North Sea

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The Mid North Sea High (MNSH) Seaway, otherwise known as Jenyon's Channel, was the only major marine connection between the Northern and Southern Zechstein Basins during the latest Permian. Current understanding favours a model where Permian basin replenishment occurred via a northern connection to the Arctic Sea along an incipient arm of the proto-North Atlantic Rift System. With this model in mind, marine waters from the Arctic Sea travelled south through the northern connection, then across the Northern Zechstein Basin, through the MNSH Seaway before finally reaching the Southern Zechstein Basin. Drawing on extensive petrophysical datasets, this study aims to understand seaway activity and whether this influenced Zechstein facies distribution. The first four Zechstein Cycles are identified on the MNSH platform which shows that this structure was always covered by a thin water column during sea level highstand; however, during Z2 sea level lowstand, the MNSH Seaway provided the only connection between the basins. As relative sea level fell, the throat size of the MNSH Seaway became constricted. Limited volumes of marine water reaching the Southern Zechstein Basin caused hypersalinity. This system precipitated vast volumes of Z2 halite (late Wuchiapingian) in the Southern Zechstein Basin, whereas this facies remains limited in the Northern Zechstein Basin. In Z3 and Z4 times (Changhsingian), relative average sea level was higher resulting in sustained communication between the basins even throughout lowstand. This is evidenced through a regionally traceable blanket of the Z3 halite, along with some examples of Z2 carbonate platforms becoming entombed in Z3 halite. This work provides revised paleoenvironmental understanding for the latest Permian, and the findings should aid in the study of other oceanic gateways with further implications for hydrocarbon exploration efforts and emerging energy transition technologies such as subsurface storage on the UK Continental Shelf.

# Fine-scale characterization of distribution of thin-layered sand groups in the shallow-water delta front of the Jurassic Qigu Formation (Yongjin area, Junggar Basin) based on multi-scale integration of seismic sedimentology

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Seismic sedimentology combines sedimentary geology and geophysics to characterize thin sand bodies, reservoirs, and lithological traps. The Qigu Formation in China's Yongjin area of the Junggar Basin is crucial for oil and gas exploration. However, studying its sand bodies is challenging due to their burial at considerable depths and their thinness, which falls below the seismic resolution limit. This project employs seismic sedimentology to establish a precise sequence stratigraphic framework using core, logging, and seismic data. Techniques like phase adjustment, attribute fusion, clustering, stratigraphic slicing, waveform inversion, and 3D sculpting are used to reconstruct sedimentary systems, characterize sand body distribution, and build evolution models. The research reveals a three-level sequence framework in the Jurassic Qigu Formation, including a lowstand system tract and a lacustrine transgressive system tract. The delta front sedimentary system in the Qigu Formation exhibits inner and outer fronts. During the lowstand system tract, thick sand bodies extend to the central basin with continuous inner front distributary channels and intermittent outer front channels. In the lacustrine transgressive system tract, thinner sand bodies reach closer to the central basin with restricted inner front channels and intermittent outer front channels. The distribution of subaqueous distributary channels in shallow-water deltas is controlled by paleogeomorphology and lake-level fluctuations. The study area displays two types of delta fronts with distinct distribution patterns. One type is a shallow-water braided river delta front with branching subaqueous distributary channels formed in a shallow-water environment during the lowstand system tract. The other type corresponds to a shallow-water braided river delta front with a network-like distribution of subaqueous distributary channels formed in a relatively deep-water environment during the lacustrine transgressive system tract. These findings enhance understanding of sand body distribution in the Qigu Formation and contribute to reservoir characterization and sedimentary modeling in oil and gas exploration.

# The influence of geomorphology on 'fluvial fan- braided river- delta' system: from modern deposition to subsurface reservoirs

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A 'fluvial fan – braided river - delta' system usually developed at the basin margin slope zone. The distribution, size, and characteristics of different types of depositional facies are influenced by slope.
Modern deposition of the Daihai Lake is studied. From the mountain to the lake, alluvial fan, braided river and delta developed successively within 7 km. Site survey and unmanned aerial vehicle (UAV) mapping are integrated to characterize geomorphology and modern deposition. A 3D geomorphology model is built with the remote sensing and UAV data.
1) There are three slope zones from mountain to the lake with slope of 3.42°, 1.71°, and 0.99° separately which are marked as zone A, B, and C. Fluvial fan, braided river, and delta deposited successively from zone A to zone C; 2) there are 5 types of paleo-valleys which developed in different slope zones and control the depositions; 3) there developed a set of lobe-shaped fluvial fans around the mountain front; 4) the braided rivers in zone B is at the downstream part of huge mountain valley; 5) the geometric parameters and elevation data of braided bars are obtained from the 3D geomorphic model by UAV scanning. Size of the braided bars and depth of channels decrease with the decrease of the slope; 6) influenced by the low slope, geometry of the delta which is at the end of the system is small in scale and mainly controlled by wave in the lake.
Sedimentary model is established and applied in slope zone of eastern Liaohe Depression. There developed a 'fluvial fan – braided river – delta' system. Sedimentary facies is characterized with wells and 3D seismic data based on the established sedimentary model. The result provides geological support for oil and gas exploration in slope zone of basin margin.

# Paleoenvironment restoration under differential sedimentary backgrounds: insight for organic matter enrichment in Jurassic fine-grained sediments

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The complex tectonic movements during the Jurassic period in northwestern China resulted in different sedimentary assemblages in a fluctuating environment, led to the development of various types of source rocks characterized by significant heterogeneity. The second member of the Middle Jurassic Qiketai Formation (J2q2) is the most important target for lacustrine shale oil exploration in the Taibei Sag, Turpan-Hami Bain, NW China. Petrological, mineralogical, trace element, and isotopic analyses and biomarkers were used to reconstruct the paleo-environment and reveal the organic matter enrichment mechanisms. The lithology of J2q2 shale is mainly composed of mixed sediments dominated by carbonate minerals and has medium-high TOC and S1+S2 values, exhibiting an intermediate-good hydrocarbon potential. The Tmax values and the plot of C29-sterane ββ/(ββ+αα) versus ααα C29-sterane 20S/(20S+20R) and OEP-CPI, suggest that the shale samples are in the low-maturity stage. The kerogen in the OM of J2q2 is mainly Types I and II1, and varies periodically with depth. The redox-sensitive proxies and salinity-sensitive indicators suggest that oxic-dysoxic, mildly-brackish conditions prevailed without much fluctuation during the deposition of J2q2. The paleoclimate indicators and the distribution of the carbonate minerals, suggest that J2q2 was deposited under moderately semi-arid and semi-humid conditions, and the environment of the upper unit was more hot-arid than that of the lower unit. The P/Al, Ba/Al, and P/Ti ratios and carbon isotopes of the carbonate indicate a high paleoproductivity in J2q2 with local fluctuations. The positive correlation between the TOC content and the paleoproductivity and paleoclimate-sensitive proxies, suggest that high paleoproductivity and warm-humid paleoclimate conditions were very important to the OM enrichment in the study area. A palaeolimnological model with low sediment supply, medium-high paleoproductivity and dysoxic-oxic condition under a transitional climate was proposed to explain the formation of organic-rich source rocks during the deposition of the J2q2.

# Evaluation of pore structure and reservoir quality in shale reservoir using well logs:

## A case study of the Fengcheng Formation in Mahu Sag, Junggar Basin, China

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The shale of Fengcheng Formation in Mahu Sag, Junggar Basin has strong heterogeneity, frequent longitudinal changes of lithofacies and complex nanoscale pore structure, which bring great challenges to the evaluation of shale oil sweet spot. In this study, the pore structure of the Fengcheng Formation shale was characterized by scanning electron microscopy (SEM), nuclear magnetic resonance (NMR) experiments and two-dimensional(2D) NMR logging. The pore structure was divided into four types by NMR parameters including T2 spectral morphology, T2gm, total porosity, and movable fluid porosity. Combined with core NMR experiments and 2D NMR logs, 21 ms was adopted as the T2cutoff value to represent the demarcation between movable and bound fluids. From Type I to Type IV of pore structure, the energy clusters reflect the movable fluids including movable oil and movable water gradually decreasing in the upper right corner. The energy clusters reflect the bound fluids including clay-bound water and bitumen gradually increasing in the lower left corner in the T1-T2 map. The results show that the heterogeneity of mineral compositions and lamina structures are the key factors directly leading to the complexity and distribution of pore structure. Quartz with strong compaction resistance helps keep a large number of primary interparticle pores, and feldspar dissolution pores caused by organic acids are present. Dolomite intercrystalline pores and dissolution pores provide a large amount of storage space for the shale, while the cementation of calcite reduces pore spaces. The increase of felsic mineral content is conducive to improving the pore structure and oil-bearing potential of oil shale reservoir, while clay minerals and calcite are contrary. The above results combine core experimental data and well logging information, providing a new perspective for establishing the link between shale pore structure and reservoir quality.

# Seismic sedimentology characterization of paleo-fluvial-shallow water delta system in complex petrophysical area

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The fluvial - shallow water delta sedimentary system is developed in the H3 member of the deep Paleogene Huagang Formation in the Xihu Depression, East China Sea Basin. There are two challenges in the characterization of sand body and sedimentary facies with seismic data: 1) the difference of acoustic impedance between the sandstone and mudstone is little, and the data distribution is overlapping; 2) the sand body types are diverse, thickness of sand bodies who have different origin varies greatly.

In this study, a variety of geophysical methods are used and an effective workflow is built to identify the distribution of rivers and deltas. 1) Based on rock physical analysis, Vp/Vs is selected as the geophysical parameter to distinguish sandstone from mudstone. Vp/Vs 3D data volume is obtained by prestack seismic inversion and is used as the data source for subsequent seismic interpretation. 2) An integrated method of seismic frequency division and RGB fusion is employed to carry out plane imaging of channel sand bodies with different thickness, and to qualitatively identify the distribution of different channels and delta lobes. 3) Distribution of sand body thickness is predicted by the method of 2D convolution neural network driven seismic multi-attribute analysis. The result is used to make fine description of the sedimentary facies distribution.

The distribution of sedimentary facies in the three sub-layers of H3 in the area is characterized. In the 3 sublayers, there developed deposition of river, delta plain and delta front deposits from the bottom to the top in H3 Formation. It is deposition of a typical lacustrine transgressive sedimentary sequence. In this study, the sedimentary environment and evolution of H3 member is restored. The result provide the support of sand body distribution for oil and gas development in the area.

# Bottom current erosion, along-slope transport and deposition associated with the Southland current along the south-eastern slope of New Zealand.

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A series of large (1-10 km), deep seafloor depressions occur along the Chatham Rise, South-Island New Zealand in a water depth of around 500-1200 m. Geostatistical analysis applied to the multibeam bathymetry and 2D seismic data have been used to investigate the morphological parameters of 97 of these seafloor depressions and determine the relationship between bottom current flow and their geomorphometric parameters. They display elliptical, elongated, crescentic, circular and irregular shapes in plan-view. The crescentic shape is most common. These have a crescent length (CL) from 1.1 to 10 km, and width (CW) from 0.42 to 2.9 km, with an average central depression of 1.1 km. Parametric characterisation reveals about 80% of the depressions having a direct link between their escarpment height and the long-axis of orientation. The long-axis of orientation also has a strong relationship with the direction of current flow. These depressions are elliptical and asymmetrical in profile. Their asymmetry is strongly linked to current erosion, which is inferred to exert the most influence on their final geometry. The depression density and spatial distribution reveal patterns attributed to different processes operating simultaneously or at different scales. As observed in the seismic data beneath the depressions, high-amplitude reflections, and vertical pipes showing amplitude attenuation are indicative of possible fluid migration and escape. The results of our study, therefore, concludes that the seafloor depressions formed as a result of a combination of bottom current erosion and fluid escape at the seafloor.

# Paleoclimate and sedimentation interaction and dynamics in a (carbonate) lacustrine basin: a multiproxy analysis of the lower Cretaceous El Castellar Formation (Iberian Range, NE Spain)

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With the aim of studying the cyclic orbital signal, reconstructing paleoclimatic variations and understanding the relationships between climate changes and lake sedimentation, as well as how these are reflected in different proxies and their interaction, a multivariate analysis, including correlation and principal component analysis (PCA), and a power decomposition analysis have been carried out on multiproxy data series. Twelve data series, such as Magnetic Susceptibility (MS), Gamma Ray (GR), concentration ratios, color (L*, a*, b*), carbonate content or sedimentology-based (SB) numeric model, were studied in the Castillo de Aliaga section of the Lower Cretaceous El Castellar Formation (NE Spain).
The data series show similar trends, with a clear shift in behavior in the midsection, where GR, MS, a* and b* values increase, while SB, L* and carbonate content decrease. Correlation matrix shows quite a correlation between all the data series, with exception of the U/Th ratio. Lightness is strongly correlated with carbonate content, while increases in red (a*) and yellow (b*) components, as well as GR and MS, are directly correlated and respond to clay enrichment. In the same way, PCA results show a first principal component clearly related to lithology, which would represent variations in clastic input to the lake associated with changes in precipitation and runoff. A second component is controlled by magnetic susceptibility, suggesting the influence of another different factor within similar lithologies. The null correlation of U/Th or influence on PCA suggests that redox conditions were not relevant in sedimentation and paleoclimatic changes, even though a dysoxic event can be inferred from the curve. The results obtained reaffirm the efficacy and reliability of these proxies as paleoclimatic indicators and recorders of climatic ciclicity in paleolakes, and allow us to conclude a relatively wet and warm climate with an event of very high humidity and clastic input.

# Storm-flood deltas reconsidered: A tectonically passive, arctic counterpart to the tectonically active, tropical standard

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'Storm-floods' are a rapidly developing concept of shallow-marine sedimentology, referring to the concomitant occurrence of riverine oceanic floods caused by heightened inland precipitation, and amplified waves and currents caused by strong coastal winds, during storms. The interplay of these processes has been recognized in the stratigraphic record of many ancient deltas, where the facies of storm-deposited event beds (tempestites) have been interpreted to represent a combination of predominantly wave reworking, relaxation currents, hyperpycnal and turbidity flows, and flocculation of buoyant mud plumes. However, such 'storm-flood deltas' are almost exclusively described from lower-latitude tropical climates and tectonically active margins with narrow and steep coastal areas fed by short-catchment rivers (< 300 km).

In this study, we expand this paradigm by presenting an unusual example of storm-flood deltas within the Lower Cretaceous Rurikfjellet Formation in Svalbard, which represents deposition associated with a higher-latitude temperate–polar climate and tectonically passive platform characterized by a wide and flat ramp area fed by long-catchment rivers (> 300 km). The succession comprises a diverse range of sandstone and mudstone event beds representing tempestites, hyperpycnites, turbidites and fluid-mud deposits, which are intercalated with muddy fair-weather deposits. Collectively, the facies associations conform to storm-flood-dominated prodelta and delta-front environments. The facies stack into parasequences that can be traced regionally, reflecting that deposition took place in a widespread, relatively shallow epeiric sea deprived of shelf breaks and instead governed by an extensive low-gradient ramp physiography. Nevertheless, the parasequence architecture is characterized by diverse interfingering and abundant lateral thickness and facies shifts, highlighting the complexity and allogenic/autogenic shift sensitivity of storm-flood deltaic wedges located even vast distances from the shore (> 100 km). This study, therefore, serves as a benchmark for future analysis of storm-flood deltas representing tectonically passive, arctic counterparts to the tectonically active, tropical standard.

# Reservoir architecture and modeling of fan-delta sandbody: A case study of the upper fan-delta front subfacies of Es3 in Gangzhong Oilfield

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Taking the Gangzhong area as an example, a comprehensive analysis of the characteristics of reservoir architecture elements in the frontal part of a fan delta was conducted, utilizing core, well logging, seismic, dense well network, and analytical test data. Through identification and division, we successfully distinguished six lithofacies and four lithofacies combination types, and established a hierarchical system for the classification of architecture interfaces. Simultaneously, qualitative identification criteria for single sand layer-level architecture interfaces were developed, and a detailed study of three internal architecture interfaces in the research area was undertaken. These interfaces include the shale-mudstone to mudstone-siltstone lithological transition interface, erosional cutting interface, and well logging curve transition interface, serving as the basis for vertically dividing 3-5 level architecture elements. Based on dense well network data, overlay architecture patterns in planar, cross-sectional, and three-dimensional spaces between architecture element were established. Summarizing the developmental forms and distribution patterns of various architecture element in planar and cross-sectional views, we derived quantitative parameters and empirical formulas for 3-5 level architecture element, and established a fan delta reservoir architecture mode. Comprehensive research results, following the principle of hierarchical control modeling, we used the scale, distribution range, and overlay pattern of architecture element at different levels as constraints for hierarchical modeling, successfully constructing a fan delta architecture model for the study area. This model holds significant importance for the detailed exploration of reservoirs and the study of reservoir heterogeneity in the study area. Moreover, it provides a feasible research approach for the high-precision modeling of reservoir architecture in the frontal part of fan deltas.

# A special sedimentary system distribution characteristics in continental half-graben faulted basin: a case study from the Paleogene Dainan Formation of Subei half-graben fault basin, East China

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Sedimentary systems and lithofacies distribution in the Paleogene Dainan Formation of the Subei half-graben fault basin neither follow the general patterns of half-graben faulted basins in East China, nor the common patterns that trench belts are the main fans and sandbodies in the continental basins. In this study, firstly, provenance of the central sag was analyzed according to the integrated interpretation of the characteristics of seismic progradation reflection, the scale of underwater distributary channel and the configuration relationship between main and secondary distributary channel. Then, the planar distribution characteristics of sedimentary facies during the depositional period are described in detail by the analysis of lithology, grain size and interpretation of seismic facies, attributes and slices. According to a large number of seismic profile observations, we found that the provenance and depositional system characteristics of the first member of the Dainan formation in Qintong Sag are both similar and special compared with the general understanding basins in East China. The Qintong Sag was serviced by both the gentle slope zone and fault-terrace zone provenance, rather than only sedimentary sources from the fault-terrace zone. Additionally, delta lobes deposited by provenance from Wubao Low Uplift was first discovered. The sedimentary facies of the central Qintong Sag is characterized by "zonation from east to west", which can be divided into delta front in the western gentle slope zone, shore-shallow lake in the central deep concave zone and fan delta front in the eastern deep depression slope zone.The planar distribution of sedimentary facies in both the eastern fan delta and the western delta is characterized by widely-covered, the sedimentary facies development is mainly controlled by the supply capacity of provenance, there is no obvious relationship between fault and sedimentary facies distribution and “fault accompanying sand body”.

# Architecture and temporal evaluation of the Late Messinian drainage systems that modify (dissolution, incision, and erosion) the top evaporite seismic unit (Nahr Menashe) in the NE Levant Basin, Eastern Mediterranean

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The Late Miocene (5.97 to 5.33 Ma) oceanographic drawdown of the Mediterranean Basin generated a thick accumulation of evaporites and is referred to as the 'Messinian Salinity Crisis (MSC)'. Despite a long research history, multiple hypotheses regarding the drawdown magnitude, the nature of deposition, and termination processes of this enigmatic event remain unresolved. Here, we appraise the uppermost part of the salt giant using seismic data to reconstruct the termination of the MSC in the Levant Basin. Our study focuses on the Nahr Menashe Seismic Unit (NMU) and associated Late Messinian Drainage Systems (LMDS). The NMU is bounded by two challenging seismic events at the top and bottom that allow clear distinction from the underlying lower Messinian succession and overlying Plio-Quaternary succession. Internally, the NMU displays repetitive (maximum 2 to 3 cycles), coherent, moderate to solid amplitude, semi-continuous to chaotic reflection packages that have been either dissolved or eroded beneath the LMDS which forms north-south trending paleo drainage systems that are incised into the top of the NMU. Mapping of channel/valley systems allows tributary drainage networks to be identified that indicate an overall southerly directed paleo flow. The drainage systems are up to 160 m deep and show evidence of terracing indicating multiple erosion events. Post-salt movements destroyed or modified the drainage configuration. However, reconstruction shows an increase in incision southwards (downstream). Specific seismic observations of the relationship between the NMU and LMDS indicate high-angle reflection terminations along valley walls. The valley fill material comprises parallel reflectors that may be draped over underlying or adjacent topography. The LMDS is incised into the NMU and is thought to have formed due to the maximum base level fall associated with the final stage of the MSC event (stage 3) and subsequently infilled by a swift burial of transgressive/high stand sediments.

# Advancing Knowledge in Chalk–CO2 Reactivity within Reservoir Settings

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We investigate the reaction of chalk to supercritical CO2 injection in the Maastrichtian Tor and Danian Ekofisk formations of the Halfdan Field, Danish North Sea Central Graben. Carbonate reservoirs undergo alteration processes, mainly dissolution and precipitation, impacting flow dynamics and storage efficiency. Our research aims to provide fundamental insights into advancing CO2 storage in depleted oil/gas fields with chalk reservoirs during and after CO2 injection. Our methodology integrates petrographic studies using SEM, geochemical and physical experiments, and numerical modeling. The pre-and post-CO2 injection SEM petrography will be used to analyze crystal microtextures influencing fluid flow- and storage capacity and track any alterations. Batch reactor experiments involving chalk samples exposed to brine and supercritical CO2 aim to replicate reservoir conditions, focusing on fluid-rock interactions, mineral dissolution, and rock structure changes. Approximately 15 experiments are planned to validate procedures and determine chalk solubility constants. Based on initial geochemical models, divalent cations are expected to form carbonates during calcite dissolution following CO2 injection, making Sr, Ba, Mn, Fe, Cd, and Zn potential reactive tracers for chalk dissolution. Success involves identifying a suitable tracer and understanding its behavior. This experimental data will inform the development of a geochemical model, aiding in the precise determination of dissolution locations and degrees in core-flooding data. Exploring pressure-dependent calcite solubility, we will investigate episodic pressure fluctuations inducing dissolution/reprecipitation and net crystal growth (Ostwald ripening). In 3 experiments with daily pressure changes, we may use reactive tracers or isotope-labeled Ca. Additionally, we aim to gain a new fundamental understanding of the specific diagenetic features in highly porous, low-permeable carbonate chalk. Successful outcomes include quantifying calcite recrystallization and its spatial distribution for modeling or establishing its negligible extent in experiments and integration of data in a sector-scale numerical model to assess the feasibility of CO2 storage in tight carbonate reservoirs.

# Sedimentary facies analysis, paleogeography, and reservoir quality of the Middle-Late Cambrian Xixiangchi Formation in Southeast Sichuan Basin, Southwest China

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The observation of typical outcrops, drilling cores, microscopic thin sections, scanning electron microscopy, combined with experimental analysis data, such as petrophysical data, radioactive elements, the sedimentary facies, paleogeography, and reservoir quality were investigated. The Middle-Late Cambrian Xixiangchi Formation is mainly deposited in the restricted platform with a lithology essentially composed of dolomite with local occurrences of limestone and other rock types in small thicknesses. From west to east, the paleogeographic pattern was mainly dominated by carbonate deposits. Four 3rd-order sequences (SQ1-SQ4) were identified in this study. Each sequence is composed of a complete cycle with HST and TST. Reservoir areas are principally developed on high-energy grain shoal deposits located in SQ2 and SQ3 with a minor occurrence in SQ1 and SQ4. These shoal deposits have a lithology essentially composed of sandy dolomite and crystalline dolomite characterized by relatively low porosity (average 2.61%) and low permeability (average 1.0073 mD) values which were further enhanced by seepage and connecting dissolution pores and vugs through fractures. The occurrence of karst caves through superimposed supergene karstification and bedding karstification highly improved the reservoir's physical properties in some areas. The reservoir space is principally dominated by intergranular dissolution pores, karst caves, and fractures, and their formation was controlled by sedimentation, diagenesis, penecontemporaneous dissolution, and tectonic fractures, which can also be influenced by paleogeomorphology and sea level fluctuation. The reservoir is characterized by relatively thin single-layer thicknesses (3-45 m) with poor lateral continuity. Favorable hydrocarbon exploration areas with relatively good source conditions, high positions in the paleostructure, and conducive to the migration and accumulation of hydrocarbon were identified in three areas of the basin: (1) on the slope around the Central Sichuan Uplift; (2) in the northeastern part; and (3) in the southeastern part.

# Geochemical characteristics and hydrocarbon potential of carbonate rocks of Ordovician units in the Sichuan Basin, southwest China

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We studied outcrops, rock samples, and thin sections, and together with organic matter types, abundance, and thermal maturity assessment we predicted favorable reservoir development areas and provided insights into the hydrocarbon-generating capacity of potential source rocks on this basis. Favorable reservoir areas are developed in three facies zones of the Tongzi and Honghuayuan formations including intra-platform shoal, platform marginal shoal, and paleokarst. The main reservoir spaces comprise intergranular pores, residual intergranular pores, matrix dissolution pores, intergranular dissolution pores, and karst caves. Hydrogen Index (HI, mg HC/g TOC) versus temperature of maximum generation (Tmax, °C) cross plot shows that the samples from the Xishuihoutan and Nanchuan Sanquan section have very low HI values (12.05<HI<7.75 mg HC/g TOC) and are suggesting kerogen type IV which is inert and do not generate hydrocarbons. Samples from the Tongzi-Honghuayuan section have medium to good quality source rocks (0.76<TOC<1.54 wt.%) with vitrinite reflectance (Ro) and Tmax values ranging from 0.98% to 1.96% and from 398 to 559̊ C, respectively, demonstrating the over-maturity stage. The potential source rocks in the investigated region are mainly type IIb kerogens which are in the mature to post-mature stage. Samples from the Early Ordovician Tongzi and Honghuayuan, Middle Ordovician Shizipu, and Late Ordovician Baota Formation have low Total Organic Carbon (TOC) values (<0.5 wt.%) and are considered non-effective source rocks. In the Early/Middle Ordovician Meitan Formation and the Late Ordovician Wufeng Formation, there are effective source rock sections with TOC values varying from 0.76 to 1.54 wt.% and 0.26 to 3.16 wt.%, respectively, and are both in the dry gas generation window. The depositional environment, potential source rock characteristics, and the hydrocarbon-generating capacity of the Ordovician strata in the Sichuan Basin provide valuable insights for upcoming research and hydrocarbon exploration.

# Investigating biological and environmental controls on calcrete development through geological time

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Here, we aim to investigate the hypothesis that pedogenic calcrete fabrics co-evolved with terrestrial life from the Ordovician to the Quaternary. We hypothesise that key intervals were likely related to (i) development of vascular plants in the Silurian; (ii) development of bigger rooting systems through the Devonian and into the Carboniferous; and (iii) development of more modern soil ecosystems, potentially including earthworms, from the Mesozoic. Here, we compare the petrographic fabrics and stable isotope geochemistry (O and C) of (i) the Siluro-Devonian Lower Old Red Sandstone, (ii) the Devono-Carboniferous Upper Old Red Sandstone; and (iii) the Permo-Triassic New Red Sandstone of the UK. Initial observations suggest that there was a transition from calcretes of the Old Red Sandstone which are dominated by abiotic micromorphological structures, known as alpha fabrics, to examples with biologically-influenced structures, known as beta fabrics, through time. However, there is also variability in the fabrics and carbon stable isotope compositions of calcretes of similar ages at different locations. For example, the calcretes of the Lower Old Red Sandstone of New Aberdour, Scotland, are seemingly less nodular than the Lower Old Red Sandstone calcretes of South Wales. This ongoing work will help to unravel complexities in spatial and temporal trends in soil and calcrete evolution related to biological evolution from the Palaeozoic to the Quaternary.

# Depositional environment and lithofacies analyses of the Eocene lacustrine shale in the Bohai

# Bay Basin: Insights from mineralogy and elemental geochemistry

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The effect of various depositional parameters including paleoclimate, paleosalinity and provenance, on the depositional mechanism of lacustrine shale is very important in reconstructing the depositional environment. The classification of shale lithofacies and the interpretation of shale depositional environment are key features used in shale oil and gas exploration and development activity. The lower 3rd member of the Eocene Shahejie Formation (Es3x shale) was selected for this study, as one of the main prospective intervals for shale oil exploration and development in the intracratonic Bohai Bay Basin. Mineralogically, it is composed of quartz (avg. 9.6%), calcite (avg. 58.5%), dolomite (avg. 7%), pyrite (avg. 3.3%) and clay minerals (avg. 20%). An advanced methodology (thin-section petrography, total organic carbon and total organic sulfur contents analysis, X-ray diffraction (XRD), X-ray fluorescence (XRF), field-emission scanning electron microscopy (FE-SEM)) was adopted to establish shale lithofacies and to interpret the depositional environment in the lacustrine basin. Six different types of lithofacies were recognized, based on mineral composition, total organic carbon (TOC) content and sedimentary structures. Various inorganic geochemical proxies (Rb/Sr, Ca/(Ca + Fe), Ti/Al, Al/Ca, Al/Ti, Zr/Rb) have been used to interpret and screen variations in depositional environmental parameters during the deposition of the Es3x shale. The experimental results indicate that the environment during the deposition of the Es3x shale was warm and humid with heightened salinities, moderate to limited detrital input, higher paleohydrodynamic settings and strong oxygen deficient (reducing) conditions. A comprehensive depositional model of the lacustrine shale was developed. The interpretations deduced from this research work are expected to not only expand the knowledge of shale lithofacies classification for lacustrine fine-grained rocks, but can also offer a theoretical foundation for lacustrine shale oil exploration and development.

# Shape-controlled longshore transport of pebble-to-cobble on a gravel beach, Wando, southern coast of Korea

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A number of previous studies indicate that larger cobbles travel faster than smaller cobbles, due to small gravels to be trapped in interstices between larger gravels. Overpassing process has long been used to explain alongshore segregation of smaller and larger sediment at different transport rates through acceptance or rejection into background material. Some works showed, however, that in a tracer study larger cobbles moved similar distances alongshore as smaller clasts. It is therefore not clear whether sorting by size, and sorting by shape are achieved by two fundamentally different mechanisms. The primary purpose of this study is thus to evaluate the relative importance of size and shape in sorting and longshore transport of cobbles on a gravel beach in Wando, south coast of Korea. For this purpose, grain-size measurements by manual counting were conducted at 100 stations. In addition, 3D mapping using a drone and beach profiling survey have been carried out regularly to capture beach morphologic change. Tidal range in the area is 3.06 m corresponding to mesotidal regime and annual mean wave height 0.4 m. Mean sizes of cobbles range from -8.5 to -3.7 phi, and sediments are composed of three different modes. Cobble size distribution reveals that cobbles and boulders up to -8 phi were armoured only at the eastern zone, and they became finer towards the west. However, at the end of the western zone the cobbles were slightly coarser. Alongshore distribution patterns of cobble shape showed that oblate clasts decrease up to 40%, by contrast, equant one increases up to 50% at the western zone. We suggest that cobbles are shape-controlled in a longshore transport, rather than size-sorted. The role of storms and typhoons which produce high waves capable of redistributing significantly has yet to be resolved.

# Modal composition and textural characteristics of Upper Miocene to Quaternary sediments of the North Croatian Basin as indicators of tectonic and climatic events during the post-rift evolution of the Pannonian Basin System

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The North Croatian Basin (NCB) is located in the southwestern part of the Pannonian Basin System. Since the Late Miocene, the basin has accumulated a sequence of clastic material more than one kilometre thick.

Analysis of the modal composition and textural characteristics of the detritus revealed that the Upper Miocene sediment is texturally mature and has a uniform modal composition. It was formed by the weathering of metamorphic and clastic sedimentary rocks in the Eastern Alps and Western Carpathians. During the Pliocene, the basin was filled with detritus of the same origin, with an admixture of texturally and mineralogically immature detritus from the Inner Dinarides in its southwestern and eastern parts. During the Pleistocene, loess originating from the Danube floodplain covered most of the NCB. In addition, mineralogically and texturally immature sandy and gravelly detritus was deposited around intrabasinal highs and along the basin's southern margin.

The modal composition and textural characteristics of the clastic detritus that filled the NCB during the postrift phase of its evolution indicate intense tectonic activity and climatic changes during the Late Miocene, Pliocene and Pleistocene. Detritus formed by the increased erosion of the Eastern Alps and the Western Carpathians and deposited in the NCB at the end of the Miocene and in the Pliocene suggests subsidence of the basin floor and a warm and humid climate. The presence of material from the Inner Dinarides and uplifted blocks within the NCB indicates the onset of basin inversion. The deposition of loess is indicative of colder climatic periods in the Pleistocene. The deposits formed by the erosion of the pre-Neogene basement rocks of the NCB accumulated around the present-day mountains in the basin and indicate uplift of individual blocks resulting from the compressional phase of basin development in the Quaternary.

# Facies characterization and stratigraphy of the Upper Cretaceous Chalk Group in the Molenbeersel borehole, Roer Valley Graben, Belgium

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The Chalk Group of the eastern Campine Basin, in South Limburg, the Netherlands, was deposited in a proximal zone of the Upper Cretaceous Chalk Sea. In contrast to the typical Chalk of northwest Europe, the Chalk Group of South Limburg is coarser and contains a significant siliciclastic component. Lateral correlation of the Chalk Group of South Limburg to rocks elsewhere in the Netherlands is often challenging due to insufficient mapping and inadequate lithostratigraphic subdivision of the unit in the Roer Valley Graben. The Roer Valley Graben is a Late Jurassic to Early Cretaceous basin that underwent inversion in the Late Cretaceous. It separates the Campine Basin from other basins in the Netherlands. To better understand the lateral relationship between the Chalk Group of South Limburg and the Upper Cretaceous in other parts of the Netherlands, we studied the Molenbeersel borehole located on the southern shoulder of the Roer Valley Graben, in Belgium. The Chalk Group in the Molenbeersel borehole represents the link between the rocks that occur north and south of the graben. For this project, we studied the cores of the borehole, carried out a (micro)facies analysis, and quantified the mineral composition using X-ray diffraction analysis. The Chalk Group in the Molenbeersel borehole consists mainly of hybrid arenites, bioclastic calcarenites, and algal boundstones. Hybrid arenites and bioclastic calcarenites are common facies in the Chalk Group of South Limburg, suggesting that the depositional setting of South Limburg was extended further north-northwest towards the Roer Valley Graben. Algal boundstones, on the other hand, have no direct equivalent. Here, we present a revision of the lithostratigraphy of the Chalk Group in the Roer Valley Graben. Our results improve regional stratigraphic correlations and contribute to a more accurate understanding of the paleogeographic evolution of the Chalk Group in the Campine Basin.

# Mixed carbonate–siliciclastic deposits: depositional insights from the Chalk Group of South Limburg, the Netherlands

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Relative sea level and sediment supply are often considered the primary drivers in the alternating deposition of carbonate and siliciclastic sediments in shallow-marine settings. In mixed carbonate–siliciclastic successions, however, in which carbonate and siliciclastic grains coexist, distinguishing the signature of depositional drivers can be challenging. The Upper Cretaceous to Danian Chalk Group of South Limburg, the Netherlands, consists of estuarine to marine deposits of a proximal zone of the Late Cretaceous Chalk Sea. Despite the name, the unit consists of rather coarse mixed carbonate–siliciclastic sedimentary rocks divided into a siliciclastic-dominated, a mixed siliciclastic–carbonate, and a carbonate-dominated stages. The significant siliciclastic component of the rocks of the Chalk Group in South Limburg is attributed to Late Cretaceous inversion of the Roer Valley Graben, a Late Jurassic to Early Cretaceous basin located north of South Limburg. Little is known, however, about the relationship between inversion of the graben and sea-level change with changes in the composition of the rocks. For this project, we studied a new borehole in South Limburg (Eys01). We carried out a litho- and microfacies analysis of the Chalk Group and quantified the mineral composition using X-ray diffraction analysis. Here, we present a new depositional model for the South Limburg Chalk Group. We will discuss controls on the deposition of mixed carbonate–siliciclastic deposits in proximal epeiric seas.

# Carboniferous paleosols developed under different fluvial systems: a case study from the Upper Silesia Coal Basin

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The Upper Silesia Coal Basin (USCB) encompasses a continental succession of Pennsylvanian age, spanning approximately 8 km in thickness and characterized by numerous coal seams and clastic paleosol horizons. Among the youngest coal-bearing members of this succession are the Mudstone Series (MS) and the Cracow Sandstone Series (CSS). Notably, MS deposition is attributed to meandering river systems, while CSS is associated with braided river systems.
Following deposition, USCB sediments underwent burial diagenesis, reaching temperatures exceeding 140°C in the western region and remaining below 100°C in the eastern part during the early Permian. Subsequently, a hydrothermal diagenetic pulse occurred in the Jurassic. This study aims to explore whether the shift in depositional environments is correlated with changes in the mineralogy, chemistry, and micromorphology of clastic paleosols within both the Mudstone Series and Cracow Sandstone Series, considering their diagenetic history.
Micromorphological investigations of paleosols revealed a more pronounced development in the CSS, aligning with prior research findings. Interestingly, certain samples from the CSS exhibited features indicative of a lacustrine environment, contrary to the prevailing high-energy braided river systems during CSS deposition.
To assess the potential degree of diagenetic alteration, mineralogical indicators were employed and compared with existing literature data. This comparative analysis served as a foundation to validate the reliability of geochemical indicators for weathering. The results shed light on the intricate interplay between depositional environments, diagenetic processes, and the evolution of clastic paleosols in the Upper Silesia Coal Basin.
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# Early hypogenic dissolution of Cretaceous shallow-marine limestones (eastern Basque-Cantabrian Basin, western Pyrenees)

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The interpretation of dissolution textures in carbonates can be very controversial as the origin and nature of the fluids involved is very diverse. In such cases, the combination of sedimentological and geochemical methods is key to solve interpretative problems. Cemented and sediment-filled fissures and cemented mosaic packbreccias hosted into upper Albian limestones of the eastern rift margin of the Mesozoic Basque-Cantabrian Basin, in the western Pyrenees, are a good example of ancient syntectonic limestone dissolution, cementation and internal sedimentation at early diagenetic stages. Sedimentological and petrographic observations combined with geochemical data ($\delta^{13}C$ and $\delta^{18}O$, clumped isotope thermometry and elemental analysis) allowed the identification of (1) fractures and dissolution cavities filled with high-Mg radiaxial fibrous calcite (RFC) and red carbonaceous internal sediment and (2) Fe-rich spar calcite, saddle dolomite and cubic pyrite. Data suggest that organic matter maturation of underlying Jurassic-Lower Cretaceous rocks was accelerated due to the elevation of the isotherms and the difference in subsidence between uplifted areas and minibasins caused by synextensional salt-tectonics. Hydrocarbons migrated towards Triassic evaporite cored anticlines interacting with Keuper facies and triggering thermo-chemical sulphate reduction. That reaction increased the concentration of $CO_2$ and $H_2S$, acidifying the diagenetic environment. Subsequently, acid fluids were expelled through the fracture networks of the growing salt-cored forced-folds dissolving reactive overlying upper Albian shallow-marine limestones in their upwards path and induced precipitation of hydrothermal spar calcite, saddle dolomite and pyrite. Later, due to the dilution of the hypogenic fluids in the marine-phreatic diagenetic realm, alkalinity increased and void-filling RFC crusts formed in the dissolved cavities. Finally, internal sedimentation occluded remaining porosity. Therefore, this study demonstrates the importance of hydrothermal activity in producing early dissolution of shallow-marine limestones due to hypogenic acidic fluid-flow in tectonically active regimes.

# Geological and geomechanical sweet spots in unconventional hydrocarbon reservoirs

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Geophysical well-log evaluation in the era of unconventional hydrocarbon resources (mainly tight oil and gas, shale oil and gas) is complicated and challenging. This review aims to fill this gap between well-log evaluation and unconventional hydrocarbon resources by characterizing the source rock property, reservoir property and engineering property using petrophysical well logs. The advanced well-log series used for unconventional oil and gas evaluation include nuclear magnetic resonance (NMR) log, image logs, array acoustic logs, elemental capture spectroscopy (ECS) and LithoScanner logs. The source rock property in terms of total organic carbon content is predicted using conventional logs and LithoScanner log. Then petrophysical parameters including porosity, permeability and oil saturation are calculated, and the appearance of natural fracture is predicted from conventional, sonic logs, image logs and NMR logs.
Additionally, the reservoir property is evaluated to optimize the favorable layers with high hydrocarbon bearing property and productivity. Brittleness index as well as in situ stress direction and magnitudes are characterized by the comprehensive use of density, sonic log, ECS log and image logs. Then, the engineering property (high brittleness index but low horizontal stress difference) is evaluated to screen out the prospected layers for hydraulic fracturing. The internal relationships between the three types of properties are unraveled, and the geological and engineering sweet spots are optimized by integrating lithology, reservoir quality, hydrocarbon bearing property, source rock property, brittleness and in situ stress magnitude and direction. This multidisciplinary approach provides a comprehensive method for optimizing sweet spots in unconventional play, and will support petroleum geoscientists' and engineers' decisions in exploration and exploitation of unconventional hydrocarbon resources.

# Effect of different pore throat combinations on moveable fluid of tight reservoirs in the Ordos Basin, China

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Clarifying the size, morphology, connectivity of pores and throat, and pore throat structure can provide a scientific basis for the effective development of tight sandstone reservoirs to a certain extent. In this study, a series of experiments were carried out on tight sandstone samples from the Yanchang Formation of the Ordos Basin, China to study pore throat structure, including cast thin section analysis, scanning electron microscopy, pressure mercury intrusion and nuclear magnetic resonance test. The results show that the major reservoir space is typically formed by the combination of intergranular pores and dissolution pores. Pore and throat combination types mainly include large pore-narrow throat, conduit-like pore throat combination, and tree-like network combination. The pore-throat fractal curve has one segment, while the throat has two segments. The fractal dimensions of narrow throat (Dt1) is larger than that the fractal dimensions of wide throats (Dt2), indicating that small throat has higher self-similarity and more homogeneous distribution. The large pore-narrow throat type and conduit-like pore throat combination type contribute the major permeability, the tree-like network combination type has good connectivity of pore throats and contributes the major storage space. The wide throats connecting the intergranular pores constrain the flow of fluids in the tight sandstone. The study of the fluid movability based on bound water modeling shows that the higher proportion of the conduit-like pore throat combination type, the more homogeneous the pore throat structure is, bound water is redistributed on the pore-throat surface to form a thin water film after centrifugation, leading to a higher proportion of movable fluid, and the overall seepage capacity was stronger. A large number of laumontite dissolved pores as well as intercrystalline clay pores exit from the tree-like network combination type, and the strong capillary pressure causes a low proportion of moveable fluid.

# Palaeoenvironmental reconstruction of the middle-upper Eocene Loza-Portilla Formation: Palustrine-lacustrine sequences in a tectonically-active syncline basin (Western Pyrenees, N Spain)

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Upper Eocene palustrine-lacustrine carbonates and associated siliciclastic alluvial deposits are common in several outcrop areas of the southern Pyrenean fold and thrust belt. They occur infilling several small syncline basins associated to the beginning of the Pyrenean convergence at the back of the South Pyrenean thrust front (SPTF). The Loza-Portilla Formation represents the first continental infilling of the Miranda-Trebiño basin, one of the most representative among these syncline basins, overlying a tilted and folded upper Cretaceous to Paleocene carbonate substrate. According to paleontological studies of microvertebrates and charophytes, this formation can be constrained in age between the late Lutetian? and the middle Priabonian. This work focusses on the facies and stratigraphic architecture of the Loza-Portilla Fm, it consists of up to 300 m thick marginal alluvial siliciclastic grading to palustrine-lacustrine carbonates and minor proportions of evaporates, stacked in three depositional sequences (DS1 to DS3) separated by erosional discontinuities. Each of these sequences represents a complete cycle of gradual lake expansion and contraction culminating with extensive subaerial exposure. These depositional cycles can be correlated with distinct phases of tectonic deformation affecting the western Pyrenean domain. Additionally, the deposition of the Loza-Portilla Fm was directly controlled by the increasing activity of several local diapiric structures, which seem to have determined the distribution and lateral migration of the successive lake depocenters and the location of the marginal alluvial fan systems. The range of pedogenic features found in the alluvial to palustrine deposits denote the prevalence of sub-humid to semiarid climatic conditions during deposition of the Loza-Portilla Fm, with a short-lived episode of increasing aridity recorded within sequence DS1.

# Microfacies and diagenetic overprints of arid continental carbonates from the Divisadero Largo Formation, Southern Central Andes 33ºs (Argentina)

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The arid continental environments are generally composed of aeolian, alluvial and fluvial siliciclastics. Carbonate deposits are common in these systems but rarely studied with high resolution even though they provide relevant paleoenvironmental information because they are highly sensitive to tectonic and climate changes. This work focuses on microfacies analysis of the continental carbonate deposits of the Divisadero Largo Formation, situated in the Southern Central Andean foreland region of Argentina, at 33°S in the Cuyana Basin. The age of this formation has been established from previous U-Pb studies in detrital zircons that limit deposition between 41 to 65 Ma (Paleocene to middle Eocene). Divisadero Largo Fm. comprises up to 100 m clastic, evaporite and less common carbonate deposits. The predominant alluvial plain succession grade into a mixed carbonate/clastic sedimentary deposit interbedded with evaporitic and carbonate levels, interpreted as shallow lacustrine. Carbonate materials are concentrated in the top of the formation and are arranged in centimetric strata interspersed with marls levels. The main goal of this work is characterising the carbonate factory of the system and to establish the different diagenetic stages that affected primary precipitation. One microfacies has been identified: fibro-radial spar mosaics featuring layers of different grain size; sparite euhedral crystals infill voids and veins. It has been possible to recognize original structures as stromatolitic bands, pseudomorphs of gypsum and opaque concentrations of organic matter. Silica nodules are common in these facies disposed as isolated centimetric and elongated nodules or patches of chalcedony crystals. Described carbonate levels represent marginal facies within a playa lake system surrounded by a saline pan with intermittent detrital contributions from fluvial systems and the common subaerial exposure that record a complex diagenetic history.

# Sedimentary rocks heterogeneity and properties changes induced by CO2 injection experiments

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With carbon neutrality targets for 2050 in mind, $CO_2$ sequestration in underground reservoirs is one of a number of solutions to be considered. Although the idea is far from new, injecting $CO_2$ into the subsurface with the aim of trapping and storing it for the long term still poses a number of scientific and technical challenges. Our goal is to develop, at the lab scale, new ways to better characterize $CO_2$-brine-rock interactions at depth. Our focus is on how rock heterogeneity will influence $CO_2$ behavior and control physical and chemical changes during injection.
A set of 5 reference lithologies (2 limestones, 2 dolomites, 1 sandstone) were chosen to represent common sedimentary units in north American sedimentary basins. The experimental setup consists of a pressurized vessel, a liquid $CO_2$ tank and a high-pressure metering pump. The setup was designed to work at reservoir pressure (supercritical $CO_2$ ) but with higher temperature to increase reactions kinetics. $CO_2$ is injected into brine saturated samples and reactions conditions are maintained for several days. Conventional poroperm measurements and µCT imaging are made before and after experiments on dry samples. Petrographic analyses (conventional, SEM, µXRF) are made on the core after reaction and compared to analyses made on unreacted core replicates. µCT showed that the most obvious density changes occurred for the Indiana limestone and Silurian dolomite. Dissolution marks in the intraparticle pore space and corrosion marks on the surface of minerals were observed. Chemical etching is also visible within interparticle space, along with evidence of particle stripping and displacement. A decrease in porosity (5.3 and 4.7% respectively) was measured, while permeability remained almost the same. These tend to suggest pore clogging and pore enhancing mechanisms induced by $CO_2$, while pore throats did not change significantly, thus preserving fluid transport potential in the most reactive carbonates.

# Deep-water Turbidites Characterisation with Emphasis on Facies Zonation in Mixed/Hybrid Depositional Environment – case study

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The aim of this study was to characterise the conceptual model followed by facial zonation. One particular layer of interest, described in this paper, being located on the shelf edge, slope, and deep-water environment, has increased the complexity of this study.
Analysing the seismic image, together with core data and well logs, features that could imply the differentiation between shelf and deep-water environments were distinguished. At the shelf edge towards the slope, a distinctive pattern of chaotic seismic resolution is noticed, typical for mass transport deposits (MTD). Therefore, the moment of distinction between the depositional environments has been localised. Knowing the potential architecture of the reservoirs in such environments, from previous research, the base for zones and facies characterisation is established. Detailed analysis of the core data from 25 wells gave insight into which type of facies has been developed. Using that information, a fair set of wells (35 wells) is selected for electrofacial analysis. The criteria for wells selection is based on wells with core data and their spatial distribution. Core and well data gave us 8 facies assemblies, 4 at the shelf and 4 at the deep-water depositional environment. The next step was detailed seismic attributes analysis which resulted in spatial distribution of facies.
Based on core data features (structures, textures, bioturbations and mineral content) and electrofacies analysis, the following facies were identified on the shelf depositional environment: channels, bars, beach/transition zone and shelf clays.
Through the aforementioned analyses, the following facies were identified on the deep-water depositional environment: fan channels, submarine fans, MTDs and basin floor clays.
Using seismic analysis, in correlation with well data, the spatial distribution of each facies was determined.
As the final part of this study, the conceptual model is proposed, as well as the evaluation of facies potential.

# Sedimentary driven morphologies and structures in the NW Black Sea

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The Black Sea basin was extremely dynamic during the Quaternary Period, when the regional changes superimposed on the global ones. The dynamics of the Black Sea featured significant sea-level variations (up to 150 m or even more), important fluctuations in its watershed and associated sedimentary modifications, along with changes in paleo-temperatures and salinity of surface and deep-waters.

The dynamics of all above mentioned parameters produced specific morphologies and structures of the sedimentary bodies. In specific settings, fluid dynamics produced large pockmarks, which could be found in general in the whole Black Sea basin, and especially in its NW part.

The NW continental shelf of the Black Sea is the widest in the whole basin; since the LGM (Last Glacial Maximum) it was subject of successive transgressions and regressions that together with changes in water-sediment supply and climate (temperatures, salinity, and wind regime) created intricated structures and fluvial, lacustrine and marine morphologies. By means of multibeam echosounding and very high resolution seismics we have identified delta like structures, aeolian dunes, erosions, paleo-valleys, and others. In some areas of the continental shelf, the reworking of sediments lead to strange sedimentary successions. In the flexure area there are specific sea-bottom morphologies (large arrays of pockmarks) produced by fluid seeps; these features are associated to high sedimentation rates of some specific upper slope sections of the NW Black Sea. The flexure area is also characterized by the presence of canyon heads the supply with sediments the continental slope. In this setting, two intricated deep sea fans produced by paleo-Danube and paleo-Dnieper rivers are present.

# Late Jurassic carbonate sedimentation and contemporary submarine volcanic flow in the Black Flysch Domaine, East Carpathians

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[1]University of Bucharest

Remnants of the Black Flysch Sedimentary Domain are exposed in the Maramureş Mountains of East Carpathians, forming the Black Flysch unit which consists of several tectonic thrust sheets. Lithostratigraphy records in the lower part of these tectonic divisions the Mafic Complex represented by alkaline pillow-lava basalts, pyroclastics, and stromatites - a local term that describes the interlayers of irregular thin basalts and micritic limestones. The overlying sedimentary deposits are represented by different siliclastic and carbonate rocks of Late Jurassic – (?) Earliest Cretaceous time interval. The carbonate sequences are scarce, being preserved only in several tectonic units. One of the most interesting carbonate sequences crops out in the Șteviora tectonic unit, containing a succession of red nodular limestones (8 to 10 meters thick) overlying the densely packed elliptical pillow lavas of the Mafic Complex. Moreover, the carbonate deposits are interlayered with levels of rounded basaltic grains (of millimetric to centimetric size). The sequence is medium bedded and shows normal grading and erosional bases. The identified microfacies are: i) terrigenous packstone to floatstone with various worn skeletal grains, rounded basalts, and carbonate intraclasts; ii) autochthonous pelagic sediment represented by bioclastic packstone-wackestone bearing calcispheres and pelagic crinoids (Saccocoma), reworked benthic crinoid ossicles and numerous Lamellapthychus plates; iii) carbonate intraclasts of Ammonitico Rosso-type limestones; iv) packstone-wackestone with Saccocoma, Globochaete, radiolarians and rare Calpionella alpina Lorenz.
The abundance of Lamellapthychus plates and Saccocoma ossicles indicate late Kimmeridgian-Tithonian interval. Rare specimens of Calpionella alpina could indicate the earliest Berriasian.
The carbonate succession from Ştevioara tectonic unit is interpreted as deep-water calciturbidites supplied by the tops or steeped flanks of a pelagic carbonate platform - where Ammonitico-Rosso-type limestones were formed - and synchronous submarine volcanic flows. This work was supported by the project PN-III-P4-PCE-2021-0901.

# Salt-related intrabasinal sediment rerouting and its impact on facies distribution in the Burgoa and Jata minibasins, Basque Country, Spain

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It is well understood that the syndepositional growth of salt diapirs is responsible for funnelling sediment into adjacent deep-water minibasins. Minor salt bodies can act as topographical barriers and divert incoming flows. However, the relationship between intrabasinal sedimentary pathways and sub-seismic sedimentary architecture during the fill of a minibasin is poorly understood. Separated by the Bakio Diapir, the Jata and Burgoa minibasins of the Basque Cantabrian Basin northern Spain, are ideal outcrop analogues for understanding these interactions in detail. Using geological mapping and virtual outcrop models, this study aims to highlight how failures triggered by the continuous growth of the Bakio Diapir influenced facies distribution and the occurrence of stratigraphic pinch-outs during the fill of these minibasins. During the Albian as the Bakio Diapir grew, the shallow water conditions created facilitated the growth of carbonate reef platforms on the diapir crest. During periods of continuous diapir growth, the platforms became unstable and shed megabreccias of the Bakio Breccias Group. Once emplaced in the adjacent minibasins, the megabreccias created positive relief and acted as topographical barriers, perturbing and rerouting incoming sediment gravity flows, further segmenting facies distribution within both minibasins. Their presence also reduced accommodation and may account for the deposition of finer grained facies associated with the distal lobe sub-environment along onlap surfaces. Only more dilute flows were able to surmount the breccia topography until the relief was subsequently healed. This study provides outcrop analogues for stratigraphic traps within salt controlled minibasins which would not usually be imaged in seismic datasets, further enhancing our reservoir geo-model accuracy.

# Deposition in a tide-influenced seaway and porosity distribution: The Jurassic Garn Formation in Dvalin/Dvalin North (Haltenbanken/Dønna Terrace, offshore Norway)

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Garn Formation sandstone was deposited during the Middle Jurassic on Halten and Dønna Terraces in the Norwegian Sea. Shallow marine and deltaic sandstone dominate the early syn-rift deposits, which are stratigraphically older in the North than in the South. Aalenian Lower Garn sandstone is overlain by Bajocian Upper Garn sandstone in the study area at the transition from Dønna to Halten Terraces and buried to >4000 m.

Based on core material, wireline logs and image logs of 10 wells the depositional environment in the transition area was reconstructed. The Lower Garn Formation is interpreted as southwards prograding delta with paleosols at the top. Transgression of the delta resulted in deposition of marine or lagoonal mudstones, tidal bars and channels, depending on the relative position to the former bayline. The Upper Garn Formation shows a different depositional environment and progradation direction compared to the underlying deposits. Eastward advancing fan deltas are interpreted based on grain size distribution and paleocurrent directions in the Dvalin area. Towards the basin axis and laterally to the sediment entry points, the pebbly sands were reworked into sand sheets (dune fields) and tidal ridges along the NNE-SSW trending basin axis. Eastwards of the study area, along the eastern margin of the rift basin, a shoreface belt developed. The lateral changes in sediment transport directions and facies are typical for deposition in a tide-influenced seaway. The change in depositional systems between the Lower and Upper Garn Formations is attributed to rift-related structural reorganization.

Reservoir quality of the deeply buried sandstone in Dvalin / Dvalin North depends on preservation of primary porosity by pore-lining illite and corrensite and complete dissolution of unstable grains. Secondary porosity increases upwards in the Lower and Upper Garn Formations, suggesting an underlying link between sediment source area and porosity in the Garn reservoirs.

# Study on the Differences in Pore Space Types of Mixed Sedimentary Rocks under Continental Saline Lake Environment and the Influence of Diagenesis on Reservoir Development: A Case Study of the Permian Lucaogou Formation in Jimusar Sag.

Dr Guan Li[1], Dr Xiaoyang Gao[1], Dr Changcheng Han[2]
[1]Yangtze University, [2]Xinjiang University

The Junggar Basin is widely distributed with mixed sedimentary reservoirs. These reservoirs are characterized by complex lithology, ultra-low permeability, and highly uneven pore structures, significantly affecting the efficiency of oil field development. Based on core observations combined with logging and well-logging data, the study area is divided into semi-deep lake - deep lake, mixed shallow lake, and detrital shallow lake subfacies, further subdivided into cloud platform, mixed beach bar, mixed shallow lake mud, and shallow lake sandbar -four types of microfacies. The four types of sedimentary microfacies correspond to four types of lithofacies combinations. Based on the lithofacies combinations, employing multifractal theory, combined with XRD diffraction, high-pressure mercury intrusion, and liquid nitrogen adsorption experiments for core sample analysis, producing multifractal spectra, it was found that the porosity development of the Lu-1 cloud platform and mixed beach bar is higher, and the porosity of the Lu-2 shallow lake sandbar is higher. The study of core samples' cast thin sections and scanning electron microscope data revealed the heterogeneity of microscopic pore structures of different microfacies controlled by the distribution of different lithologic combinations and varying degrees of diagenetic alteration. Strong compaction is the main factor causing the decline in the quality of the shallow lake sandbar reservoirs. Carbonate cementation promotes the densification of reservoirs. Irregular flaky clay minerals cause an exponential decrease in permeability, and dissolution is the main diagenetic action improving reservoir quality. Due to the overlying dolomite layer's resistance to compaction, the cloud platform-like reservoirs have a large number of dissolution pores, enhancing the reservoir quality, making it the best. Additionally, the cloud platform-like reservoirs are far from the sand-mudstone interface, with lower carbonate cement content. This is of great importance for assessing reservoir quality and the potential of oil and gas fields.

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# In situ stress field and reservoir quality evaluation of Jurassic Ahe Formation in Kuqa depression

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The reservoir quality of Jurassic Ahe Formation in the Kuqa depression is strongly affected by in situ stress field, resulting in complex pore structures and macro-microfractures. The pore structure and fracture effectiveness in reservoir are controlled by the in situ stress field, which is important factor affecting the reservoir quality and fluid flow in tight sandstones. Through well log calculations, the in-situ stress orientation and magnitudes in the Jurassic Ahe Formation were analyzed, and the impact of stress fields on reservoir quality (matrix properties and fracture effectiveness) was discussed. The results reveal that matrix properties are negatively correlated with horizontal stress difference (SHmax-Shmin). With the increasing stress difference, the microscopic pore structure will be complex, and macroscopic reservoir quality will be poor. Under the same in-situ stress conditions, finer grain size or poor sorting results in weaker compressive strength and dense physical properties. Fracture effectiveness is not only related to in-situ stress magnitude but also to in-situ stress orientation. Low stress difference is mainly related to fault zones, Fractures with strike parallel to SHmax tend to have large aperture. The differential distribution of in-situ stress fields in different tectonic locations determines differences in reservoir quality and productivity in the foreland basin. At the core of the fold, there are local weak stress areas where fluid movement is frequent, intragranular dissolution pores and macro-microfractures are developed, pores can be effectively preserved with good connectivity, and productivity is high. At the wing of the fold or the footwall fault, there are strong stress areas where fluid movement is weak, reservoir is tight, pores and fractures are underdeveloped, and productivity is low. Revealing the effect of in-situ stress fields on reservoirs is of great significance for oil and gas exploration and development Jurassic Ahe Formation in Kuqa depression, and in similar basins worldwide.

# The controlling factors of reservoir space of fault-karst systems in the deep Ordovician carbonate reservoirs in the Tahe Oilfield Tarim Basin, China

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Fault-karst systems in the deep and ultra-deep carbonate reservoirs have a huge potential for hydrocarbon exploration. However the characteristics of reservoir space and the main controlling factors of fault-karst reservoirs are unclear due to strong heterogeneity. Therefore, the exploration and development of deep and ultra-deep carbonate reservoirs are restricted. To fill the gap, core, thin section and well log (conventional logs and image logs) data are used to analyze the lithology and main reservoir space in the deep Ordovician reservoirs in the Tahe Oilfield, Tarim Basin, China. The lithologies are dominated by intraclastic limestone, dolomitic limestone and silt to fine-sized crystalline dolostone. The reservoir space mainly includes dissolution vug, fracture, fracture-vug and cave. Among them, caves and their surrounding fractures are the main storage spaces for hydrocarbons. The direction of maximum horizontal in-situ stress is NE-SW determined by induced fractures picked up by image logs. The NE orientation faults and fractures are increased and the effect of karst fluid on reservoirs is enhanced. However, the NW direction faults and fractures are restricted. The fluid alteration has two influences on the reservoir quality. On the one hand, the fluid alteration can dissolve the carbonate rocks and expand the reservoir scale; on the other hand, the fluid will carry mud and sand, which will reduce the reservoir space scale. The distance from the fault will affect the types of reservoir space of the fault-karst system. Away from the fault, the reservoir space will change from caves and fractures to facture-vug, and finally into small-scale dissolution vugs. This study can help clarify the main controlling factors of reservoir space of the fault-karst system.

# The delta-fluvial evolution of a lacustrine basin with gentle slope and low sedimentation rate: A case study of the Fudong Slope, Junggar Basin, Northwest China

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Gentle slope belts of lacustrine basins are important areas for the generation of stratigraphic petroleum reservoirs controlled by sedimentary systems. Based on coring, well logging, 3D seismic and analytical test data, the sedimentary system and sandbody distribution characteristics of the Jurassic Toutunhe Formation ($J_2t$) in the Fudong slope of the Junggar Basin were analysed. The results show that from the early to the late $J_2t$ stages, the sedimentary system evolved from a delta to a meandering river, resulting in a delta front facies in the 1st member ($J_2t_1$) and a meandering river facies in the 2nd ($J_2t_2$) and 3rd ($J_2t_3$) members of the Toutunhe Formation. A sedimentary evolution pattern for the gentle slope with low sediment input was established. Thick deltaic sandbodies developed locally in the $J_2t_1$ stage. However, meandering rivers with high sinuosities predominantly developed and resulted in a striped geometry in the $J_2t_2$ and $J_2t_3$ members. Moreover, the meandering sandbodies exhibited an anastomosing morphology after multistage superposition. The channel and point bar facies in $J_2t_2$ were more developed than those in $J_2t_3$ because of sediment input differences. Under low-sediment input conditions, the sedimentary environment of the gentle slope belt in the lacustrine basin was controlled by changes in the palaeoclimate, palaeogeomorphology, gradient (slope) and base level. Palaeoclimate was the main factor controlling the evolution of the sedimentary environment. Palaeogeomorphology and slope controlled the distribution of sedimentary microfacies, channel sinuosity and sandbodies. Base-level change restricted the sandbody superimposition style. Under the low sediment input conditions, the subaqueous distributary channels of the delta environment and the point bars of the meandering river environment in the transitional belt of the Fudong slope are the main potential targets for stratigraphic petroleum reservoirs, whilst the 2nd member of the Toutunhe Formation ($J_2t_2$) is the main favourable interval for stratigraphic reservoir exploration.

# Sedimentary, diagenetic and their control on calcarenaceous sandstones reservoirs development of Xujiahe Formation 3 Member in Yuanba area， Northeast Sichuan

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High production commercial gas flow was found from Upper Triassic Xujiahe Formation 3 Member in Yuanba area, Northeast Sichuan. It shows better exploration and development potential. The control factors of reservoir development in the third Member of Xujiahe formation are not clearly understood, which restricts the exploration and development. Sedimentary facies, reservoir characteristics, diagenesis and their control on reservoirs development are researched, uitilizing core observation, thin section identification and physical property analysis. The research results indicate that Xu 3 Member is relatively instable in thickness with the characteristics of 'northwest think and southeast thin', and belongs to progradational braided river delta deposits. Reservoir rocks, which mainly belong to calcarenaceous sandstones with the characteristics of dissolved pores, microscopic dissolved pores, have the characteristics of super-low porosity and super-low permeability with strong heterogeneity. Reservoir diagenesis mainly includes compaction, cementation, dissolution, recrystallization and fracture. For pore development, constructive diagenesis includes mainly burial dissolution and fracture, and compaction and calcite cementation belong to the most important destructive diagenesis. Comprehensive studies show that calcarenaceous sandstones deposited in the braided river delta plain-front (i.e., the transitional position of delta plain and delta front) are the most favorable sedimentary microfacies. For reservoir development, the burial dissolution diagenesis could be controlled by the relatively coal-rich sedimentary environment of braided river delta plain-front.
In conclusion, the sedimentary microfacies of underwater distributary channel and plain distributary channel in braided river delta front and plain is the foundation of pore development of calcareous sandstone in Xu 3 Member. Diagenesis such as burial dissolution and fracture is conducive to the formation and improvement of reservoir pores. Therefore, the relatively developed areas of thin coal seam or coal seam interlayer in distributary channel and the relatively developed area of faults and fractures may be favorable for reservoir development district.

# Electrofacies modes and novel method for lithofacies identification of microbial carbonate: a case study of the Sinian Dengying Formation in Moxi-Gaoshiti, Sichuan Basin, China

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The giant carbonate gas reserve deposited in the Sinian Dengying Formation was discovered in Chuanzhong paleo-uplift of Sichuan Basin in 2011. As for pilot area of Moxi-Gaoshiti region, the gas-bearing intervals of the Dengying Formation characterized by dissolved pores and vugs, where facies of algal mounds and grain shoals determined development of good reservoirs. However, genetic variations and complex petrophysical responses of carbonates lead to the issue of lithofacies identification, which affect facies analysis and reservoir evaluation. Therefore, based on cores from over 100 meters in three wells, combing with petrologic observations and well logging data, the integrated electrofacies modes and a novel method of lithofacies identification for microbial carbonates were introduced. There are over 8 lithofacies within intervals, and four dominant dolomite lithofacies representing major depositional settings were classified, including algae dolomite, grainstone, mudstone and argillaceous mudstone. The calibration between cores and well logs showed algae dolomite was characterized by low gamma ray (GR), long ultrasonic transit time (AC), and medium reading in deep measurements of borehole resistivity (RD).These electrofacies were unfavorably applied to identify lithofacies, since sensitively logging responses failed to display within 2-D or 3-D cross-plots and similar responses among lithofacies could not be well divided. Therefore, an alternative method called color modes were designed. Firstly, the most sensitive parameters (GR, AC and RD) were normalized for individual lithofacies. Secondly, the normalized data were segmented by four ranges with corresponding colors of blue, yellow, red and green, which means data array were converted into visible color associations. Finally, after calibration with detailed core descriptions, a total of 53 meaningful color associations representing lithofacies and color modes of four dominant dolomites were acquired. The novel electrofacies modes were successfully applied to determine lithofacies with coincidence rate of above 80% among core wells.

# High-resolution sequence stratigraphy and filling evolution model of Lower Cambrian fine-grained sedimentary rocks in southwestern Sichuan

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The Lower Cambrian shale in the Upper Yangtze region shows a good prospect of shale gas exploration, which is an important field for the exploration and research of marine shale gas in China. The sequence division and comparison of the Lower Cambrian in southwestern Sichuan can effectively predict the organic-rich development intervals and guide unconventional oil and gas exploration. This paper takes the fine-grained sedmentary rocks of the Maidiping-Qiongzhusi Formations in southwestern Sichuan as the research object, conducts the elaborate description of core and high-precision analysis of thin sections, and divides the Maidiping-Qiongzhusi Formations to 11 lithofacies types. On this basis, five types of sedimentary facies are identified: mixed tidal flat facies, muddy deep-water shelf facies, sandy argillaceous deep-water shelf facies, muddy shallow-water shelf facies and sandy muddy shallow-water shelf facies. According to lithofacies superposition style and the quantitative statistics of sedimentary structure, 35 parasequences and 14 parasequence sets are divided in Maidiping Formation-Qiongzhusi Formation, four types of parasequence styles are summarized, such as “phosphorite grainstone + phosphorite-calcareous sandstone + calcareous-phosphorite argillaceous siltstone parasequence” dominated by tidal flow control, “calcareous cemented siltstone + massive siltstone / deformed bedding argillaceous siltstone + dark laminated silty mudstone parasequence” by the synergy of gravity flow and bottom flow, “lenticular graded argillaceous siltstone / wavy laminated argillaceous siltstone / deformed bedding argillaceous siltstone + dark laminated silty mudstone parasequence” led by storm wave action and co-influenced by bottom flow, “calcareous cemented siltstone + rich laminated argillaceous siltstone + poor laminated silty mudstone parasequence” influenced by wave and gravity flow, 6 system tracts are identified, and three complete third-order sequence units are divided; Combined with characteristics of sedimentary facies and sequence, the evolution process of 'mixed shelf-deep shelf-shallow shelf' of Maidiping -Qiongzhusi Formations was established.

# Depositional process of the depression lacustrine hyperpycnal system and its control on reservoir quality: the second member of the Lower Jurassic Sangonghe Formation, Qiudong subsag, Turpan-Hami Basin, Northwest China

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The study of hyperpycnal flow has gradually become one of the hot spots in the current research. However, the study of hyperpycnal flow deposits in the depression lacustrine basin is still insufficient. In this study, the depositional process and reservoir quality control factors of the second member of Sangonghe Formation in Taibei subsag are analyzed. The results show that 10 types of lithofacies are formed during the depositional process, which can be summarized as Gravel bed load and suspended load lithofacies association(GBS), Gravel reverse-to-normally graded lithofacies association(GNR) of bedload lithofacies and Coarse-grained sandy suspended load lithofacies association(CSS), Fine-grained sandy suspended load lithofacies association(FSS) of suspended sandy facies. From the edge of the sag to the center of the sag, the flood erosion gradually weakened, and the erosional channel gradually evolved into the lobe. Meanwhile, the gravel bed load lithofacies gradually decreased, and the sandy suspended load lithofacies gradually increased. The paleogeomorphology further controls the development of the hyperpycnal system. The restricted geomorphology is more conducive to developing erosional channels, while the open geomorphology is more conducive to forming lobes. The lithofacies association of the erosional channel is dominated by GBS and GNR, and type I and II reservoirs are developed, which have the best quality and the latest densification time. In the transitional channel, GNR is the main lithofacies association, and type II and III reservoirs are developed, which have good reservoir quality and late densification time.CSS dominates the lithofacies association of the lobes, and type III reservoirs are developed. The quality of the reservoirs is general, and the densification time is earlier. FSS is the main lithofacies association of lobe fringe and over-bank deposits, which develop type IV reservoirs. Type IV reservoirs have the worst quality and the earliest densification time.

# Mechanisms of formation and preservation of pore space in dense sandstone reservoirs of the stratigraphic Benxi Formation of the Carboniferous in the eastern Ordos Basin

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In recent years, the tight sandstone of the Benxi Formation in the eastern Ordos Basin has become an important target for natural gas exploration. However, the diagenetic characteristics, pore formation, and preservation mechanisms of this tight quartz sandstone reservoir are not yet clear. In this study, various analytical and testing methods such as CTS, SEM,HPMI, Fluid Inclusion, and Vitrinite reflectance were employed to systematically analyze the petrological, reservoir space, rock properties, and diagenetic characteristics of the tight sandstone reservoir of the Benxi Formation in the eastern Ordos Basin. The results showed that the Benxi Formation mainly consists of quartz sandstone and lithic quartz sandstone, with high structural maturity and composition maturity characteristics. The reservoir space is mainly comprised of residual intergranular pores and intergranular dissolution pores, with an average porosity of 6.2%. The sandstones of the Benxi Formation have undergone compaction, cementation, alteration, and dissolution diagenetic processes, among which compaction is the main reason for the overall tightness of the Benxi Formation. The study area has experienced two periods of dissolution, with the most developed acid dissolution being associated with lithic fragments and carbonate cement. The study demonstrated that under strong hydraulic conditions the high quartz content, coarse grain size, good sorting, and low matrix content of the tidal channel sandstones of the Benxi Formation, are the main reasons for the preservation of primary porosity. The secondary porosity formation in the quartz sandstone enriched in lithic fragments and feldspar is controlled by the dissolution of organic acids during two stages and the late-stage alkaline dissolution. The mid-stage diagenesis B transformed the Benxi Formation sandstones into a closed diagenetic system of mud and carbonate cement, and rapid burial played a key role in preserving the porosity of the Benxi Formation tight sandstone reservoir.

# Spatial Configuration Relationship and Accumulation Mode of Tight Sandstone and Bioclastic Limestone Reservoirs in the eastern Ordos Basin, Permian Taiyuan Formation

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In recent years, the complex lithologic reservoirs of the Permian Taiyuan Formation in the eastern Ordos Basin have become important targets for natural gas exploration. However, the spatial configuration relationship and accumulation mode of tight sandstone and bioclastic limestone reservoirs are not well understood. In this study, field geological surveys, restoration of ancient landforms, and other analytical techniques were used to systematically analyze the petrology, reservoir space, and rock properties of the two reservoirs in the eastern Ordos Basin. The spatial configuration relationship of the two difference reservoirs was determined, and based on this, the accumulation mode of the Taiyuan Formation was elucidated. The results show that: ①On the plane, the southern part of the study area in the Tai 2 sandstone group is a shoreface tidal flat depositional system, mainly composed of bioclastic limestone and a small amount of tight sandstone reservoirs, while the northern part is a delta front deposition, mainly consisting of tight sandstone reservoirs. On the profile, the coastline gradually moved northwards from bottom to top, and the range of limestone gradually expanded.②In the Tai 2 sandstone group, both the tight sandstone reservoirs and the bioclastic limestone reservoirs exist simultaneously, representing two different types of sedimentary facies: tidal channels and biotic mounds. Both of them are controlled by paleogeomorphology, with bioclastic limestone located at higher positions and tight sandstone reservoirs at lower positions.③The natural gas in the Taiyuan Formation gas reservoirs in the study area mainly comes from the top coal layer of the Benxi Formation and some coal layers within the Taiyuan Formation itself. The source rock has a thick thickness and high thermal evolution degree. The gas reservoirs have good hydrocarbon generation conditions and sealing conditions, exhibiting two favorable configurations: "bottom generation, upper storage, upper sealing," and "adjacent generation, lateral storage, upper sealing. "

# Development characteristics and main controlling factors of laminated shale in the Cambrian Qiongzhusi Formation, southern Sichuan Basin

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The Lower Cambrian Qiongzhusi Formation's black shale in the Sichuan Basin, South China, has drawn significant academic focus due to its deep-burial, intricate lithology, marked heterogeneity, and substantial sedimentary environmental impact. Uniquely, its laminated shale is exceptionally developed compared to other formations. Yet, the ramifications of these laminations on shale gas enrichment and their fundamental driving factors are not fully understood. This paper investigates the developmental characteristics, reservoir heterogeneity, and key controlling factors of the laminated shale through core observation, X-ray diffraction, logging, and geochemical analysis. Our research identifies two primary types of laminated shale in the Qiongzhusi Formation: Type I and Type II. Type I, located in the lower Member, features horizontal laminae with high carbonate content and thin, densely packed calcareous and mud laminae, exhibiting high TOC. Type II, in the middle to upper Member, consists of thin, high-density horizontal and interlaced quartz-rich sandy and mud laminae, with relatively lower TOC. Ultimately, We discovered that Type I is related to seasonal aquatic changes from ancient climates, while Type II's development correlates with relative sea-level changes during the late sedimentary phase of the Mianyang-Changning extensional trough. Additionally, integrating the Lower Cambrian sedimentary setting of the Sichuan Basin, we formulated two distinct marine shale sedimentary models for the Qiongzhusi Formation in the southern region, influenced by climatic and sedimentary factors.

# DDE-Outcrop3D：digital construction of global classic geological outcrops

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The investigation and observation of geological outcrops is a key aspect of geology majors in teaching and research. When investigating geological outcrops in the field, it is usually limited by natural factors such as time, weather, season, and vegetation cover, and the traditional methods are difficult to comply with the development trend of data-based research. In order to break through these limitations, we conducted diverse digital collection and modelling of more than 120 classical geological outcrops in 12 countries, including China, United Arab Emirates, Italy, France, Germany, Spain and Namibia, etc. High-precision oblique photographic acquisition by drone is the main form of acquisition, along with Insta360 panoramic camera photography, DSLR camera photography, and recording videos of geologists' presentations. There are 96 geological outcrops in China, which are mainly the routes for the geological field trips of the 21st International Congress of Sedimentology. The 24 geological outcrops in Europe and 3 geological outcrops in Africa include UNESCO World Geoparks, the first 100 geological sites of the International Union of Geological Sciences (IUGS), and the routes of the International Association of Sedimentologists (IAS) conferences. All these geological outcrops are now uploaded on the DDE-Outcrop3D platform. The DDE-Outcrop3D achieves the visualization of high-precision 3D models of geological outcrops, combining outcrop-related information such as text, pictures, videos, panoramas, documents, observatories, geological maps, etc. with 3D outcrop models, and realizing the uploading and panoramic roaming of outcrop 3D models as well as the self-supply, sharing and visualization of outcrop-related information. The platform realizes the construction and sharing of geological outcrop resources in a digital environment, allowing scientists, scholars and earth science enthusiasts around the world to enjoy world-famous geological outcrops and geological relics without having to leave home, which will be applied to scientific research, science popularization and teaching of geology in the future.

# Characterization and Genesis of 'Sweet Spot' Reservoirs in the Huagang Formation, Xihu Depression, East China Sea Basin

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The upper Huagang Formation in the north-central segment of the Xihu Depression, East China Sea Basin, is notable for its extensive, superimposed thick braided river sandstone deposits, presenting significant potential for natural gas exploitation. However, the physical properties of these sandstone reservoirs display marked heterogeneity, ranging from low permeability to tight formations, and the genesis of "sweet spots" within them remains enigmatic. This study delves into the types and formation mechanisms of "sweet spots" in the Huagang Formation, employing methods such as core analysis, thin section evaluation, and SEM-EDS and SEM-CL analysis. The investigation reveals two predominant "sweet spot" reservoir types in the Huagang Formation: chlorite-coated and quartz-cemented. Chlorite-coated "sweet spots" are found in both low- and high-energy braided channels, exhibiting enhanced reservoir quality in coarser-grained sandstones. The presence of a high clay coat is instrumental in impeding quartz cementation, thus preserving primary porosity and facilitating porosity enhancement through late-stage dissolution processes. On the other hand, quartz-cemented "sweet spots" predominantly occur in medium to coarse-grained sandstones within high-energy braided channels. The insufficient clay coat coverage in these areas leads to pronounced quartz overgrowth, diminishing porosity. Nevertheless, the interplay of relatively clean, coarse-grained sandstone and early quartz overgrowth maintains a degree of permeability, qualifying these as secondary "sweet spots." As burial depth increases, the quartz-cemented "sweet spots" may experience further densification due to ongoing quartz cementation, whereas the chlorite-coated variants demonstrate a higher potential for sustained reservoir quality. These insights offer a theoretical basis for identifying favorable exploration zones and optimizing well productivity strategies in the region.

# An integrated micro-CT and thin-section method for quantitative 3D analysis of unconsolidated sediments

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High-resolution imaging of unconsolidated sediment at the grain level is increasingly required for the accurate reconstruction of past climate and environment. The primary tool to investigate the arrangement of particles and matrix of unconsolidated sediments from different depositional environments is thin-section micromorphology. It allows the detailed characterisation of sedimentary facies on a microscopic scale (i.e. microstratigraphy), providing depositional and post-depositional process information. However, thin-section preparation poses a potential risk to the integrity of the sediment (micro)fabric, and thin-section analysis is spatially limited to 2D representation of 3D samples, which can lead to incorrect classification of sedimentary features and structures. A promising technique to overcome the limitations of thin-section micromorphology is X-ray computed microtomography (µCT), as it allows visualisation of internal 3D sediment composition, texture and fabric at high resolution. We created an integrated method of µCT and thin-section analysis by developing a 3D-printed subsampler that can effectively (1) extract areas of interest from soft sediment cores, (2) stabilise the unconsolidated "wet" sediment during µCT scanning and (3) allow dehydration and impregnation to be carried out while the sample is in the subsampler, which ensures an undisturbed sample for thin-section preparation. Here we apply our new methodological approach on sediment cores from Alaskan and Chilean lakes. Subsamples (8.0x1.5x1.5 cm) of different depositional environments (turbidites and glacial varves) were extracted from the sediment cores, scanned with µCT at a resolution of 5 and 20 µm at the Centre for X-ray Tomography of Ghent University (www.ugct.ugent.be) and thin sections were prepared. The µCT scanning of subsamples enabled the systematic and quantitative 3D analysis of sedimentary microfacies and proved to be a valuable integration tool for the conventional (qualitative) descriptions of thin sections, improving the paleoenvironmental reconstructions in the study areas.

# Fibrous calcite veins ： Insight to early primary hydrocarbon generation and expulsion from organic-rich shales

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The formation of veins in hydrocarbon-bearing formations is closely related to the early primary hydrocarbon generation and expulsion. Fibrous calcite veins are often associated with organic laminae of organic-rich shales in continental saline lacustrine. Fibrous calcite veins are horizontally distributed and interstratified parallel to organic or clay laminae. The shape is lenticular and the thickness ranges from tens of micrometers to several millimeters. Within veins, calcite crystals with high degree of crystallization are distributed vertically to the edge of the vein edges, in a flat and uniform fibrous shape. Individual crystal widths are similar, exhibiting the same extinction position, indicating contemporaneous crystallization. A dark intermediate surface is commonly seen inside veins, dividing veins into upper and lower parts. The peak values of G and D of Raman spectra of the dark material indicate that this material is asphalt-soaked calcite. Frequent lake level changes during the sedimentary period resulted in abundant horizontal laminations in organic-rich shales. The early horizontal laminations opened by overpressure from early hydrocarbon generation. Hydrocarbon fluids migrate along the horizontal fractures, while acidic fluids dissolve surrounding rock, calcium and bicarbonate ions oversaturated, then $CaCO_3$ precipitated in the horizontal fracture. Dark material is the residual heavy component formed by early hydrocarbon fluid migration and fractionation during calcite columnar growth. Preferential intrusion of hydrocarbon fluids causes defects in the calcite lattice that tend to trap early hydrocarbon fluids, making large number of HI can be found in veins. Studies show that fibrous calcite veins only appear in layer with high TOC over 3000m (Jiyang Depression), and not produced in shallow layer, indicating the formation is related to the maturation of organic matter. The oil and gas exploration practice also indicates that shale layer developed in the fibrous calcite veins often has good oil and gas shows and high production.

# Study on single sand body architecture model of gravity flow channel of Ban 1 oil group in Banqiao Oilfield

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The Ban 1 oil group is the main oil-bearing interval of the second member of the Shahejie Formation in Banqiao Oilfield, Bohai Bay Basin. This layer is a lacustrine gravity flow deposition, and is mainly composed of channel deposition. Based on the in-depth anatomy of the gravity flow channel in the Ban 1 oil group in this area, the characteristics of the sedimentary architecture of the gravity flow channel under different influencing factors such as channel stage, scale and swing stability are analyzed, and different channel architecture patterns are summarized for the follow-up. We select key blocks with dense wells network and high development level, combine coring data with dynamic information such as tracers, the channel architecture boundary is determined. The research results show that there are two complex channels in the study area, and there are multiple single water channels in each complex. The water channel complex is mainly developed in the north area of Banqiao, and the water channel gradually bifurcates into the lobe in the middle area of Banqiao. The average thickness of a single channel is 7.2 m, the plane width of the channel is 664 m, and the width–thickness ratio is between 120:1 and 172:1. Statistical analysis of the size of a single sand body shows that the width and thickness of a single sand body in this area are positively correlated ($w = 182.79 \times h_{max} - 237.7$). On the basis of studying the single sand body configuration and geometric characteristics of the gravity flow channel, the three-dimensional configuration of the gravity flow channel in this area is summarized according to the channel stage, channel size and swing stability. The model provides a geological basis for the subsequent determination of the remaining oil distribution and well location deployment.

# Carbonate seismic geomorphology: A case study of the Cambrian Longwangmiao Formation in the Gaoshiti-Moxi area, Sichuan Basin, China

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This study applied seismic geomorphology to analyze and reconstruct the paleogeomorphology of the sedimentation of the Cambrian Longwangmiao Formation in the central Sichuan area. By fully considering factors such as the stratigraphic sedimentary filling characteristics, the tectonic setting, and the sedimentation rate, the 3D seismic, logging data, as well as core and thin section analyses were used to compare the reconstruction principles of the cast and isopach methods. It is believed that the thickness of the Cang-2 member reflects the paleogeomorphology during the sedimentation of the Longwangmiao Formation. Forward seismic modeling was used to select the seismic physical attributes sensitive to the Cang-2 member, which were then used to reconstruct the paleogeomorphology. The results show that the stronger the amplitude of the bottom trough of the Longwangmiao Formation, the higher the landform during the sedimentation period. Therefore, the Caledonian paleo-uplift had already taken shape before the sedimentation of the Longwangmiao Formation, with a high in the NW and a low in the SE, and the NE-SW-trending geomorphic lowland in the central part divided the study area into a NW high zone and a SE sub-high zone. The geomorphologic distribution controlled the development of the shoals and reservoirs. The geomorphic highlands not only contained shoals with large areas and thicknesses but were also susceptible to superimposed syngenetic and quasi-syngenetic exposures, which provided preferential flow channels for karst fluid in the later period. The Longwangmiao Formation in the NW high area was uplifted and exposed during Caledonian period, and it became the preferred area for the development of supergene karst and bedding karst. Due to the differences in the potential energy of the topography, the quality of the reservoirs in the NW slope zone is the best, followed by that in the NW high zone and the SE sub-high zone.

# Applying seismic sedimentology for carbonate platform evolution and facies analysis : An example from Tarim Basin, China

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Three-dimensional seismic data offers opportunity to study the growth pattern, paleoecology and reservoir heterogeneities of ancient carbonate platform systems. As the low-quality seismic data caused by large burial depth of Cambrian carbonate rocks, it is still difficult to obtain information of platform evolution and facies in Tarim Basin. In this study, seismic sedimentology was used to improve facies interpretation in ultradeep (over 7000 m), high-velocity (6000-7000 m/s) carbonate rocks using low-frequency (up to 20 Hz) seismic data.

The study area named Xiaotangnan locates in middle of east Cambrian platform margin. The stacked, migrated seismic data is characterized by a frequency range of 10~60Hz with a dominant frequency of 20Hz. Phase rotation, frequency decomposition, stratal slicing and RGB color blending are used to interpret platform architecture and facies.

The growth of Cambrian platform can be divided into two stages, ramp and rimmed platform. Contour map of time-thickness (Txsd-Tg8) shows that there is no sudden change in deposit thickness. During this time, carbonate shoals are widely distributed and most are in irregular ellipse shape.

The transition from ramp to rimmed platform began at the end of Xiaoerbulake period. Slight rimmed architecture can be observed in seismic profile. At the end of early Cambrian (Wusonggeer Formation), sharp shelf break is distinct in seismic profile and isopach map. Lagoon locates behind the platform margin where lobate tidal deltas were common. Intraplatform is characterized by shoals. The middle Cambrian was the heyday of platform evolution, as a strongly prograding accretionary platform the edge migrated 3 km to the sea. Rimmed platform and arid climate lead to the deposition of evaporite in carbonate platform.

Seismic sedimentology provides an effective means for deep buried carbonate platform interpretation. Although drilling data is absent in this area, outcrops and modern sedimentary correlation analysis provide support for geological interpretation.

# Reservoir characteristics and effectiveness control factors of Carboniferous weathering crust volcanic rocks around well Pen-1 west depression, Junggar Basin

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In order to clarify the reservoir characteristics of weathering crust type volcanic rocks and the controlling factors of its effectiveness, the Carboniferous volcanic rocks around well Pen-1 west depression in Junggar Basin are taken as the research target, the internal vertical structural unit division scheme and geological characteristics of weathering crust are analyzed, and the controlling factors influencing the thickness of weathering crust development and later modification are discussed. The study shows that the weathering crusts of Carboniferous volcanic rocks in the work area are mainly andesite, volcanic breccia, tuff, basalt and andesite. According to the geochemical analysis, physical properties test and well logging data, the weathering crust can be further divided into three secondary reservoir units: clay layer, strongly weathered layer and weakly weathered layer, and most of the oil and gas-producing layers are distributed in the strongly weathered layer. The thickness of reservoir space developed in the weathering crust is dominated by primary intergranular pores, secondary dissolution pores and cracks, and the pore structure is of pore type. Weathering leaching time and ancient landscape control the thickness of weathering crust reservoirs, and the difference in lithology is an important modification control factor. Therefore, the weathering crust composed of dominant lithology and formed in the raised area has the largest reservoir thickness due to the long time of weathering and leaching, which is a favorable area for the development of this type of reservoir.

# Depositional characteristics of fault-controlled reservoirs of Ordovician ultra-deep carbonate in the Shunbei area of Tarim Basin, China

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The discovery of oil and gas in ultra-deep carbonate formations in Shunbei area of Tarim Basin reveals its large exploration potential. Fault-controlled reservoirs of Ordovician carbonates in the study area are controlled by deep strike-slip fault activity and developed along strike-slip fracture zones.Through core observation, thin section identification, conventional logging curve and imaging logging image analysis, elemental geochemical testing and 3D seismic interpretation, the depositional characteristics, diagenetic types, reservoir spatial characteristics and reservoir response of the fault-controlled reservoirs of the Ordovician Yingshan and Yijianfang formations were systematically studied.The mass fraction of Mn in the Ordovician Yingshan and Yijianfang Formations is greater than 0.0005, the average value of Sr/Ba is 2.019~3.1562, the average value of U/Th is 2.1, mostly greater than 0.75, and the average value of δU is 1.21, mostly greater than 1. This indicates that the area was deposited in a weakly oxidized-weakly reduced marine sedimentary environment with deep to shallow water depth, normal salinity and warm and humid.The Yingshan Formation and Yijainfang Formation of Ordovician in the study area is an open platform facies deposit, with two subfacies developed: platform flat and five microfacies, such as limestone flat, dolomite flat, sandy debris shoal, bioclastic shoal and granular beach.In the seismic data, root-mean-square amplitude attributes are extracted, and the distribution of favorable reservoirs in the Shunbei area is considered to be gradually transitioning from the south-west to the north-east direction.The reservoir properties and extent are controlled by the strike-slip fault, and the reservoir property is higher at the fault superposition site.Strike-slip faults allow fluids to enter the faults and dissolve carbonate minerals, forming fault-controlled reservoirs consisting of fractures, dissolution holes and caves.The results of the study provide a reference for the study of deep carbonate reservoirs in the Shunbei area.

# The Modern and Ancient Central-Mediterranean Gateway

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The Modern Central-Mediterranean Gateway (MCMG) is a geographic physical constriction that separates the Mediterranean into two adjacent sub-basins. This complex passageway is nowadays represented by the coalescent Strait of Sicily, Egadi Islands, and Messina Strait. These connections drive continuous water exchange and sediment transport between the western and eastern Mediterranean, representing an example of a modern multiple gateway.

In this presentation, we provide outcrop-based examples of the sedimentary record of the ancient counterpart of this gateway, i.e.: the Ancient Central-Mediterranean Gateway (ACMG), represented by four major paleo-straits that developed during the Pliocene-Quaternary period along localized grabens dissecting the southernmost edge of the Italian peninsula. We show and compare the geological features of each of these straits, along with their depositional architectures and facies. These elements record the development of current-dominated depositional processes, possibly stimulated/enhanced by a stronger penetration of the Atlantic Water Inflow from the Gibraltar Strait, reinforced by the onset of the northern hemisphere glaciation.

This study aims to provide diagnostic criteria from the sedimentary record that are crucial to unravelling modern processes and sediment transport dynamics in analogous systems in tidal straits.

# Effects of grain size bias in Heavy Minerals from fluvial Quaternary deposits of the Western Amazon

Effects Of Grain Size Bias In Heavy Minerals From Fluvial Quaternary Deposits Of The Western Amazon Rafaela Maciel Lopes De Paula;[1]
[1]Tbc

Heavy mineral analysis is commonly used as a provenance tool and typically involves the examination of very fine-grained (64µm to 125µm) and fine-grained (125µm to 250µm) sand grains. While widely used, this method introduces bias by excluding finer grains (smaller than 64µm). The main challenge is to determine the mineralogy of clasts on this scale using a conventional optical microscope. However, recent literature has explored the analysis of fine fractions in heavy mineral studies using Raman spectrometers. This allows for the identification of the mineral composition of heavy mineral extracts in silt granulometric fractions (5µm~64µm). Furthermore, traditional petrographic microscope counting has other limitations, such as the exclusion of opaque minerals (e.g. oxides and sulfides), which can be addressed to enable a more accurate and confident characterization of heavy mineral assemblages. Sedimentary fluvial deposits in the Içá Formation and nearby modern terraces were surveyed to determine their heavy mineral assemblage characteristics. Amazonian sedimentary deposits from both river terraces in submerged areas (Terra Firme) and floodplains (lowland) have garnered significant academic interest. This is because the time range covered by these deposits, dating back to the Pliocene, aligns with periods of significant diversification of Amazonian biodiversity. The study area is a crucial area of West Amazon fluvial deposits, located in the Solimões River valley between the mouths of the Içá River and the Purus River. Preliminary data indicates a significant difference in heavy mineral composition between fine (siltstone) and coarse (sandstone) deposits. This difference could be attributed to shifts in the source of sediment, or it could be the outcome of differential intra-stratal dissolution of heavy minerals within the strata. These results indicate characteristics that are particularly relevant for investigations of sedimentary successions in the western Amazon.

# Volcaniclastic facies model of a Miocene explosive eruptive period recorded in North Patagonian retroarc

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Advances in understanding volcaniclastic processes have occurred episodically through direct observations of historical volcanic eruptions, while the study of ancient successions has enhanced our knowledge of how volcaniclastic sediments organize in the geological record. Volcaniclastic stratigraphy has dealt with the signals resulting from eruptive dynamics and syn- to inter-eruptive Earth System responses. Explosive eruptions deliver different types of tephra, resulting in pyroclastic and resedimented to reworked volcaniclastic deposits. Through architectural, sedimentological, and petrographic analysis of a Miocene volcaniclastic record preserved in the North Patagonian retroarc, we performed a hierarchized time-rock scheme that reveals short- and mid-term (seconds to years) depositional processes.
Two tephra units composed of tuffaceous PDC, ash to lapilli fall out and resedimented volcaniclastic sandstones bounded by First order discontinuity surfaces were recognized as the product of different eruptive episodes (years to months). Each PDC, fall out and resedimented deposit is bounded by Second order discontinuity surfaces and was interpreted as individual eruption units resulting from different eruptive phases (hours to months). Third order discontinuity surfaces bound internal layers with textural and compositional variations interpreted as different eruptive pulses (minutes to seconds). Occasional levels limited by Fourth order discontinuity surfaces evidence for instance lower flow boundary zone variations (≤seconds).
The sequence assembles of hierarchized time-rock units reveal two tephra units related to Volcanic Explosivity Index 6-7 volcanic eruption episodes that occurred within the North Patagonian Andes. Phases of sustained volcanic columns are evidenced by ash to lapilli fall out deposits, while punctual column collapses produced PDCs with 100 to 150km run outs. Internal layers and levels reveal high-order changes in eruption dynamics. Resedimentation resulted from the rapid remobilization of juvenile lapilli, incorporated by fall out and gravity flow transformations. Discontinuities indicate a delay between eruption dynamic variations and Earth System responses in controlling volcaniclastic depositional processes.

# Rhythmites preserved into intertidal flat successions of the hypertidal Santa Cruz – Chico River estuary (Southern Patagonia, Argentina)

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Within tide-dominated estuaries, upper intertidal sediment successions frequently contain well-preserved tidal rhythmites, basically recording semi-diurnal to neap-spring-neap cycles, occasionally annual cycles in the uppermost part of the successions, and that provide valuable information on hydrosedimentary processes and sedimentation rates.
Tidal rhythmites are observed and cored into the hypertidal (12 m tidal range) Santa Cruz – Chico River ria-type estuary (Southern Patagonia, Argentina). The system is made of two estuarine arms (the Chico River arm; the Santa Cruz River arm), both converging into an intermediate and deep (subtidal) basin connected to the Atlantic ocean. Tidal dynamics are dominant along the Chico river arm, the fluvial discharge of which is low. In contrast, the water discharge of the Santa Cruz River is much higher so that the influence of tidal dynamics quickly drops down a few kilometers upstream. Extensive sandy to muddy tidal flats develop along the edges of the outer portion of the two arms. Upper intertidal sediment successions appear along secondary tidal channel cutbanks, revealing well-developped rhythmic layering, resembling tidal rhythmites. In order to better understand their origin, two 1 m-long cores were retrieved, one from the tide-dominated Chico River arm, and one from the tide-influenced Santa Cruz River arm. Core analyses comprised high resolution facies description, X-ray imaging, grain-size and geochemistry analyses, in addition to laminae thickness measurements. The results show that the Chico River sediment succession is made of a fairly regular stacking of typical semi-diurnal sand-mud couplets arranged to form neap-spring-neap tidal rhythmites. Semi-diurnal tidal couplets are visible on the Santa Cruz arm succession, but the fortnightly cyclicity is altered, due to the influence of fluvial dynamics and westerlies-induced wave agitation and aeolian sediment supply. 137Cs and 210Pbex measurements are in course to specify the chronological frame of the successions and to confirm very high sedimentation rates.

# Impact of the Zechstein Transgression on Upper Rotliegend Sandstones in the Permian of Northeast England

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Rising levels of carbon dioxide emissions have prompted researchers to explore various solutions to mitigate the problem, including carbon capture and sequestration. This project aims to analyse the impact of the Zechstein transgression on the Yellow Sands of County Durham, Northeast England. By doing so, we aim to understand better the relationship between sea level change, sequence stratigraphy, and diagenetic alterations in the formation. Additionally, we aim to determine if this area could serve as a viable $CO_2$ sequestration reservoir and compare it to the Rotliegendes-Zechstein boundary in the southern North Sea. A diverse range of sedimentological observations and diagenetic analyses were conducted to assess the transgression's impact on the Yellow Sands. These included detailed outcrop observations, facies descriptions, panel architecture correlations, thin-section petrography, and SEM, isotopic, and XRD analyses. The Yellow Sands of County Durham consist predominantly of a remarkable large-scale cross-bedded unit with foresets that can reach up to 10 meters in thickness each. These facies are identified by a surprising and almost complete absence of cementation.

Small-scale sedimentary features facies (e.g., soft-sediment deformation) and interdune facies have also been identified. Diagenetic alterations include clay coatings such as illite, K-feldspar dissolution, kaolinite and a thin calcite-cemented layer found immediately below the transgressive surface. The Marl Slate facies (marine transgressive muds equivalent to the extensive Kupferschiefer) overlay the Yellow Sands and represent the transgressive surface and the beginning of the first cycle of the Zechstein.

# Origin of Carbonate cements in Eocene turbidite sandstones, Dongying depression, Bohai Bay Basin: Evidence from petrology and geochemistry

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Diagenetic carbonate cements occur throughout Eocene turbidite lithic arkose in Niuzhuang Sag, Eastern China, displaying as sporadical siderite, dolomite, calcite 1 (C1), and massive ankerite (Ak) and calcite 2 (C2). Petrographic and geochemical investigations suggest that the non-ferroan C1 (δ13Ccar +3.1 to +4.7‰VPDB; δ18Ocar −12.5 to −10.5‰VPDB) was the earliest carbonate cement that was followed by Ak (δ13Ccar +0.2 to +5.1‰VPDB; δ18Ocar −12.8 to −10‰VPDB) and ferroan C2 (δ13Ccar +2 to +3.1‰VPDB; δ18Ocar −12.6‰ to −15.8‰ VPDB). The homogenization temperatures (Th, 74.3 to 105.8oC, 105.6 to 130.4oC, and 119.7 to 144.6oC, respectively) reflect the pattern of increasing temperature with progressive burial. The δ13Ccar values suggest that C1 and C2 were mainly derived from dissolution of carbonates in calcareous shales (δ13Ccar +3.5‰ to +6.3‰VPDB), with minor contributions from organic matter. The δ13Ccar values of Ak documented some contributions from magmatic carbon.
Ankerite and C2 were restricted under the top seal (geochemical barrier) of overpressure compartment and the of highly cemented zones occur mainly along faults. Carbonate cementation seems to negatively impact the reservoir quality when it exceeds 10%.

# Sedimentary archives of Late Carboniferan-Early Permian marine-continental transitional cycle in the southeastern Ordos Basin, China

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Abstract: The majority of the transgressive-regressive cycle indicate changes between the marine and continental in history geology, related to global sea-level fluctuations of which may be notoriously difficult to discriminate by sedimentological cycles and biostratigraphic, especially in case of limited outcrop exposures. Ordos Basin is a typical of marine-continental transitional facies during the Late Carboniferous to Early Permian as a secondary structural unit of the North China Craton (NCC), experiencing huge marine-continental changes and many transgression-regressive cycles occurred in the stratigraphic record. It was difficult to distinguish transgressive-regressive cycles and contrast the conversion process, sedimentary evolution, sedimentary environment and palaeogeography pattern accurately. Whenever possible, an accurate identification of the nature of these deposits should consider a multidisciplinary approach. In this paper, based on the 128 boreholes formation and palaeontology, sedimentary structure and lithology characteristics as the foundation, combined with well log response in the southeast of Ordos Basin， and sedimentary rock (shale) geochemical data, the selection of trace elements is more sensitive to reflect the sedimentary environment, the analysis of trace elements in strata in the study area and its ratio and the corresponding relationship between sedimentary medium environment changes. Twenty-five lithofacies associations and eleven sedimentary facies, four medium-term, nine short-term sequence boundaries, two medium-term and six short-term maximum flooding surfaces, two maximum transgression surfaces and three maximum regression surfaces accordance were identified.
Key words: Ordos Basin; Late Carboniferous to Early Permian; Marine-continental transitional; Transgression-regressive cycles

# Mineral-chemical stratigraphy and provenance analysis: refining intrusive vs in-situ interpretation

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Even with modern advancements in seismic imaging and interpretation differentiation of intrusive sandstones from sandstones remobilised in situ is not trivial. In situ remobilisation of depositional sandstone can produce similar geometry and seismic expressions to those associated with sand injection including irregular and discontinuous upper surfaces, jack-up of overlying strata, and discordant features associated with contact between sandstone and the host strata.

An example is the enigmatic sandstone penetrated by well N24/9-3 (the Gamma discovery, South Viking Graben). The sandstone is in the early Eocene Balder Formation (Early Eocene) and has many characteristics of sandstone intrusions but is substantially larger than is typical of sandstone intrusions.

Mineral-chemical stratigraphy is used to define the provenance signature of the Gamma sandstone and adjacent depositional sandstones to elucidate possible relationships between. Specifically, is the Gamma sandstone depositional, remobilised, or injected. Odin Member sandstone, which is in the Balder Formation, has a very similar provenance signature to the Gamma sandstone, whereas older depositional sandstones are dissimilar. On this basis, we conclude that the Gamma sandstone is primarily depositional and belongs to the Odin Member. It occupies its original stratigraphic position but has been extensively modified by intense in situ remobilisation, and locally thickened by laterally discontinuous sandstone intrusions.

# A new method of pore pressure prediction based on the grain stress and its application in Jimusar Depression, Junggar Basin.

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Pore pressure can be very complex and changeable. Unclear distribution of overpressure not only hinders the safety of drilling engineering but also restricts the hydrocarbon exploration. Therefore, pore pressure prediction technology needs to be improved to adapt to diverse regions and deep formations. Based on the principle of rock static equilibrium, grain stress is put forward and a new model of pore pressure prediction is established to predict overpressure distribution of the Permian in Jimusar Depression. The new method adopts the rock static equilibrium equation instead of the Terzaghi model. It is indisputable that overburden stress is shared by rock matrix and pore fluid, but pore pressure acts on an area of porosity and grain stress acts on the rest. This equation compensates for the limitation of effective stress not accounting for skeleton density, and serves as a balanced equation following stress decomposition based on porosity. In this study, it is found that grain stress is controlled by both depth and velocity. The difference between grain stress and effective stress is that after entering the overpressure, effective stress remains unchanged, while grain stress increases slightly. In other words, the traditional view is that the overpressure part is completely borne by pore fluid, but the new method thinks that it is shared by both grain and fluid. The pressure prediction results show that the overpressure distribution of Wutonggou Formation and Lucaogou Formation of Permian has strong regularity and inheritance. The pore pressure coefficient can reach up to 1.8, with overpressure predominantly observed in the central and western deep buried sag as well as the slope zone of the depression, gradually diminishing around the periphery. The direction of maximum decrease along the gradient corresponds to the migration path of hydrocarbon, which indicates the direction for future exploration.

# Sedimentary Geology, Lithofacies, depositional environments and regional Planktonic Foraminifera biostratigraphy of the Eocene Pir Koh and Drazinda Formations, Zindapir area, Eastern Sulaiman Range, Pakistan

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The Eocene succession is well exposed in the Zindapir area, eastern Sulaiman Range, Pakistan. The Eocene Drazinda and Pir Koh Formations were selected for detailed sedimentological study from the Belab Nala Section, Zinda Pir area. The thickness of the measured starta is 260m and 300m respectively. Pir Koh Limestone is mainly composed of limestone and marl. The Drazinda Formation is composed of shale/claystone and limestone, and rare sandstone. The rapid sedimentation and anoxic conditions promoted the preservation of organic matter in these facies. The paleontological analysis revealed the presence of large and smaller benthic foraminiferal species. Planktonic foraminifera species were also observed at the top of Pir Koh limestone. Microfacies analysis shows that Pir Koh limestone is composed of a rich assemblage of benthic and planktonic foraminifera with minor bioclasts. The microfacies analyses and paleoecology of Fauna suggest a ramp model for the deposition of Pir Koh Formation, and it was deposited under the well circulates, open marine conditions over middle ramp to upper slope settings. The shelly limestone beds found in the Drainda formation indicate the intermittent catastrophic events of the rise and decline of the sea level in shallow marine depositional conditions. The Pir Koh limestone is the end result of a second sea-level rise resulting in a shallow to deeper open marine shelf (TST to HST). The Drazinda Formation is deposited by more than one sea-level fluctuation, resulting in a semi-restricted shallow shelf to open marine shelf environment (TST and HST). The shallow shelf facies of Pirkoh limestone have vuggy porosity and have good reservoir potential.

# A Coniacian to Santonian carbonate successions of Ausoni and Lepini Mts. (Latium, Central Italy): the role of subsidence, hydrodynamic conditions and paleogeographic setting.

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The Latium-Abruzzi carbonate platform (Central Apennines, Italy) is characterized by a deposition occurred on an open shelf. During the Coniacian-Campanian stages, similar lithofacies occurred in different paleogeographic positions, nowadays exposed in the succession of the Lepini and Ausoni Mts. (Latium, Central Italy). In particular, the Lepini Mts. succession is composed by three different lithofacies associations, labelled as LF1, LF2 and LF3. The LF1 lithofacies is characterized by mudstone-wackestone and laminated bindstone mainly related to intertidal and shallow-subtidal depositional environment. Rudist biostrome and bioclastic rudstone-floatstone, characterize the LF2 lithofacies, testifying a deposition occurred in a low-moderate energy environments of the inner shelf. The LF3 lithofacies is instead associated to cross-bedded bioclastic grainstone derived from the rudist biostrome colonized shelf areas. The Ausoni Mts. coeval succession is also composed by three lithofacies associations, labelled as LFa, LFb and LFc. Mudstone-packstone and laminated binsdstone developed in an intertidal and shallow-subtidal environments characterize the LFa lithofacies, while bioclastic grainstone-packstone, related to more open conditions represent the LFb lithofacies, passing toward the top to LFc rudist floatstone-rudstone, representative of more restricted environmental conditions affected by mud input. In particular, facies analysis reveals more in detail the similarities between LF3 and LFb lithofacies. In the Ausoni Mts. succession, nevertheless the predominance of bioclastic grainstone-packstone in comparison with the Lepini Mts. succession, suggest that subsidence combined with hydrodynamic conditions have affected more such area, in comparison with the Lepini Mts., probably developed in a different and more restricted paleogeographic setting of the Latium-Abruzzi carbonate platform.

# Late Cenozoic paleosols as climatic proxies: the Sauce Grande River, Buenos Aires province, Argentina, as a study case

Late Cenozoic Paleosols As Climatic Proxies: The Sauce Grande River, Buenos Aires Province, Argentina, As A Study Case Lara Manoccio[1,2,3], Elisa Beilinson[1,2,3], Maria Sol Raigemborn[1,2,3]
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The Late Cenozoic of the Sauce Grande River basin (Pampas plain, Argentina) is represented by fluvial, eolian and alluvial units that, in part, are pedogenically modified. The aim of this work is to present the different recognized paleosols to characterize the main paleopedogenic processes and to infer preliminary paleoclimatic conditions.
Characterization of the paleosols was made based on macro- and micromorphological features recognized in a detail outcrop study. Ten paleosols samples were analyzed using geochemical analysis (ICP-MS) to calculate climofunctions, and X-ray diffraction used to identify the clay mineral composition. We used samples from Bt, Btk and Bw horizons to calculate PWI, CIA-K and clayness, and to estimate mean annual precipitation (MAP), and mean annual temperature, (MAT).
Four pedotypes were defined. Calcic Argillisols (P1) present argillic coatings, micritic nodules and incomplete sparitic infillings (Btk, Bk horizons). Smectite predominates over illite, CIA-K is 44, MAP(CIA-K) is 535±182 mm/yr and MAT(PWI) is 9° ±2.1°C. Calcisols (P2) are characterized by micritic groundmass, sparitic hypocoatings and micritic nodules (Bk horizons). Clay minerals are smectite and illite, CIA-K is 57, MAP(CIA-K) is 674.76±182 mm/yr and MAT(PWI) is 10.3°±2.1°C. Argillisols (P3) show argillic coatings (Bt horizons). Illite is the main clay mineral. CIA-K is 68, MAP(CIA-K) is 841±182 mm/yr and MAT(PWI) is 10.6°±2.1°C. Protosols (P4) present channels and Fe and Mn nodules (Bw horizons). Clay minerals are illite and smectite. CIA-K is 62, MAP(CIA-K) is 756±182 mm/yr and MAT(Clayness) is 11°±0.6°C.
Macro- and micromorphology, geochemical analyses, and X-ray diffraction, indicate that the main pedogenic processes were calcification in P1, illuviation and calcification in P2, illuviation in P3, and bioturbation and hidromorphism in P4. A cyclical alternation is interpretated between Calcic Argillisols and Calcisols that formed under seasonal semiarid temperate conditions, while Protosols and Argillisols develop under subhumid temperate conditions.

# Numerical Insights into Stress Patterns from Cenozoic Compression in NW Himalayas, Pakistan

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Cenozoic compressional events of NW Himalayas, Pakistan, are considered important events in the formation of major thrust faults, i.e., Panjal Thrust (PT), Nathia Gali Thrust (NGT), Main Boundary Thrust (MBT), and Salt Range Thrust (SRT). These thrust faults are considered major discontinuities along which total deformation and maximum principal stress (σ1) calculated. For numerical modelling of Cenozoic compressional events of NW Himalayas, Pakistan: a 2-D thin plate approach used with available data and assumed plane strain conditions. Finite element technique (FEM) was adopted using Ansys Workbench 19.2 TM in order to observe the simulation and rotation of stresses along these thrusts. Different parameters, i.e. density (2.5–2.8), Poisson's ratio (0.25), and Youngs (60 GPa–100 GPa), were used to observe possible results. Source of regional force is considered as the collision between the Indian and Eurasian Plates, which is directed from north to south. Pressure of 60 MPa exerted from north to south, and the remaining sides of the model were kept rigid. Results obtained from this numerical simulation show that the study area is divided into two different provinces along PT (Panjal Thrust): metamorphic/igneous (Higher/Lesser Himalayan Metamorphic Zone) and the sedimentary region (Lesser Himalayan Sedimentary Zone and Sub Himalaya). Maximum principle (σ1) stress is in the N-S direction, but it shows rotation along discontinuities due to changes in angle and material properties. Stress patterns in the NW Himalayas also agree well with the observed present-day stress configuration. σ1 rotates 40–45 degrees at some segments along major thrusts, and it becomes parallel to the fault plane at some points. Strike-slip movements observed along major thrusts indicate significant geological activity.

# The Eocene-Oligocene transition: sedimentary processes and environmental evolution in the Apulian Platform, southeastern Italy

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The Eocene-Oligocene transition (EOT) is a pivotal moment in Earth's history, signifying substantial alterations in oceanic and climatic conditions. Marked by the Oi-1 isotope shift, it represents a crucial shift from a greenhouse to an icehouse climate, that impacted shallow carbonate depositional systems. This shift led to widespread emersion of platforms due to a substantial drop in sea level attributed to Antarctic ice sheet growth.

In this study, focusing on the southeastern part of the Apulia carbonate platform (central Mediterranean) in the southeastern Italian Peninsula, we examine sedimentary dynamics during the EOT. The transition from Eocene slope carbonate deposits, comprising coral, foraminiferal, and red algal bindstone to wackestone, to the Oligocene carbonate ramp unit, dominated by Lepidocyclina and red algal packstone to floatstone, exhibits evidence of platform emersion. This evidence includes paleokarst features, meteoric carbonate cements, and calcite-alabaster at the boundary. Breccia deposits and fissure fill networks found at the top of the Eocene unit indicate dissolution, collapse, and subsequent refilling of carbonate layers due to meteoric water infiltration. The presence of both marine and meteoric cements attests to the complex diagenetic history of carbonate units, while the occurrence of calcite-alabaster signifies continental conditions during the EOT. Furthermore, evidence of Pleistocene karst activity has been identified in the same layer of the EOT. This second, more pervasive karst system is associated with conduits and caves filled with red soils, enclosing Eocene and Oligocene carbonate clasts, and a substantial quantity of vertebrate bones.

Through field descriptions, microfacies analyses, and geochemical assessments, this study distinguishes between the two karst events, focusing on the EOT. This approach provides insights into the complex interplay between climatic shifts, sea-level fluctuations, and sedimentary processes during the EOT. It sheds light on the environmental evolution of the Mediterranean and specific changes on the Apulia carbonate platform.

# Upper Oligocene reef coral-neritic carbonates of Southern Kirthar fold and thrust belt (Pakistan): a bridge between the Mediterranean Tethys and the Indo-Pacific region

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The Oligocene-Miocene boundary corresponds to major changes in flora, fauna, and global temperatures, with the shift from the relatively warm conditions of the Late Oligocene to the Mi-1 glaciation. Significant changes can be observed in the composition of neritic carbonates, and in the distribution of zooxanthellate reef corals. World-wide, within a sizable share of Oligocene neritic carbonate successions, reef corals are abundant and widespread. Based on the analysis of a limited number of successions, mainly located in Europe, Iran, Indo-Pacific and in the Caribbean, we preliminarily observe that after the Oligocene their importance as carbonate producers temporarily decreases, reaching a minimum around the Middle Miocene. Given the importance of the distribution of reef corals during warming events of the geological past, this research focuses on the Upper Oligocene coral-bearing units of Southern Khirthar fold and thrust belt (Pakistan). The investigated neritic limestones are attributed to the poorly studied Jhill Limestone Unit of the Gaj Formation. The skeletal assemblages of the four studied sections are dominated by coralline algae (both encrusting and articulated), large benthic foraminifera (mainly Miogypsinoides, Miogypsina, Spiroclypeus, Nephrolepidina and Archaias, associated with Operculina, Sorites, and rare Eulepidina) and reef corals. Minor components consist of bryozoans, echinoderms, molluscs and small benthic foraminifera. Reef corals are represented by colonies that form small patches in three out of four investigated sections and locally dominate the skeletal assemblages. Large benthic foraminiferal associations suggest a deposition during the Late Oligocene (possibly Shallow Benthic Zone 23) and thus within the LOWE (Late Oligocene Warming Event), contrary to previous studies indicating a Burdigalian age for the Gaj Formation in the study area. These improved stratigraphic constraints allow for the comparison of the coral-bearing shallow-water carbonates of the Gaj Formation with similar units from the European and Indo-Pacific regions, providing a bridge between the two bio-provinces.

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# Sedimentology and dinosaur palaeontology of the Lower Cretaceous Wessex Formation, Isle of Wight

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The Wessex Formation on the Isle of Wight is famous for hosting part of the highest diversity assemblage of dinosaur fossils in the UK. However, whilst the fossils are well studied, the sedimentary rocks lack investigation using modern techniques. Consequently, the rocks are poorly understood and a detailed chronostratigraphic framework is lacking, hindering efforts to understand the dinosaurs' distribution, evolution, and ecology. The Wessex Formation comprises fluvial floodplain sediments of Barremian age (125.77–~121.4 Ma) deposited within the extensional Wessex Basin. The Alpine Orogeny folded the succession into a gentle anticline. Today it outcrops variably near Yaverland on the southeast coast of the island, though along the southwest coast south of The Needles there is an excellent 8 km continuous exposure, which is our selected field area.

In this study we use detailed facies analysis and sedimentary logging to constrain past depositional environments using a combined approach of field and virtual outcrop studies. The facies associations identified during fieldwork have been drawn onto the virtual outcrop model, from which sedimentary graphic logs have been compiled. These data have been interpreted by applying fluvial and shallow marine sequence stratigraphic principles, resulting in a new chronostratigraphic framework.

Our initial results suggest the top ~100 m of both limbs are directly correlative, though the southern limb is markedly thicker than the northern limb (~160 m and 100 m respectively). The thickness difference between the two limbs may be due to post-depositional faulting cutting out or repeating strata, or the presence of a syn-depositional normal fault. Future work will include testing of these hypotheses, and mapping of dinosaur occurrences onto the resulting chronostratigraphic framework. Ultimately, this will allow the relationship between dinosaur remains, sedimentary facies and chronostratigraphy to be studied in greater detail than previously possible.

# Precessional scale cyclochronology of the lowermost Ypresian Basque-Cantabrian basin (North-Iberian paleomargin)

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In order to reconstruct the evolution of sedimentary systems and understand how environmental feedback mechanisms act, an accurate time framework is necessary. The accuracy of astronomical timescale generally exceeds other age dating methods, but orbital models fail beyond 40-50 Ma and actual geological data are incomplete. The expanded lower Ypresian Arnakatxa section studied herein displays a well-defined arrangement of strata in couplets and bundles, which make it a potentially valuable orbitally paced geological record for the early Eocene. The spectral analyses of colour data series of powered rock samples showed the dominance of two main periodicities, which were related to orbital forcing on sedimentation by precession (20 kyr) and short (100 kyr) eccentricity cycles. Although long (405 kyr) eccentricity cycles are not represented in the spectrograms, their influence on sedimentation was also deduced. Moreover, the orbital signal in the upper half of the Arnakatxa section displays a disruption that correlates with a very long (2.4 Myr) eccentricity node centred at ~54.6 Ma. At this node, an amplification of the orbital signal related to obliquity (41 kyr) is also observed. Overall, the cyclostratigraphic analysis carried out in Arnakatxa provided a precessional scale orbital chronology for the time interval between 55.805 and 54.435 Ma (duration of 1.37 Myr). Thus, the Arnakatxa succession can be reliably correlated with Atlantic ODP records, which are the main reference for Ypresian astrochronology. Additionally, the results from Arnakatxa also help to identify the astronomical solutions that better match actual geological data, contributing to the construction of a definitive Ypresian astronomically calibrated time scale. In this regard, the Arnakatxa results are not a good fit for solutions La10a, La10d, La11 and ZB18, but match well with the previously thought to be less reliable solutions La10b and La10c

# Integrated Reservoir Characterization of a Pre-salt Field, Campos Basin, Through Rock Analysis, Petrophysics, Seismic Inversion, Static and Dynamic Modelling

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The reservoir characterization of pre-salt carbonates in the Brazilian Campos Basin poses a significant challenge due to faciological and depositional complexity, resulting in high lateral and vertical heterogeneities. This study employed a comprehensive range of techniques, highlighting the synergies of geological and engineering analyses with the goal of constructing a reservoir model to allow the field development. Analysis of core and sidewall core samples, along with detailed XRD analyses, revealed well-developed shrub and locally thick stromatolite facies, intermittent shoal facies, spherulites, and reworking facies as grainstones. The interpretation suggests a relatively proximal lacustrine shoreline within a paleo-high in a lake scenario. Close to the oil-water contact, solid hydrocarbon are present coating grains and occupying pore spaces. Routine petrophysics laboratory analysis (RCAL) indicated an average reservoir porosity of 12% and an average permeability of 80mD. Petrophysical interpretation identified five distinct flow zone units (FZU) using the Flow Zone Indicator, derived from calculated porosity and permeability values calibrated with RCAL data. Seismic interpretation, involving well-seismic tie-in, wavelet extraction, and acoustic inversion, improved seismic resolution by 30%. Within the reservoir, acoustic impedance and effective porosity exhibited a 90% correlation. Bayesian classification established a correlation between flow units and the probability of occurrence based on impedance values. This probabilistic approach generated five cubes representing the probabilities of occurrence for each FZU, integrated into the conceptual geological model to construct the 3D static geological model. Interpretation of drillstem test indicated good reservoir properties and faults contributing to flow. The well test results were implemented, and history matched on the dynamic numerical model. These crucial steps in translating subsurface information into a coherent seismic and reservoir framework significantly contributed to a more accurate reservoir model, reducing uncertainties associated with the reservoir heterogeneity and enhancing the prediction of reservoir behaviour, optimizing well placement and resource recovery strategies.

# ENHANCED WEATHERING FOR $CO_2$ DRAWDOWN IN A TEMPERATE AGRICULTURAL SETTING

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Anthropogenically driven climate change is a major global concern.

It is now widely accepted that any attempt to restore atmospheric carbon dioxide to pre-industrial levels within a meaningful timeframe will require the deployment of Carbon Dioxide Removal (CDR) strategies alongside a background of reduced greenhouse gas emissions.

One such CDR strategy is the process of Enhanced Weathering. Enhanced weathering is a nature-based solution that typically involves the application of finely ground mafic or ultramafic silicate rocks to land. Carbon dioxide, dissolved in rainwater, naturally weathers the rocks, chemically reacting with the mineral phases to remove $CO_2$ from the atmosphere and store it as minerals or bicarbonate. A fortunate byproduct of this process is the liberation of leached minerals that enhance soil quality and provide nutrients to plants.

Our field-based study undertakes a quantitative assessment of $CO_2$ drawdown and tertiary benefits during the application of both raw quarry waste and pulverised rock as treatments to regenerative agricultural land in a temperate climate setting.

The field site is situated in an agricultural meadow in Meynell Langley, Derbyshire. The site is subdivided into 84 9 m2 quadrats of which 66 are treated with silicate and carbonate rocks at varying grain sizes and doses, while the remaining 18 quadrats are controls. All of the quadrats are subjected to repeated monitoring of parameters including $CO_2$ and methane flux, temperature, soil pH, soil structure, and floral spectral reflectance. Field observations are complemented with laboratory analyses to characterise the evolution of the treatment materials and assess soil health, nutrient availability, and $CO_2$ sequestration capability at larger scales.

Keywords: Enhanced weathering, carbon dioxide removal, climate change, Paris Agreement.

# Effects of land plant evolution on Palaeozoic shallow marine communities: Testing the Land Plant Weathering Hypothesis.

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The Palaeozoic evolution of land plants resulted in some of the greatest changes to Earth's terrestrial environments. Sediment trapping and baffling by primitive and early vascular plants lead to a large secular increase in the proportion of mud size sediment retained on land from the Silurian onward, and is also argued to have been responsible for changes in river expression. With the consequent evolution of deepening roots in the Devonian, land plants also increased pedogenic weathering rates, increasing the flux of nutrients and sediment in fluvial environments.

Less is known about the potential impact of land plants on the marine realm. Changes in weathering and retention on land must lead to changes in net sediment flux to the ocean, and this would affect the various stressors Palaeozoic communities faced, particularly those receiving the bulk of the sediment input in shallow marine environments. Palaeozoic corals are known to have survived and even flourished in high sediment stress environments that arise from increases in terrestrial input, with several examples from the Devonian of Germany, France and the UK. However, a synthesis on the full effects of plant evolution on shallow marine communities cannot be answered at an outcrop level of individual cases, it can only be interrogated through a global study.

We are creating a database of shallow Palaeozoic reef communities from the latest Ordovician through the end of the Devonian, focusing on their biodiversity, terrestrial sediment content, algal content and other metrics for the health of a reef. These - along with global metrics such as total reef extent, coral diversity, terrestrial weathering proxies and climate - are contrasted against the timeline of land plant evolution to determine whether specific evolutionary innovations (first appearance on land, development of vascular systems, deepening of roots) resulted in a response in shallow marine communities.

# Hydrotermal Events in Cabonates of Pre-Salt, Distal Domain of Campos Basin, Southeast Brazil

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Neoaptian carbonates (Macabu Formation), distal portion of the Campos Basin, southeastern Brazil, occur below the evaporitic sequence (Retiro Formation), and were deposited above Eoaptian rocks of the rift sequence, or above volcanic basement, in areas of thinned and hyper-stretched crust, controlled by ENE transfer zone and affected by deep faults, where hydrothermal fluids ascended.

Carbonate facies compose finely laminated low energy associations (upper interval); low-moderate energy (intermediate interval), with intercalations of laminites spherulites and packstones; moderate-high energy facies (lower part), represented by shrubs and grainstones.

Main processes modifying the original texture are dolomitization and silicification. Four dolomitization phases are observed: very fine dolomite (D1) associated with laminated facies, precede an initial phase of silicification; fine to medium dolomite (D2), possibly precedes intermediate stage of silicification; late coarse dolomite (D3), overgrows from D2; thick saddle dolomite (D4), close to fracture zones. Silicification is multiphasic, also in four main phases. S1 replaces precursor clay facies with muscovite and D1. S2 represents a hyaline spherulitic silica, where the initial stages present intra-spherulite bitumen inclusions. S3 is characterized by a medium to thick mosaic of quartz in porosity, and it precedes a calcite phase in fractures. S4 occurs as euhedral quartz in enlarged porosity and fractures. Other hydrothermal cements are also present: sphalerite, Sr-barite, calcite, fluorite and kaolinite in late fractures, goyzite in micropores. Bitumen inclusions are present from the most primary phases of silica to later hydrothermal phases.

Paragenetic sequence was calibrated with U/Pb dating in carbonate phases, composition and temperature of fluid inclusions in the quartz cements. The ages obtained so far record an event between 108-106Ma for recrystallization and/or diagenetic shrubs formation; dolomite recrystallization age (D2) at 90-95Ma; dolomite recrystallization and/or precipitation event (D3/D4) 79-73Ma. This last age is associated with generation of secondary porosity, where the hydrocarbon is stored.

# Insights into early diagenetic porosity formation in recent microbialites (Turquesa Lake, Central Andes, Argentina): assessing biotic vs abiotic impacts

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Stromatolites are laminated organosedimentary structures originated by the trapping and binding of sediment and/or the mineralization resulting from the metabolic activities of microbes or eukaryotic microorganisms. The lithification of these structures occurs when precipitation of sedimentary minerals (commonly calcium carbonate) outweighs dissolution, so the net carbonate precipitating activities favor the preservation of these deposits in the rock record. The interaction among microbial metabolism, microbial extracellular polymeric substances (EPS), and environmental physics and chemistry serves as pivotal drivers influencing the early attributes of the carbonate deposit. These products include macrostructure, depositional texture, and, notably, the formation and development of porosity.

Terrestrial microbialites flourishing in arid- semiarid climates tend to be exposed to a range of perturbations including remarkable oscillations in water chemistry, insolation, salinity, lake shoreline retreat, among others. In these settings, the composition and abundance of microbial mats, coupled with the solubilities of minerals in lake water, collectively shape the final texture and mineralogy of lake bottom microbialite substrates, providing intriguing proxies for detecting basin-wide climatic perturbations.

In this work, we test whether a specific balance between microbial taxonomic composition and lacustrine physiographic conditions can result in distinctive microbialite petrographic signatures, with a particular emphasis on investigating the drivers of early porosity formation in distinct recent examples in Turquesa Lake (Central Andes, Argentina). By integrating data on microbial genomic DNA, with petrography, X-ray microtomography, and mineralogy from microbialite samples, this work evaluates the impacts of lake environmental dynamics, and microbial mat metabolic diversity in selective early diagenetic porosity inception and development. The examination of microbialites thriving in extreme environments can provide valuable insights into how life and the environment contribute to the formation of distinct lake bottom types and whether mineral precipitation is influenced by biotic or abiotic mechanisms.

# Depositional architecture and heterogeneities of hydrocarbon analogue fluvial reservoir of the Uberaba formation of the Bauru Basin

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The present work is based on data from outcrops of the Uberaba Formation (Upper Cretaceous of the Bauru Basin), located in Brazil. It combines outcrop data, petrographic descriptions and porosity and permeability analysis, with the aim of understanding the heterogeneities of river deposits. It presents detailed descriptions of the lithologies, sedimentary structures and textural aspects that allowed understanding, in addition to the depositional processes and environment, the variations in porosity and permeability of the stratigraphic unit. Through analysis of photographic panels, the limiting surfaces between the strata of 4 sections were identified, enabling the definition of architectural elements: macroform of lateral accretion (LA) and downstream (DA), channels (CH), overbank fines ( FF), sandy bedforms (SB) and gravelly bedforms and bars (GB). The architectural elements together with the set of facies described indicated a braided river system with small sinuosity in an arid/semi-arid climate, with the possibility of there being periods of non-deposition. Using microporosity data obtained from 2D thin sections, combined with permeability values, it was possible to generate a 3D depositional model that correlates heterogeneities at different scales. As the architectural elements DA and LA predominate in the filling of the channels (CH) classified as medium to good reservoirs, due to intervals with a higher incidence of cemented lenses they can hinder the recovery of the hydrocarbon. With the sandstone facies with tabular stratification (Aet) present in the accretion bars presenting better permeability values, correlated with greater energy and grain selection. Factors such as the presence of a greenish clayey amorphous material in the sandstones, carbonate cementation in the form of poikilotopic calcite and the large amount of plasma in the paleosols decrease the quality of the analogous reservoir, obstructing the connectivity of the pores.

# From Stone to Scone: Insights Gained at the Crossroads of Science Communication and Food Business Management

Dr Jo Morris
[1]SciRecipes

Science communication is an essential skill for scientists to share research outcomes with the public, yet it is often considered an extracurricular task and performed without adequate compensation.  SciRecipes is a business designed to employ scientists to practice their science communication, engage with members of the public and be paid a fair salary for their work.

Using everyday recipes infused with science, such as Journey to the Centre of the Pizza, SciRecipes offers an engaging way for people to learn about scientific principles.  Each recipe includes a 'sciency bit' explaining the underlying science.  Unlike traditional market-targeted branding, SciRecipes aims to reach a diverse group of demographics.  To date, the business has received overwhelmingly positive feedback from various age groups, including parents of children with autism and WI members.

The business employs a 'trojan-horse' marketing approach, presenting itself as a food business before delving into science communication.  This strategy allows participation in selling events, such as farmers markets, providing unique advantages.  Being the sole scientist at these events avoids competition for attention, selling food products generates revenue for fair compensation, and barriers are broken for those hesitant to attend traditional science festivals.  Market research reveals that many adults lack confidence in attending science events, stemming from childhood experiences of being discouraged from pursuing science careers due to perceived inadequacy.

SciRecipes, though in its early stages, has achieved notable success, winning awards like the Audience Vote winner at FameLab, two 1-star Great Taste Awards, and #SBS Small Business Sunday with Theo Paphitis.  The business plan acknowledges the need to reach beyond those already interested in science and is positioned to share valuable lessons as it continues to evolve.

# A review of a Bulk Rock Elemental Chemostratigraphy study conducted on Buntsandstein Fluvial Sediments in the Castilian branch of the Iberian Ranges, Spain

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Chemostratigraphy utilises the changes in geochemistry (chemo-) within layers of rock (-stratigraphy). More specifically, bulk rock elemental chemostratigraphy analyses the bulk rock geochemistry of an entire sample where the results yield a full suite of elements that can be plotted together to form any combination of elemental ratios. These ratios can then be used to define correlatable surfaces that are otherwise indistinguishable through other techniques.

While extensively applied in subsurface reservoir studies for the hydrocarbon industry, limited attention has been given to surface exposures. A notable study focused on the Buntsandstein fluvial sandstones and mudstones in the Castilian branch of the Iberian Ranges, Spain. Correlating Permo-Triassic sediments in this region proves challenging due to complex internal heterogeneities and the lack of key biostratigraphic markers and distinct correlatable horizons. Conducted at eight locations along the Castilian branch, the bulk rock elemental chemostratigraphic study aimed to observe geochemical changes within preserved syn-rift sediments. The objective was to establish correlations where previous attempts had failed.

Interpreting the results yielded two alternative conclusions, emphasising the need for an evaluation of bulk rock elemental chemostratigraphy. Reviewing the method for sample collection, the analysis, and the justification for the selection of elemental ratios could help define the correct interpretation. Conducting these studies on field areas where little to no corroborating sedimentological evidence exists highlights the potential pitfall of using circular reasoning to define the elemental ratio boundaries.

Reviews of this kind are an important procedure within science. Advancing new techniques to better understand geological processes are imperative but should be undertaken with due care and process. If the technique of bulk rock elemental chemostratigraphy is to become an accepted correlation tool then it is the role of the wider geological community to understand and advance it rather than it be ring fenced by a select few.

# Fine characterization of meandering river reservoir architecture in Caofeidian 11-1 Oilfield based on Seismic

Rui Mu[1], Fine characterization of meandering river reservoir architecture in Caofeidian 11-1 Oilfield based on Seismic sedimentology zhijun Yin[1], Fine characterization of meandering river reservoir architecture in Caofeidian 11-1 Oilfield based on Seismic sedimentology dongmei Hou[2]
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The Minghuazhen Formation of Caofeidian 11-1 Oilfield in the Bohai Sea of China is a meandering river sediment, with proven geological reserves of hundreds of millions of cubic meters. The oilfield was put into operation in 2004 and is currently in the development stage of high water cut, and the fine characterization of different hierarchy of reservoir architecture units and their interfaces is the key geological basis for revealing the law of remaining oil distribution and optimizing the injection-production development plan. In this paper, based on core observation and logging response, the hierarchy division plan of meandering river reservoir architecture in the work area is determined, the identification marks of the 5-3 level architecture units were established, and the geological significance of the interface of different hierarchical architecture was clarified. On the basis of single well architecture calibration, the boundary of single point bar and abandoned channel was detected, plane distribution of fourth-level architecture units was completed, and the scale size and overlapping relationship of the single-genetic type reservoir sand body were revealed as well. Relying on the occurrence of the third-level architecture interface calculated by the side-tracked twin wells in dense well pattern area, and the slice response of the third-level architecture interface provided by the fusion of seismic attributes, the spatial distribution of the third-level architecture interface of one single point bar has been successfully realized. The result of this paper , fine characterization of Caofeidian 11-1 oilfield reservoir of the architecture units and architecture interface, reservoir connectivity and reservoir flow barriers, provided a direct geological basis for the adjustment of well location deployment and the optimization of development measures, and laid a solid foundation for greatly improving the development effect of the oilfield.

# Hypogene karst in carbonates – Processes, products and geothermal energy potential

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Hypogene (hypogenic) karsting of carbonate rocks is a common feature in many sedimentary basins. Unlike meteoric karst, hypogene karst forms by the activity of corrosive hydrothermal fluids in the intermediate to deep burial domain. Driven by the global search for renewable energy sources, hypogene karstification of limestone and dolostone has received interest as they might enhance the potential of geothermal reservoirs. The main issues in identifying hypogene karst features are their often cement-clogged nature and, in uplifted outcrop belts, the late-stage overprint by meteoric karst features. Industrial drilling campaigns document that the cement precipitation occluding the hypogene cavities in outcrops is a feature best assigned to the uplift phase of the rock units under consideration, while at depth, corrosive fluids can create cavities up to some tens of meters in scale. Here, we present outcrop and drill core data from two Palaeozoic case examples in western Germany. We combined petrographic, geochemical and palaeothermometric methods with laser ablation U-Pb carbonate dating. Based on individual paragenetic sequences, four hypogene karstification events in Devonian and three in Carboniferous host carbonates were dated. Direct dating of host carbonate and void-filling cement allows for distinction between hypogene karst and later overprint by meteoric fluids. All hypogene dissolution events occurred between Variscan Orogeny and the Palaeogene and were driven by supra-regional to basin-scale tectonism and fluid mixing. A large spread in palaeofluid temperatures (50 to 230 °C), salinity (2 to 25 wt.% NaCl) and isotope values ($\delta^{13}C$ = -7 to 5 ‰; $\delta^{18}O$ = -14 to 0 ‰) points to partial mixing of hot basement with meteoric fluids. The case examples presented here have the potential to act as a template for the study of hypogene subsurface processes elsewhere.

# Petrographic heterogeneity and authigenic clay distribution in Rotliegend sandstones of the Groningen field

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Fluid extraction from geological formations for purposes of subsurface utilization leads to pore pressure drop in reservoirs and subsequent compaction and seismicity, especially in porous sandstones. Petrography controls the geomechanical properties of the reservoir, crucial for predicting a reservoir's response to fluid extraction and understanding its lateral variability. One of these reservoirs is the Groningen gas field, situated in the north-eastern part of the Netherlands, where gas depletion led to compaction and associated surface subsidence and seismicity. The main goal of this study is to provide a petrographic model of the Groningen gas field at microscale, based on core samples, in order to predict reservoir compaction. Mineralogical composition and textural relationships were determined together with diagenetic processes and paragenetic sequences. The sandstones mainly consist of sublitharenites. Authigenic minerals mainly consist of dolomite and quartz cement and varying forms of clay such as kaolinite, illite and chlorite. On reservoir scale, petrographic relations between certain minerals can be observed such as decreasing feldspar with depth, a linear relationship between kaolinite and amount of feldspar, and an increase of chlorite and quartz cement in core material towards the north of the field (also present in aquifer cores). Generally, feldspar is dissolved to a high degree, which can have an impact on the structural integrity of the sandstones. Authigenic products seem to be controlled by depositional facies and locally fault related fluids. The clays often surround grains as clay coatings and occupy pore space, which locally inhibits cementation of pore-filling quartz or dolomite. Therefore, the timing and extent of authigenic products play an important role on the stability of the sandstones throughout the reservoir. This study contributes to our understanding of the reservoir heterogeneity of the Groningen gas field and improves our knowledge of subsurface response to subsurface utilisation.

# An unusual pyritiferous tonsteins from the Upper Silesian Coal Basin (Poland): preliminary mineralogical characterization

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The term 'tonstein' refers to airborne material of pyroclastic origin, deposited and altered in peat-forming environments, and having a kaolinite-dominant composition. They form thin but persistent layers within coal seams and are perfect chronostratigraphic markers. The mineralogical suites of high-pyrite tonsteins from coal seams Nos. 209 and 207 of the Upper Silesian Coal Basin (Poland) were studied by optical microscopy, scanning electron microscopy with energy dispersive X-ray spectrometer and cathodoluminescence. Kaolinite is the most abundant authigenic phase, occurring as fine microcrystalline clay groundmass, vermicular Ti-bearing crystals and pseudomorphs with abundant inclusions of euhedral pyrite. In addition to pyrite, anatase and Ti-bearing phases with possibly poor crystallinity, traces of quartz were observed in the kaolinitic matrix. The formation of pyrite probably coincided with the early diagenetic dissolution of unstable volcanic components, releasing Fe which reacted with sulphur from the decomposing coal-forming plants. Anatase is another common secondary mineral that appears to have formed early in the diagenetic history, probably as a result of the breakdown of Ti-rich volcanic glass and the transformation of biotite into kaolinite, controlled by reducing pore fluid conditions typical of peat swamp environments. These scenarios exclude the external source of Fe and Ti, and therefore the abundance of pyrite and anatase (and/or Ti-bearing phases) may be indicative of the intermediate to mafic composition of the parent magma associated with bimodal volcanism in the far foreland of the Variscan orogen in central Europe. Further works should include trace elements modelling to establish precisely the tectono-magmatic setting of the parent volcano. Once the mafic source of volcanic ash is confirmed, the stratigraphic significance of the tonsteins and their age dating suitability will be re-evaluated.

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# Lithofacies classification and chlorite quantity prediction using machine learning techniques in the deep deltaic sandstone reservoir of the Tilje Formation

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The Lower Jurassic deltaic sandstones of the Tilje Formation in the Halten Terrace area of the North Sea host anomalously high porosity (up to 26%) and permeability (up to 3000 mD) intervals at depths greater than 4 km. Enhanced reservoir quality in these deep intervals is attributed to the formation of grain-coating chlorite which has inhibited the precipitation of quartz cement, representing a major control on reservoir quality. The occurrence of chlorite-coated intervals in the Tilje Formation is interpreted to be facies-controlled, predominantly occurring in facies associated with a slightly muddy tidal-fluvial bar environment.

Here we use eight measured wireline log parameters in a machine learning classification model to predict the distribution of facies (calibrated using core), and in a regression model to predict the abundance of grain-coating chlorite (calibrated using point-count data). The modelling approach has adapted an established machine learning workflow to incorporate qualitative core data, and quantitative point-count and wireline data from three reservoir intervals (43 m total) in the Tilje Formation from a single well. Results of facies classification modelling show that facies hosting porosity-enhancing chlorite grain coats can be distinguished from non-reservoir facies with an accuracy of approximately 80%. The quantitative predictions of grain-coating chlorite had a mean absolute error of 2.9% (actual values ranged between 0 and 16%).

This study demonstrates how wireline data can be used to predict the occurrence of high reservoir quality facies and quantities of grain-coating chlorite in a deep sandstone reservoir. This approach could be expanded to include data from other cored sections from the same stratigraphic interval to build a model which can provide field-wide predictions of facies distribution and chlorite coat occurrence in non-cored wells.

# High-resolution cyclostratigraphy and astronomically driven paleoenvironmental evolution of the Northern Iberian continental margin during the Bartonian/Priabonian transition (Eocene Pamplona Marl Formation, Western Pyrenees)

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Spectral analysis of high-resolution bulk low-field magnetic susceptibility data series from a nearly 260 m thick land-based cyclic hemipelagic succession of the Pamplona Marl Formation (Jaca-Pamplona basin, Western Pyrenees) allowed the identification of precession (~20 ky) cycles as the main forcing mechanism on sedimentation, which were modulated by short eccentricity (~100 ky) and long eccentricity (~405 ky) cycles. An unusually high (compacted) sedimentation rate of 23.566 cm/kyr was estimated using TimeOpt. The age of the succession was addressed by the combination of calcareous nannofossil biostratigraphy (CNE15 to CNE18 zones of Agnini et al., 2014) and a detailed magnetostratigraphic analysis spanning chrons C17r and C17n.1n. The succession was tuned with orbital solutions by the use of 13 short eccentricity maxima as tie-points, allowing a robust and detailed astrochronology of the interval between 38.284 to 37.081 Ma resolved at precession resolution. This tuned record was correlated at short eccentricity and precession level with the Global Stratotype Section and Point of the Bartonian/Priabonian boundary in Alano di Piave section (Italy; Agnini et al., 2021), as well as with IODP Site 320-U1334 from the equatorial Pacific (PEAT, IODP Exp. 320/321, Westerhold et al., 2014), which is the only oceanic record tuned at high-resolution for the studied time interval. The expanded nature of the succession allowed the paleoenvironmental interpretation of the astronomically induced lithological alternation found in the succession. The alternation represents seasonality fluctuations driven by precession cycles, which caused periodic variations in the rates of carbonate productivity and siliceous dilution, the prevalence of these processes increasing or decreasing with the modulation by short and long eccentricity cycles.

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# Late Cretaceous to Paleocene foreland basin evolution along the carbonate platform margin of the Dinarides

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Within the Dinarides, the Pre-Karst subzone marks a Mesozoic transitional paleogeographic realm linking the shallow-water successions of the Adriatic Carbonate Platform (AdCP) with the condensed deep-water sediments of the subsided eastern Adria plate margin. Europe-Adria convergence during the Cretaceous resulted in nappe propagation within the Adria plate. Consequently, areas along the western margin of the AdCP experienced emersion followed by transgression in the Late Cretaceous. Local uplift and subsidence due to lithosphere flexure and migration of foreland basin depocenters eventually brought on the final demise of the long standing Tethyan isolated platform. Biostratigraphic and petrographic data from Late Cretaceous to Paleocene sections in Croatia and Bosnia and Herzegovina reveal specific characteristics in basin development along the length of the Dinarides. Transgressive sequences dated as Santonian to lower Campanian are commonly topped by middle Campanian deepwater limestones and marls, together with calciclastics and typically Maastrichtian-Paleocene siliciclastic flysch-type deposits. Calciclastics consist of both shallow marine material shed from the adjacent platform environments and carbonate lithoclasts, indicating uplift and exposure of older platform units. Composition of siliciclastic detritus reflects tectonic exposure of the Adria basement and ophiolites previously obducted on the continental margin within advancing nappes. Key points of interest related to the character and timing of specific stages in basin development and changes in calciclastic and siliciclastic sediment supply are identified and are the focus of study within a joint Slovenian-Croatian research project under the Weave initiative.
The presented work is supported by the Croatian Science Foundation project SECret (HRZZ IPS-2023-02-2683).

# Quantification of the internal heterogeneity across a deep-marine slope channel bend: An example from the late Tortonian Tachrift Channel Complex 5 (Taza-Guercif Basin, NE Morocco)

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The nature of sediment transport and deposition within deep-marine slope systems is affected by numerous parameters leading to the formation of complicated sedimentary bodies, characterized by large lateral and vertical heterogeneity in sedimentary facies, which is crucial to understand the subsurface. More particularly, the heterogeneity of deposits accumulating at the bends of sinuous channels is poorly constrained, although bar-like and laterally accreting deposit geometries appear to be very common in seismic imaging of subsurface analogues.

The wonderfully exposed outcrops of Channel Complex 5 belonging the late Tortonian Tachrift Turbidite System (NE Morocco), offer an opportunity to document the lateral and vertical heterogeneity within a ~1 Km wide and ~25 m thick channel complex. Seventy acquired logs of the outcropping sediments provided a robust dataset of parameters such as sand to mud ratio, amalgamation ratio, grain-size, facies proportions etc., trends of which were observed across the channel complex. Overall, the studied channel complex is comprised of four main stratigraphic packages. These were accumulated across a large-scale channel bend that evolved through time. An initial small-scale laterally migrating channel phase with adjacent levees passes to a thicker, sinuous, and aggrading unit. Upwards, the stratigraphy is characterized by units consisting of sigmoidal beds of large lateral variability, representing a late laterally accreting phase. Characteristic changes in quantified lateral trends possibly reflect different depositional settings within channel elements or channel-levee transitions in some cases.

Documented trends of facies and bedding patterns provide unprecedented insights into the heterogeneity of sinuous channel fills, which can be particularly useful for lithological calibration of subsurface analogues.

# Three drilled-cores at the river estuary mouth record interaction between river discharge and tidal prism during the Holocene

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Estuaries are the transition zone where tidal and river currents interact and, as a consequence, shape a dynamic morphology by infilling with time. The degree of tidal and fluvial influence depends on the interaction between tidal prism and river discharge, and varies spatio-temporally along the longitudinal and transverse profiles. Many of previous works focus variation of facies trends and development history along the longitudinal profile at the fluvial-to-marine transition. Little known is the cross/transverse variation of them to be able to better document the style and pattern of estuary infills. Three drilled-cores taken at the mouth of Seomjin river estuary, south coast of Korea were examined to understand interaction between river and tidal flux during the Holocene. For the stratigraphic correlation, 14C-AMS ages of shell fragments and organic matters were obtained. Based on facies analysis, the Seomjin river estuary deposits are classified into 21 sedimentary facies, being grouped into 7 facies associations: FA1) fluvial channel, FA2) mudflat, FA3) tidal channel, FA4) prodelta, FA5) delta front, FA6) muddy mouth bar, FA7) mouth bar sand. Stratigraphically, the lowermost estuarine tidal flats are followed by delta front to prodelta, and mouth bar facies occupies the uppermost succession. The transverse profile of the mouth reveals that tidal sedimentation was dominated along the margin of the estuary from 9 to 4 ka BP in the course of rapid transgression associated with rapid rise in sea-levels. The transition from tidal to fluvial influence occurred from about 1,000 years BP with about 3 ka of time break. Tidal prism decreased since then, whereas river discharge became culminated, thereby resulting in estuary infilling. Extremely large sediment supply over the last millennium may be associated with the increased intensity of summer monsoon.

# Seismic geomorphology and quantitative characterization of mass-transport deposits in carbonate depositional environments: Insights from the Cenozoic margin of the Exmouth Sub-basin (North West Shelf, Australia)

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Mass-transport deposits (MTDs) play an important role in shaping continental margins and controlling sedimentary basin fill, but they also constitute a significant geohazard. Therefore, understanding their triggering mechanisms and controls on their geomorphology is critical. While MTDs have been extensively studied in siliciclastic settings, they remain poorly understood in carbonate depositional environments.

The North West Shelf (NWS) of Australia is characterized by an approximately 2,400 km long carbonate platform. In the Exmouth Sub-basin (southwestern part of the NWS), Cenozoic MTDs were identified and mapped using a 11,731 km² high-resolution 3D seismic dataset. Thanks to full-volume seismic interpretation methods and semi-automated workflows, four MTDs ranging from 40 to 185 km³ were quantitatively characterized and imaged in unprecedented detail. Interpretation was undertaken within a seismic stratigraphic framework calibrated by exploration well Ravensworth 1/CH1.

Seismic facies and geomorphologic architectural elements of the Exmouth Sub-basin MTDs reveal a down-slope continuum of deformation along a basal shear surface comprising: (1) coherent slide blocks up to 3.3 km long near the headscarp; (2) slide blocks hundreds of meters long; (3) chaotic mass flows; and (4) turbidite systems in the toe region. Run-out distances range from 11 to 80 km and are controlled by paleotopography and rheology.

Quantitative relationships between different morphometric parameters are established. MTDs dimensions are found comparable to the ones observed along the carbonate slopes of the Great Bahama Bank. Links between headscarps and underlying faults indicate reactivation of older faults as a possible triggering mechanism due to far-field compressional stresses and tectonic inversion in the sub-basin.

Present-day instability on the shelf is evidenced by retrogressive headscarps and proto-slumps, crown cracks and pockmarks. On the NWS, an earthquake could trigger a MTD with a volume exceeding 10 to 40 km³, significantly damaging offshore infrastructure and impacting coastal communities (i.e., tsunami risks).

# Cyclostratigraphy in turbiditic successions: comparison of results derived from actual and hypothetical pelagic-only data series (Eocene, Lutetian GSSP, Gorrondatxe, W Pyrenees)

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Turbidity currents are thought to occur randomly and to be inherently non-cyclical events. Furthermore, as they commonly involve erosive processes, turbiditic successions are seldom continuous and the probability of any cyclical process being fully recorded is low. Consequently, turbiditic successions are not ideal for cyclostratigraphic analysis. The 120 m-thick Gorrondatxe section is composed of hemipelagic marls and limestones with abundant intercalations of turbidites. Despite the variable distribution of turbidites, a cyclostratigraphic analysis was undertaken based on 266 magnetic susceptibility measurements. To this end, the thickness represented by turbidites should be subtracted from the succession, assuming that the sedimentation rate of the remaining hemipelagic-only hypothetical succession would be constant. However, it was not possible to measure all the turbidites in Gorrondatxe due to their abundance (>1000 estimated) and thin-bedded nature. As an alternative, we calculated the turbiditic percentage in a 1 m thick interval of each 10 m thick slice of the section and extrapolated that percentage to the rest of the 10 m thick stratigraphic slice, the actual 120 m thick succession thus reducing to a hypothetical hemipelagic-only succession 36.60 m thick. Subsequently, two independent cyclostratigraphic analyses were undertaken using Acycle software, one for the actual succession (including turbidites) and the other for the hypothetical hemipelagic-only section. Power spectrum analyses of the two detrended data series were carried out, sedimentation rates were determined using correlation coefficients, and the most significant frequencies were isolated using Gaussian bandpass filtering. The results from both data series identified several periodicities which, based on estimated sedimentation rates, can be attributed to 18-24 ky precession cycles, 40 and 55 ky obliquity cycles, and 100 and 405 ky eccentricity cycles. Filtering outputs identified 11 short eccentricity and 3 long eccentricity cycles. The results show that the cyclostratigraphic analysis of actual turbiditic successions is sometimes possible.

# LATERAL AND VERTICAL VARIATIONS IN THE RECORD OF CRETACEOUS ERG-MARGIN SYSTEMS OF THE NEUQUÉN BASIN, ARGENTINA

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Hybrid sedimentological systems where processes of fluvial and aeolian genesis interact are typical of erg margins. Understanding how the spatial and temporal variations identified in these environments are transferred to the geological record is a big challenge. The Neuquén Basin in Argentina has several Mesozoic units that record the interaction between aeolian and fluvial systems across erg-margin systems. Hence, this work aims to study three of these units which are known to record these hybrid systems and characterize distinct types and scales of fluvio-aeolian interactions are transferred to the rock record. Some of these units are excellent hydrocarbon reservoirs, so the identification of both lateral and vertical variations is important to measure the compartmentalization and distribution of heterogeneities of these reservoirs. To accomplish this work, a classic high-resolution sedimentological study was carried out that included gathering sedimentary sections, the elaboration of a facies scheme and the appropriate architectural analysis for the units considering different surfaces' hierarchies to understand the high-resolution stratigraphic framework. Elements related to aeolian processes were identified, such as deposits product of aeolian dunes, sand sheets and different types of interdunes. Additionally, elements that are more linked to fluvial processes such as channelized flow deposits and non-channelized flow deposits, both in distal and proximal expression, were defined as well. The dimensions, geometry, and lateral and vertical distribution of these elements were quantified to analyze the spatial and temporal variation of sedimentary processes within these systems. The results are key to understand the nature and expression of these hybrid systems, and for the interpretation, prediction, and modelling of subsurface deposits. We expect to provide valuable input for other subsurface units of this origin known for their importance as hydrocarbon reservoirs and gas and $CO_2$ storage targets.

# Interactions between distal epiclastic and biochemogenic Late Oligocene sedimentation at the foothills of a mafic alkaline volcano

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The Late Oligocene (ca. 25 Ma) volcano-sedimentary successions on the western periphery of the Doupovské Hory Volcanic Complex (Karlovy Vary, NW Czech Republic) unveil a multi-episodic sedimentation history influenced by the decay of the alkali basalt volcanic edifice. The weathering of these volcanic rocks supplied reactants for carbonate precipitation in peripheral palaeolakes, as indicated by the strongly non-radiogenic $^{87}Sr/^{86}Sr$ values (0.7038–0.7041). The initial shallow lake sediments underwent deformation due to the bulldozing effect of a debris avalanche. This event significantly altered the original basin morphology, filling up the depression and pushing the lacustrine setting away from the volcanic edifice. As the landscape evolved, surface water influx from the surrounding granitic terrain imparted a more radiogenic signature to the calcrete deposits, reflected in $^{87}Sr/^{86}Sr$ values of 0.7046–0.7049. The fossil assemblages and limestone textures within these deposits suggest pronounced seasonal water-level fluctuations, likely mirroring the alternating rainy and dry seasons characteristic of the humid Central-European Late Oligocene climate. Periodic desiccation led to substantial $^{18}O$ enrichment. While the near-zero $\delta^{13}C$ values might typically suggest a mixing of atmospheric and volcanic $CO_2$ during carbonate formation, the absence of active volcanic conduits in close proximity suggests an alternative origin. These lower $\delta^{13}C$ values are more likely attributable to mantle degassing through rift faults, a phenomenon still observed in the now magmatically extinct Ohře (Eger) Rift. This study highlights that limestones derived from weathered alkaline basalt are characterized by non-radiogenic Sr isotopic ratios ($^{87}Sr/^{86}Sr$ ca. 0.704). It challenges the conventional interpretation of Sr isotopes in carbonates, asserting that in alkali basalt-sourced environments, these isotopes reflect the source of Sr and Ca ions, rather than indicating the presence of carbonatite.

Rapprich, V., Čáp, P., Erban Kochergina, Y.V., [...], & Petrash, D. A. (2023). The Depositional Record, 9, 871–894. doi: 10.1002/dep2.240

# Architecture, internal heterogeneity and vertical evolution within a deep-water channel-levee complex: a spectacularly well-exposed outcrop from the Taza-Guercif Basin (NE Morocco)

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Recent advances in high-resolution 3D seismic studies provide unprecedented imaging of deep-water sedimentary systems. However, numerous research questions persist regarding detailed facies complexity and depositional element relationships within channel-levee complexes. Hence, outcrop analysis is crucial for understanding and predicting sedimentary variability.

This work focuses on a 500-meter-wide, ca. 35-meter-thick, well-exposed outcrop of a late Tortonian channel-levee complex (Complex 7) in the Tachrift Turbidite System, Taza-Guercif Basin (NE Morocco). This outcrop presents an excellent opportunity to investigate internal sedimentary heterogeneity and the vertical evolution of a channel belt at outcrop scale. Through the collection of thirty-five closely spaced stratigraphic logs, physical correlation, hierarchical arrangement of main boundary surfaces, and statistical analysis of key sedimentological variables (e.g., grain size, bed thickness, S/M ratio, etc.), three depositional units (unit 1, 2, and 3) have been identified. Different facies associations within each unit are attributed to the lateral transition between channel fills (in which lateral accreting elements and cut-and-fill elements have been distinguished) and their correlative levee deposits.

The study allows the reconstruction of the stratigraphic evolution of the channel-belt: (i) a first phase is identified (Unit 1), during which lateral accreting elements follow a common migration pathway of the channel axis towards the east. Subsequently (ii), a deep erosion with sediment bypass took place, followed by the infilling of the channel and consequent vertical aggradation by cut and fill elements (Unit 2). (iii) In the final stage (Unit 3), lateral accreting elements resumed their migration pathway toward the east, preceding the deactivation of Complex 7.

This study offers a detailed sedimentological characterization of different architectural element relationships within a channel-levee complex, providing valuable insights into vertical stacking development and facilitating sub-seismic lithological calibration for seismic analogues.

# A source-to-sink pursuit between the Romanian Carpathians and the Lower Danube Basin using geochronology, lithology, and geomorphology approaches

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Over the past 16 million years, the course of the Lower Danube has undergone multiple changes influenced by various geological processes, such as shifts in regional sea levels, local tectonic activities, and alterations in the sedimentary landscape. The analysis of Quaternary sediments from the river's surface layer has revealed compelling evidence of significant erosion in geological formations, especially from the Southern and Eastern Carpathians.
We aimed to establish a link between these recent Lower Danube sediments and their primary source by utilizing detrital zircons (DZ) geochronology, considering lithological compositions, geomorphology of the basin terrain, and accounting for tectonic factors. Through U-Pb geochronology, the majority of DZ revealed three key age groups: i. Cambrian-Ordovician ages (600 – 440 Mya), associated with back-arc basins and island arcs linked to Peri-Gondwana subduction; ii. Lower to Middle Carboniferous ages (350 – 320 Mya) primarily originating from magmatic and metamorphic Variscan units, displaying predominant peaks across most analyzed samples; iii Upper Cretaceous to Tertiary ages (younger than 100 Ma), potentially connected to the Late Cretaceous Banatitic arc in the Southern Carpathians and the Neogene volcanic activity in the Eastern Carpathians and Apuseni Mountains.
Furthermore, the primary sources of DZ in the western tributaries of the Lower Danube are the medium- and high-grade metamorphic rocks characteristic of the Danubian tectonic units within the Dacia mega-unit. Conversely, certain larger tributaries in the easternmost part of the Lower Danube exhibit scattered peaks in DZ geochronology, likely reflecting successive recycling processes.
In conclusion, the main contributors to the Quaternary sediments in the Lower Danube are the metamorphic rocks found in the Southern Carpathians, between the Iron Gates and the Olt River basin. In the eastern Lower Danube, within Romanian territory, a combination of igneous, metamorphic, and sedimentary rocks has been identified as major contributing sources.

# Application of Magnetostratigraphy to delimit the time of formation of injection complexes: the example of the Panoche Giant Injection Complex in the San Joaquin Basin, California (USA)

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Sand injection complexes are formed by the subsurface sand fluidization and injection, and sometimes extrusion of sand at the surface forming extrudites. As the shallowest and last formed part of an injection complex, extrudites are optimal candidates for assessing the timing of injectites formation. However, because of their complex origin and visual similarity with conventional depositional sandstone, defining and interpreting extrudites pose challenges that compromising accurate geological and geochronological models. As the shallowest part of injection complexes, extrudites significantly impact storage capacity, adding reservoir volume and possibly forming zones for fluid leakage. Paleomagnetic methods were applied to the upper section of the Moreno Formation (Maastrichtian-Paleocene) in the San Joaquin Basin, where extrudites in the Panoche Giant Injection Complex occur, aiming to assess the temporal context of the sand extrudites and the associated sedimentary succession. Magnetostratigraphy is an established method for temporal correlation, identifies the remnant magnetization of units to provide vector data on inclination, declination, and intensity of magnetism at the time of deposition, and is amenable to high-resolution applications. Analyses were conducted on mudstone and sandstone samples using alternating field demagnetization revealing approximately linear behaviour in mudstone demagnetization, with up to 80% efficiency in natural remanent magnetization (NRM) elimination. In sandstones, a dispersed behaviour with an elimination range from 50% to 50 mT . The magnetic minerals carrying NRM are primarily magnetite and titanomagnetite. Following data processing and the application of Fischer group statistical analysis, variations in declination and inclination were identified, indicating poles with normal and reverse polarity related to periods of the Danian, potentially associated with Chrons C29r, C29n, C28r, C28n, C27r, and C27n. The data will be integrated with biostratigraphic analysis and C and O stable isotope data to evaluate the precision of the magnetostratigraphy and its applicability to high-resolution correlation between sedimentary and extrusive units.

# Anisotropy of magnetic susceptibility (AMS) applied to determination of paleoflow in sand extrusions of the Panoche Giant Injection Complex, San Joaquin Basin

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Sand extrusions represent the shallowest genetic and architectural element in sand injection complexes. Formed by the extrusion of fluidized sand at the surface, fuelled by an intrusive network of underlying sandstone intrusions, extrudites create deposits with sedimentary structures that define the paleoflow of sand and are interpreted to be geologically instantaneous – formed during days to weeks – and are excellent timelines, in particular if timing of their occurrence is possible. Sand extrudites can form significant fluid storage volume but may also enhance fluid leakage above injection complexes. Extrudites are sparsely documented in outcrops and the subsurface.To enhance the understanding of the geometry and mineral fabric of extrudites, palaeomagnetic methods were applied to sand extrudite samples from the shallowest part of the Panoche Giant Injection Complex developed into the Moreno Formation (Maastrichtian-Paleocene) of the San Joaquin Basin. Anisotropy of magnetic susceptibility (AMS) data, thermomagnetic curves, hysteresis cycles, and isothermal remnant magnetization were used to obtain precise characteristics of magnetic fabric orientation and magnetic mineralogy. The results indicate complexity in the magnetic characteristics of the sand extrudite, requiring an integrated approach from detailed mapping to understanding of the geological significance of the system. AMS data from the extrusion complex reveal a range of directional patterns with a predominance of more horizontal magnetic foliations in adjacent mudstone and oblique to sub-horizontal in sandstone units. Sand volcanoes and vent-fills have predominantly vertically to high-angle oriented magnetic foliations in their central parts associated to intensely deformed central area with convolute and flame structures. The dip values progressively become horizontal toward the margins along divergent parallel to low-angle cross lamination with different dip directions, materializing a semi-circular sedimentary dispersion paleoflow. Magnetite and titanomagnetite are the primary sources of magnetization, and predominantly exhibit low coercivity, primarily with pseudo-single domain (PSD) characteristics.

# Facies and depositional geometry of a mixed clastic-carbonate platform system in a changing basin morphology (Eocene Àger Basin, Southern Pyrenees, Spain)

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The lower Eocene mixed clastic-carbonate succession of the Àger Basin, in the South Pyrenean Foreland Basin, share similarities with other Tethyan basins, particularly in the deposition and proliferation of large-benthic foraminifera forming extensive platform systems during the period following the Paleocene-Eocene Thermal Maximum (PETM) event. While previous studies in the area have focused on the siliciclastic-dominated systems of the succession, little attention has been given to the mixed clastic-carbonate platform deposits dominated by Alveolina and other large benthic foraminifera (known as Cadí Formation and Barranc de Contorna limestones). The present study aims to investigate the morphological changes of the basin and their impact on the development of carbonate factories and platform evolution. Analysis of facies associations and microfacies reveals the older Cadí Formation limestones formed in a shallow-water setting of an inner ramp with restricted environments, during a period of slow tectonic activity, whereas the younger Barranc de Contorna limestones were deposited concurrently with siliciclastic deposits, and show shallow-water mixed carbonate inner platform to offshore deposits, and a progradational slope setting, with progressive unconformities, consistent with faster uplift rates linked to thrust- or salt-related structures. The integration of stratigraphic data with a detailed lithological mapping show that tectonic activity controlled the basin margin evolution from a low gradient, carbonate-dominated ramp, into a steeper and more topographically unstable mixed clastic-carbonate platform. The findings of this study have implications for better understanding the role played by tectonic uplift, sediment delivery, and carbonate production styles in shaping platform architecture, with potential applications for the study of other similar Tethyan mixed successions, for example those forming reservoirs or aquifer systems in the Middle East.

# A subsurface carbonate tidal delta system of Mid-Cretaceous Mishrif Formation in Southeast Iraq: implications for reservoir heterogeneity

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Carbonate tidal delta systems used to be put much less attention than the counterparts in siliciclastic systems, and its unique architecture influences the reservoir heterogeneity and corresponding development strategy significantly. Mishrif Formation is the main producing zone in mideast. A flood tidal delta system was recognized and characterized in MB2 member of Mishrif Formation in H oilfield in Southeast Iraq, based on detailed observation of cores from 5 wells and integrated analysis on well-loggings and 3D seismic. Four lithofacies associations were recognized: (1) back-margin massive packstone to floatstone; (2) high energy channel-like bioclastic grainstone; (3) swamp carbonaceous mudstone interbedded with bioclastic wackestone; and (4) incision brown mud- to wackestone with chert nodular. The flood tidal delta system experienced the evolution of back margin wave-dominated shoal, channelized shoals, swamp, and eventually incisions. The internal architecture and stacking pattern of lithofacies associations enhanced the reservoir heterogeneity significantly. The swamp carbonaceous mudstone usually sit on the top of wave-dominated shoals separating from the flooding tidal channels, and constitutes the barrier separating the reservoir; and the valley-shaped mudstone and wackestone-filled incision, with the thickness of up to 30 m, compartmentalized the reservoir that is composed of shoal and channel-filling packstone and grainstone. Additionally, the prograding clinoforms occurred within the shoals and channels, which probably influence the fluid flow like those in siliciclastic sandstone. The tidal delta system experienced significant modification of meteoric water dissolution during the formation of incision and exposure of the platform, and consequently plenty of dissolved vugs formed along the sequence boundary, and caused the high permeable streaks. The depositional architecture and diagenetic modification resulted in the complicated reservoir architecture within the carbonate tidal delta system, which should be useful to the optimization of the development strategy of the oilfield and other counterparts with similar backgrounds.

# Validation of the Sub-Botton Profiler Bathymetry to indicate Silting rate at Itumbiara's UHE Reservoir

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Changing river flow regime when reaching a dam can lead water discharge to minimal velocities and drastically decrease its flow energy. Therefore, the sediment tends to silt, reducing useful volume and, consequently, lifetime of the reservoir. For this reason, monitoring the evolution of silting areas in the reservoir is crucial to reservoir management, the construction of engineering structures and to social purposes. Nowadays, it is common to use the difference of bathymetry at various times to reach the thickness of the sediment layers. However, there is a lack of data especially in undeveloped countries or old reservoirs making it impossible to indicate its siltation rate. As a promisor alternative, it might be possible to apply seismic methodologies to point different layers in the reservoir bed. With the use of Sub-Bottom Profiler, it is possible to shoot sound waves with 5 – 15 kHz ratio frequency in which penetrates different layers differing its materials indicating the preexisting bed and its new silting formation. In this work, the Sub-Botton Profiler Echoes 10000 was used for data collection at Itumbiara's UHE Reservoir, in Goias and Minas Gerais, Brazil with the administration of Eletrobras Furnas. The results were compared with the bathymetry of the reservoir in 2019, provided by Eletrobras Furnas, to validate the results and estimate the relative errors. With the equipment it was possible to indicate the layers' formation with satisfactory results. It shows that it is possible to infer the siltation rate of any reservoir even with the lack of past data.

# Effectiveness and petroleum geological significance of tectonic fractures in the ultra-deep zone of the Kuqa foreland thrust belt: a case study of the Cretaceous Bashijiqike Formation in the Keshen gas field

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The buried depth of the gas-producing reservoir in the Kuqa foreland thrust belt of the Tarim Basin exceeds 6000 m. The average matrix porosity of the reservoir is 5.5%, and the average matrix permeability is 0.128 mD. In order to reveal the characteristics and effectiveness of ultra-deep fractures and their effects on reservoir properties and natural gas production, outcrops, cores, thin section, image logs and production testing data are used to investigate the effectiveness of tectonic fractures in ultra-deep reservoirs in the Kuqa foreland thrust zone, and the corresponding geological significance for oil and gas exploration and development are discussed. Tectonic fractures in the thrust belt include EW-trending high-angle tensile fractures and NS-trending vertical shear fractures. The former has a relatively high filling rate, while the latter is mostly unfilled. Micro-fractures are usually grain-piercing-through cracks with width of 10–100 microns. In the planar view, the effective fractures are concentrated in the high part and wing zones of the long axis of the anticline, and along the vertical direction, they are mainly found in the tensile fracture zone above the neutral plane. The adjustment fracture zone has the strongest vertical extension abilities and high effectiveness, followed by the nearly EW longitudinal tensile fracture zone,and the netted fracture zone with multiple dip angles. The effectiveness of fracture is mainly controlled by fracture aperture and filling degrees. Effective fractures can increase reservoir permeability by 1–2 orders of magnitude. The higher part of the anticline is associated with high tectonic fracture permeability, which control enrichment and high production of natural gas. The netted vertical open fractures effectively communicate with pores and throats of the reservoir matrix, which forms an apparent-homogenous to medium-heterogeneous body that is seen with high production of natural gas sustained for a long term.

# Increasing the resilience of coastal areas to rising relative sea levels through nature-based solution: an example from the Po River Delta

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River deltas are among the largest depositional features on Earth, and are ecologically and economically important. However, increasing climate extremes, population growth, and both natural and human-induced subsidence are currently threatening many of the World's river deltas. In such a context, it is becoming increasingly clear how hard engineering measures (e.g., dams, dikes, and levees) are unsustainable and likely to reduce deltaic ecosystems' resilience in the long run. Thus, a paradigm change in river-delta management plans is underway, from hard infrastructures to "nature-based" solutions to restore deltaic lands.

Among the World's major river deltas, the Po River Delta (Italy) represents a prominent example of a heavily engineered deltaic system with compromised long-term sustainability due to: i) extensive embankments of the main river course; ii) reduced sediment and water supply from the catchment area due to over-exploitation of resources for irrigation and drinking purposes; iii) high rates of anthropogenic-induced subsidence. Nature-based solutions to restore the Po River Delta have not been considered to date, and this work aims to provide the first step to bridge this knowledge gap.

We are quantifying the inherent ability of the delta system to create new land, by studying a newly formed crevasse-splay system. The crevasse splay was recently generated by storm surges and river flood levee-breaching, leading to sediment accumulation in an area that was completely flooded due to soil subsidence over the last century. This work is based on a multidisciplinary approach involving sedimentological analyses, remote sensing, and numerical modeling. Through sedimentological and remote sensing analyses, the geomorphological evolution and potential land-building rates are estimated, taking into account local subsidence rates. The results help to improve our knowledge of natural systems resilience and offer critical insights on future management strategies for coastal areas.

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# SEDIMENTATION ON THE JURASSIC PELAGIC PLATEAU ADJACENT TO ACTIVE CARBONATE PLATFORM (JULIAN ALPS, NW SLOVENIA)

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In the Early Jurassic, the paleogeography of the transitional area between the Alps and the Dinarides (present-day Slovenia) was characterized by the Dinaric (Adriatic, Friuli) Carbonate Platform (DCP) in the south, the intermediate, E-W extending Slovenian Basin (SB), and the Julian Carbonate Platform (JCP) in the north. The carbonate platforms merged into single platform towards the west. In the Middle Jurassic, the JCP drowned and became a pelagic plateau, the Julian High, that is characterized by Ammonitico Rosso facies (the Prehodavci Formation). In the area of the former connection to the west, however, specific sedimentary sequences developed. They were studied in two sections located in the Matajur (today's Dinards) and Kobariški stol (today's Southern Alps) mountains. The investigated sections are of crucial importance for understanding the sedimentary evolution of this area. In both locations, the shallow-marine Early Jurassic limestone is overlain with the Toarcian-Aalenian stratigraphic gap by a deep-marine sequence varying in thickness from 78m on Matajur to 55m on Kobariški stol. The sequence begins with thick layers of limestone breccias (calcidebrites) alternating with micritic (pelagic) limestones and calcarenites (calciturbidites). The resediments are coarser and thicker in the Matajur section, which was located closer to the active DCP. The breccias disappear upwards and Saccoccoma bioclasts occur in the pelagic limestone. On the Matajur these beds contain chert nodules, on the Kobariški stol initially also, while they pass upwards into the Ammonitico rosso limestone. The Jurassic sequence ends with the pelagic Biancone limestone. The subsidence of the area probably occurred in the middle of the Middle Jurassic. This drowning event is interpreted as a consequence of the extensional (transtensional) tectonic pulse recently documented along the entire southern margin of the SB, where the collapse of the DCP margin formed a sequence of limestone blocky breccies up to 80m thick.

# The Miocene lacustrine carbonate factory of Ñirihuau, Argentina: Insights from detailed facies, microfacies and stable isotope analysis

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The Ñirihuau basin is located between 41° and 43° S, on the eastern side of the North Patagonian Andes, Argentina. Its infilling is characterized by a sequence of Oligocene to Miocene volcanic rocks (Ventana Formation) followed by Miocene volcaniclastic, clastic, and carbonate rocks (Ñirihuau and Collón Curá formations). The Ñirihuau Formation was interpreted to be deposited on alluvial, fluvial, deltaic, and lacustrine environments and based on available U-Pb geochronological data, was constrained to the early to late Miocene (22–11 Ma). The aim of this study is to understand the paleoenvironmental, hydrologic, paleogeographic, and climatic conditions that prevailed during the deposition of the lacustrine system that was established between ~15-13 Ma (Langhian–Serravallian). For that purpose, a detailed facies and microfacies analysis of carbonate beds from the Ñirihuau Formation in the northernmost sector basin was conducted. Detailed sedimentary logs were surveyed along the Arroyo Las Bayas, at the eastern and western flank of the David Syncline. A single facies association (FA) was defined, named FA1, and interpreted as a perennial lake associated with a deltaic system and dominated by detrital clastic material from a fluvial input. It includes two facies (Marginal lacustrine and Lower delta plain). Petrographic, cathodoluminescence, and stable isotope data of these continental carbonates suggest a mainly bio-induced subaqueous carbonate precipitation and subordinated deposition by tractive flows with low transport on a littoral lacustrine environment. Some of them exhibit subaerial exposure and very early diagenesis (eogenesis) with minor mesogenesis (such as cementation or chemical compaction) effects. Based on all the features observed in the analyzed carbonate beds, the paleolake system would have been characterized by a high energy ramp margin located to the N and E and by a low energy ramp margin towards the SW, and it would have been deposited under temperate to warm and humid conditions.

# Remote sensing for monitoring reservoir margin erosion

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Erosion of reservoir margins significantly increases the volume of sediment transported. This erosive process occurs for a variety of factors, such as winds, fluctuations in water levels caused by its use and changes due to the dry or rainy season, as well as the movement of the water wave in the reservoir, which makes a dragging movement with the soil. Waves in bodies of water occur by the transfer of energy from other sources, such as winds, to the liquid surface and this transfers to physical structures or to the margins, dissipating part of the energy. There are several ways to monitor erosion, traditional methods and by geotechnologies. In this research, remote sensing was used to acquire the data. Remote sensing is a tool used in various areas, which has been widely used in monitoring erosive processes. In geomorphology, it assists in the acquisition of data quickly with different scales. This acquisition can occur through satellite images, UAV, LiDAR; with spatial resolution that varies between meters and millimeters. The research was carried out in the Itumbiara reservoir, whose operator is Eletrobras Furnas, is located on the border of the states of Goiás and Minas Gerais, in the central west of Brazil. The margin data were obtained with low-cost and high-cost UAVs and via LiDAR during a period of reduction in the volume of the reservoir. The results of the scans were compared, showing satisfactory results, being replicable even in areas with different characteristics.

# Evidences of green sulphur bacteria in the Messinian succession of the Sorbas basin: preliminary data from organic geochemistry

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One of the main objectives of Earth Science studies today is to understand the causes and consequences of the environmental crises. Among them, the Messinian Salinity Crisis (MSC) is one of the most interesting, because it resulted in the generation of the last salt giant on Earth. Given the large volume of data collected and the high-resolution of the astronomically tuned and dated sedimentary successions, the MSC offers a unique opportunity to study the effect of short-term environmental variability and its impact on biological communities. In particular, the resilience of microbial communities has recently received attention as one of the youngest analogues to the eutrophication of modern water, extra-terrestrial conditions and a chance to study the adaptation of extremophiles. The late Miocene Sorbas basin in south-western Spain presents a good case study for these phenomena, since it hosts one of the most complete records of the MSC and is used as reference for astronomical tuning. However, in the absence of sedimentological and micropaleontological evidence in the shaly pre-evaporitic successions, it is hard to understand the impact of the extreme salinities, anoxia, and desiccation on the aquatic biosphere and on water conditions (i.e. temperatures, salinities and stratification). In this study, new constraints have been derived from the analyses of organic debris in shales from both pre- and inter-evaporitic deposits from a new 178-m deep drill core in the Sorbas basin. Our preliminary results indicate the presence of isorenieratene derivatives in the form of aryl isoprenoids, that can be evidence of green sulphur bacteria at the onset of the MSC. Other isoprenoid biomarkers indicative of halophiles and hypersaline conditions (i.e. squalane) are found in the pre-evaporitic sequences analysed so far, but aryl-isoprenoids and similar isorenieratene derivatives are not detected. Data provide first evidence that euxinic conditions established well before gypsum precipitation.

# Sedimentological core investigation of the fluvial-marine transition zone preserved in the 3.2 Ga Moodies Group from the Barberton Greenstone Belt, South Africa

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The ca. 3.22 Ga Paleoarchean Moodies Group in the Barberton Greenstone Belt (South Africa) represents one of the oldest shallow-marine quartzose sedimentary systems on Earth. Due to early silicification, sedimentary structures in the 3.7 km thick succession are usually well-preserved, allowing a detailed analysis of environments and surface conditions during the development of early life on Earth. The Moodies Group was cored in the framework of International Continental Drilling Project (ICDP) "Barberton Archean Surface Environments" (BASE). Here, we focus on the fluvial-marine transition zone in the Moodies Group using cores recently extracted in the proximal, medial and distal part of the so-called Lomati Delta Complex (LDC, Sites 4A-C). To reveal the dominant sedimentary processes within this dynamic depositional environment, we present results from detailed sedimentological logging, facies analysis, and petrography.

The LDC is a stratigraphic unit with a wedge-shaped geometry that is approximately 300 m thick at its thickest point and pinches out over a distance of 7 km. The deposits consist of cross-bedded siliciclastic coarse-grained sandstones and conglomerates that transition into finer-grained and tuffaceous sandstones. Sedimentary structures include tangential and tabular cross bedding, desiccation cracks, conglomeratic beds, rare microbial mats, and soft-sediment deformation related to fluid escapes. Mud- and tuff-rip-up clasts are common, as well as extraclasts. Based on these features, the LDC has been interpreted as a fluvial-marine system with highly variable energy conditions, likely linked to the ephemerality of local rivers. Our detailed core-based sedimentological descriptions allow for a more detailed reconstruction of the fluvial-marine transition zone in the Moodies Group compared to previous outcrop-based studies. This analysis provides the sedimentological context for follow-up geochemical and stratigraphic work, aiming at a detailed reconstruction of Paleoarchean environmental dynamics and conditions under which early life spread.

# THE EDIACARAN BASEMENT OF THE MOESIAN PLATFORM: A REVIEW BASED ON SEDIMENTOLOGICAL, MINERALOGICAL AND DETRITAL ZIRCON DATA

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In the area of Dobrogea, located in the Carpathian foreland west of the Black Sea, the Moesian Platform consists of two tectonic blocks with distinct lithological constitution. The uplifted Central Dobrogea block exposes a basement of Ediacaran turbidites (Histria Formation), while Late Neoproterozoic deposits of the South Dobrogea block (Cocoşu Group) are found in two boreholes beneath a 600 m thick succession of Upper Jurassic carbonates.

The sandstone-dominated turbidites of the Histria Formation are submarine fans, representing channel and lobe complexes deposited in a deep-sea environment from sediment-gravity flows. The overall sedimentological features and the dominance of sandstones suggest that turbidite accumulation took place on a fan developed in active margin setting. Sandstone mineralogy indicates a terrigenous, continental margin source area, as well as a bimodal, basalt-dominated volcanic source. A forearc basin, or a peripheral foreland basin (foredeep) are the models proposed as tectonic settings. The Ediacaran age is based on Vendobionts. The youngest peak of detrital zircon data of 620-610 Ma confirms the Ediacaran age of the turbiditic succession.

The Cocoşu Group is an 859 m thick succession, directly overlying a basement of Banded Iron Formation-type rocks. It consists of a lower volcano-sedimentary and an upper terrigenous complex, in tectonic contact with each other. The volcano-sedimentary complex includes basalt flows separated by pyroclastic and epiclastic sequences, representing two main upward thinning cycles. The upper complex is an upward coarsening, terrigenous sequence of shales, clays and conglomerates. Geochemical data indicate an alkali-basaltic volcanism, which possibly took place in an intraplate geotectonic setting.

The two Neoproterozoic successions show different sedimentological features and facies types, as well as mineralogical differences in their coarse members. The paper discusses all the existing data, which can help unravelling the possible relationships between them.

# Examining contemporary reef island dynamics in a Southeast Asian archipelago in light of climate change

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Low-lying coral reef islands are estimated to be one of the most vulnerable landforms to the effects of anthropogenic climate change. Increasing sea-levels, changes in wave regimes, reef degradation, are all considered key threats to their future persistence and habitability. While a number of studies have examined morphological changes on islands over multidecadal timescales, there is a paucity of high-frequency data from recent years that discern variability in shoreline change trends at the local-scale. Such analysis can enable a comprehensive understanding of island dynamics and provide robust empirical records to inform adaptation measures. In this study, we used frequently sampled high-resolution satellite imagery from the past two decades and analyzed the morphological evolution and dynamics of 22 reef islands of the Spermonde Archipelago, Indonesia - a location deemed as a climate change hotspot with sea-level rise rates higher than the global average. Analysis of 4329 transects cast across 192 recorded shorelines revealed a balance in erosional and accretionary response with 32% of transects characterized by statistically significant accretion, 29% by erosion and remaining exhibiting no significant change. The magnitude of shoreline changes showed high spatial variability across the archipelago with marked differences between islands perched on patch reefs on the outer shelf and those in the mid-shelf and nearshore. Of note, at the local-scale, accretion was predominant on the western margins of islands, while the eastern margins experienced relatively high degrees of erosion, leading to a westward migration of 55% of the islands on their reef platforms. Collectively, results provide the first high-resolution shoreline change record for the archipelago and highlight the importance of high-frequency sampling in reef island studies for informing adaptation strategies. Additionally, results have implications towards understanding island evolution over a period of accelerated sea-level rise within a region highly influenced by monsoonal changes in hydrodynamic regime.

# Facies evolution and geochemical analysis of Jurassic mixed carbonate-siliciclastic deposits from the northern Bighorn Basin (Sundance Fm, north-central Wyoming, USA)

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During the middle-late Jurassic (Bathonian to Oxfordian), deposition in the Bighorn Basin (north-central Wyoming, USA) took place in a mixed carbonate-siliciclastic platform, originated as a retroarc basin connected to the Pacific Ocean by a single entrance to the north (the Jurassic Sundance Seaway). These deposits, the Sundance Formation, represent sedimentation from intertidal to distal offshore domains. Previous analyses on the facies architecture of this unit have revealed a complex palaeogeography of the Sundance marine platform, with a changing depositional topography partly controlled by the tectonic activity originated in the evolving magmatic arc westwards. This palaeogeographic context has traditionally made the analysis and regional correlation of these deposits intricate, with the existence of some discontinuities that laterally change in different sectors of the basin. Here, we provide a high-resolution stratigraphic and sedimentological analysis of this formation combining field descriptions and petrographic observations in two new sedimentary logs in the north-central areas of the Bighorn Basin. The Sundance Fm here is mainly represented by ca. 90 m-thick succession of alternating marls rich in belemnites and oysters deposited in offshore domains; and fine- to medium-grained cross-bedded sandstones and calcarenites with variable fauna (bivalves, brachiopods, echinoderms, foraminifera), interpreted as deposited from the lower shoreface to tidal environments. Carbon- and oxygen-stable isotopes, major and trace elements and cathodoluminescence analyses were performed on oysters and belemnites from different levels. From the 21 specimens analysed, 8 showed an exceptional high degree of preservation, with most of the isotopic values ranging between 2-3‰ for $\delta 13C$, and -1 to 1‰ for $\delta 18O$; and Fe and Mn concentrations below 100 and 10 ppm, respectively. Carbon and oxygen-stable isotopes here are similar to coeval open-ocean Tethyan data, indicating a still large aperture of the Sundance Seaway towards the Pacific Ocean.

# Impact of Paleoclimatic Conditions on the Genesis of Permian Continental Red Beds, Krkonose Piedmont Basin, Czechia

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This study explores the determinants of red coloration in continental Permian sediments within the Krknose Piedmont Basin, Czech Republic. The analyzed samples originated from diverse continental environments, including deep and shallow lacustrine settings, river environments, and floodplains. XRF data reveal a higher iron percentage in deep lacustrine gray-green sediments compared to others. However, electron microscope observations, Diffuse Reflectance Spectroscopy (DRS), and XRD analysis demonstrate the absence of hematite in deep lacustrine samples and its presence in shallow lacustrine, alluvial, and floodplain samples. Despite similar diagenetic stages, different stages showed negligible effects on sediment coloration and hematitization. The red hue in these continental sediments primarily arises from prevailing sedimentary conditions and early diagenesis, with limited influence from advanced diagenesis alone on the entire sedimentary sequence. This study emphasizes that paleoclimatic changes directly impact sedimentary environments and the early diagenesis stage, influencing red sediment formation by affecting iron source availability and oxidizing environments. The absence of red color in iron-rich sediments signifies prevailing reducing conditions during their formation. Conversely, a shift to an oxidizing environment facilitated red deposits due to decreasing water levels. Notably, sediments formed in deep lacustrine and anoxic settings maintain their original color despite high iron content and varied diagenesis processes.

# Structural Dynamics, Sedimentary Characteristics, and Strati-graphic Framework of the Early Miocene to Recent Himalayan Molasse Deposits in Kashmir Basin, Pakistan

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An understanding of the structural dynamics, sedimentary characteristics, and stratigraphic framework of the Early Miocene to Recent Himalayan molasse deposits in the Kashmir Basin is crucial for unraveling the tectonic history and geological evolution of the region. However, the lack of comprehensive studies on their structural dynamics, sedimentary traits, and stratigraphic framework hinders a complete understanding of the region's geological evolution. The studied area is situated in the southern portion of the Hazara Kashmir Syntaxis Pakistan, which is a significant segment of the Himalayan Fold and Thrust Belt located in the sub-Himalayan region. This region encompasses the Chaksawari, Palak, and Rajdhani areas, which together form the Syntaxis and are positioned in the southern part of Hazara Kashmir. The Hazara Kashmir Syntax is characterized by the presence of molasse deposits, representing an antiformal structure resulting from the tectonic activity in the Himalayas. These molasse deposits range in age from the Early Miocene to the Recent Period. The Nagri Formation, Dhok Pathan Formation, Soan Formation and Mirpur Formation, as well as Recent alluvium, are exposed in the Late Miocene to Recent molasse sedimentary sequence. The deformation of the terrain in this area is a consequence of the Himalayan orogeny, leading to the formation of folds and faults. The notable folds in the study area include the Palak Syncline, Gawandh Anticline, and Rajdhani Syncline. These folds exhibit northeast or southwest vergence and trend northwest-southeast which are closed in nature. Additionally, there are three major reverse faults in the area (Gawandh fault, Kotli Sarsawah fault, and Dhongolo fault). These faults, characterized by their northwest-southeast orientation are assumed to be caused by the Himalayan compression.

# Post-glacial development of Earth's oldest terrestrial red beds as direct evidence for the Great Oxidation Event, Huronian Supergroup, Ontario and Quebec, Canada

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The early Paleoproterozoic marks the initial rise of oxygen in Earth's atmosphere, although the exact timing and dynamics of this rise is still widely debated. While initial oxygenation of the atmosphere is popularly portrayed by changes in the fractionation of sulfur isotopes, our work elucidates an alternative proxy, the first appearance of red terrestrial (fluvial) sandstones (red beds), which occur in the upper Huronian Supergroup of Ontario and Quebec, Canada. The Huronian Supergroup is a mainly siliciclastic, sedimentary succession deposited between 2.45 and 2.22 Ga. Penecontemporaneous oxidizing surface conditions are inferred from the red beds by the occurrence of pigmentary hematite dust rims on detrital quartz grains, which are encased by syntaxial quartz overgrowths, implying that the hematite dust was formed and deposited prior to burial and lithification of the sandstone. Evidence for anoxic atmospheric conditions is captured lower in the Huronian succession by the preservation of detrital pyrite and uraninite in drab fluvial conglomerates. The terrestrial red beds deposited during a major climate warming episode, following a widespread (possibly global-scale) glaciation, which suggests a link between deglaciation and the buildup of oxygen in the atmosphere. Deglacial to post-glacial fluvial sandstones increase in maturity up-section, indicating an up-section intensification of climate-related chemical weathering. This would have promoted red bed development, particularly since the hematite dust rims are observed in relatively mature subfeldspathic arenites that were affected by post-depositional in situ chemical weathering. Reddening is constrained to have occurred close to 2.31 Ga, thereby approximating the time of initiation of terrestrial oxidative weathering. This would have triggered key feedbacks in nutrient cycling that possibly drove Earth's atmosphere into a stable oxidizing state.

# Disentangling the conduits of sediment delivery to the northern Hikurangi Margin of New Zealand

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A sediment provenance study on the sand fraction of gravity flow deposits obtained from the northern Hikurangi Subduction Margin (HSM) has been undertaken with the aim of establishing where sediment is routed from toward International Ocean Drilling Program (IODP) Site U1520, and to attempt to distinguish sediment sourced from the North Island versus the South Island of New Zealand. A ~500 m sediment core from Site U1520 is the focus of this study; this is the longest sediment record ever obtained from the Hikurangi Trough, preserving a continuous sequence of sedimentation deposited over the past ~1.85 ma. Site U1520 sits directly northwards of both the Hikurangi Channel and the mouth of the shelf-incising Māhia Canyon, with regional stratigraphic studies suggesting this locality is influenced by flows from both conduits. Improving our understanding of sediment provenance at this location will provide insight into the dynamics of sedimentary gravity flows along the HSM, particularly on the influence of southern versus northern canyons, and how they have changed over long timescales.

Sediment provenance has been assessed through the analysis of the sediment composition of smear slide samples acquired from both marine and terrestrial localities, accompanied by extensive XRF scanning of the core material. The comparison of the composition of marine samples acquired from individual beds in the sediment sequence to terrestrial samples acquired from across the North Island and the South Island of New Zealand allows for the assessment of the most likely provenance of each given sample. Initial results from these studies suggest that Tolaga Bay on the east coast of New Zealand's North Island shares a strong similarity to samples acquired from both the slope and trough near Site U1520.

# Distribution and prediction of grain coating chlorite in tide-dominated sandstones of Tilje Formation in Halten Terrace area, Norwegian Continental Shelf: Implications for Hydrocarbon exploration

Ms Monika Shukla

Chlorite clay coatings are pivotal in preserving porosity within deeply buried sandstone reservoirs by inhibiting quartz cementation. The Lower Jurassic Tilje Formation on Halten Terrace was deposited in a tide-dominated environment and consists primarily of sandstone with occasional interbedded siltstone and shale layers. The sediments exhibits heterogeneous distribution of chlorite-coated sandstone throughout the stratigraphic units, impacting reservoir quality and porosity preservation. Abnormalities in porosity within deeper intervals have been observed across various fields in the Halten Terrace area of the Norwegian Continental Shelf (NCS). Despite years of research on chlorite coatings, the spatial distribution and predictive factors governing chlorite coatings remain poorly understood, leading to uncertainties in exploration efforts. The hypothesis suggests that depositional environments, specifically facies associations, significantly influence the presence of chlorite-coated zones. Establishing a correlation between these factors is essential for obtaining a comprehensive understanding of the chlorite clay coat distribution. However, the major scientific challenge lies in accurately predicting the presence and distribution of chlorite coats. To overcome this challenge, the study aims to conduct a comprehensive analysis of conventional cores and well logs from eight key wells in the Halten Terrace area, supplemented by the collection of approximately 150 core samples, proximal to the points where petrophysical data is available, for subsurface analysis of Tilje Formation. Methodologies employed include detailed petrographic analysis at a high frequency, complemented by scanning electron microscopy (SEM) and X-ray diffraction (XRD) analysis, facilitating comprehensive characterization of chlorite coats and its distribution pattern. The anticipated outcome of this study is expected to improve our understanding of the extent of chlorite-coated sandstone within Tijle formation. The study also exploit areas exhibiting anomalous high reservoir quality and provide valuable insights for optimizing hydrocarbon exploration strategies in the Halten Terrace area and other similar geological settings.

# Changes in belemnite morphology, ecology and distribution across the Toarcian oceanic anoxic event (early Jurassic)

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Significant study into the Toarcian Anoxic Event (T-OAE), a hyperthermal event during the early Jurassic (183 Ma) which saw widespread ocean deoxygenation, shows that it was an extinction event that also significantly influenced marine ecosystems, marineinvertebrates and vertebrates, affecting body size, species distributions and food webs in response to the palaeoenvironmental changes. Investigations into the response of belemnites, an important biostratigraphicindicator, and component of Jurassic marine ecosystems is relatively limited and studies into the palaeobiological shifts is equally rare.
Within this investigation, belemnite samples, collectedfrom the Toarcian Whitby Mudstone Formation (NE Yorkshire coast), are examined in order to analyse the effects the T-OAE had on belemnite populations, andchanges in species assemblages. Taxonomic turnover is observed during the early H. falciferum, accompanying a fluctuation in the belemnite body size of certain genera such as Acrocoelites after the T-OAE. Diversification of rostra morphology is observed, contrasting the relatively homogeneous rostra sizes and shapes seen before the T-OAE.
This highlights that harsh low oxygen conditions within the T-OAE influenced belemnite populations in the Whitby Mudstone Formation, reflective of similar shifts in belemnite ecology seen in sections in Spain and Argentina. This correlates with rostra geochemistry which shows low oxygen conditions, fluctuating ocean temperatures and its wider effects may enforce morphological selection.

# Mega-mapping: new insights on strata-topography interactions in the Lower Cretaceous of the North Sea post-rift basins revealed from 3D mega-merge surveys

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Sediment gravity flow interactions with topography may determine sediment routeing, the location of erosion and depositional processes, and control stratal architecture of deep-water sedimentary systems, which can host important reservoirs. Greater understanding of the evolving interactions of deep-water systems with syn- to post-rift structural configurations are needed to improve prediction of heterogeneity in reservoirs deposited adjacent to active inherited tectonic structures.

To examine post-rift deep-water sedimentary systems, 3D megamerge seismic reflection data covering approximately 140,000 km2 is being used to map the Lower Cretaceous interval of the North Sea. Surveys from the Moray Firth, Viking Graben, Danish Graben, Southern and Central North Sea have been interpreted, together with well data, using the Base Cretaceous Unconformity Complex and Base Chalk reflections to constrain the study interval. Structure and isopach mapping of the Lower Cretaceous indicates that some major structures were still active in the lower Cretaceous, whilst sedimentation was occurring. Furthermore, the inherited rift topography was only healed later into the Cretaceous, where earlier structures continued to have some influence on deposition. In addition, outcrops of the Upper Cretaceous Vallcarga Formation in the Spanish Pyrenees, which record the transition between the post-rift stage and the onset of convergence, provide a complementary analogue the subsurface dataset. Mapping sedimentary facies and tectonic structures are facilitating interpretations at a sub-seismic scale. Finally, the data acquired in these studies are being compared in a relational database, known as the Deep Marine Architectural Knowledge Store, to compare the architectures and attributes of syn-rift systems with the newly studied post-rift systems.

Backstripping of flow pathways derived from seismic interpretations, allied with facies information from outcrop analogues, is facilitating reconstruction of these depositional slopes and topography. This allows visualisation and modelling of the subsurface heterogeneities to aid reservoir predictions for efforts such as carbon capture and underground storage.

# Role of channel sedimentation and floodplain topography in flood risk assessment of Himalayan rivers

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Floods in river systems are complex phenomena influenced by a variety of factors, among which channel sedimentation and floodplain topography play pivotal roles. Ghaghra is a major mountain-fed tributary of the Ganga River, and the combined effects of large sediment flux and human interventions have caused large-scale siltation, making it highly dynamic and susceptible to flood risk. To unravel the intricate relationships between sediment dynamics and flood risk, we aim to (a) develop sediment budgeting of the Ghaghra River system, (b) understand the discharge-sediment relationship and (c) carry out stage (water level)-based frequency analysis. Our study has provided important insights into temporal and spatial variations in water flow and sediment transport, highlighting their impacts on river morphology and floodplain formation. We document that discharge and water levels showed opposite trends nearly 401 times at one of the downstream stations (Turtipar) during the last 57 years, highlighting the role of channel morphodynamics on river hydrology. This also indicates that the stage is more sensitive to river bed level changes and, therefore, can serve as a better proxy for flood frequency analysis. Between the most upstream (Elgin bridge) and downstream (Turtipar) stations, the Ghaghra gains 60 MT/yr of sediment, which is deposited within the channel belt, thereby raising the channel bed. In such situations, discharge-frequency relationships tend to be erroneous. On the other hand, the stage-based flood frequency analysis elucidates the recurring patterns and probabilities of flood events in relation to sediment deposition and erosion within the river channel. At Turtipar, our frequency analysis shows that 100-year stage value crosses the danger level by around 1 meter. This data is being used to develop flood inundation models based on high-resolution DEM of the adjacent floodplains generated from UAV surveys.

# Mechanism of quality difference in ultra-deep and ultra-high pressure fractured low-porous sandstone reservoirs: Taking Keshen 2 gas reservoir of Tarim basin as an example

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Deep and ultra-deep hydrocarbon resources have become the key field of global hydrocarbon exploration and development. Clarifying the mechanism of deep and ultra-deep reservoir quality difference is significant to hydrocarbon exploration and development. The Cretaceous Bashjiqike Formation of Keshen 2 gas reservoir is the main gas-producing layer. It is a typical ultra-deep and ultra-high pressure fractured low porosity sandstone reservoir, with a burial depth of 6000m-7500m, the matrix reservoir has low porosity and permeability, and developed fractures. Based on petrographic thin section, scanning electron microscope(SEM), confocal laser scanning micros(CLSM), X-ray diffraction, mercury injection, and imaging logging, this study reveals the mechanism of effective reservoir quality difference in the Bashijiqike Formation of Keshen 2 gas reservoir from three aspects of sedimentation, diagenesis, and structure by using core observation, slice identification, physical property analysis, and fracture interpretation. The underwater distributary channel and estuary sandbar are good reservoirs, which have strong hydrodynamic force, well-sorting, and good physical properties. The development of primary intergranular pores in the reservoir is due to the overpressure system formed by the gypsum-salt layer overlying the Bashijiqik Formation, which weakens the compaction of the reservoir. Besides, the long-term shallow burial of the reservoir in the early stage and rapid deep burial in the later stage slow down the compaction. In addition, the secondary pores are relatively developed, because overpressure strengthens the dissolution of deep acidic water to feldspar and carbonate minerals, thus promoting the formation and development of secondary pores and improving the physical properties of the reservoir. Fractures develop near faults and in areas with high curvature, which greatly improves the seepage capacity of the reservoir. Comprehensive analysis shows that the original sedimentary environment with strong hydrodynamic force, overpressure system, burial mode, dissolution, and fracture development are the main factors affecting the difference in reservoir quality.

# STRONTIUM, CARBON AND OXYGEN ISOTOPIC EVIDENCE FOR THE ORIGIN AND EVOLUTION OF PRE-SALT CARBONATES FROM THE SANTOS BASIN, BRAZIL

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The genesis of Pre-Salt rocks, which hold giant petroleum accumulations in the Brazilian marginal basins, involves a complex set of depositional and diagenetic processes, resulting in intricate mineral relationships. This study utilizes 87Sr/86Sr, δ13C, and δ18O isotopic data, along with detailed petrography, to understand their processes of formation and modification. Fifty-six samples from nine wells in three different fields at Santos Basin were examined. Strontium data were obtained through LA-MC-ICP-MS to determine 87Sr/86Sr ratios for various calcite phases (spherulitic, fascicular, rims and lamellar) and dolomite (blocky, lamellar, microcrystalline, pseudomorphic, and saddle). δ13C and δ18O analyses were conducted through differential acid extraction to obtain values relative to calcite and dolomite. The 87Sr/86Sr ratios of calcite range from 0.71402 to. 0.71194, with an average of 0.71352, while dolomite exhibits a range from 0.71439 to 0.71143, with an average of 0.71339. These strongly radiogenic values, consistent with other data for the Pre-Salt, imply in an important input of fluids from the plutonic basement to the lacustrine system. Calcite δ13C values range from 0.94 to 4.48‰VPDB, while δ18O ranges from 0.66 to 4.19‰VPDB. Dolomite δ13C varies between -1.15 and 4.65‰VPDB, while δ18O ranges from -3.03 to 3.22‰VPDB. The δ13C values suggest a predominantly inorganic carbon source, while δ18O is consistent with a highly evaporative environment. The lower dolomite δ18O values are related to higher precipitation temperatures, during diagenesis. Despite the limited variation in the 87Sr/86Sr range, a negative trend with δ13C and δ18O potentially indicates an increasing degree of diagenetic modification. Continued studies will further constrain the environmental conditions for precipitation of the diverse carbonate phases and the genetic conditions of this extraordinary system.

# Evaluating the drivers of black shale formation: a shallow marine PETM section, northern Caucasus

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The formation of black shales involves a unique set of enigmatic paleoenvironmental conditions which remain the focus of research in both academia and industry. Previous investigations at Kheu River, northern Caucasus have since dated an extensive organic rich ~80-kyr (?sapropelite) horizon, correlated over vast areas in the Peri-Tethyan region to the onset of the Paleocene-Eocene Thermal Maximum (PETM) ~56 million years ago. Although changes in relative sea level and/or the hydrological cycle have been both suggested as potential drivers of regional anoxia within the Peri-Tethys, the temporal relationship between these changing paleoenvironmental conditions and the onset of the black shale deposition remain poorly quantified. Therefore, we address this research gap by presenting a 1.3 million-year-long record of new and established geochemical, micropalaeontological, and sedimentological datasets from Kheu River, calibrated to an orbitally tuned age model. Similar shallowing and deepening trends inferred from the variations in elemental ratios up sequence suggest changes in relative sea level had a first order control on the establishment of anoxia during the onset of the PETM. Furthermore, high resolution records within the black shale horizon point to two distinct modes for organic matter deposition. The assessment of the key mechanisms driving the deposition of the PETM black shale at Kheu are paramount to improving our understanding of how regional marine tipping points interact and respond under a warming climate.

# Differentiation between different types of landslide reservoirs (MTD’s): Case Study

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Research area is located in the central part of the basin lowland. The area has been fairly well studied by 2D and 3D seismic surveys, exploration and production drilling. As a basis for development, an integrated facies model of the Neocomian clinoform complex (strata AC10-AC12) is used.
Until the recent years, lithologically limited reservoirs of deepwater landslide deposits (MTD) were not considered as promising objects.
As a result of a comprehensive study of core, logging and seismic, two types of landslide bodies were diagnosed and described.
The first type is the displacement of blocks along the slope with the preservation of the internal structure, inside the landslide blocks (structural landslides) with a ridge-hollow surface relief; the second is the displacement of landslide masses with plastic deformation and partial disintegration of the displaced deposits through the formation of a slump flow. Only MTD’s of structural type have reservoir potential.
They are characterized by an alternation of thin (tens of centimeters) intervals with landslide textures, within areas of a typical structure of channel or fan complexes, in which porosity is completely preserved and permeability does not change. Process of slumping highly impaired internal structure and reservoir properties of plastic MTD’s, thus transforming it to non-reservoirs.
Size of blocks with preserved sedimentary structure and reservoir properties is much smaller than the fan bodies.
Dimensions of the internal structural blocks of landslides were determined by using the data of the study of modern surface landslides, for which the ratio of the length of the blocks that make up the ridge-hollow relief to the length of the landslide itself is 1:6 to 1:12, and the width is 1:10 to 1:20. In addition, the height of the vertical displacement can be used as a guideline for the estimated thickness of landslide bodies..

# Prediction of facies controlled high-quality reservoirs in the second member of Xujiahe Formation in Laoguanmiao area, Northwest Sichuan, China

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A typical tight sandstone gas reservoir is developed in the second member of Xujiahe Formation in Laoguanmiao area, Northwest Sichuan. The reservoir heterogeneity is strong. The wave impedance value of relatively high-quality reservoir is similar to that of mudstone. It is difficult to identify the distribution of high-quality reservoir by using traditional wave impedance inversion and attribute analysis technology. In view of the above problems, by analyzing the seismic response characteristics of high-quality reservoirs combined with well and earthquake, the concept of clastic rock fault solution is put forward, the seismic identification model of clastic rock fault solution in Laoguanmiao area is established, and the method of jointly predicting the distribution of high-quality reservoirs in this area by seismic sedimentology analysis and structural tensor technology is further proposed, It mainly includes three steps: First, using seismic sedimentology analysis technology to predict the development area of tight sandstone reservoir in Xu2 member; Second, the structural tensor technique is used to predict the development zone of clastic rock fault solution corresponding to the second member of Xu formation; Third, combined with the results of seismic sedimentology analysis and structural tensor identification, the relatively high-quality reservoir development area is predicted through the calibration of core and logging data. The research results show that the delta front deposits distributed in the north-south direction are developed in the second member of Xu formation in Laoguanmiao, and the relatively high-quality reservoir development area is controlled by the reverse fault. It is predicted that the favorable area of the sixth sand formation of the second member of Xu formation is 21.5 km2, which is mainly distributed in the area close to the fault. The research results enrich the prediction technology of high-quality tight sandstone reservoir, and have important reference significance for guiding tight sandstone natural gas exploration.

# Carbonate platforms sequence stratigraphy at Monte Alto di Pelsa (Italy)

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Thick carbonate platform sequences are a characteristic feature of the Dolomites region (NE Italy), with several generations of carbonate buildups growing on top of each other during the time interval from Middle to Late Triassic. In many localities, almost completely preserved buildups, lifted but little deformed by Alpine tectonics, are widely exposed because of the differential erosion of the surrounding and overlying basinal sediments, allowing the direct observation of their original structures, from the microscopic to the seismic scales.

However, identification of different carbonate platform generations, and the reconstruction of their evolutionary stages, is difficult due to the limited biostratigraphic resolution of fossil assemblages in carbonate platform environment, widespread pervasive dolomitization across subsequent superimposed carbonate buildups and burial of older buildups under younger ones. At Monte Alto di Pelsa, a minor summit of the Monte Civetta massif, a Middle Triassic sequence of overlapping carbonate platforms is preserved. By means of drowning and subaerial exposure events detected within the sequence, four carbonate platforms growth phases can be identified: an initial progradational platform was followed by a backstepping platform that was terminated by drowning. As the carbonate factory recovered after the drowning event, a new progradational platform developed and it was terminated by subaerial exposure. The sequence is finally closed by the growth of an aggradational platform. Due to the resolution of available biostratigraphic data, a direct age determination of each individual carbonate platform could not be achieved. However, by means of a sequence stratigraphic approach, this sequence could be compared with the currently available Middle Triassic stratigraphic schemes, allowing the identification of the individual carbonate platform formations in a sedimentary evolution dominated by eustatic control.

# Integration of Borehole Images and Core to Identify Key stratigraphic surfaces in Upper Paleozoic Successions, Murzuq Basin, Libya

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Murzuq Basin is considered to be a sag basin in the South-Western. Sedimentary fill of the basin ranges from Precambrian to Triassic and is predominantly by clastics rocks. Recently, several wells are drilled in the northwestern part of the basin in an area called Atshan Saddle. Extensive coring program was executed covering most of the Devonian. Also, covering the same interval, high resolution borehole images were acquired delivering excellent quality images. The borehole images cover formations: Tahara, Awainat Wanin and Mrar formations. These formations have mostly been deposited in marginal settings in which wave, tide and storm produced sedimentary structures are clearly visible on core and borehole images.

A detailed sedimentological analysis of borehole images and core revealed tide-influenced heterolithic facies, storm-reworked facies and extended sections of ripple-marked heterolithics. Channel unit was interpreted in Tahara formation extending NNW-SSE. The internal structures of the channel body revealed the reservoir quality variation within the channel unit. Integration of conventional logs with borehole images led to the identification of key sequence stratigraphic surfaces such as the maximum flooding surface in the upper Mrar. A paleosol is recognized at the base of Tahara formation in all the drilled wells that can also be used as a stratigraphic marker. Borehole images have also revealed a well-documented key stratigraphic horizon where stromatolites are recorded. Stromatolites were clearly visible on borehole images.
This paper aim to show the value of integrating core with borehole images for a more comprehensive sedimentological analysis of subsuraface formations, particularly those that lack a representative surface exposure.

# Structural Characteristics And Its Origin Of The Lacustrine Carbonate Rocks In The Cretaceous Bve Formation In Santos Basin, Brazil

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The pre-salt Cretaceous Barra Velha Formation in Santos Basin, Brazil, develops dendritic and globular lacustrine carbonate rocks, and the understanding of its sedimentary genesis is still quite different. Based on the core and thin section data of the 30 wells, combined with the geochemical characteristics, this paper studies the structural characteristics of dendritic and globular minerals in Barra Velha Formation in detail, and further discusses the sedimentary genesis of these two types of rocks. The research shows that the dendritic and globular minerals have wavy extinction characteristics, which are formed by the aggregation of a large number of fibrous and prismatic calcite microcrystals, arranged in a fan-shaped and radial manner. From bottom to top, the lithologic sequence of micrite limestone, globular texture limestone and dendritic texture limestone appears in sequence vertically. The test results of trace elements, carbon and oxygen isotopes and cluster isotopes show that the fluid of spheroidal limestone and dendritic limestone has the characteristics of high temperature and high salinity, which are the evidence of the genesis of hydrothermal sedimentation. Therefore, this paper believes that the Barra Velha Formation develops hydrothermal sedimentary carbonate rocks, which provides a new direction for studying the reservoir space and distribution law of this carbonate reservoir.

# Carbonate reservoir Multicomponent Seismic Imaging

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Carbonate reservoirs are characterized by extremely heterogeneous porosity and permeability. These heterogeneities are caused by the wide spectrum of environments in which carbonates are deposited and by subsequent diagenetic alteration of the original rock fabric. Pore systems range from thick, vuggy reservoirs in the coarse grained skeletal-rich facies of the reef margin or platform margin to highly stratified, often discontinuous reservoirs in the reef interior, platform interior and nearshore facies. Seismic Imaging for the small-scale feature in complex subsurface geology such as Carbonate is not easy to capture because of seismic propagated wave affected by heterogeneous properties of objects in the subsurface. The principal goal of anisotropic seismic diffraction & reflection imaging is to get a subsurface image of structural features with the greatest sharpness or resolution. Diffraction imaging improved imaging of faults karst fracture voids karst and identification of heterogeneous regions below the resolution of reflections in a reservoir. Multicomponent seismic data (3C on land/4C on seabed) ,3C/2D, 4C/2D, 4C/3D, 4C/4D, 3D/3C-5D,4D/3C-6D,3D/9C-7D, 4D/9C/8D have unique information content that has proven to be useful in structural interpretation. The main purpose of multicomponent seismic, is to record and utilize both compressional P and shear S wave modes, information related to rock properties (compressibility, rigidity and density).Processing multicomponent PP and PS seismic data is more challenging compared to conventional PP seismic data due to the asymmetric ray paths caused by velocity variation between P and S waves. P-P and P-S amplitude maps and vertical sections from the analyzed spectral decomposition methods Continuous Wavelet Transform (CWT) in delineating the channel, thin bed imaging stratigraphic traps pich outs. The frequency-derived Vp/Vs ratio fails to distinguish the lithology variation within the channel (thalweg ) as does the Vp/Vs ratio extracted from the conventional P-P and P-S data.

# Shale Gas Diffusion of the Silurian Longmaxi Formation in the Sichuan Basin, China: Evidences from Nano-scale to Basin-scale

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Shale gas diffusion of the Silurian Longmaxi Formation shale gas reservoir in the Sichuan Basin was studied based on the FIB-SEM, Nano-CT, core observation of in-situ gas desorption, δ13C values of methane, fluid inclusion, and basin analysis. The FIB-SEM images show that the pores in the shale are mainly range from 2 nm to 400 nm, which is no favorable for gas diffusion. But the 3D pore network showed by Nano-CT indicates that the pore connectivity at horizontal direction is prominent better than that at vertical direction. The core observation of in-situ gas desorption indicates that the gas dominant bubble out along the bedding and almost no gas bubbles leak out along the vertical direction. In addition, the permeability at horizontal direction is more than 10 times higher than that at vertical direction. Therefore, from nano-scale to centimeter-scale, the gas diffusion along the bedding at horizontal direction is more favorable than that at vertical direction. Compared to the shale gas in the basin center, the shale gas in the basin margin have a reversed carbon isotope trend and the shale has 3-4 periods of fluid inclusion indicating that the multiphase gas filled in the basin margin. Therefore, although the shale generally has poor porosity and permeability, a long distance dissipation of shale gas from the basin center to basin margin still could occur. Due to the shale gas would release more quickly in the basin margin where the shale still has high organic matter content and high maturity, the gas-rich shale reservoirs are preferred located in the area far away from basin margin.

# Diagenetic response and impact on reservoir properties of clastic buried hill buried-uplifted-reburied

## —A case study from upper Shihezi formation in Permian of Gubei buried hill of Jiyang Depression

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This paper aims to gain new insights into clastic buried hill reservoirs. For this purpose, the Permian sandstone reservoirs in Upper Shihezi Formation, Gubei buried hill was taken as the object. Referring to the diagenesis in the process of burial-lifting-reburning of the reservoirs, with the aid of techniques like core observation, SEM, cathode luminescence, carbon-oxygen isotope analysis and fluid inclusion. The results show that: The diagenetic evolution of the reservoir has gone through three stages . Stage I: Late Triassic and Early-Middle Jurassic, and the main diagenetic environment was shallow burial and uplift exposure denudation. The main diagenetic responses are feldspar dissolution, kaolinite cementation, stage ① quartz cementation and limonite invasion. Stage II: Jurassic and Cretaceous, the strong tectonic activity accompanied by active volcanic activity, and the hydrothermal activity associated with volcanic activity greatly affected the reservoir. The diagenetic response is the development of stage ① carbonate cementation, stage ② quartz cementation, pyrite, sericite, chlorite and long columnar apatite. Stage Ⅲ: Cenozoic,the burial depth of Gubei buried hill increased, the maturity of organic matter increased, and the diagenetic environment was dominated by organic acid. The diagenetic response was mainly from carbonate cementation and quartz dissolution in stage ② to carbonate dissolution and feldspar dissolution in late stage. The results of quantitative restoration of pore evolution show that the compaction and cementation in stage Ⅰ and Ⅱ have a great influence on the porosity, which decreases from 40% to 19%, and the diagenesis in early alkaline environment in stage Ⅲ has a destructive effect on the porosity of the reservoir, which decreases from 19% to 6.7%; After that, the porosity of the reservoir increased from 6. 7% to 9. 1% due to the dissolution reconstruction in acidic environment.

# Multiproxy provenance study of Surma sandstone, Manipur, Northeast India: tectonic implications

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The Manipur hills of the Indo-Myanmar Range (IMR) have a distinct entity for collision between the Indian and the Myanmar Plates following a history of eastward subduction. Petrographic and multiproxy provenance study of sandstone from the Surma Group of Manipur foreland basin has been carried out. We integrate the compositional data of detrital garnet and chromite, Raman spectroscopy of garnets, and U–Pb ages of detrital zircons to decipher the provenance. The studied sample is texturally and mineralogically immature with probable sources as sedimentary and metamorphic rocks as evidenced by the presence of detrital chert, quartz, muscovite, tourmaline, and garnet. The Raman analyses of garnets indicates pyralspite solid solution. Electron microprobe analysis shows a wide compositional variation (Py16-2Al70-37Sp55-2Gr28-2), spanning from medium to high grade metamorphic rocks (biotite schists) to granitoid rocks (pegmatites and granites). Detrital chromite is a brown-black Al-chromite and some chromites are red-black and similar in compositions to the reported Manipur ophiolite spinels, while others show deviations arising probably due to secondary alteration. Zircon U–Pb ages show a wide spectrum ranging from 2900 to 40 Ma with distinct age peaks. The present study shows that the sediments of Surma Group were sourced from multiple rock types with age varying from Mesoarchaean to early Cenozoic. Implications of these findings on the tectonic evolution of the IMR are discussed.

# Factors of reservoir quality control in the upper member of Huagang Formation in the north-central inversion zone of Xihu Depression

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Huagang Formation reservoir in Xihu Depression is the key reservoir for oil and gas exploration and development in the East China Sea Basin, but due to its characteristics of low porosity, low permeability, and strong heterogeneity, the formation mechanism is not clear. The results show that: (1) Compaction is the main cause of shrinkage in the study area, and carbonate cementation formed by organic acid decarboxylation and illitalization leads to reservoir densification. (2) Diagenetic fluid is the key to determining the dissolution and porosity in the later stage. In the open diagenetic fluid environment, both the charging of acidic dissolution fluid and the discharge of a large number of dissolution products can be ensured to ensure the smooth progress of the porosity. (3) Microfractures are important factors to improve reservoir quality. Intergranular fractures or marginal fractures are formed under the action of structural stress to directly communicate acid fluids, which can not only enhance seepage but also serve as an important reservoir space. (4) The diagenetic stage of H3 and above reservoirs belongs to the meso-diagenetic stage A, with coarse grain size and strong dissolution effect, and belongs to the medium and low porosity - medium and low permeability reservoirs, which are not dense at present. At present, the H4-H5 reservoir is in the middle diagenetic stage B, with strong compaction, fine particle size, and less than 5% of solution pores. It belongs to the ultra-low porosity and ultra-low permeability reservoir. The reservoir is densified as a whole, but its structural fractures and diagenetic fractures develop, which greatly improves the tight reservoir formed by sedimentation and diagenesis.

# Comprehensive Characterization and Evaluation of Tight Sandstone Reservoirs in the Jurassic Sangonghe Formation, Tuha Basin: A Petrophysical and Deep Learning Approach

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Tight sandstone gas, an indispensable unconventional hydrocarbon reservoir, necessitates a meticulous assessment of rock types and petrophysical properties for accurate prediction of reservoir behavior. This study integrates well-established methodologies such as well logging, core analysis, NMR experiments, high-pressure mercury, and sedimentary petrology to systematically characterize and evaluate tight sandstone reservoirs within the stratigraphic confines of the Jurassic Sangonghe Formation in the Tuha Basin. The investigated reservoirs manifest substantial compaction and densification, leading to a highly intricate and variable pore system. This inherent variability presents challenges in precisely characterizing lithologies with comparable petrophysical properties. In response, the Gaussian mixture model clustering algorithm is applied to discern four distinct reservoir rock types by integrating petrophysical values derived from core data across multiple coring wells and their corresponding logging data. Classification outcomes are synergistically amalgamated with conventional techniques to assess the quality and geological characteristics of the studied formation, considering parameters including flow and storage capacity, reservoir quality index, flow zone indicator, and average pore and throat radius. Thin sections, NMR experiments and high-pressure mercury are utilized to characterize pore and throat channels within these rock types. These datasets serve as robust supporting evidence, enriching the reservoir quality assessment with heightened precision and comprehensiveness. This study endeavors to advance predictive modeling by implementing a deep learning algorithm trained on logging data to estimate porosity and rock type. A novel model, integrating axial attention mechanisms with Convolutional Neural Network (CNN), is proposed. This model captures long-range information and fusion features from disparate logging curves, establishing high-dimensional mapping relationships between logging curves and reservoir rock types and porosity, thereby achieving superior prediction performance compared to CNN and XGBoost models, particularly in the test set. This comprehensive study underscores the potential of deep learning approaches for reservoir characterization and enhances the understanding of complex reservoir properties.

# The distribution and evolution of the unidirectionally migrating deep-water channels and its response to the expansion of the South China Sea

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Mixed depositional systems characterized by down-slope sedimentary gravity flows and perpendicular flowing bottom currents have been observed and well-studied in several continental margin-settings around the world, including the South China Sea. Most of the works focused on the sedimentary characteristics, the interaction of gravity flows and bottom currents at different temporal scales, and the unique dynamic mechanism and so on. The unidirectionally migrating deep- water channels are widely developed in the South China Sea, but the distribution and evolution of the channels which revealing the close relationship between the intensity of bottom currents and the expansion of the South China Sea are rare studied.

Our study shows that the development of the unidirectionally migrating deep-water channels in the South China Sea does not start from 10.5Ma as previously thought, but from 15.5Ma, and it is also the time of the stop of the expansion of the South China Sea and the start of the Luzon Strait opened. At least six periods of channels reworked by bottom currents are identified which distinguished by parallel to sub-parallel, strong continuity, high amplitude seismic reflections in the basin margin and deep-water areas. The bottom currents reworked channels were most developed during the period from 8.2Ma to 5.5Ma, at least eight sub-period channels can be identified during this period which characterized by asymmetry levees. After 6.5ma, the intension of the bottom currents in the South China Sea significantly weakened accompanying the uplifting of the Luzon Strait caused by the arc-land collision in Taiwan, and then the unidirectionally migrating deep-water channels stopped developing.

The Luzon Strait serves as the threshold to control the intensity of bottom currents' activity in the South China Sea, and then affect the distribution and evolution of the unidirectionally migrating deep-water channels .

# Banana holes and pit caves of Andros, North Bahamas: Does one model fit all?

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Island karst is product of various processes that affect carbonates in small island settings. These karst features form by very different mechanisms, providing an understanding of geomorphological processes and clues to sea level fluctuation history. Pit caves and banana holes with examples from one of the largest islands of the northern Bahamas, Andros are discussed in this review. Pit caves and banana holes are characterized by their near vertical or stair-step profiles. The key difference between banana holes and pit caves is the width-to-depth ratio of banana holes is greater than one, while pit caves consistently have width-to-depth ratios of less than one. Banana holes also have partially to fully intact roofs, small openings leading to large chambers and overhanging roofs, the geometry that leads to few competing genetic models; vadose dissolution, phreatic, mixing of vadose and phreatic at the water table, and episodic dissolution within perched aquifers. The pit caves has a more definitive origin as a product of meteoric dissolution, occurring in the highest density at elevations above +7 m RSL. Besides geomorphology and spatial assessment, this study examines rock samples from various pit caves and banana holes to understand the diagenesis processes involved. Field and petrography observations have revealed four different units, each with different cement types and geochemistry. The morphology and differential dissolution of the beds have been examined in several of the caves using photogrammetry to create three dimensional models. Some of the mapped pit caves demonstrate that using dimension cutoff to define the type of cave might lead to misidentification. The preliminary result from this 'back to basic' approach shows valuable insight from the rock record and indicates that one model fit all is unlikely applicable to explain the genetics of the caves.

# Sedimentology and diagenesis of Ordovician sandstones (Brittany coast, France) ; an analogue for CCS (Carbon Capture and Storage) in tight sandstones

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CCS ("Carbon Capture & Storage") for tight reservoirs involves many challenges that require a good understanding of matrix heterogeneities linked to sedimentology and diagenesis, as well as fracture heterogeneities. This preliminary project is focusing on the Ordovician Erquy-Fréhel red sandstone series as an outcrop case study to provide guidelines and recommendations for optimizing CCS approaches. This series outcrops exceptionally well along the Emerald coast in Brittany over more than 15 km, along cliffs up to a hundred meters high. This series is related to the erosion of the Cadomian chain in a rift (or even post-rift) context. This study aims to establish a comprehensive understanding of the Erquy-Fréhel red sandstone series, focusing on its stratigraphic architecture, lithology, diagenetic evolution according to the basin dynamic, and fracturing to serve as a reservoir analogue for strategic CO2 storage applications in similar siliciclastic reservoirs (e.g., Ilizi Basin, western Algeria).

To date, this series is divided into several members, and sedimentological analyses indicate mainly coastal marine environment. Two more recent studies, carried out at the UniLaSalle Institute, have completed, and refined the sedimentary and stratigraphic architecture models highlighting an overall evolution of the deposits from proximal, even probably emerged deposits in a humid tropical climate to more distal marine deposits having estuarine affinities.

Sandstones are also altered and fractured. Fractures are linked to large-scale brittle or regional tectonics, but can also be related more locally to injections of doleritic dykes emplaced later during carboniferous variscan orogeny accompanied by W-E oriented axis folds.

Eventually, sandstones have experienced pressure-solution diagenesis visible through large quartz overgrowth development. Moreover, Fe-bearing minerals are ubiquitous and are of prime importance, considering the increased reactivity of this type of iron-rich sandstones when injected with supercritical CO2 conducing to newly crystallized carbonates.

# A Source to sink approach for microplastic distribution and characterisation in the River Don's sediments and surface water

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Anthropogenic plastic production and subsequent mismanaged plastic waste is a major global scale environmental concern of the 21st century. Freshwater environments are believed to be the dominant vector of microplastic (MP) transport from terrestrial soils to the marine environment, accounting for 80% of ocean plastic suggesting an overlooked and significant component of the global MP life cycle. To date there has been 3.8% of MP studies covering terrestrial soils. This study, the first to sample soils and waters spanning the length of the River Don sets out to evaluate the abundance, distribution and composition of MP pollution in 10 locations spanning from the source of the Don River in the highlands of Scotland to the Estuary at the mouth of the River Don in Aberdeen.

Standard MP processing techniques were used for both the soils and water samples. MP concentration in the River Don low water riverbed samples were greater than surface water samples due to the substantial accumulation of MPs in sediment and the limited degradation within this environment. Many of the MP fragments found (circa 80%) were fibers. The soil samples at the estuary had the largest discrepancy between MP fibers and MP fragments with fibrous MP fragments dominating the samples.

SEM analysis revealed that within the same MP fragments there were differences in the elemental signatures indicating degradation, weathering and inhabitation of organic material on the frayed fibrous ends of the MP fibers. Using a source to sink approach for soil and water to generate a baseline for determining MP abundance, size and type that will potentially be expelled into the ocean. Using the data may help determine point sources of MP pollution and subsequent remediation.

# New contributions for the Late Paleozoic Ice Age in southwestern Gondwana: a multi-proxy approach

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The Late Paleozoic Ice Age (LPIA) records the most intense and largest ice sheet expansion event of the Phanerozoic Eon. During this interval, glacial and interglacial stages were marked by several diachronous ice centers over the Gondwana supercontinent. A good example of this interval to explore occurs in the Paraná Basin (Brazil), which registers in the sedimentary succession the advance and retreat of glacial phases. This research aims to contribute to the understanding of the climate and environmental variability conditions of the LPIA interval in the southern part of the Paraná Basin. The methods include a multi-proxy approach, integrating sedimentological, and geochemistry (inorganic and organic) data of a drill core. The geochemistry includes elemental ratios, chemical index of alteration (CIA), total organic carbon (TOC), and biomarkers. This dataset shows a significant change in the middle part of the interval. The lower part provides sedimentological evidence of iceberg activity (e.g. dump and dropstone structures) in a turbidite succession, recording a deepening-upward trend (from dominantly sandstone and siltstone to rhythmite). This sedimentological information is combined by low chemical weathering intensity (CIA values varying from ~54 to ~70), lower organic matter concentration (TOC values varying from 0.1 to 0.7 wt. %), oxic predominance, and lower input of higher plants (biomarkers). The upper interval begins with a predominance of dark gray mudstone, showing no glacial evidence. This is combined with an increase of CIA (from ~77 to ~90), higher organic matter concentration (TOC values from 1.9 to 7.5 wt. %), more redox conditions, and an increase of both higher and aquatic plants input pointed by the biomarkers. According to these results, the climate changed from cold and arid to wetter and warmer conditions. Consequently, melting the glaciers, increasing the chemical weathering intensity, and changing the redox and organic matter concentration.

# DIAGENESIS AND RESERVOIR QUALITY OF REDEPOSITED CARBONATE ROCKS FROM THE GIANT BUZIOS FIELD, SANTOS BASIN, BRAZIL

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Intraclastic reservoirs present large thickness and extension of in the Búzios Field of Santos Basin. These deposits were generated by the erosion and redeposition of fascicular and spherulitic calcite aggregates, associated with magnesian clay intraclasts, ooids and peloids, and detritic materials. The aim of this study was to characterize the diagenetic and porosity evolution of calcarenites and calcirudites in two wells of the Búzios field in order to understand the impact of diagenesis in these reservoirs. Diagenetic evolution and reservoir quality models of intraclastic deposits were created correlating with well-logs petrophysic data. Diagenetic processes occur heterogeneously decreasing, preserving, or increasing porosity in these rocks. Dolomitization and silicification were the main processes of replacement and cementation. At least two phases of pore filling by silica occur, with fibrose chalcedony covering particles and surrounding pores and macrocrystalline quartz filling pores. The dissolution of dolomite blocks and the replacement by quartz indicate alternations in the geochemical environment conditions. In addition to the dissolution porosity of primary and diagenetic constituents, pore-filling cement, and mineral replacements, the porous system is intensely and heterogeneously affected by physical and chemical compaction processes controlled by the early dolomite cementation and the primary textural variation. Pore-filling accessory minerals such as fluorite and dawsonite were also identified, indicating high CO2 and Na pressure in the geochemical system. The discrete occurrence of pyrite, commonly associated with organic matter, indicates a diagenetic environment with low sulfate and iron availability. Even with diagenetic changes that affect the porosity of redeposited rocks, the intervals of redeposited rocks are correlated with highest and vertically continuous magnetic resonance porosity values. Understanding the characteristics, controls, and distribution of the cemented and porous zones of the reworked rocks of the Búzios field is crucial for the development of reservoir models.

# DIAGENETIC PROCESSES IN APTIAN PRE-SALT RESEDIMENTED CARBONATE AND HYBRID ROCKS OF SANTOS BASIN, BRAZIL

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The South Atlantic Aptian Pre-Salt lacustrine carbonate deposits represent one of the largest hydrocarbon provinces in the world. Intraclastic deposits of the Barra Velha Formation from the Santos Basin were generated by resedimentation of the in situ calcite and clay aggregates. Millimetric intercalations between in situ and reworked deposits are extremely common, indicating high-frequency changes in depositional conditions. This study aimed to characterize the diagenetic processes, distribution patterns, and their impact on reservoir quality of reworked deposits in seven wells from the three different fields. Dolomitization and silicification are the main diagenetic processes in calcarenites and calcirudites. Blocky and saddle dolomite occur filling interparticle pores and less commonly replacing intraclasts, while the rare matrix remnants are replaced by dolomite. Locally, pseudomorphic dolomite preserved the original internal textures of the intraclasts. Interparticle and vugular pores are lined by prismatic quartz and filled by drusiform and coarsely-crystalline quartz. Chalcedony is present as fibrous rims and spherulitic aggregates both cementing and replacing grains. Microcrystalline quartz preferentially replaces intraclasts. Diagenetic calcite is less common and appears as rims lining and locally filling pores. One exception is the rare hybrid arenites composed of volcanic fragments mixed with carbonate intraclasts and clay ooids, which show pervasive cementation by macrocrystalline calcite and heterogeneous compaction. Extensive silicification associated with hydrothermal activity, barite, dawsonite, and intense fracturing erased the primary features and strongly reduced the primary porosity. Unlike the associated in-situ deposits, the porosity of the reworked rocks was strongly reduced by mechanical and chemical compaction, while also was controlled by primary textural features and early diagenetic processes. Understanding the patterns and impacts of post-depositional alterations on the Pre-salt reworked rocks will contribute to mitigating exploration risks and enhancing production optimization.

# Clay mineralogy and bulk geochemistry of the terrestrial Esplugafreda sequence, Spain: sedimentary response to non-climatic factors and climate change across the Paleocene-Eocene boundary

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Lower Paleogene continental deposits, formed in the subtropical zone (paleolatitude ~35 °N), are well-preserved in the Tremp-Graus Basin, northern Spain. One of the key exposures is the Esplugafreda section, which is made up of ~250 m of red mudstones with abundant paleosols and contains numerous multi-episodic channel-like bodies. The paleosols contain abundant centimeter-sized soil nodules and gypsum indicating a semi-arid to arid paleoenvironment. The Paleocene-Eocene (P-E) boundary is located near the top of the continental section, based on a 6‰ negative carbon isotope excursion (CIE). The CIE spans more than 15–20 m of yellow cumulate paleosols, which were formed during the Paleocene-Eocene Thermal Maximum (PETM). The post-PETM interval in the Esplugafreda section comprises 20 m of red paleosols rich in gypsum and with normal δ13C values. Laser diffraction particle size analyses demonstrate that these sediments are poorly sorted and belong to the sandy mud/muddy sand textural groups. The grain size distributions are uni- to polymodal, dominantly fine skewed with the mode/mean in the coarse silt/very fine sand fraction. The clay mineral assemblage of the Upper Paleocene sediments is dominated by illite and smectite (45±7, 40±7 wt%) with smaller amounts of kaolinite and chlorite (7±2, 8±1 wt%). The PETM yellow soils are lower in illite (31±6 wt%), but have more smectite and kaolinite (48±6, 12±2 wt%). Clay mineral ratios (kln/ilt, sme/ilt, sme/ilt+chl) indicate slightly enhanced chemical weathering for the yellow soils, and basin-wide deeper physical erosion and source changes. Bulk geochemistry reveals granodioritic sources of these sediments, close to an UCC-like composition, and that these sediments may have undergone at least one, but potentially multiple stages of sedimentary differentiation. Weathering indices (CIA, PIA) and the A-CN-K diagram provide evidence that the PETM yellow soils are slightly more weathered than the underlying mudstone paleosols of Late Paleocene age.

# Outcrop gamma-ray spectrometry as a tool for refining depositional environment and diagenetic history in Carboniferous carbonate slope deposits, Bolshoi Karatau, Kazakhstan.

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Carboniferous carbonate platform and slope deposits outcropping in the Bolshoi Karatau, Kazakhstan have been used for decades as analogs for coeval giant oil and gas fields in the Pricaspian Basin, but their characterization by gamma-ray spectroscopy is lacking. This study aims to document the advantages of integrating spectral gamma-ray data with measured stratigraphic sections. An RS-230 gamma-ray spectrometer (assay 120 seconds) was used for high-resolution (0.2-0.5 m apart) measurements of potassium (K), uranium (U) and thorium (Th) content in carbonate slope deposits exposed in sections at Aktobe (103 m) and Akuiuk (25 m). Below-detection-limit measurements (5 ppm for U and Th, and 1% for K) were removed from the results. Results show: (i) Predominance of CGR (computed gamma-ray; Th+K) in the lower part of the section and SGR (standard gamma-ray; U+Th+K) in the upper part, primarily due to increased potassium and uranium content, respectively. (ii) Some fine-grained facies are characterized by increased potassium content, while others with complete absence of potassium and increased uranium content. (iii) Isolated thorium spikes. (iv) Lack of correlation between upward-increasing thorium and potassium trend-cycle (up to 5 m thick) with facies observations. Qualitative comparisons of gamma-ray data with facies/microfacies coupled with quantitative investigation of various uranium-thorium-potassium ratios suggest that: (1) Uranium readings commonly increase in organic-rich facies, dolomites, and/or carbonate fluorapatites within fractures. (2) Potassium is more abundant in clay and algae-rich facies. (3) Thorium spikes are caused by zircon minerals, likely derived from volcanic ash-falls. We speculate that the absence of potassium in fine-grained uranium-enriched facies is due to its microbial consumption in nutrient-starved anoxic conditions. Interpretation of upward-increasing CGR trends remains challenging. These data and observations can be utilized to better interpret and understand subsurface log data in the Pricaspian basin and around the world.

# Net transport patterns of surficial marine sediments in the North Aegean Sea, Greece.

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The spatial distribution of sediments in the seafloor reflects the various dynamic processes involved in the marine realm. To assess sediment transport patterns of the North Aegean Sea, 323 surficial samples were acquired and analyzed. Granulometry data suggested a diversity of grain size of surficial sediments, ranging from purely sandy to clay. Silt and muddy sand are the predominant size classes followed by sandy silt and mud; notably, very few samples fall within the clay classes. The sorting coefficient ranges from 0.21 to 5.48, while skewness from -1.09 to 1.29. Based on the grain size parameters (mean, sorting, and skewness) sediment transport patterns were assessed. The results revealed the variability of flow parameters involved in sediment distribution. Adjacent to shoreline, river influx and longshore drift are the key factors of sediment transport. At the open sea, sediment distribution is controlled by the general water circulation pattern, especially by the outflow of low-salinity waters (originating from the Black Sea) from the Dardanelles through the Marmara Sea. This is reflected by the heterogeneity of sediment textural parameters across the study area suggesting further reworking of seafloor sediments in areas where water masses are highly energetic. It can be finally concluded that open sea water circulation controls sediment distribution patterns at the open shelf, while river discharge is more significant proximal to the coast.

# TURBIDITE SANDS FILLING ACCOMMODATION ASSOCIATED WITH SUPRA-MASS TRANSPORT DEPOSIT TOPOGRAPHY: A CASE STUDY FROM WESTERN ARGENTINA

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Mass transport deposits (MTDs) commonly generate topographic relief on their upper surfaces. The scale and geometry of the topographic features, and the interconnectivity their sediment fills play a crucial role in defining the characteristics of turbidite reservoirs formed through sediment accumulation on top of the MTDs. Turbidite sands may be ponded in isolated depocenters created by supra-MTD topography or terminate in onlap against local slopes associated with this topography. The spacing and maximum thickness of isolated ponded or tortuously interconnected sands within a depositional system are controlled by the dominant topographic wavelength and amplitude. Once the topography is filled to the saddles (the lowest point between adjacent topographic lows), the sand body forms a continuous sheet peppered with lacunae ('holes') marking the emergent highs ('nunataks'). We illustrate these phenomena with ponded turbidites on top of a 200-m thick MTD at Cerro Bola, Western Argentina. These are characterized by their sand-rich composition and the influence of the topography of the upper surface of the underlying MTD.

In our field data, the ponded turbidites can be differentiated into:

a) Underfilled; a lower set of sand bodies confined within the short-wavelength (tens to hundreds of metres) topography. Apparent correlation of thicker beds suggests larger flows that were able to over-ran at least the saddles in the topography, with only a small portion of the flow being captured in each low. Palaeocurrent patterns are complex, suggesting vigorous interaction with topography.

b) Overfilled; a continuous sand body that lies wholly above the short wavelength topography, but progressively onlaps in both directions onto longer wavelength (> 7 km) topography. Long distance correlations of most of the thicker beds indicates flows large enough to be capable of filling the long-wavelength accommodation. Palaeocurrent patterns are simpler, but nonetheless indicate reflection off the long-wavelength topography.

# EXPLORING STRATIGRAPHIC TRAPPING STYLES IN TURBIDITE SYSTEMS BY INTEGRATING SUBSURFACE (OFFSHORE BRAZIL) AND OUTCROP (ARGENTINA) STUDIES

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The success of oil and gas exploration in deep and ultra-deep marine environments critically hinges on the discovery of effective stratigraphic traps, where turbidite pinch-outs play a central role and pose a considerable exploration challenge. The characteristics of the margins of sheet sands are important at all stages of exploration, appraisal, and development. Imaging of the internal architecture and lateral facies changes of sheet sands (typically 10 to 30 m thick) is almost always limited by the resolution of seismic data at the depths of most reservoirs. However, outcrop studies can provide a powerful source of analogue information to generate data and develop conceptual models on the critical pinch-out edges. This research project is dedicated to an in-depth investigation of turbidite stratal termination patterns, leveraging a multifaceted approach that integrates subsurface and outcrop analogues. Subsurface information (3D seismic and well logs) is from a Campanian deep sea fan in the Sergipe-Alagoas Basin, offshore NE Brazil. Outcrop data is from the Carboniferous strata located in Paganzo Basin, western Argentina. Preliminary observations indicate that turbidite sandstone termination/detachment in outcrop are associated with topography controlled by mass-transport deposits (MTDs). In the subsurface, stratigraphic traps form due to slope turbidity current bypass and onlap against external levees. By meticulously documenting and analysing these termination patterns at different scales, the objective is to develop a robust conceptual framework for understanding reservoir attributes in the context of stratigraphic trapping. To enhance the applicability of our findings, interactive visualization tools will be generated in both two and three dimensions, empowering geoscientists and industry decision-makers to explore the nuances of reservoir attributes across varying spatial scales.

# Abyssal sedimentary processes revealed through geophysical and geochemical records for the West Equatorial Atlantic during the Late Quaternary

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The Atlantic Meridional Overturning Circulation (AMOC) represents one of the main components of the regulation and balance of the global climate. The West Equatorial Atlantic (WEA) region is an ideal location for palaeoclimatological and palaeoceanographic reconstructions due to the changes in the oceanic circulation, interactions between deep and intermediate AMOC system water masses and changes of the atmospheric circulation. The present work analyzes the sedimentary core MD09-3253CQ (2°20.48 S, 35°26.78 W), collected at a depth of 3867 m, influenced by North Atlantic Deep Water (NADW). Here we analyzed the elemental composition, P wave velocity, density, magnetic susceptibility, grain size, total organic carbon and nitrogen, mercury content and isotopic composition (δ13C and δ18O) in planktonic (Trilobatus sacculifer) and benthic (Cibicides wuellerstorfi) foraminifera. We show siliciclastic-carbonate sedimentary evolution of the deep sea in the Equatorial Atlantic Margin of Brazil, intervals with input of continental material, most likely associated with extreme climatic events as well as changes in the productivity and oceanographic characteristics of the WEA region. Our results suggest that during the Termination 1 (18 – 11kyr), with the decrease in the formation of NADW, the deep-sea region had a decrease circulation and low bottom oxygenation, depicting high influence of the southern-sourced water mass, the Antarctic Intermediate Water (AAIW). In this way, our study will allow the elaboration of a conceptual model on paleoceanographic sedimentary dynamics over the Late Quaternary and the role of the AMOC in regulating the global climate.

# Exploring Latin America's Passive Margins with an Innovative Sea Level Curve

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Recent exploration efforts in South American passive margin basins, such as the Guyana-Suriname Basin, have yielded significant success with over 10+ Bboe discovered, primarily within the late Cretaceous play/mega-sequence. Most recently the Southern Atlantic margin, spanning Brazil, Uruguay, and Argentina, has also garnered industry attention, particularly following discoveries at the conjugate margin of Namibia.
In an award-winning study by Van der Meer et al. (2022), plate tectonic eustasy estimates were updated using the 87Sr/86Sr record of seawater, coupled with a novel glacio-eustasy estimates based on a recent Phanerozoic paleotemperature model (Scotese et al., 2021). This innovative Tectono-Glacio-Eustatic (TGE) curve for the entire Phanerozoic correlates well with mega-sequence stratigraphy in global passive margin basins.
Examining key basins like Guyana, the TGE curve aligns with the mega-sequences, showcasing the influence of plate tectonic and glacio-eustatic drivers on the petroleum system. The petroleum system elements in deepwater, correlate well with predictable patterns.
Similarly, southern Atlantic basins also exhibit predictable elements of the drift play (post-Aptian), with the TGE curve serving as a tool for undrilled sections of the stratigraphy. This research underscores the interplay between plate tectonics, glacio-eustasy, and basin evolution, offering valuable insights for future and ongoing exploration endeavours.

# Long and short term glacio-eustasy as potential key driver for deposition of reservoirs in the Moray Firth Basin

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Global mean sea level (GMSL), or eustasy, is a key driver for passive margin stratigraphy, and GMSL reconstructions have been made since at least the 1970's based on stratigraphy. However, these reconstructions have been hotly debated as basins and their associated (sequence)-stratigraphy may not represent a global signal. In addition, the source data (wells, seismic) is generally not disclosed and is therefore impossible to verify. Hence eustatic reconstructions remain poorly constrained. A novel, independent method based on isotope geochemistry, was recently published (Van der Meer et al. 2022) yielding a Tectono-Glacio-Eustatic (TGE) curve, focussing on the two key drivers of GMSL. The method assessed plate tectonic eustasy (i.e., mid-ocean ridge spreading) using the well-established strontium record. Long-term glacio-eustasy was estimated using a recent compilation of global average paleotemperature derived from δ18O data. In combination with paleogeographic reconstructions, ice volumes on land and continental shelf margins were estimated. Eustatic sea level variations associated with long-term glaciations (>1 Myr) reach up to ~90 m, whereas plate tectonic-derived eustasy reached up to 150m amplitude.
On shorter timescales (<1 Myr), Milankovitch glacio-eustatic cyclicity affects GMSL. Prior to the Cenozoic, orbital motions are poorly constrained, but it is generally assumed that these must have occurred in similar manner. In combination with presence of land ice at high-latitudes, short-term glacio-eustasy must have occurred too.
We therefore test whether both the long-term and short-term eustatic cyclicity, as predicted from the TGE curve, is recognisable at field scale for several fields in the Moray Firth Basin. We demonstrate that novel insights are obtained, which may lead to future opportunities. Other explanations exist, but we find that glacio-eustasy may have been the only driver that is needed to explain the timing of deposition of these Late Jurassic-Early Cretaceous reservoirs.

# Sediment budget of coupled erosion along storm channels and deposition on washover fans, Schiermonnikoog Wadden Island: field observations, high-resolution aerial photographs, digital elevation data and mobile phone 3D scans

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The uninhabited, natural eastern tail of Schiermonnikoog has experienced strong seaward progradation of its North Sea coastline in the last decade. Progradation was accompanied by the formation of a new dune ridge, which encloses a wide salt marsh. These low dunes are regularly cut by storm channels, facilitating development of washover fans on the enclosed marsh.

Since 2021, the National Land Survey of The Netherlands provides a nation-wide high-resolution orthophoto (8 cm pixel size), which has a 10-fold increase in resolution over the previous generation of 2016-2020. It complements a high-resolution digital elevation map. The larger geometries seen in the field are clearly visible on the orthophoto, which provides an opportunity for assessing sediment budgets of coupled erosion along storm channels and deposition on washover fans.

Field work was carried out before and after the Winter storm season in December and April of 2021, 2022 and 2023. The study area (3 km along coast and 100-200 m width) encompasses the low dune ridge and adjacent enclosed marsh. Recent erosion events and fresh sand deposits were identified and documented (GPS location, geometry, architecture and sedimentary structures). Photographic records enable distinction of new erosion and sedimentation events during each subsequent field visit. Selected objects were scanned with a 3D scanner app on a mobile phone with LiDAR sensor.

Widespread erosion and deposition occurred in Winter 2021 and 2022, but 2023 witnessed only local redeposition of sand on the largest fan. Geometries of sand bodies change with elevation of the washover fan surface, apparently reflecting deposition on dry ground or inundated marsh. Digitised geometries in GIS software provide input for calculating sediment volumes, together with sandbody thickness and depth of erosion estimated in the field. Preliminary results show that volumes of erosion and coupled sand deposits are comparable, suggesting local sourcing of sand.

# Backwater length estimates in modern and ancient fluvio-deltaic settings: review and proposal of standardized workflows

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The backwater effect (i.e. adjustments in open-channel flow as a response to proximity of standing water) is used to predict down-dip changes in fluvial morphodynamics and consequent sediment distribution on delta plains. However, there is currently no standardized method to obtain input parameters to estimate backwater length, nor consensus on where to measure these variables, for both modern and ancient settings. This study reviews existing methods for estimating backwater lengths in ancient and modern settings and proposes workflows to minimize ambiguity in resultant estimates.
The proposed workflows are tailored to both modern and ancient settings and are prioritized based on practicality, accuracy, smallest uncertainty ranges and allow different data types as input parameters. For the first time, application of multiple methods, i.e. the proposed workflows, is tested on a single modern and ancient river system. In the modern case study, riverbed intersection with sea level matches previously documented major changes in sedimentary trends. However, backwater lengths based on h/S (h = maximum bankfull channel dept, S = slope) plot downstream of this zone characterized by major changes, when input parameters are derived from discharge and grain size. In the ancient case study, backwater lengths based on maximum bankfull channel depth and slope based on Shields' empirical relation with grain size, match changes in fluvial architectural style interpreted as a result of backwater effects. The proposed workflows facilitate comparability and applicability of future backwater length estimates and their corresponding influence on the hydrodynamic environment and ultimately quantification of source-2-sink segments.

# Sedimentary aspects and organisation of liquefied sands in the alluvial sediments of the Kupa River (Croatia)

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Extensive liquefaction phenomena occurred during the devastating 2020 Petrinja earthquake (Mw6.4) in the alluvial plains of the Kupa, Glina and Sava rivers in Croatia. Such an effect raised many questions, notably regarding the nature and properties of soils conducive to water overpressures during ground shaking on the one hand and the geometries of sedimentary bodies in depth on the other hand. The sandy ejecta lines and cracks at the surface are often subparallel to the riverbanks in convex meanders and could reveal buried sand point bars below a thick layer of silts. To highlight the different structures, estimate their mechanical properties and define their geometries, sedimentological, geotechnical and geophysical investigations were carried out at selected sites along the Kupa River in the Petrinja area. For that purpose, two 2.5m deep and about 10m long trenches perpendicular to sand ejecta crack orientation were also excavated, described, and sampled for a detailed sedimentological analysis. The trenches revealed sand at the bottom of the trench covered by a homogenous 140 cm clayey-sandy silt layer. Liquefaction processes (sand dykes and sand blows) disturbed both layers, exposing a different sand, probably coming from an even deeper source and depth. Some dykes do not reach the surface and might be related to paleo-liquefactions linked to the "Kupa Valley earthquake" in October 1909 or even still older events.
As part of the ongoing study, the excavated alluvial deposits and sandy dykes are investigated in more detail to establish their chronological framework. The luminescence dating methods have been applied to present the timing of the deposition of the investigated sediments and to determine the ages of the liquefied sands. Furthermore, detailed mineralogical and sedimentological analyses are performed to describe and understand their depositional mechanism and to determine their provenance.

# Characterisation of parent units within the Panoche Giant Injection Complex, California, USA

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Parent units are the source of the sand and site of overpressure which triggers sand fluidisation and injection. Therefore, parent units capture a complex history from primary deposition through fluidisation and remobilisation of the sand into intrusions. Understanding the processes that occurred within parent units is critical to understanding the formation of the injection complex.

The Panoche Giant Injection Complex (PGIC) is in central California, on the western margin of the San Joaquin fore-arc basin and is the largest continuous area of exposure of sand injectites in the world. Parent units within the PGIC are base of slope channelised turbidites, which belong to the Dosados Mbr and Uhalde Sandstone (Maastrichtian), of the Moreno and Panoche formations. Parent units in the PGIC feed a 600m thick network of sandstone intrusions, which enhance vertical and lateral connectivity though otherwise fine-grained strata.

The PGIC is exposed in 30km long strike section, making it ideal to examine lateral and vertical variability in the parent units including characteristics of sand remobilisation present.  Over 500m of sedimentary logs from twenty-nine locations were collected from the Dosados Sandstone, with samples collected at 2m vertical intervals for petrography and grainsize analysis. The Dosados Sandstone comprises poorly sorted, fine to medium grained sandstone and is extensively fluidised. Sand remobilisation modifies or obliterates primary depositional structures and fabrics, often forming structureless sandstone. Characteristic erosion along the upper margins of the sandstone is attributed to turbulent flow during sand fluidisation. Parent units are characterised by a range of internal structures, from fully preserved primary structures, partially deformed primary structures and fully fluidised facies including structureless units, intervals of injection breccia and banding.

# Sedimentary characteristics during the Lower Cretaceous Depression in Santos Basin of Brazi

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The sedimentary environment during the Lower Cretaceous Depression in the Santos Basin of Brazil were characterized by shallow lake facies by comprehensive analysis of seismic data and logging. With lake water level shallowing from K46 to K48, Rock types such as stromatelite, spherulite, grainstone, mudstone or laminate were identified. One third order sequence, two fourth order sequences, and five fifth order sequences were divided into during Depression period. Five types of sedimentary microfacies: stromatelite mound, spherulite shoal, grainstone shoal, intershoal depression and semi-deep lake were developed. Due to the influence of palaeotopography and changes in lake level, the early stage of the depression (K46) mainly deposited mudstone or laminate. At the same time the spherulite shoal was deposited at the high part of the structure. When the lake level upward became shallower , the range of the spherulite shoal by Lateral accretion became larger. Stromatelite mounds and grainstone shoal were deposited. In the late stage of the depression, the mound and shoal microfacies basically were covered at the entire high part of the structure. Semi deep lake and deep lake mud were developed in the lower part of the structure. The vertical and horizontal sedimentary patterns of lacustrine carbonate rocks were clarifies during the basin depression period. This research conclusion provided geological basis for oil and gas exploration in presalt formation of the Santos Basin.

# The concept, geological model, and seismic characterization techniques for ultra-deep fractured Shoals.

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The fractured shoals represent a novel type of ultra-deep reservoir in the Tarim Basin, significantly contributing to the sustained growth of ultra-deep oil and gas reserves. However, due to the deep burial of the Ordovician strata (7000 meters) and the rapid attenuation of seismic signals, identifying the boundaries of these reservoirs and the low-order fractures within it presents a significant challenge.

Summarizing the characteristics of the fractured shoals, we find that it primarily develops in the ultra-deep carbonate platform interior gray limestone strata. The mechanical compaction in ultra-deep layers leads to lower permeability in the unaltered reservoir bodies. Second, low-order fractures or fissures serve as another essential condition for the formation of these reservoirs. The fractures influence the reservoir's storage performance, and their abundance and distribution are related to stress magnitude and rock competency. Under the same stress conditions, reservoirs with better competency exhibit favorable pore-permeability conditions, fostering the development of various reservoir space types. Third, these reservoirs exhibit favorable fluid migration properties, making it an advantageous region for the accumulation of oil and gas in ultra-deep gray limestone reservoirs.

Based on field data and a combination of drilling, seismic, and production dynamic information, a geological development model for these reservoirs has been established. Additionally, a seismic characterization technique for the "Fractured Shoals" has been developed.

Research indicates that the "Fractured Shoals" primarily develop in the relatively compacted gray limestone strata within the ultra-deep layers, where the main faults and secondary grid fractures, influenced by the differential activity of the main faults, contribute to the reservoir's modification. The identification of the reservoir boundaries and low-order fractures is achieved through waveform inversion, seismic waveform decomposition, and fusion techniques. This method has been successfully applied in the Fudong area of the Tarim Basin, identifying typical fractured shoals and clarifying the reservoir closure.

# Exploring Fracture-Cavity Reservoirs in Tarim basin: Challenges and Seismic Solutions

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The Ordovician strata in China's northwest Tarim Basin have developed significant fracture-cavity reservoirs, contributing to an annual crude oil production up to 3 million tons. This productivity stems from the fragmentation of limestone in the Middle Ordovician due to strike-slip faults, creating ample storage space. These fracture-cavity reservoirs, characterized by bead-like structures in seismic data, are mainly located near strike-slip faults. Together with overlying mudstones from the Upper Ordovician and hydrocarbon source rocks from the Cambrian, they form a set of reservoir-seal-cap combinations.

However, the industry still encounters challenges, including difficulty in identifying these reservoirs and uncertain connectivity, leading to increasing development costs. This paper, based on three-dimensional seismic data, addresses these challenges by selecting seismic attributes to describe the geometric characteristics of fracture-cavity reservoirs, reservoir scale, and fracture distribution.

Our approach involves three main steps:

Multidimensional Decomposition: We decompose seismic data into two sub-volumes. One highlights small-scale strike-slip fault features, and the other emphasizes fracture-cavity body reflections by removing strong reflections from the top of reservoirs—originating from unconformities between overlying mudstone and limestone.

Hilbert Transformation: We apply Hilbert transformation to the seismic data, obtaining a -90-degree phase volume. This process accentuates the distribution of internal storage spaces within fracture-cavity bodies, thereby enhancing the accuracy of reservoir prediction. This leverages the sensitivity of reservoirs to phase variations. Seismic impedance anomalies caused by reservoirs typically do not always exhibit obvious amplitude anomalies but can induce significant phase changes.

Data Integration by Random Forest Method: Integrating volumes highlighting fracture, fracture-cavity bodies, and internal storage spaces from the previous step, we use the random forest method to invert optimal weights for the three attribute data volumes. These weights, derived from existing well data as a reference, facilitate the combination of the volumes into a new integrated volume, suitable for predicting fracture-cavity reservoirs.

# Discrimination and Hydrocarbon Expulsion Characteristics of Effective Source Rocks in Fushan Sag， Beibu Gulf basin， China

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Source rocks are the key to determining the potential of oil and gas resources. There are many sets of source rocks in the Fushan Sag, Through the statistics of the thickness of dark mudstones of different lithofacies, combined with the analysis of test data and the constraints of sedimentary facies, the plane distribution characteristics of source rocks are predicted, and it is revealed that the areas with high thickness are mainly located in the Huangtong sub-sag in the west and the Bailian sub-sag in the east. According to the comprehensive evaluation of the organic geochemical characteristic parameters of the source rocks of each submember it is clear that the abundance of organic matter is relatively high,the organic carbon content is between 0.16% and 3.05%, the average is 1.71%, and the hydrocarbon generation potential is medium, the types of organic matter are mainly type Ⅱ1 and Ⅱ2, which are in the mature-high maturity stage.The hydrocarbon generation potential method is used to determine that the hydrocarbon expulsion threshold of source rocks is Ro=0.66%, and the TOC lower limits of effective source rocks are 0.9% and 1.1%,The distribution of effective source rocks is mostly concentrated in the deep depressions of two sub-sags., the thickest part is located in the Bailian sub-sag in the east of the Fushan Sag, up to more than 450m, extending from the center of the sag to the edge and the central uplift belt.According to the hydrocarbon expulsion model, when Ro is 0.80%, the source rock reaches the peak of hydrocarbon expulsion, and the maximum hydrocarbon expulsion efficiency can reach 97.7%.The Huangtong sub-sag in the west and the Bailian sub-sag in the east are the main hydrocarbon expulsion areas.The hydrocarbon expulsion intensity can reach up to 184.22×104t/km2 and 45.39×104t/km2, and the cumulative hydrocarbon expulsion amounts are 52.99×108t and 15.58×108t.

# Coupling relationship between structure movement and sedimentation in Jiyang Depression, Bohai Bay Basin, China

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The formation of Jiyang Depression, which is an important target for oil and gas exploration, is the result of the coupling effect between structural forces and sedimentary processes. Based on seismic data, well-log data, and sedimentary facies distribution maps, the fault evolution of Jiyang Depression was studied, and the coupling relationship between structure movement and sedimentary facies distribution was verified. The structural sand control plane model, the structural sand control section model and the structural sediment control three-dimensional model were established. The model we propose effectively illustrates how structures control sedimentation, and the fault transformation zone is the key to controlling the input and distribution of sediment sources. The structural sand control plane model can be divided into four types: independent faults, intersecting faults, same dip echelon faults, and opposite dip echelon faults. Different fault types have differences in settlement centers and optimal sand body channels. The structural sand control profile model include five types: extension, contraction, strike slip, gravity, and inversion, which can be further subdivided into eleven subtypes: horst, tilted fault block, rollover anticline, compound half graben, thrust block, positive flower shaped structure, negative flower shaped structure, cover diapir, balanced diapir, positive inversion, and negative inversion, corresponding to different distribution patterns of sedimentary sand bodies. The source injection port is controlled by faults, and the distribution of sand bodies is closely related to the structure. The fault steep slope zone, gentle slope zone, and rolling anticline zone on the profile are the development areas of folded sand, anticline sand, and fan-shaped sand bodies, while the fault displacement change zone and transfer zone on the plane are the development areas of transformation slope fans and collapse fans. The associated profundal zone is the development area of deep-water fan turbidite, thus forming a three-dimensional model of structural controlled sedimentation.

# Characteristic of Tingt Reservoir on the First Member of Benxi Formation in central south Ordos Basin

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The Ordos Basin is one of the important oil and gas producing reservoirs in China and its tight gas in Upper Paleozoic formation is one of the most essential parts of the current national natural gas production. 165 wells drilled in the Benxi Formation have obtained natural gas shows which demonstrating good exploration potential .However, the reservoir characteristics and diagenesis in the Benxi Formation poorly understood which led to generate bad strategy in targeting the high production formations. Combined with the core observation, petrographic microscopy, scanning electron microscope, overburden pressure permeability measurements, and high pressure mercury injection, The diagenetic period of tight reservoirs in the Benxi Formation is investigated based on the quantitative porosity evolution modeling and homogenization temperature of fluid inclusions analyses. The results show as follows： quartz sandstone and lithic quartz sandstone are the primary lithology types of the Benxi Formation. The average porosity of the Benxi Formation are 5.8%. The pore types are dominated by secondary pores, followed by primary pores and microfractures. The reservoirs are divided into three types based on the data from high-pressure mercury injection. The physical properties of Type I and Type II reservoirs are better in porosity and permeability. The tight reservoirs of Benxi Formation have mainly experienced diagenesis such as compaction, cementation and dissolution. The diagenesis in the northeast (depth3000 m) is in the late diagenetic period. Porosity evolution model was established using back stripping method. It is calculated that the porosity losing caused by compaction is 25.0%~35.0%, the porosity losing caused by cementation is 4.0%~15.0%, and the porosity increased by dissolution is 2.0%~4.0% in the Benxi Formation. The homogenization temperature of fluid inclusions determines that two stages of gas charging occurred in Benxi Formation. The reservoir is first densified and then natural gas started to accumulation.

# Automated multi-scale stratigraphic subdivision and correlation using wavelet transforms: performance and optimization

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Wavelet analysis has been developed as an intelligent approach for automatically detecting sequence surfaces and sedimentary cyclicity by transforming depth-related signals into time-frequency domains. To date, it has not been conclusively demonstrated that wavelet transform allows sequence stratigraphical subdivision and correlation at varied spatio-temporal scales. This study introduces a wavelet transform program (WavSeq) specifically developed for automated multi-scale stratigraphic subdivision and correlation under MATLAB R2022a. A continuous wavelet transform (CWT) approach was applied to decompose gamma ray and density logs into a set of wavelet coefficients at varying scales. An equation was established to explain the scale used in CWT and its relationship with sedimentary period and frequency. The variances of wavelet coefficients were calculated, and their peak values were used to locate the critical scales corresponding to principal cycles quantitatively. To mitigate edge effects and enhance precision, a discrete wavelet transform (DWT) method was conducted on CWT curves, resulting in the removal of extraneous noise and a refined wavelet scalogram. The performance of this method was assessed based on four well-explained cross sections from the Early Cretaceous Shahezi Formation from the Songliao Basin, NE Asia, and the Jurassic to mid-Cretaceous rift successions from the Brooks-Mackenzie Basin, Arctic North America. The wavelet transform results were validated by a good agreement between the core-derived stratigraphic framework and it derived from CWT decomposition of well logs. This work demonstrates that the wavelet transform is a successful, fast, and easy method for subdivision and correlation from wireline log data. An optimized workflow and a computer code of wavelet transform were involved in the WavSeq program.

# Diagenetic evolution of alkaline diagenetic minerals in rich tuffaceous sandstone: A case study of Shaximiao Formation in the Sichuan Basin, China

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The Sichuan Basin is a crucial area for natural gas exploration in China. Recent strides in exploring the Middle Jurassic Shaximiao Formation's tight sandstone reservoir in central Sichuan have led to confirmed reserves surpassing billions of cubic meters. The reservoir, rich in volcanic tuffaceous elements, undergoes prolonged diagenesis, resulting in a complex evolution. This intricate process forms various alkaline minerals like zeolites, calcite, chlorite, and illite. These minerals contribute to the reservoir's remarkably low to ultra-low permeability, resulting in significant heterogeneity.

The reservoirs primarily exist in the middle diagenetic stage, having undergone several significant diagenetic events: tuffaceous material hydrolysis, resulting in chlorite film; early-stage authigenic quartz formation; zeolite precipitation; calcite; smectite-illitization; hydrocarbon charging; feldspar dissolution; authigenic quartz and albite formation; zeolite dissolution; late-stage calcite, zeolite, and chlorite precipitation. During the early diagenetic stage (pre-70℃), tuffaceous material begins hydrolysis, forming early authigenic quartz and smectite. Subsequently, smectite encapsulates detrital grains in the form of clay films, gradually transitioning into chlorite films. With increased burial depth and diagenetic temperature (70-110℃), intensifying tuffaceous hydrolysis accompanies plagioclase-albitization within sandstones and clay mineral transformation within mudstones. The pH of pore fluids gradually rises, leading to the development of zeolite cementation and early calcite cementation within sandstone reservoirs. During this phase (70-100℃), smectite within the sandstones continues dehydration, releasing cations like Fe2+, Mg2+, and Ca2+, transforming into illite via illite-smectite mixed layers. Upon hydrocarbon intrusion into the reservoirs, often exceeding 110℃, the organic acids accompanying hydrocarbon intrusion dissolve a significant portion of feldspar and zeolite cement. As the organic acids are depleted and the diagenetic environment trends towards alkalinity, late-stage calcite, zeolite, and infill chlorite continue to precipitate.

The complex diagenesis of the Shaximiao Formation in the Sichuan Basin, influenced by volcanic tuffaceous material, highlights the importance of a systematic analysis of tuffaceous sandstone evolution.

# Geochemistry characteristics, origins and classification of Oligocene source rocks with different facies: A case study from the southwestern Bozhong Sag, Bohai Bay Basin, China

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Abstract
There are noticeable differences between lacustrine and marine systems in terms of depositional environments and organic matter (OM) origins. Previous studies have concentrated on the Eocene source rocks (Shahejie Formation Mbrs 1 and 3) (E2s1 and E2s3) of the Bozhong Sag, Bohai Bay Basin in Northeast China, but the OM enrichment mechanisms, depositional environment characteristics and laterally variable facies of Oligocene source rocks (Dongying Formation Mbrs 2 and 3) (E3d2 and E3d3) remain controversial, especially those in the lower of Dongying Formation Mbrs 2 (E3d2L). To address these issues, based on Rock-Eval pyrolysis, vitrinite reflectance, and saturated/aromatic hydrocarbons gas chromatography–mass spectrometry, the geochemical properties, depositional environments and OM origins of E3d2L and E3d3 source rocks from 7 prospecting wells in the southwestern Bozhong Sag were evaluated. The results show that the E3d2L belong to poor to medium quality source rocks, while the E3d3 are good to excellent source rocks, and the geochemical characteristics in the two intervals lacustrine source rocks have distinct differences. Using hierarchical cluster analysis, five genetic organic facies were identified. The E3d2L source rocks consists of facies D2-Ⅰ, D2-Ⅱ, D2-Ⅲ and D2-D3, whereas the E3d3 contains facies D3 and D2-D3, with one being common to both formations. Furthermore, an integrated model was established to provide evaluation of the Oligocene source rocks. The five genetic organic facies have distinct differences and some similarities in redox conditions, water salinity and OM origins. In addition, the geochemical characteristics in the same intervals have apparent lateral heterogeneity from deep to marginal source rocks. The established models may have positive implications for the evaluation and prediction of Oligocene source rocks in the Bozhong Sag.

Keywords: depositional environments, organic geochemistry, biomarkers, hierarchical cluster analysis, Bozhong Sag, Bohai Bay Basin

# Typical misinterpretations and scientific concepts in well-logging geologic studies

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The methods and theories of well logging geology have been widely used in the fields of basic geology, petroleum geology and engineering geology. The issues of sensitivity difference between various well log series and geological information, and the mismatching between geophysical properties of multiple well logs and the geological mechanisms of rocks will result in the misunderstandings in the research of well logging geology. Consequently these typical misunderstandings should be clarified in order to propose the countermeasures and scientific thinking in terms of geological interpretation of well logs. The contradiction between vertical resolution and depth of investigation of various log series is summarized, and the importance of integration of geological and geophysical data is clarified. Then the effects of borehole regularity and drilling mud types on the well log data collection are summarized, and they will result in the presences of "fake well log data", which mislead the well log interpretation. The response of petrophysics mechanisms should be carefully considered due to the presences of high gamma sandstones and high density and high resistivity mudstones. The new well log series should be incorporated in terms of well log evaluation of unconventional hydrocarbon resources, and the calibration of well log data as well as the integration of geological thinking will improve the accuracy of well log interpretation. At last, the misunderstandings existing in the analysis of borehole structure, well logging sedimentology, evaluation of in situ stress, identification and evaluation of fracture are summarized, and the related countermeasures as well as scientific thinking methods are proposed. The research results are hoped to give scientific guidance for the comprehensive study of well logging geology.

# Hydrodynamic- and reservoir modelling of chlorite-coated sandstones in the Norwegian Continental Shelf

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Chlorite-coated sandstones are important reservoirs for hydrocarbon exploration and production on the Norwegian Continental Shelf (NCS), as they preserve high porosity and permeability at great depths. However, the distribution and quality of chlorite coats are difficult to predict and likely depend on various factors such as sedimentary facies, provenance, diagenesis and fluid flow. In this project, we use hydrodynamic- and reservoir modelling to investigate how the architecture of chlorite-coated zones influences fluid flow and reservoir performance in sub- surface reservoirs. The project starts with Delft3D, a process-based modelling software, to simulate the sediment transport and deposition of chlorite-coat pre- cursor clays in shallow- marine environments, using the well-studied Ravenglass Estuary, UK as a comparison. We then use Petrel, a reservoir modelling software, to build 3D geological models of chlorite-coated sandstones based on subsurface data from the Halten Terrace fields and outcrop analogues from East Greenland. Finally, we will perform fluid flow simulations to evaluate the impact of chlorite coating on reservoir quality parameters. Previous results show that chlorite coats can create complex heterogeneities in the reservoir, affecting both vertical and lateral fluid flow, enhance reservoir quality by reducing cementation and perme- ability loss, and have potential on promoting long term mineralization in CO2 storage. Our work will provide a novel approach to predict reservoir properties in deep chlorite-coated sandstones on the NCS and worldwide. In this contribution, we will give an overview of the project, the methodologies, and showcase preliminary results.

# Tectonic roles in the mid-Late Cretaceous desertification in SE Asia

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The relative roles of tectonics and climate change in global and regional desertification are not well constrained. Previous studies have emphasized the role played by climate change as a dominant cause of southeastern (SE) Asia desertification during the mid-Late Cretaceous. The effect of early uplift of the Tibetan Plateau prior to the collision between Eurasia and India on regional desertification remains poorly understood. We present a comprehensive set of provenance data on two aeolian sequences deposited in the Simao Basin and Khorat Plateau desert environments adjacent to southeast Tibet. Our provenance results suggest that the aeolian sandstones of the Pashahe Formation in the Simao Basin were largely recycled from exposed sedimentary rocks of the Songpan-Garze terrane, Southern Qiangtang terranes and northern Yangtze Block with minor contributions from the magmatic rocks of the Tengchong and Southern Qiangtang terranes. Combined with other evidence, provenance results indicate the source areas started to grow and to be rapidly unroofed and determined the birth of the transcontinental southerly flow paleo-river carried sand to be stored. In contrast, the Phu Thok aeolian sandstones in the Khorat Plateau were predominantly sourced from the exposed Sibumasu igneous rocks together with recycled detritus in the Sukhothai Arc terrane, which was possibly transported by a local river. Hence, our thesis is that elevated topography caused by the closure of the Bangong-Nujiang Mesotethys profoundly affected the atmospheric circulation and drainage development, leading to mid-Late Cretaceous desertification across SE Asia.

# Paleoenvironmental Reconstruction and Organic Matter Accumulation of the Paleogene Shahejie Oil Shale in the Zhanhua sag, Bohai Bay Basin, Eastern China

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The sedimentary environment plays an important role in the enrichment and preservation of organic-rich fine sediment. This paper reveals the mineralogy, geochemistry and paleoenvironmental evolution of the Paleogene Shahejie Formation. The effects of paleoclimate, paleosalinity, paleo-redox conditions, paleo-water depth and paleo-productivity on organic matter enrichment were discussed. The environmental evolution and enrichment models of organic matter were established. The results show that the minerals are mainly composed of calcite (average 40.13%), quartz (average 21.64%) and clay minerals (average 24.07%), accompanied by dolomite (average 7.1%), feldspar (average 6.4%) and pyrite (average 3.0%). The abundance of organic matter is high, and the total organic carbon (TOC) is between 1.07 and 5.12 wt%. The type of organic matter is mainly type I ~ II , which is generally high quality source rock. The source of organic matter is the mixed input of lower bacteria, algae and higher plants. In the early sedimentary stage, the ancient ice land was dry and cold, with high salinity, strong reducibility and relatively low productivity. In the late sedimentary period, the climate became warm and humid, the salinity decreased appropriately, and the input of terrigenous debris led to the weakening of the reducibility and the gradual increase of productivity. Paleosalinity and paleoclimate determine the sedimentary environment, and paleoproductivity and paleoredox conditions indicate the formation and preservation conditions of organic matter. The abundance of organic matter is determined by the influence of paleoclimatology, paleo-salinity, paleo-reduction conditions and primary productivity. Warm and humid climate, brackish water, suitable reduction conditions and high yield are favorable conditions for the formation and preservation of organic matter. The research results are of great significance to the genetic mechanism of organic matter accumulation and provide theoretical and technical guidance for shale oil exploration and development.

# Quantitative reconstruction of late Ediacaran Stromatolite build-ups of the Xifengsi Formation, western Zhejiang, South China, based on 3D digital outcrop

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Compared to studies based on a single stratigraphic profile, multidimensional studies are adequate in understanding the structure heterogeneity and growth process of ancient reefal build-ups such as stromatolites. However, limitations in outcrop size and accessibility have hindered data collection through traditional fieldwork. Unmanned aerial vehicles (UAVs), particularly commercial drones, offer low-cost and efficient solutions for outcrop investigation. Close-range photogrammetry using high-resolution UAV images creates accurate three-dimensional models of outcrops down to the centimeter level.
Using the late Ediacaran stromatolite banks of the Xifengsi Formation in the Xintangwu section at Zhejiang Province, South China, as an example, this study visualized, documented, and analyzed data of stromatolite build-ups on the 3D digital outcrops which constructed using the method of close-range photogrammetry. Formerly reported stromatolites of the Xifengsi Formation were continuously developed up to 60m intervals (Tang et al., 1981; Yu et al., 1982), which is exceptional in scale among known late Ediacaran stromatolites in South China. The diameter and height of the stromatolites are calculated systematically across the studied section, and the distribution of laminated, wavy, cone-shaped, and columnar stromatolites is outlined on the digital outcrop, which shows heterogeneity of stromatolites on size, shape, and structure in the whole section. In-situ LA-ICP-MS are applied to the stromatolites and the early marine cements to recover the sea-water geochemistry. Our results show that the stromatolites were developed in an oxygenated environment; the continuous growth of the stromatolites may be controlled by a sustaining increase of sedimentary accommodation and the low impact of terrigenous input and metazoan.

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# Control of hydrothermal activity on sedimentary organic matter enrichment and favorable interval selection for shale gas: A case study of the Lower Cambrian in southern China

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Lower Cambrian is the main target intervals of marine shale gas exploration and exploitation in China. Shale gas bearing varies greatly among different intervals and how to determine favorable targets is an important problem to be solved. In this article, taking Jiangye-1 well in Xiuwu Basin as an example, according to core description, logging data analysis, mineral and elemental composition analysis, bulk and effective porosity tests, total organic carbon (TOC) and gas content tests, lower Cambrian Wangyinpu and Guanyintang formations have been studied. Results show that TOC content is the dominating factors for effective porosity and gas bearing content; redox conditions and bioproductivity control the enrichment of sedimentary organic matter. The water reducibility of SQ1 varies greatly, of SQ2 and SQ3 is generally strong, reducibility of all the three sequences is stronger than those of SQ4 and SQ5; the bioproductivity of SQ3 is the highest and little difference in the bioproductivity has been found between SQ1 and SQ2, both of which show higher values than SQ4 and SQ5. Besides terrigenous siliceous minerals, large amounts of hydrothermal origin siliceous minerals exist in lower Cambrian Wangyinpu and Guanyintang formations. Specifically, siliceous origin of SQ1 varies greatly, part of intervals are terrigeneous origin and part of intervals are hydrothermal origin; most siliceous minerals of SQ2 and SQ3 are hydrothermal origin, whose content takes up 10%~30%; compared with SQ2 and SQ3, content of hydrothermal origin siliceous minerals drops in SQ4 and terrigeneous siliceous content increases; siliceous minerals of SQ5 originate from normal terrigeneous clastic deposition. Hydrothermal activities are helpful for the increase of reducibility of seawater and enhancing bioproductivity, the sedimentary organic matter abundance is thus controlled and the enrichment of shale gas is further affected. The intervals deposited when frequent hydrothermal activities occurred are exactly favorable targets of shale gas in lower Cambrian.

# Sedimentary environment of Permian high-quality source rocks in Santanghu Basin

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The Permian Lucaogou Formation (P2l) and Tiaohu Formation (P2t) are important hydrocarbon source strata in Santanghu Basin, NW China. There are obvious differences between the two source rocks in lithology, TOC, organic matter type and sedimentary environment. Fine-grained sediments of P2l were dominated by carbonate and pyroclastic, with high TOC and type I-II1 kerogen. The source rocks of P2t are mainly mudstone and tuff, with II2-III kerogen and low TOC. The formation environment of source rocks was analyzed by biomarker compound and trace element. The results show that the P2l source rocks have high values of gammacerane index, Sr/Ba ratio, Sr/Cu ratio, and paleoclimate index "C" with low Pr/Ph. The P2t source rocks has low values of gammacerane index, low Sr/Ba ratio, Sr/Cu ratio, and paleoclimate index "C" with high Pr/Ph,. Comprehensive analysis shows that during the sedimentation period of P2l, the climate was arid, the water body was clearly stratified with high salinity, Pr/nC17-Ph/nC18 and C27C28C29 regular sterane suggesting a reducing environment, and the organic matter was mainly contributed by algae. During the sedimentary period of P2t, the climate was humid and the water body was weakly stratified with low salinity. Pr/nC17-Ph/nC18 and C27C28C29 regular steranes showed a weakly reduction environment, and the organic matter was contributed by mixed sources (terrestrial higher plants, phytoplankton and algae). The intense volcanic activity in P2l deposited a large amount of volcanic ash material (felsic), which favored the growth of algae, while the P2t source rocks had less volcanic ash material and algae input. Comprehensive analysis shows that the reducing environment with high input of volcanic ash and algae, high salinity and dry heat is more conducive to the development of high-quality source rocks.

# Facies architecture and aggradation rates of supercritical alluvial fans: control by autogenic processes or high-frequency climatic oscillations?

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Alluvial fans are present in many terrestrial environments and provide important archives of environmental change. Despite the overwhelming documentation of alluvial-fan systems, few sedimentological studies have documented the facies architecture of sand-rich, supercritical flow fans and addressed the role of autogenic processes and how autogenic processes may be distinguished from the effects of tectonics and climate change. To fill this gap, we present sedimentological and architectural data from two different sand-rich, streamflow-dominated Late Pleistocene alluvial-fan systems. The studied fans developed under similar tectonic and climate conditions, but differ in size and drainage area, allowing to estimate the role of tectonics, climate, and autogenic controls on flow processes and facies architecture for different fan types and lithological settings. Luminescence dating was used to determine the timing of fan onset and aggradation rates. Both fans represent rather small tributary-junction fan systems that developed over a short period of time. Such systems rapidly respond to climate change and the relatively low complexity of fans is well comparable to experimental fans. Fan onset and aggradation occurred in response to climate change at the end of MIS 3. The highest aggradation rates are recorded from the early stage of fan building, during which more than 35 m thick sediments accumulated within a few thousand years. Sediment-laden, rapidly waning flows favoured the deposition and preservation of supercritical bedforms and allowed for the aggradation of stable antidunes. Meter-scale coarsening upward successions of sandy sheet-flood deposits, overlain by multilateral or single-storey channel bodies with gravelly infills, are related to high-frequency climatic fluctuations or seasonal fluctuations in water and sediment supply. The recurrent pattern of multistorey, multilateral, and single-storey channel bodies with a lateral offset to vertical stacking pattern most probably was controlled by autogenic switch in an avulsion-dominated system.

# Response of uranium mineralization in Kuqa depression driven by basin-mountain coupling mechanism

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Uranium mineralization around Kuqa depression is very active. The ore-controlling factors, metallogenic mechanism and metallogenic law of sandstone type uranium deposits in the lower member of Pliocene Kuqa formation are the focus of uranium geologists. The authors analyze the key ore-controlling factors and temporal and spatial allocation relationship of the formation and development of sandstone type uranium deposits in the context of basin mountain coupling mechanism (tectonics & sediments & geomorphology), following the research idea from source to sink. The main understanding is as follows:

1.The large-scale intracontinental thrust nappe of the Cenozoic South Tianshan orogenic belt not only controls the filling evolution process of the uranium bearing rock series of the Kuqa formation, but also restricts the basic pattern and metallogenic process of uranium mineralization in the lower member of the Kuqa formation.

2. Although the distribution scale of magmatic rocks in the South Tianshan orogen is limited, U-rich granites exist in the Tomur peak area. The fully developed surface water drainage system, on the one hand, can carry the debris of the orogenic belt to accumulate in the Kuqa depression, thus forming a series of large provenance-sedimentary lobes in stages, creating potential uranium bearing rock series and high-quality uranium reservoir. On the other hand, the drainage system crossing the U-rich granites in the orogenic belt not only provides the accumulation of original trace uranium for the uranium reservoir through physical transportation, but also promotes the development of regional interlayer oxidation zone and dissolved uranium required for mineralization through the derived underground ore-bearing fluid system.

3.In Kuqa depression, the near East-West structure limits the ore-bearing flow field and the development space of interlayer oxidation zone (Baicheng sag). Uranium mineralization is concentrated near the front line of regional interlayer oxidation zone (especially the "water blocking surface" side in the South).

# Molecular dynamics simulation experiment on the effect of stress on quartz dissolution under deep geological conditions

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Deep and ultra deep reservoirs contain about 23% of oil and 50% of natural gas, with enormous potential for oil and gas resources. Among them, 60% of recoverable reserves are distributed in clastic rock reservoirs. In the ultra deep clastic rock reservoirs found in Kelasu structural belt of Kuqa depression, Tarim Basin, China, the proven natural gas reserves exceed trillion cubic meters. Under the tectonic background of the foreland basin, the Kelasu structural belt as a whole has characteristics such as ultra deep, high temperature, high pressure, high lateral stress, and strong structural deformation. At present, the understanding of reservoir development laws in this area is not clear, which to some extent restricts the exploration and development process. One important scientific issue is that under the conditions of temperature, pressure, and environmental closure in the buried strata, it is not yet clear whether lateral compressive stress promotes or suppresses the dissolution or precipitation of minerals. For the widely distributed mineral quartz in clastic rocks, we use the molecular dynamics simulation methods to establish a quartz-aqueous solution molecular reaction model. Comparative experiments were conducted under stress free and stressed conditions under the conditions of temperature and pressure in the formation and a series of solution pH values (1, 7.5, 9.5, 11). The experimental results show that the addition of stress can significantly reduce the free energy of quartz dissolution in the temperature, pressure, and alkaline solution environments of the formation. However, in acidic solution environments, the promotion effect of stress addition on quartz dissolution is limited. The experimental results also intuitively elucidate the dissolution mechanism of quartz under acidic and alkaline conditions.

# Depositional Evolution and Driving Mechanisms of the Lower Cretaceous Gravity Flow Deposits in the Scotia Basin, Eastern Canada

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Sedimentary evolution of the gravity flow deposits in the Scotia Basin has not been clear. Based on the integral analysis of core samples, logging and seismic data in the Sable subbasin of the Scotia Basin, distribution layers, sedimentary units and sedimentary evolution of the gravity flow deposits are systematically revealed aiming to provide a certain reference for the deep-water petroleum exploration within the basin. The Lower Cretaceous Mississauga Formation （MF） and Logan Canyon Formation (LF) in the Sable subbasin of the Scotia Basin developed large-scale gravity flow deposits, including MTDs, gravity flow channels, levee-overbanks and lobes; Small-scale gravity flow deposits developed in the west of the study area at 147 Ma, the early stage of MF, and large-scale slope bottom fans developed in the middle of the study area at 130 Ma, the late stage of MF; Small-scale gravity flow deposits commonly developed at the early stage of LF (113 Ma) in the study area, and large-scale slope bottom fans developed in the southeast of the study area at the late stage of LF (101 Ma).

# The deposition and burial processes of cave sediments

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Karst caves are underground cavities formed by the process of dissolution, typically occurring in soluble rocks such as limestone, gypsum, and marble. During the formation process of karst caves, influenced by various natural, biological, and anthropogenic forces, the cave floor preserves exceptionally rich cave sediments. Sediments of different ages, origins, or genesis are superimposed on the cave floor, forming distinct depositional sequences and interfaces. However, due to the loose and unconsolidated nature of cave sediments, there are challenges in conducting research from an in-situ, micro-scale, directional, and process-oriented perspective.

Micromorphology is a subdiscipline within sedimentology and soil science that utilizes (ultra)microscopic techniques to investigate resin-impregnated in-situ and oriented samples. Its principal objective is to analyze the components, fabric, microstructure, as well as their temporal, spatial, and genetic relationships, which are not readily discernible by the naked eye.

Using micro-morphological techniques on solidified samples and thin sections of cave sediments, combined with macroscopic profile observations, enables the effective identification of micro-morphological characteristics of different cave sediments and post-depositional processes. By introducing the concept of sedimentary microfacies and tracking the development and evolutionary patterns of key micro-morphological features within a comprehensive chronostratigraphic framework, it becomes possible to infer the processes, patterns, and mechanisms of accumulation and burial of cave sediments on a four-dimensional scale.

Currently, we have conducted micromorphological studies and analyses on the cave profiles of Fodongdi cave and Naninan cave, located in the Southeast Asian subtropical region. Our specific aims were to investigate and clarify the environmental conditions during deposition of each lithological layer, identify the diagenetic processes that have occurred (e.g., any modification of the sediments or the material contained within them) and to explore possible signals of hominin behaviour preserved.

# Logging characterization and reservoir classification of carbonate reservoirs : A case study of Carboniferous carbonate reservoirs in Akraol Oilfield

Logging Characterization And Reservoir Classification Of Carbonate Reservoirs:A case study of Carboniferous carbonate reservoirs in Akraol Oilfield Lu Xiao[1], Logging characterization and reservoir classification of carbonate reservoirs : A case study of Carboniferous carbonate reservoirs in Akraol Oilfield Jin Lai[1,2], Logging characterization and reservoir classification of carbonate reservoirs : A case study of Carboniferous carbonate reservoirs in Akraol Oilfield Guiwen Wang[1,2], Logging characterization and reservoir classification of carbonate reservoirs : A case study of Carboniferous carbonate reservoirs in Akraol Oilfield Song Wang[1,2]
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The Precaspian Basin is one of the most valuable large-scale oil and gas basins for exploration, and is the main oil and gas producing area in Kazakhstan. Akeroer Oilfield is located in the eastern margin of the Precaspian Basin, which is a carbonate reservoir controlled by lithology. In order to solve the problem of heterogeneity of Carboniferous carbonate reservoir in Akraol Oilfield in the eastern margin of Precaspian Basin, the reservoir characteristics are analyzed and studied in detail. Through the observation of core and thin section in the study area, it is found that the lithology is mainly bright crystal grain limestone, bright crystal biological limestone and micritic bioclastic limestone. Through the observation of casting thin sections and scanning electron microscopy, it is clear that the main reservoir space types include intergranular dissolved pores, intra-granular dissolved pores, intercrystalline pores, fractures and biological body cavity pores. The imaging logging data can well reflect the information of fractures, holes and lithology around the well. Combined with core and imaging logging analysis, a large number of low-angle fractures and dissolution pores are developed in the study area, and high-angle fractures are less developed. Then, the reservoir types of single wells are characterized, including pore-dominated type, fracture-pore dominated type and fracture-hole dominated type reservoirs, and the vertical distribution characteristics of different types of reservoirs also can be clarified. Combined with sedimentary environment, under different sedimentary facies belts, the lateral distribution difference and vertical distribution law of reservoirs are clarified. The research results can provide guidance for the distribution of high-quality carbonate reservoirs in the study area.

# Geochemical characteristics of the late Eocene mudstones in the eastern Nima Basin, Tibet: Implications for the paleoenvironment, provenance, and tectonic setting

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Paleoenvironmental reconstruction plays a pivotal role in providing insights into the uplift history of the Tibetan Plateau during the Cenozoic. The Nima basin, situated in the central Tibetan Plateau, is crucial for studying the tectonic and geomorphic evolution of this region. The clastic composition and geochemical characteristics of the Niubao Formation hold considerable potential for unravelling the geological history and reconstructing depositional environments of central Tibet in the early Cenozoic. In this study, we present detailed geochemical characteristics to determine their provenance, paleoenvironmental conditions, and tectonic origins. The index of compositional variability (ICV>1) of mudstones indicates that low compositional maturity sediments underwent weak sedimentary recycling. The chemical index of alteration (CIA: 59.8-72.9) reveals that parental rocks experienced a moderate chemical weathering degree. The paleoclimate indicators of the mudstones suggest an oxidizing and arid depositional environment, with a mean annual temperature (MAT) of 11.64 ± 4.19 °C. The geochemical evidence also demonstrates that the mudstones were derived from mixed felsic and intermediate igneous rocks that formed in a dominantly continental island arc tectonic setting. Similarities in the geochemical characteristics among the Niubao Formation and surrounding igneous rocks indicate that a continental-scale drainage system once drained westward in central Tibet. It is concluded that the central plateau experienced a cooler and drier climate coinciding with the presence of a large-scale drainage system during the late Eocene.

# Channelized lobes of fan delta mainly controlled by debris flow: internal architecture and origin

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Fan delta has always been an important place for the distribution of oil and gas mineral resources. Under different paleogeographic conditions, the distribution and internal architecture of fan deltas are different. The internal architecture of the fan-delta front sedimentary type dominated by lobes is still unclear. Taking the PI formation of Baobab N oilfield, Bongor Basin, Chad as an example, the sedimentary architecture model of fan delta under steep slope background is discussed by core observation and description, logging data and 3-D seismic data analyses. The results show that the climate was mainly droughty, and the paleo-water depth was an average of 14m during the sedimentary period, which was conducive to the development of the fan delta. The fan delta sandstone has coarse grain size and low component maturity value, which is mainly composed of turbidity -flow sedimentary structures with debris flow transport mechanism, while bedding and other sedimentary structures representing tractive current are few. The seismic reflection in the direction of the cutting source is hummocky, showing that the lobe body is mainly mound superposition. The delta architecture model of debris flow master fan under steep slope background is established. The proximal provenance of fan delta is dominated by passing deposit, the front sand body is dominated by lobe, and the distributary channel is poorly developed. Vertically, the sand body is superimposed along the source, and the vertical and lateral superimposed along the incisal edge. Stable mudstone interlayers are developed between the sand bodies in a single stage, and the structural styles are different under different slopes. When the gradient is small, the lobes are linguoid and the width is small, whlie the slope is large, the lobes are mostly lobate and the width is large.

# Quantitative study of the structural reworking effect on the N21 clastic reservoir in the Yingdong region, Qaidam Basin

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The structural reworking effect on the physical properties of clastic reservoirs is a significant focus in the study of clastic rock diagenesis and reservoir formation. Continuous structural stress experienced in the Qaidam Basin has led to a considerable reconstruction of clastic reservoirs. However, there exists a gap in systematic and quantitative researches. This study concentrates on the No.1 structure in the Yingdong region and conducts 3-D finite element numerical simulations to explore the paleo-structural stress affecting the $N_2^1$ clastic reservoir from the Late Neogene to the Early Quaternary. Porosity estimation is accomplished through statistical analyses of cast thin sections and empirical formulas, involving several parameters: present porosity (ϕ), residual porosity after thermal compaction (ϕT), porosity loss by chemical cementation (ϕcem), porosity increase by dissolution (ϕdis), and structural fractures (ϕfra). Quantifying porosity loss by structural compression (ϕstr) involves subtracting ϕ and ϕcem from ϕT, then adding ϕdis and ϕfra. The reworking effect of structural compression can be quantitatively predicted by establishing a fitted relationship between structural stress and ϕstr. Our findings highlight that structural compression contributes to porosity loss in this region. The maximum paleo-structural stress inversely correlates with reservoir porosity, yet positively linearly relates to ϕstr within specific depths. The Youshanshan Fault exhibits an average compression stress of 71.00 MPa on the hanging wall and 75.10 MPa on the footwall. The ϕ averages 22.70% and 19.68% at two highly deformed locations on the hanging wall, with average ϕcem at 8.50% and 6.00%, and average ϕT at 34.58% and 29.90%. Estimated ϕstr stands at 6.88% and 7.72%, assuming ϕdis of 1.50% and ϕfra of 2.00%. The calculated porosity loss rate caused by structural compression approximates 0.17%/Mpa. This method aids in predicting the distribution of reservoir properties in the deeper regions of both limbs of the Yingxiongling structural belt.

# Quantitative identification of the Middle Cambrian gypsum-salt rock and their planar distribution characteristics in the platform-basin region of the Tarim Basin, Northwest China

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The Middle-Lower Cambrian strata in the platform-basin region of the Tarim Basin present a favorable combination of source rock, reservoir, and caprock, making them a crucial domain in basin's strategic succession of oil and gas resources. The planar distribution characteristics of the Middle Cambrian gypsum-salt rock, serving as effective caprock within this combination, remain highly contentious, significantly hampering Lower Cambrian subsalt exploration. This study, based on logging and core data, employs an optimized random forest algorithm and data mining techniques to establish logging response models for various lithologies in the Middle Cambrian. Subsequently, machine learning and fuzzy discriminant analysis are applied to identify gypsum and salt rocks in wells, calculating their thickness ratios to the total Middle Cambrian strata. On this basis, distinct seismic reflection characteristics of gypsum and salt rocks are integrated to determine their planar thickness variations and distribution patterns. The research findings indicate that five types encompassing 14 subtypes of lithologies can be discerned using five logging curves including density, acoustic, and relative sulfur content, among others. Gypsum rock exhibits an average density greater than 2.89 g/cm³, acoustic interval transit times mainly fall within the range of 52-71 us/ft, and sulfur content exceeds 10%. The accuracy of lithology identification via machine learning exceeds 85%. Spatially, the gypsum-salt rock exhibit a bull's eye architecture of halite-gypsum-dolomite. Salt rock are mainly distributed in the Bachu uplift, while gypsum rock are primarily found in the Tazhong uplift. Within the Awatage Formation, both gypsum and salt rocks exhibit three depocenters, while in the Shayilike Formation, they only have one depocenter, found respectively in the Bachu uplift and the Tazhong uplift, reflecting multiple transgressive-regressive cycles during the Middle Cambrian. These findings hold significant guiding implications for future exploration of oil and gas resources in the ultra-deep Lower Cambrian subsalt.

# Sedimentary burial of shelf shale and its controls on reservoir formation of shallow shale gas—A case study on Luowang syncline in Zhaotong Demonstration Area

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The Well Y6 and Well Y7 in the Luowang syncline of the Zhaotong Demonstration Area have achieved good shale gas discoveries in the Wufeng-Longmaxi Formation. The gas reservoir is characterized by shallow burial, high methane content, and large thickness of gas bearing intervals.The Wufeng-Longmaxi Formation in this area is a semi deep-water to deep-water continental shelf sedimentary system,with a wide distribution range and stable thickness.It was deeply buried in the early stage and uplifted and shallowly buried in the late stage due to tectonic activity.Comprehensive field geological survey,single well analysis,combined with organic carbon,X-ray diffraction,field emission scanning electron microscopy and other test results, the lithology and geochemistry of source rock, the sedimentary facies, mineral component, micro pore characteristics of reservoir and gas bearing system analysis were studied,the geological conditons of shallow shale gas accumulation are analyzed, and the reservoir forming model is established.The results indicate that:①A rich organic shale with integrated source and reservoir,self generated and self stored,clear layered structure,and favorable reservoir spaces such as nanopores and microfractures,which is favorable geological body for shale gas occurrence;②The appropriate degree of thermal evolution ensures sufficient gas supply;③Shale top and bottom cover layers are developed,with obvious shielding effect.The main form of occurrence is adsorbed gas,supplemented by free gas,which is conducive to the formation and preservation of shallow shale gas reservoirs.The conclusion is that early deep burial gas and late shallow burial sealing are the basic characteristics of the high-quality shale gas bearing system in this area.The syncline is located in the deep-water continental shelf sedimentary area,with well-developed shale bedding structure,strong adsorption ability,and significant self generation and self storage characteristics,which are conducive to the long-term stable occurrence of shale gas.It is the target area for the next step of shale gas exploration.

# Application of seismic lithological landform in prediction of Lower-middle Cambrian dolomite reservoir in Gucheng area

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Previous studies suggest that middle Cambrian evaporite and lower Cambrian shoal dolomite have good reservoir combination in Tarim Basin. The Gucheng Lower Uplift is located in the central uplift zone of Tarim Basin. It is a Middle Cambrian to Lower-middle Ordovician carbonate platform developed in the Precambrian landform, and the carbonate sedimentary reservoir is developed on a large scale.At present, the prediction of dolomite reservoir mainly depends on the drilling situation, while the few drilling, complex lithology and the lack of seismic data application in Gucheng area seriously restrict the oil and gas exploration and development in this area.In this study, taking the Gucheng area of Tadong as an example, under the guidance of seismic sedimentology theory, using the Wheeler domain thickness constraint layer automatic tracking technology to build the third sequence stratigraphic framework.On the basis of the seismic structure template and the analysis of ancient landform, Multi attribute cluster is used to characterize the structural characteristics of dolomite rock seismic geomorphology,combined with AI frequency inversion to prediction the thickness and boundary range of dolomite.Finally, it jointly guides the identification of gentle slope dolomite granular beach body and sedimentary reservoir distribution in the lower Cambrian sedimentary period of the Gucheng area.

# Features and controlling factors of Late Miocene deep-water channels in Zhongjian Area

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In order to clarify the features and controlling factors of the Late Miocene deep-water channels in the Zhongjian Area, based on 2D and 3D seismic data and regional tectonic,we established models of the deep-water channels . The results show that there were two types of deep-water channels of different provenance in Miocene in Zhongjian Area. One type is a deep-water channel that is filled by carbonate debris from the Xisha carbonate platform, and another type is a deep-water channel that is filled by terrigenous debris from the Eastern Vietnamese drainage system. Deep-water channels filled by terrigenous debris are highly mobile due to the impact of paleotopography and sea level , with the features of mutual cutting between channels; The deep-water channels that supply by carbonate rock fragments are mainly controlled by paleotopography and are dominated by vertical aggradation with weak mobility. The results have guiding significance for the identification of deep-water channels and reservoir prediction in oil and gas exploration in Zhongjian Area.

# Well logging identification marks and geological significance of siliceous rocks in the Middle Permian Maokou Formation, Sichuan Basin, China

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There is a set of siliceous rocks developed between the Middle Permian Maokou Formation and Wujiaping Formation in Sichuan Basin. Because the siliceous rocks are closely related to water depth and tectonic activity, the problem of stratigraphic attribution of asphaltic siliceous rocks is of great significance to the study of the sedimentary pattern of the Middle Permian Maokou Formation in Sichuan Basin. In this study, the interface of Maokou Formation and Wujiaping Formation is redivided by using natural gamma spectrum logging, and the siliceous rocks belong to Maokou Formation. Based on the geochemical analysis data, it is revealed that the siliceous rocks are biogenic and indicate a deep water environment. Finally, a new understanding of the late sedimentary pattern of the Maokou Formation in Sichuan Basin is put forward. It is believed that the Kaijiang-Liangping trough had its early form in the late Maokou Formation.

# Late Pleistocene-Holocene Evolution of Malé Island (North Malé Atoll Rim, Republic of Maldives)

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Malé, the capital of the Republic of Maldives, is established on an island of about 6.8 square kilometers, with a maximum relief of 2.7 m and a population of 236000 inhabitants. This study focuses on the late Pleistocene-Holocene evolution of Malé island that recently formed as part of the discontinuous North Malé Atoll rim. Understanding the formation of Malé Island is relevant in predicting its future in the context of accelerating rates of sea level rise in the next centuries due to anthropogenic Earth gloabl warming. Analyses of two boreholes and published information from additional boreholes drilled on Malé Island are available for this study, in addition to a high resolution multi-beam bathymetric survey acquired along its upper slopes and deep surroundings. Two distinct sedimentary units were recovered in the boreholes. Facies analyses of the lower unit reveal an overall deepening coralgal reef that accumulated probably during the previous interglacial (MIS 5e) and subsequently was altered by meteoric diagenesis during a 100 kyr-long time of exposure. The upper unit consists of Holocene unconsolidated coralgal accumulation, unconformably overlying the karstified coralgal MIS 5e lower unit. The upper unit, protected behind a karstified late Pleistocene reef, was initiated at ~8200 yr BP and vertically grew 25 m high until 6510 yr BP in the northern part of Malé island farrow. A narrow 30-35 m deep, newly formed central faro lagoon started to fill up only at ~5500 yr BP, when a reef initiated on top of the southern highest Pleistocene karstified reef and sea-level rise stalled. The infilling of the lagoon was completed about 4500 yr BP, and at this time Malé island itself initially formed.

# Broadband and wide-azimuth ocean bottom node (OBN) seismic anisotropy analysis and fracture detection

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Ocean bottom nodes(OBN) seismic acquisition can effectively realize detection and imaging of complex or high-speed shielded structures (such as salt structure), which can provide wide-azimuth, long offset and high coverage times dataset comparing with the conventional seismic exploration, This technology has become the preferred seismic acquisition technology in the evaluation and development stage of offshore deep-water oilfields. During the completion logging and DST testing of carbonate reservoir in an offshore research area, the reservoir has strong local inhomogeneity or micro fractures development, the fracture network enhances the reservoir's dynamic permeability obviously, which is the main control factors of the predominant transportation systems and high production. Referencing to the directional vertical fracture detection theories and mathematical models of Ruger two approximate equation and Fourier series decomposition, the exploratory research of fracture density and orientation were conducted based on OBN five-dimensional seismic data, Multi-method were compared and drilling wells were confirmed to be reliable, the preliminary application obtained good effect.

# Application of seismic inversion and spectrum decomposition technology in deepwater exploration

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Due to high investment， high risk and high technology in deepwater exploration， it is crucial to boost exploration success rate and search for prospects in frontiers or some areas with low degree of exploration or even no wells． In this article， no-well wave impedance inversion and spectrum decomposition were applied to a deepwater basin in West Africa． Spectrum decomposition was employed to research on reservoir lateral distribution through tuning the corresponding relationship of amplitude properties in frequency domain． The seismic resolution after decomposition is higher than conventional seismic． This aids the researchers to delineate reservoir and estimate layer thickness． Moreover， no-well wave impedance inversion in combination with seismic decomposition can be used to predict the beneficial facies tracts and reservoirs．

# The complexities of using the biogenic carbonate clumped isotope (Δ47) thermometer

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The biogenic carbonate clumped isotope (Δ47) thermometer has become an important tool for interpreting paleoseawater temperatures. In this study, modern bimineralic pearl oysters (Pinctada radiata) were collected from the Arabian Gulf to investigate whether the clumped isotope microstratigraphy of aragonite and calcite shell layers forming individual valves faithfully record ambient seawater temperature. Valves were microsampled to capture seasonal variability and calculated clumped isotope temperatures (TΔ47) were compared to oceanographic buoy data. Results show that TΔ47 values from calcite layers closely correlate to actual seasonal temperature variations (±1.5°C). In contrast, TΔ47 values from aragonite layers are significantly higher (+12°C), highlighting differences in Δ47 composition between calcite and aragonite. Aragonite layers are interpreted to reflect disequilibrium precipitation in the extrapallial fluid surrounding the mantle as kinetic fractionation and vital effects influenced the isotopic composition of nacreous aragonite. At the most evaporitic collection site, calcite layers have elevated Mg concentrations (100000 to 300000 ppm) and consistently overestimate seawater temperature by ca. 5°C. This relationship between Mg concentration and calculated clumped isotope temperature might have important implications for understanding TΔ47 values from dolomite. The presence of Mg in the crystal lattice could reduce activation energy, promoting the reordering of Δ47. Such 'declumping' would produce an overestimation of temperature, a trend commonly observed in dolomite TΔ47 values.

# Characterization of Clay-Hosted Pore Networks and their Impacts on Reservoir Quality in Tight Conglomerate Reservoirs of the Triassic Baikouquan Formation in the Mahu Sag, Junggar Basin, Western China

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Authigenic clay minerals, namely illite, smectite, chlorite, and kaolinite, are ubiquitously distributed and critically influence the reservoir quality in tight conglomerate reservoirs. This study, focusing on the Triassic Baikouquan formation in the Mahu Sag of the Junggar Basin, Western China, addresses the less-explored aspect of clay pore networks. Employing an integrative approach comprising petrographical analysis, X-ray diffraction (XRD), scanning electron microscopy (SEM), and mercury intrusion capillary pressure (MICP), we present a comprehensive characterization of these clay-hosted pore networks, their occurrences, and impacts on reservoir quality. The study establishes a paragenetic sequence of the conglomerate reservoir based on burial history, diagenetic mineral contact relationships, and hydrocarbon charging periods. Special attention is given to the occurrence and arrangement of illite, which is identified as a critical determinant of reservoir permeability. Illite displays three distinct types: Type I, forming honeycomb-like shaped aggregates mainly through smectite transformation; Type III, exhibiting flake-shaped occurrences with a directional arrangement resulting from the transformation of K-feldspar; and the more complex Type II. The study underscores that sediment sources, compaction, and hydrocarbon charging primarily contribute to the complexity of clay pore networks in the conglomerate reservoir. This work highlight the significant role of these networks in influencing reservoir permeability. The research elucidates the controlling factors behind porosity and permeability heterogeneity within the third member of the Baikouquan formation. The outcomes of this study offer a deeper understanding of the geological characteristics of the Mahu Sag and provide valuable insights for optimizing exploration and development strategies in similar tight conglomerate reservoirs.

# The enlightenment of foreign large-scale CO2 geological storage site suitability Analysis to China's CCS work-A case study of Longdong area, Ordos Basin, China

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Geologic CO2 storage (CCS or GCS) in deep saline aquifers or reservoirs has been widely accepted as an economic and reliable large-scale carbon emission reduction technology. Nearly 50 CCS projects have been put into operation worldwide, but CCS in China is still in its infancy. Development of an applicable framework of the geographical source-sink matching and CCS site selection is essential before the large-scale CCS project can commence. In this study, for large scale site suitability analyzed, 6 CCS main geological criteria (reservoir storage capacity, structural characteristics, rock physical properties, infrastructure availability, geothermal condition, sustainability) were discussed under the case analysis of Illinois Basin–Decatur project, Sleipner, In salah and other typical CCS project. Based on the above evaluation indexes, the site suitability analysis in Zhengning area was evaluated using the outcrop, core, well-log, and seismic data. The study indicates that three sets of reservoir-caprock assemblage (from top to bottom, they are assemblage of Yanchang - Zhifang Formation, assemblage of Heshanggou - Liujiagou Formation, and assemblage of Shiqianfeng - Shihezi Formation, respectively) in Zhengning area are potential assemblages for large-scale geologic CO2 storage. The 2×100MW generator set of Huaneng Zhengning Power Plant can provide stable carbon source. According to the geological data, Zhengning area is located in the southwest of Yishan slop in Ordos Basin, which is a structurally stable area. There are no large faults across the effective reservoir-caprock assemblage within 30km around the Huaneng Zhengning Power Plant. The large-scale site suitability analyzed in the study increases the effectiveness and feasibility of the CCS project. Meanwhile, the site selection evaluation for Zhengning area provides the basis for the implementation of large-scale CCS project in the later stage.

# Provenances Analysis and Sedimentary Evolution of Middle Jurassic in Sichuan Basin, SW China

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This study takes Middle Jurassic in Sichuan basin as an example to investigate the evolution of the provenance system based on the chronostratigraphy data and heavy mineral assemblages, to reveal the paleoenvironment from element geochemical characteristics, finally to discuss the tectonics implication and sedimentary evolution.

A significant changes of sedimentary system and provenance characteristics is recognized within the Lianggaoshan Formation, which deposited in early period of Middle Jurassic. The provenance analysis shows that there were three types of provenances for Lianggaoshan Formation. Specifically, the sediments of Type I were mainly from acidic igneous rocks in the proximal northern margin of the Yangtze Plate. Sediments of Type II were from the central parts of the southern and northern Qinling orogenic belts; which were dominated by intermediate-acid igneous rocks and metamorphic rocks. That of Type III were mainly metamorphic rocks followed by intermediate–acid igneous rocks from the North Daba Mountain area. The provenance characteristics indicates that the sedimentary evolution of J2l in Sichuan Basin was mainly controlled by the tectonic compression of the Qinling orogenic belt. In the early stage, the lake basin was restricted to the east area of  basin. With the intensifying north-south compression of the Qinling orogenic belt, the lake basin expanded rapidly and migrated northward. In the middle and late stages, the uplift of the North Daba Mountain led to the lake basin migration.

In later stage of middle Jurassic, Thick sequences of terrestrial multi colored mudstones were deposited, called Shaximiao Formation. Paleoenvironment analysis shows that the mudstones were mainly deposited in a shallow oxygen-rich freshwater lake basin under semiarid to semihumid conditions, with Sha-2 Member precipitated in a drier and more oxygen-rich environment. The regional paleoclimateis possibly controlled by global geological events and local topography. A two-stage sedimentary environmental model of Shaximiao Formation is proposed.

# The Role of Deep Geofluids in the Enrichment of Sedimentary Organic Matter: A Case Study of the Late Ordovician-Early Silurian in the Upper Yangtze Region and Early Cambrian in the Lower Yangtze Region, South China

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Organic matter is the material basis for shales to generate hydrocarbon. When the thermal evolution degree is consistent, the organic carbon content in present shales is subject to the abundance of primitive sedimentary organic matter. Deep geofluids significantly influence the sedimentary organic matter's enrichment, but the mechanism remains unclear. This paper is aimed at determining how hydrothermal and volcanic activities affected the enrichment of sedimentary organic matter by studying lower Cambrian shales in the lower Yangtze region and upper Ordovician-lower Silurian shales. Oxidation-reduction and biological productivity are used as indicators in the study. The result shows that hydrothermal or volcanic activities affected the enrichment of sedimentary organic matter by influencing climate changes and the nutrients' sources on the waterbody's surface and reducing water at the bottom. In the lower Cambrian shales of the Wangyinpu Formation in the lower Yangtze region, hydrothermal origin caused excess silicon. During the sedimentary period of the lower and middle-upper Wangyinpu Formation, vigorous hydrothermal activities increased the biological productivity on the waterbody's surface and intensified the reducibility at the bottom of the waterbody, which enabled the rich sedimentary organic matter to be well preserved. During the sedimentary period of the lower upper Ordovician Wufeng Formation and the lower Silurian Longmaxi Formation in the upper Yangtze region, frequent volcanic activities caused high biological productivity on the waterbody surface and strong reducibility at the bottom of the waterbody. As a result, the abundant organic matter deposited from the water surface can be well preserved. During the sedimentary period of the upper Longmaxi Formation, volcanic activities died down gradually then disappeared, causing the biological productivity on the water surface to decrease. Besides, the small amount of organic matter deposited from the water surface was destroyed due to oxidation.

# Types, characteristics, and forming of Bar-top Hollows in braided river: from outcrops to depositional simulation

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Bar-top hollows (BTH) are a morphological element recognized in modern braided rivers; however, information regarding their depositional features and types of filling units in ancient strata are unclear. This is an important reason that makes it difficult to identify BTH units in subsurface reservoirs. A Middle Jurassic sandy braided-river outcrop in northwestern China is characterized in this study through the application of unmanned aerial vehicle (UAV) mapping, modeling, and ground penetrating radar (GPR). Two types of BTH filled-units were found: a) sandstone-filled, and b) mudstone-filled hollows. Both of these units were located between two adjacent bar-units in an area that is limited to a compound bar, and were developed in the upper part of a braided-bar depositional sequence. The ellipse-shaped, sandstone-filled unit measures 10 m × 27 m in map view and reaches a maximum thickness of 5 m. the transversal cross-section across the BTHs displays a concave-upward basal surface, while the angle of the inclined structures infilling the BTHs decreases up-section. The GPR data shows that, in the longitudinal profile, the basal surface is relatively flat, and low-angle, inclined layers can be observed in the lower- and middle part of the sandstone-filled BTHs. In contrast, no obvious depositional structures were observed in the mudstone-filled BTH in outcrop. The mudstone-filled hollow formed in a weak hydrodynamic environment. Depositional process simulation revealed that the paleo-water velocity forming the sandstone-filled hollows is 2.2-6.5 times of that in the mudstone-filled hollow. Additionally, the water flow velocity in the modeled BTH during filling had no certain correlation with their size. This new understanding of BTH has a wide application including optimization of CO2 storage sites, fresh water aquifers exploration, and oil and gas reservoir characterization.

# Seismic interpretation of fan delta reservoir with machine learning driven seismic multi-attributes fusion

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Fan deltas always developed in groups which consist of superimposed fans formed in multi-stages, especially in the slope zone of basin margin. However, it is a challenge to interpret the architecture of fan delta complex with single seismic attributes and seismic sections because there are few significant acoustic impedance interfaces in the reservoir.

In this work, a variety of seismic attributes are fused to predict sandstone thickness based on machine learning method in the interpretation of fan delta architecture. The method is used in the slope zone of a Paleogene basin in northeastern China where fan deltas developed. The method and workflow in this work are as follows: 1) thirty types of seismic attributes are analyzed; 2) the cross-correlation analysis of sandstone thickness and seismic attribute value with well data is carried out and then 12 seismic attributes are selected based on the cross-correlation; 3) Cluster analysis was carried out on the 12 selected seismic attributes and 3 of them are fatherly selected; 4) a training set is constructed with the selected 3 types of seismic attributes and sandstone thickness at drilling wells; machine learning is carried on with the method extreme learning machine (ELM) and the trained correlation index is 0.82; 5) predict sandstone thickness with the trained network.

According to the predicted sandstone thickness variation and distribution, it can be interpreted that 1) there are 3 fan delta complex in study area; 2) the largest one is formed by three single fan delta lobes which developed in different stages.

The interpretation result can not only indicate evolution of paleo-environment but also characterize reservoir heterogeneity of fan delta reservoirs which provides geological support for oil and gas exploration and development.

# New age constraints of the Bilong Co oil shale in the Qiangtang Basin, northern Tibet: Evidence from in situ U–Pb dating and paleontology

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The Bilong Co oil shale is one of the most significant source rocks in the Mesozoic Qiangtang Basin (Northern Tibet), however, its absolute chronology remains controversial. In this paper, in situ carbonate U–Pb isotope dating analysis was carried out for the first time. Detailed field geological investigations yielded some age-diagnostic ammonites, enabling a re-evaluation of the stratigraphic age of the Bilong Co oil shale. A total of 61 spots of U–Pb isotope dating from the middle part of the Bilong Co oil shale section suggests an average age of 181±13 Ma. Elemental geochemistry and diagenetic analysis indicate that the proposed age represents the early deposition of the calcite and the oil shale was deposited during the Early Jurassic time. This estimated age is further supported by the newly discovered ammonite assemblage of Hildoceratidae–Tiltoniceras sp. at the top part of the oil shale section, which confirms the deposition of oil shales during the Toarcian age of the late Early Jurassic. Consequently, the Bilong Co oil shale can be assigned to the Quse Formation which is attributed to the Lower Jurassic rather than the Middle Jurassic. The re-assessment of the stratigraphic age of the Bilong Co oil shale is of great significance for regional evaluation and exploration activities of hydrocarbon source rock layers in the Qiangtang Basin as well as for global stratigraphic correlation of the late Early Jurassic Toarcian oceanic anoxic event.

# Types and genesis mechanism of glauconite in the Meso-Neoproterozoic in North China

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The field investigation and thin section observation showed that glauconite with granular, cemented, fecal pellet, and halo - rimmed forms is widely developed in the Tieling, Xiamaling, Changlongshan, and Jingeryu Formations of Meso-Neoproterozoic in North China. Based on oxide components, color, SEM energy spectrum and XRD, glauconite are low mature to mature, and the maturity of glauconite in the Longshan and Jiguanshan areas is higher. Glauconites with different substrate components indicate different genesis mechanisms. The glauconite with quartz and feldspar grains as the substrate is of a pseudomorphic replacement genesis, while the glauconite with biotite as the substrate is of a layer lattice theory genesis, and cemented glauconite is of an authigenic precipitation genesis. Furthermore, the study revealed that glauconites with fecal pellets and stromatolites as substrate are a combination of biogenesis and verdissement or authigenic precipitation, and halo - rimmed glauconite is of a combination of pseudomorphic replacement and authigenic precipitation. According to the findings, the evolution of K2O-TFeO in Precambrian glauconite is not only controlled by a specific substrate, but also by specific chemical conditions. Because of the differences in composition of solubility of the substrate, the pH conditions of the pore water required for glauconization are different. The sedimentary environment and substrate type affect the form and genetic mechanism of glauconite, but the varied pH conditions suitable for the substrate and the sub-oxide environment near the Fe oxidation-reduction interface are the necessary conditions for glauconization. As a result, glauconite can be used as a signature mineral for the palaeo-redox facies. The study provides insights into the formation mechanism of different glauconite in the process of sedimentation or diagenesis, and the scientific basis for the restoration of diagenesis conditions and the paleogeographic environment in North China.

# Sedimentary Characteristics and Depositional Model of Intrabasinal Turbidities in Lacustrine Basin: A Case Study from the Dongying Formation, Nanpu Sag, Bohai bay Basin, Eastern China

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Abstract: Sediment gravity flows have been a hot research topic for sedimentology because of their crucial functions in petroleum exploration. Similar to marine sediment gravity flows, they can also be found in lacustrine environments. Turbidites can be classified into intrabasinal and extrabasinal types based on their origin. The accumulation of intrabasinal turbidites typically occurs at or near the toe of a regional slope. Intrabasinal turbidites are caused by avalanche of unstable material in the slope areas. Based on the observation of drill cores and wire logs of Paleogene Dongying Formation from the Nanpu Sag, this study further divides intrabasinal turbidites into two types. The first type mainly including slump deposits transformed into debris flow covered by fluid mud. Part of debris flow deposits are then transformed into hybrid event beds and finally into turbidity current deposits. The second type of turbidites are characterized by slump deposits first which are altered into debris flow. The recognition of different kinds of intrabasinal turbidites can be useful in the determining whether they occurred in the proximal or distal part of slump in the slope and help us understanding turbidities reservoirs.

# Distribution pattern of braided river deltaic sand bodies in different structural belts of foreland basin: A case study from the Triassic Xujiahe Formation in the southwestern Sichuan Basin, Southwestern China

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Deltaic sandstone reservoirs are important tight gas exploration target. Sedimentary research in the past twenty years have revealed the distributary channels were important reservoirs. However, the distribution model illustrating both distributary channels and mouth bars is still understudied, especially in different structural zones of the foreland basin. In this study, core analysis, wireline log data, and outcrop were used for identification and characterization of distributary channels and river mouth bar depositional facies. The tight sandstones were formed in braided river delta deposits. The mouth bar sand body mostly has a flat bottom or gradually contacts with parallel bedding siltstone. The mouth bar deposits show upward-coarsening sequence vertically. Massive bedding, low angle cross bedding, and parallel bedding are developed in those sandstone. The thickness of a single mouth bar is mostly greater than 10m. During the sedimentary period of the Xu2 member in the Xujiahe Formation , the western delta deposition near the foredeep had a relatively large accommodation space, with the development of superimposed braided river deltas. The multi stage mouth bars in the western delta were well developed overlaid by subaqueous distributary channels deposits. From proximal to distal part of the delta, the mouth bars have higher proportion in the sequence. The eastern delta near the forebulge also developed distributary channel and mouth bar deposits. The deposits also have coarsening upward and overlying fining upwards sequence. The proportion of mouth bar and distributary channels is different from the western delta. More distributary channel deposits could be found in the delta. From proximal to distal part of the delta, the proportion of distributary channels decrease in the sequence. This study interpreted the mouth bar deposits and spatial variation in foreland basin using wireline log curves. This could offer insights to better predict deep tight reservoirs in foreland basins.

# Study on sedimentary facies characteristics and sedimentary environment change of modern sedimentary body in Xi'an section of Fenghe River

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This paper makes a comprehensive study on the rock types, sedimentary facies types, sedimentary models and climate changes of the modern river sediments in the Xi'an section of the Fenghe river.Through google satellite images, field surveys, sample collection and geochemical element content and ratio analysis of the modern river systems in this area.the results show that the lithology of the modern river sediments in Xi'an is mainly yellowish mudstone Grayish white sandstone and argillaceous siltstone and a small amount of light gray fine conglomerate series；Three subfacies were identified, namely, channel filling subfacies, channel margin subfacies and flood basin subfacies; Four microfacies, i.e. riverbed retained sediments, point bar, estuarine fan and flood plain, develop three sets of different sedimentary sequences in the vertical direction: the lower sequence has anti rhythmic characteristics, and the middle and upper parts show obvious positive rhythmic sediments, indicating the process of hydrodynamic first increasing and then gradually decreasing；By analyzing the changes of the contents of trace elements such as Co, Cr, Cu, Ni, Rb, Sr, V, Zn and Zr in sediments, as well as Sr/Cu, V/(V + Ni), V/Cr, Ni/Co and Sr/Ba, it is determined that the main environment during the deposition period is arid climate, accompanied by seasonal rainfall, and the water body is a weak oxidation-oxidation freshwater environment.

# Origin of dispersed organic matter within sandstones and its implication for uranium mineralization: A case study from Ordos basin in China

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Carbonaceous debris (CD), common dispersed organic matter (i.e., DOM), is widely disseminated in sandstones from uranium-bearing strata from the Dongsheng uranium ore field of the northern Ordos Basin. Compositions of maceral, element and biomarkers of CD were investigated through a series of methods with optical microscope, elemental analyzer and gas chromatography-mass spectrometry analyses to study origin of CD. The results show that macerals of CD are composed of vitrinite (i.e., V), inertinite (i.e., I), and minerals, including that V is primary (V>95%). The (C27+C29)/(C31+C33) ratios of n-alkanes biomarkers indicate that the percentage of woody plants accounting for vegetation composition of CD predominate over that of coal, which is also evidenced by the higher C/N ratios and oleanane contents of CD. The evidence is also supported by plant branch buried in sandstones. The tissue preservation index, gelification index, ground water level index, and vegetation index reflect that the paleoenvironment of CD is controlled by fluctuating water, which is also supported by the existences of round CD. Compared with peat, sedimentary paleoenvironment where CD deposits is of weaker reducibility, higher salinity by analyzing Pr/Ph ratios and gammacerane index. Distributions of n-alkanes carbon number of CD with the presence of unknown complex mixtures show that microbial activities exist in sand bodies. Differences in hydrodynamic intensity, redox condition, and microbial activity intensity between sedimentary paleoenvironment of CD and peat, show that CD is born in synsedimentary sandstone environment not in peat. Hence, it comprehensively draws conclusions that immature 'non-peatborn' CD is formed from the trunk, stem, branch, root fragments buried in sandstones, depositing in (micro) allochthonous positions by the influences of fluctuating water. The DOM from synsedimentary plant debris might play more roles in adsorption and complexation, and microorganisms may participate in uranium mineralization, which could provide certain guidance for uranium exploration and mining.

# Cenozoic salt-related structural deformation characteristics and control function of reservoir forming: A case study in the middle-eastern section of the Qiulitage structural belt, Kuqa Depression, NW China

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The Kuqa Depression in northwest China is rich in oil and gas resources. The middle-eastern section of the Qiulitage structural belt is located in the front edge of the fold-thrust belt of the Kuqa Depression. In recent years, in order to expand the oil and gas exploration results, it is urgent to study the deformation characteristics and formation mechanism of salt-related structures in the study area.
We used drilling, logging, seismic data and other data to conduct fine structural interpretation, and analyzed salt-related structural styles, structural evolution processes, formation mechanisms, and hydrocarbon accumulation characteristics.
The results show that there are two sets of gypsum salt rock layers deposited in the middle-eastern section of the Qiulitage structural belt, which lead to abnormally complex structural deformation. There are four structural styles developed in the suprasalt strata, three structural styles developed in the subsalt strata, and seven structural assemblage styles developed in the suprasalt strata and subsalt strata. The salt-related structural deformation in the middle-eastern section of the Qiulitage structural belt has the distribution characteristics of vertical stratification and E-W trending segmentation, which is related to plate compression, boundary conditions and the existence of gypsum salt rocks (distribution range, development horizon and thickness). The main tectonic activity deformation period is from the Neogene Kuqa Formation deposition period to the present. Gypsum salt rocks not only have good oil and gas sealing properties, but also have a protective effect on the integrity of subsalt traps, so salt-related structures can form good oil and gas traps. The study area has good source-reservoir-cap conditions, and the trap formation period can be effectively matched with the oil and gas migration period. Therefore, it is believed that the oil and gas prospects in the middle-eastern section of the Qiulitage structural belt are broad.

# Multiscale evaluation of pore structure characteristics in mixed shale oil reservoirs, Qaidam Basin, NW China

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Taking reservoirs in the upper member of Lower Ganchaigou Formation in the Ganchaigou District of Qaidam Basin as an example, an indepth study of pore structure characteristics in mixed shale oil reservoirs of saline lacustrine was conducted through the core experiment and well logging technology. The results show that pores are mainly intercrystalline pores, intercrystalline/intergranular dissolution pores and intraparticle pores, organic matter pores are rarely developed. Throats are mainly slit-like shape with poor filtration capacity. Micro-fractures are widely developed but filled or half filled by carbonate cement, which seriously reduces filtration capacity. Macro-fractures are divided into high angle fractures, oblique fractures and low angle fractures, which can connect micro-fractures between beddings to form a reticulate seepage system and improve the reservoir physical property. Porosity in the study area is mainly 0.5%~8%, permeability is generally less than 1mD, pore-throat radius is mainly 0.02~2.13μm, and the pore size is mainly nano-micron. The reservoir is characterized by ultra-low porosity and low permeability, poor correlation between porosity and permeability, and complex pore structure. Aiming at the characteristics of multi-scale and large-span pore sizes in the study area, the pore structure was classified into four categories and the classification criteria were established by designing the experimental combinations of gas adsorption + mercury injection capillary pressure + nuclear magnetic resonance + micro/nano CT + three-dimensional FIB-SEM and extracting several characterization parameters from them. In addition, based on the core scale logs mode, parameters such as T2 geometric mean and movable fluid porosity were preferred to establish the logging evaluation criteria for pore structure. On this basis, a conventional logs identification model for different pore structures was established using the eXtreme Gradient Boosting (XGBoost) to realize the continuous logs identification and characterization of the multiscale pore structure of the mixed shale oil reservoirs.

# the Fluid-rock Interactions and their Impact on Underground Hydrogen Storage

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Underground hydrogen storage is a promising solution for large-scale energy storage, necessitating a comprehensive understanding of fluid-rock interactions and their implications. These interactions are pivotal in defining the storage capacity, integrity, and overall performance of subsurface storage facilities. Hydrogen molecules may undergo adsorption onto the rock surfaces or absorption into the rock matrix, processes that are governed by the rock's characteristics such as porosity and surface area, as well as the ambient pressure and temperature. The caprock's role as an impermeable barrier is vital to prevent hydrogen escape, with its integrity being susceptible to alteration through fluid-rock reactions that may lead to changes in mineral composition or induce fracturing. The phenomenon of mineral trapping, where hydrogen induces the formation of new minerals, can offer a more stable form of storage, whereas dissolution trapping involves hydrogen dissolution in pore water, potentially altering porosity and permeability. Residual trapping of hydrogen occurs due to capillary forces after removal of hydrogen, influenced by the rock's wetting properties. Moreover, geomechanical effects induced by hydrogen injection can alter the stress state within the subsurface, leading to rock deformation or fracturing. Additionally, the presence of subsurface microbial activity can interact with hydrogen, affecting the storage site's chemistry. These fluid-rock interactions collectively impact storage efficiency through additional hydrogen trapping mechanisms, influence storage capacity by altering rock properties, and pose safety and leakage risks if storage integrity is compromised. Operational strategies and long-term monitoring plans must be informed by these interactions to optimize injection and withdrawal processes.

# Prediction of total organic carbon (TOC) content of organic-rich shale using machine learning: A case study from Gulong sag, China

Prediction Of Total Organic Carbon (toc) Content Of Organic-rich Shale Using Machine Learning: A Case Study From Gulong Sag, China Fei Zhao[1], Prediction of total organic carbon (TOC) content of organic-rich shale using machine learning: A case study from Gulong sag, China Jin Lai[1,2], Prediction of total organic carbon (TOC) content of organic-rich shale using machine learning: A case study from Gulong sag, China Guiwen Wang[1,2], Prediction of total organic carbon (TOC) content of organic-rich shale using machine learning: A case study from Gulong sag, China Xiaojiao Pang[1], Prediction of total organic carbon (TOC) content of organic-rich shale using machine learning: A case study from Gulong sag, China Yuyue Huang[1]

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The total organic carbon (TOC) content is one of the significantly crucial parameters of organic shale reservoirs, can be used to evaluate the hydrocarbon potential and screen for sweet spots for unconventional shale reservoirs. However, the determination of TOC can be costly, depending on laboratory tests in samples from source rock. Traditional methods of determining of TOC content based on gamma ray (GR), neutron porosity (CNL), bulk density (DEN), acoustic interval transit time (AC), uranium (U) and resistivity (RT) logging curves, many scholars have proposed various method for TOC content predictions, such as ΔlogR method, Schmoker gamma-ray log method, multiple linear regression method and so on. For shale reservoirs, the well logs response of TOC are complicated due to complex lithologies and fluid properties. Then there remains large uncertainty in delineation and quantitation of TOC using well log data due to the complex non-linear relationships between TOC and well log information, and traditional methods are low-accuracy and non-applicable, do not provide accurate TOC content in shale reservoirs. In this study, we propose three machine learning methods of Extreme Gradient Boosting (XGBoost), random forest (RF), back propagation (BP) neural network to prediction the TOC content using well logs, and the performance of models are compared with the traditional methods. Then, 717 data points of Rock-Eval analysis determining TOC content collected from Gulong sag are used to train and test each model. The results show that the XGBoost model predicted TOC matched well with that from the laboratory measurements, has a better adaptation and generalization ability compared with other machine learning methods. Overall, the proposed model based on XGBoost method provides an accurate way for the TOC prediction in the shale oil reservoirs.

# Micro mechanism of reservoirs damage caused by $CO_2$ displacement in tight reservoirs

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$CO_2$-fluid-rock interactions during $CO_2$ injection in tight oil reservoirs, i.e. asphaltene precipitation and geochemical reactions, alter the pore-throat structure , which will in turn affect the $CO_2$ displacement efficiency. In this work, pore structures of tight sandstone from the Ordos Basin, China were characterized comprehensively using the X-ray diffraction, cast thin sections, scanning electron microscopy, nuclear magnetic resonance, and high-pressure mercury intrusion. In addition, pore structure and asphaltene precipitation before and after $CO_2$ displacement were analyzed to clarify the influences of $CO_2$-fluid-rock interactions on the pore throat structure and wettability of tight sandstone reservoirs, including mineral dissolution, asphaltene precipitation location and aggregation mode. The results indicate that the Chang8 tight sandstone can be divided into three classes based on pore throat combination: narrow channel intergranular pore type (I), wide channel and dissolution pore type, intergranular pore type (II), and mixed type (III). The porosity of the three types gradually decreases and the percentage of small pore throats increases. With the injection of $CO_2$, secondary pores are formed due to the dissolution of feldspar in Class I reservoirs, and asphaltene precipitates in the macropores, mainly distributed on the surface of mineral particles and clustered in a point-like manner. The impact on the macropore throat is relatively small, and the wettability is reversed towards oil wetting. In the Class II reservoir, feldspar dissolution produces a large number of secondary pores, and the proportion of pore throat of fine and small pores developed by asphaltene precipitation in Clay mineral increases. Asphaltene content in Class III reservoir is precipitated in a large amount in small pores and throats, and accumulates in clusters. Asphaltene precipitation is usually concentrated more closely in the pore throat structure where Chlorite group and Illite are more developed and Wettability constantly shifts towards oil wetting direction.

# A study on the diagenesis of uranium reservoir sandstone of the Zhiluo Formation in the Shenshangou Outcrop , Northeastern Ordos Basin

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Affected by temperature, pressure, pore fluid, and epigenetic processes, a rich variety of diagenesis has occurred in the uranium reservoir sandstone of the Shenshangou outcrop in the northeastern Ordos Basin, including compaction, cementation, leaching, and epigenetic oxidation-reduction alteration.The process of diagenesis is complex and often manifested as the superposition of multiple effects.Research has shown that there are a wide variety of cementation types, including clay cementation, pyrite cementation, jarosite cementation, and carbonate cementation, with carbonate cement predominating.Under the influence of cementation, clastic particles show free and point contact types during compaction.Leaching is manifested as the dissolution of mineral components (quartz, feldspar, rock debris, and cements), which constitutes the main part of the secondary pores in sandstone.Epigenetic oxidation-reduction alteration is most closely related to uranium mineralization, and the resulting rock geochemical types are the geological basis for identifying interlayer oxidation zones. Three types of epigenetic altered sandstones are present, including purplish-red sandstones that were preserved after interlayer oxidation during the mineralization period and were subsequently cemented by carbonates, green altered sandstones that underwent secondary reduction, and yellow sandstones formed by modern surface oxidation. Through the study of diagenesis in the uranium reservoir, it is helpful to understand the properties of pore fluids, reservoir physical conditions, and provide accurate geological evidence for the identification of interlayer oxidation zones, which is of guiding significance for uranium mining.

# Petrography, geochemistry, chronology features and their significance of microbial dolomite in Lower Cambrian of Tarim Basin, NW China

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Lower Cambrian Scholbrak formation is an important exploration target in Tarim Basin, microbial dolomite is the main reservoir rocks. However, The features and genesis of reservoir are unclear due to few Wells drilled into Scholbrak Fm.. This study took outcrop area of 28km in the NW Tarim Basin as an example, based on 800 thin sections and many geochemical data, it was found that: (1) The thickness of Scholbrak Fm. is about 170m, it can be divided into 5 members, Member Ⅰ consists of laminated microbial dolomite (LMD); Member Ⅱ mainly consists of layered thrombolite dolomite (LTD) ; Member Ⅲ is dominated by massive thrombolite dolomite (MTD); Member Ⅳ mainly consists of grain dolomite with bonding structure (GDBS), foamy microbial dolomite (FMD) and crystalline dolomite remaining grain apparition (CDGA); Member Ⅴ is dominated by stromatolite dolomite (SD), micritic dolomite (MD) and argillaceous dolomite (AD); (2) Framework pores and vugs are the main reservoir spaces; There is a correlation between porosity and lithofacies, FSD has the highest porosity, LTD, MTD and GDBS are next. (3) Low dolomite order degree, Partitioning patterns of REEs, δ18O and 87Sr/86Sr have the characteristics of Cambrian seawater, indicate that the dolomitization were took place in early diagenetic stage and dolomitization fluid is relevant to coeval seawater. (4) Pores were formed in synsedimentary or penecontemporaneous period, the ages of 5 microbial dolomites range from 490~501 Ma; The ages of three sparry calcites filled in the vugs range from 467~472 Ma, and have the features of low temperature(39.6 ℃) and negative δ18Ow (-5.19 ‰). In brief, the microbial dolomite reservoir was mainly controlled by lithofacies, high–frequency sequence and early dolomitization. By establishing the reservoir geological model of study area, it shows that microbial mounds in inner ramp around the paleo-uplift are the favorable exploration zone in Tarim Basin.

# Quantitative study on the key diagenetic stages of ancient carbonate reservoir

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There are multiple stages of diagenesis fluids flow modification during the forming process of dolomite reservoir in Ordovician of Tarim basin. These process made the reservoir's strong heterogeneous and caused the controversy during the study on dolomitiation path of different domomite occurrence and their reservoir space evolution process. Lock down key diagenesis stage accurately is a crucial step to study the reservoir evolution process. Based on techniques such as laser ablated U-Pb dating and element mapping, rock components including powder dolomite, surrounding rock, medium-coarse crystal dolomite on the wall of pore or vug, calcite cementation in vug were tested. Dating results show that shoal carbonate sediment age is approximately 475.35Ma. There are 2 stages of dolomitation and 1 stage of calcite cementation during its evolution process. The first stage dolomitation age is approximately 470.1Ma, which indicate a shallow burial stage. The age of second stage dolomitation is approximately 452.1Ma, which made dolomites crystals of surrounding rock larger. The age of calcite cementation is not later than 448Ma, which caused the damage of reservoir spaces. The existing pore spaces in dolomite mainly inherits from the preexistent pores, instead of the traditional understanding of tectonic hydrothermal corrosion pores. Fracture and hydrothermal fluid are important modification factors for pore evolution but not the major factors. These information from laser ablation in situ U-Pb dating can provide several evidence for the study of reservoir spaces formation and effective reservoir prediction of deep dolomite reservoir in Tarim basin and other similar areas.

# Microbe-sediment interaction controls the earliest stages of marine lithification

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The transition of unconsolidated carbonate sediment into limestones is a complex, multi-stage process commencing at the seafloor. Hence, much work has been dedicated to carbonate burial and cementation, eventually leading to fully lithified rocks. Conversely, the earliest marine carbonate stabilisation and cementation stages (occurring over periods of many weeks to a few years) are less well understood. In particular, the role of microbe-sediment interaction versus that of abiotic processes (seawater supersaturation, hydrodynamic levels etc.) is relevant. This presentation documents the earliest microbial stabilisation and cementation of carbonate grains from a near-beach environment in the modern lagoon of Abu Dhabi. Detailed SEM images from actively forming firmgrounds are used to exemplify processes and products. The aim is to provide evidence that microbially-mediated processes control the earliest stages of sediment stabilisation and cementation. Our data show that extracellular polymeric substances (EPS) and microbes stabilise sediment particles and trigger the nucleation and precipitation of nano-amorphous calcium carbonate grains (nano-ACC grains) following the EPS decay and synergistic microbe-microenvironment processes. Initial nano-ACC grains aggregate and evolve into micrite cement envelopes. Other nano-ACC grains, interacting with microbial consortia, are oriented spatially and assemble to form wheat-shape mesocrystals bundles nucleating on the micrite cement substratum. Mesocrystals coherently fuse and form aragonite cement. Aragonite cements (forming bundles) radiate out from the nucleation centres with a range of crystal terminations (pointed, chisel, irregular and frequent twinning). These are the most common early marine cement phases in the study sites, resulting in porous but lithified carbonates. Subsequent stages include the formation of isopachous seams of elongated aragonite cements with different morphologies (hexagonal, tabular, bladed, etc.) on carbonate grains. These observations are significant in the context of seafloor lithification and question conventional hardground models invoking hydrodynamics and seawater supersaturation as main agents.

# Seismic-scale seaward-dipping unconformities linked to supercritical turbidity currents in the Yongshi submarine fan of the Southern South China Sea

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Supercritical flow bedforms are common in modern environments. Yet, their documentation in the stratigraphic record remains limited, revealing gaps in our understanding of the interactions between associated processes and resulting products. Specifically, there is a absence of criteria for identifying related paleo-deposits. In this study, we present new findings on seaward-dipping unconformities associated with supercritical turbidity currents within the Yongshi submarine fan in the southern continental margin of the South China Sea. These findings are obtained by interpreting high-quality two-dimensional multi-channel seismic reflection data. The Yongshi fan, nourished by two submarine canyons, encompasses deposits ranging from approximately 520 to 1650 m in thickness, spanning the Late Miocene to Quaternary periods. Within this fan, numerous seismic-scale bedforms have developed, exhibiting wavelengths ranging from 1 to 4 km and wave heights between 10 and 50 m. These bedforms can be classified into three main types: (1) fully depositional cyclic steps, characterized by laterally continuous laminae transitioning from backsets to foresets; (2) partially depositional cyclic steps, predominatly characterized by backsets; and (3) downslope migrating antidunes or dunes, distinguished by foresets. Our observations reveal bedding-crossing unconformities, identified by seaward-inclined reflections arranged in a linear to en-echelon pattern. These unconformities serve as natural boundaries, emphasizing coeval bedforms primarily dominated by backsets. We attribute these unconformities to lee-side erosion and the rapid upslope migration of supercritical flow bedforms. Within the context of deep-sea turbidite systems, which often span vast areas from thousands to millions of square kilometers, these bedding-crossing unconformities introduce new criteria for identifying related paleo-deposits. Furthermore, they provide invaluable insights for deep-sea stratigraphic and sedimentological analyses. This research was funded by the National Key Research and Development Program of China (Grant Number 2022YFF0800503) and the Key Special Project for Introduced Talents Team of Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou) (Grant number GML2019ZD0207).

# Formation of bauxite and helium-rich gas reservoir in bauxite stratum in the Ordos Basin

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Abundant natural gas reserves and production have been obtained in the Ordovician Majiagou Formation carbonate and Carboniferous and Permian tight sandstone reservoirs, in the Ordos Basin, NW China. In recent years, helium-rich natural gas has been discovered in a special type of reservoir, the bauxite reservoir. The bauxite layer is located in the Carboniferous Benxi-Taiyuan Formation above the unconformity surface of the Majiagou Formation. The bauxite is deposited on the weathering crust during the Caledonian period. The development and distribution of bauxite are mainly controlled by sedimentary landforms and ancient environment. The deposits are thick on slopes, buried pits and low-lying areas above the Ordovician unconformity, generally up to 20-50m. The bauxite contains abundant intergranular primary pores and dissolved pores, and consequently became a good reservoir. The gas test of Taiyuan Formation bauxite in Well Long47 in the southwestern margin of the basin yielded an industrial gas flow of 67.38×104m$^3$/d; Well D1-568 in the Daniudi area obtained a gas flow of 3.5532×104m3/d in the Benxi Formation bauxite reservoir. The natural gas in the bauxite formation is rich in helium. For example, the helium content is 0.05%-0.07% in Shixi, 0.138% in Dongsheng, and 0.131% in Yichuan Gas Field. The 3He/4He ratio is between 0.02 and 0.08 Ra, indicating that helium gas is formed from the radioactivity of uranium and thorium in crust rocks. The ancient granite and metamorphic rocks rich in uranium and thorium in the basement are the source rocks for the helium. And the bauxites, organic-rich mudstones and coal rocks may also contribute a large amount helium due to relatively high uranium and thorium content. Therefore, helium and natural gas in the bauxite reservoirs form a special reservoir model: helium and hydrocarbon from multiple sources while in the same bauxite reservoir. (Sponsored by NSFC foundation, No. U2244209)

# Sequence architectures and depositional systems of different tectonic stages in Chinese eastern continental rifted basins

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As continental rifted basins are very productive in oil and gas resources, clarifying the sequence stratigraphic architectures and depositional system characteristics in different tectonic evolution stages is the key foundation for the high efficient exploration and development of hydrocarbon resources. With the research of the development status of sequence stratigraphy and the sedimentological characteristics in Chinese eastern continental rifted basins, according to the analysis of tectonic evolution history and seismic geomorphology in Chinese eastern rifted basins, the sequence stratigraphic architectures and depositional system characteristics have been characterized: ① During the early syn-rift stage, basin boundary faults just begin to grow, the parasequence is featured by vertical aggradation and superposition, and the basin is filled with near sources of coarse-grained alluvial fans, distributary fluvial systems, and fan deltas. ② During the main syn-rift stage, the fault activity is obvious strong. In different structural belts and systems tracts, the parasequence mostly shows a variety of overlapping styles and the basin is mainly filled with fluvial, delta or fan delta and gravity flow systems. ③ During the late syn-rift stage, the fault activity becomes much weak. The overlapping styles of parasequence are dominated by progradation and aggradation, and the basin filling is mainly featured by axial fluvial systems and deltaic systems. ④ During the post rift and subsidence stages, the fault activity almost stopped, the basin stays in overcompensation status and the sediment filling is mainly characterized by the fluvial-shoal water deltas. Combined with the above analysis, this paper also discusses the current hot topics and future development of sequence stratigraphy and depositional system researches in continental rifted basins.

# Sedimentary microfacies of thick sandstone in the Huagang Formation of Oligocene in the central area of Xihu Sag, China

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The Cenozoic Oligocene Huagang Formation of Z Gas field in the central area of Xihu Sag, East China Sea Basin, has developed several stages of extremely thick sandstone with continuous thickness of over 100 meters. It is generally believed that the microfacies and their superimposition are the main factors controlling the spatial distribution of sand bodies. This research comprehensively utilizes the description of sedimentary structure and lithology characteristics of 8 wells with more than 200 meters of core, conventional logging data of 8 Wells and nuclear magnetic and imaging logging data of 3 Wells, geophysical data of 3 seismic profiles of 8 Wells, lithology and physical property experiments of 128 rock thin-sections and 46 scanning electron microscopy and relevant regional geological basic data. To search for sedimentary facies markers of thick clastic rocks in the upper member of Huagang Formation, The study shows that the rocks are composed of sandstone, pebbled sandstone and siltstone, which are formed from braided delta front to braided river. The thick sandstone is mainly developed from the underwater distributary channel in the braided delta front and distributary channel in the braided delta plain, does not develop sediment and facies markers reflecting marine facies and transgression. It is a sedimentary sequence formed from braided delta to lake environment. The sedimentary sequence of the Huagang Formation, from the bottom to the top, the bottom is composed of multi-stage underwater distributary channel in braided delta front, and the top is composed of multi-stage underwater distributary channel in delta front transition to distributary channel in delta plain. It is clear that the study area belongs to the lacustrine delta depositional system. The distributary channel and underwater distributary channel are favorable factors for the development of high reservoirs.
Key words: sedimentary microfacies, braided river delta, East China Sea basin.

# Sedimentary architecture of estuarine deposits dominated by tidal current: insights from ancient rock records of the Oriente Basin M1 Sandstone

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The impact of mixed hydrodynamic conditions on estuarine sedimentation is significant. The varying strength of interactions among fluvial, tidal, and wave currents undergoes modification along the vertical direction of shoreline, leading to a longitudinal gradient shift in facies associations and distinctive sediment distribution patterns. Compared to river and delta deposits, research on sedimentary architecture of ancient estuaries is relatively limited. In our study, we analyzed the sedimentary characteristics of sand and mud deposits in tidal-influenced estuarine preserved in Oriente Basin M1 Sandstone formation. We explained several types of tidal sedimentary structures and facies associations in rock records based on core data and found that the proportion of tidal facies is quite high, reflecting the extensive reformation of sediments in the region by tides. In central axis of the estuary zone, the thickness and continuity of tidal bars are substantial, and there is a lack of clear sedimentary discontinuity in core or logging curves that can indicate obvious sedimentary discontinuities. Controlled by tight well spacing, the lateral variation characteristics of sand body were dissected. In the direction perpendicular to the shoreline, tidal bars in outer mouth area showed a forward contact relationship, and the hydrodynamic forces between bars weakened, forming a barrier layer mainly composed of fine-grained sedimentation. On the contrary, the sensitivity of sediment to changes in water depth provides evidence for dividing sedimentary periods in the tidal flat areas on both sides of the estuary. Finally, through our analysis of regional short-term sea level changes, we believe that in the early stage of marine invasion, the high-flow sand flat area dominates, and the relatively dense tidal channel forms erosive contact with the tidal flat sand body; With further marine invasion, sandy sediments from the ocean rapidly accumulate in estuary forming a erosional stacking pattern with early sand bodies.

# Diagenesis Analysis On Sandstone Reservior In The Sub-Member Of Middle Member Of The Third Member In Shahejie Formation Of Qingshui Sub-sag In Liaohe Depression Of Eastern China

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Abstract: The central and southern Qingshui Sub-sag in the Western Depression of the Liaohe Depression in the Bohai Bay Basin of eastern China has rich sandstone reservoirs developed in the sub-section of middle section in the third member of the Shahejie Formation, showing strong heterogeneity. By utilizing core observation and a series of experimental analysis, a comprehensive analysis is conducted on the lithology and physical properties, diagenesis and evolution of sandstone reservoirs in the middle section of the third member of the Shahejie Formation in the Qingshui Depression, exploring their diagenesis, reservoir formation, densification mechanisms and control factors, in order to predict the distribution of high-quality reservoirs. Rock of this section is mainly composed of argillaceous feldspathic lithic sandstone and lithic feldspathic sandstone; Formed in two types of water flow systems, dominated by braided river delta and lacustrine fan sedimentation; There is strong compaction, cementation, dissolution, metasomatism, and the transformation of new minerals; The moderate to strong compaction effect is obvious, with the cementitious material mainly composed of mud crystal to fine crystal calcite, and a small amount of authigenic quartz and clay minerals. The dissolution of feldspar and rock debris is common, while authigenic clay minerals are common, with the development of clay mineral transformation and carbonate mineral transformation and substitution. This section is in the A or B sub-stage of diagenesis, exhibiting a weak acid/weak alkali acidic alkaline fluid field evolution. Normal pressure field mainly dominated the evolution of this section, with partial abnormal pressure fields. Early hydrocarbon injection is beneficial for maintaining porosity, while dissolution and structural fracturing improve reservoir physical properties and affect mineral transformation. Later, deep thermal compaction and cementation cause sandstone to be generally tight; Diagenesis is the main cause of density, and this section is characterized by reservoir formation followed by density.

# Facies correlation of Opalinus Clay in Switzerland: unravelling the depositional model

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The Opalinus Clay, a silty to sandy claystone formation, deposited during the Early to Middle Jurassic age (latest Toarcian to Aalenian), holds significance in Switzerland as the selected host rock for deep geological disposal of radioactive waste. Over more than thirty years, extensive geotechnical, mineralogical and sedimentological studies have addressed the Opalinus Clay, such as those conducted within the Mont Terri Project and the deep drilling campaigns of Nagra (National Cooperative for the Disposal of Radioactive Waste).
The aim of the present study is to understand the lateral and vertical facies variability within the Opalinus Clay in central northern Switzerland and neighbouring areas. Petrographic descriptions performed on nineteen drill cores resulted in an integrative and revised subfacies classification scheme. This scheme is based on texture (colour, grain-size, sedimentary structures) and composition (mineralogy), offering a novel framework applicable not only to the entire Opalinus Clay in Switzerland but potentially to analogous mudstone formations globally. The application and use of this subfacies classification scheme for the Opalinus Clay in Switzerland and neighbouring areas is discussed.
Based on the subfacies descriptions, elemental content (XRF logging) and mineralogy (XRD), small-scale vertical facies variations as well as marker horizons (timemarkers) are identified, which can be correlated at regional scale. Classical grain size analyses (laser particle size analyses and component analyses based on thin sections) combined with 3D visualisation resulted in the assessment of grain size variations and mean sortable silt to reconstruct past current dynamics in the Opalinus Basin. The observed complex lateral and vertical facies variability requires to revise and develop an improved depositional model for the Opalinus Clay at both regional and basin scale.

# A quantitative method to characterize primary clay mineral assemblages of the Shahejie shales from the Dongpu Sag

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As a major composition of shales, clay mineral plays a vital role in unconventional petroleum geology. However, the effective method to characterize clay mineral contents during sedimentary processes of shales is scarce. Based on this, the Shahejie shales from the Dongpu Sag have been studied. After a series of analysis, there are some findings:
The shales were uniformly derived from felsic igneous rocks. The indexes of composition and the A-CN-K diagram reflects the shales are firstly deposited and have gone through weak K metasomatism during diagenesis. Thus, the secondary clay mineralogy was predominantly controlled by weathering intensity, which can be indicated by chemical index of alteration (CIA). The shales are rich in clay minerals, consisting of abundant illite/smectite mixed layer (I/S) and illite and little smectite. Some samples were selected to identify detrital clay mineral and authigenic clay mineral by SEM observation. The kaolinite and chlorite are both of detrital origin. The illite and I/S are of diverse origins. Their origins and even precursor minerals can be indicated by their shapes. In addition, chlorites and illite of detrital origin have been steady during diagenesis. In combination with imageJ, area proportions of illite and I/S with diverse originations were counted. According to the above, the detrital clay mineral compositions of the selected samples were calculated. The further research shows that the detrital illite content and the detrital chlorite content have a close relationship, and the detrital smectite content corresponds well with the CIA. Above all, the fitting formulas for the detrital clay mineral contents can be established. There is no distinct rule about the detrital kaolinite contents, which may be controlled by the parent rocks. With the application of the fitting formulas, the average contents of the detrital illite and smectite of the Shahejie shales are 9.42% and 7.24% respectively.

# Unravelling World-Class Outcrops of the Tumey Giant Injection Complex as an Important Analogue for Subsurface Interpretation

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Nestled in the Eocene succession of the San Joaquin Basin, the Tumey Giant Injection Complex (TGIC) is an outcrop laboratory to understand the architectural organization, lithological characteristics, and genesis of injection complexes.
This study employed field mapping and analysis of high-resolution 3D outcrop models, along with structural, and petrological analysis to extract valuable information and insights into the geometry, connectivity, and petrological characteristics of injectites inherent in subsurface reservoirs.
The outcrop area of the TGIC is at least 100 km2 and comprises: (1) parent units defined as sandy turbiditic slope channel-fills (up to ~35 m thick) intensely deformed by sand fluidization; (2) intrusive network of interconnected sills, dykes, and injection breccia forming composite sandstone units (100`s m long and 10`s m thick) of sill-complexes and saucer- and wing-intrusions; (3) hydraulically fractured mudstone and bio siliceous mudstone host strata, which were the main seals during development of overpressure.
In Tumey Hills area, a wing system >1.2 km long that crosscuts at least 200 m of stratigraphy, is defined by multiple stepped sills and dykes (up to ~15 m thick), and associated clast- and matrix-supported breccia with an average net-to-gross of 0.5. in the monocline Ridge area, a lower sandstone-rich section (~150 m thick) deformed by fluidization is overlain by mudstone-rich succession that hosts saucers, wings, sill complexes, and injection breccia. The intrusion network extends for 10`s km laterally and crosscuts ~350 m of host strata with intrusive bodies distribution and geometry comparable to intrusions imaged in North Sea seismic surveys (e.g., Volund, and Viper-Kobra fields).
The research shows that the TGIC can not only support subsurface mapping, but also suggests that the identification of sandstone intrusions not previously recognised on seismic data can help to build models in which sandstone connectivity and total storage volume can be increased.

# Characteristics and formation mechanisms of gravity-flow deposits in a lacustrine depression basin: Examples from Es3 in the Boxing Subsag of Dongying Sag, Bohai Bay Basin, China

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This study analyses gravity-flow deposits of the Es3 in the Boxing Subsag of Dongying Sag, Bohai Bay Basin, using a combination of well-log analysis, core observations, thin-section analysis, and laboratory measurements. The research results indicate that: There are three types of gravity-flow.: Slumping deposits, debris flow deposits and turbidity current deposits, with turbidity current deposits being the most common in this region. Based on sedimentary particle size and sedimentary structures, 10 lithofacies and 5 lithofacies associations are identified. The lithology is mainly sandstone, mudstone, and transitional lithology from mudstone to sandstone. Structures including blocky, parallel lamination, deformation and normal grading are developed. (2) There are two mechanisms for the formation of gravity flows: slope failure triggered gravity flows and flood sustained turbidity currents. At the base of the delta front slope, debris flows are formed ahead of slump deposits. During the forward movement, the debris flows are diluted and gradually transform into turbidity currents. The flood sustained turbidity currents are controlled by the sediment supply from the source area and the intensity of flood energy. Various types of gravity flow fluids are developed, including debris flows, turbidity currents. (3) The depositional patterns are divided into two types based on the formation mechanisms: For the slope failure triggered mechanism, the typical combination of depositional elements includes the delta front collapse zone, mixed deposits, lobes and tongue-shaped deposits in sequence. For the flood sustained mechanism, the typical combination includes gravity flow channels-levees, channel-lobe transition zone, and lobe deposits in sequence.From the perspective of core observation, correct understanding of gravity flow deposition types and clear depositional pattern of deep-water gravity flows can provide theoretical guidance for deep-water gravity flow deposition in Boxing Sag and deep-water lacustrine gravity flow deposition.

# A



# B

# C

# G



# H

# I



# J



# K

# L

# M

# R



# S

# T



# U



# V

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# X



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