63rd British Sedimentological Research Group Annual General Meeting

16th – 18th December 2024
University of Leeds

Sponsors:

A very warm welcome to Leeds, host of the 2024 BSRG AGM!

We hope you will enjoy the exciting range of activities over the three days, from icebreaker drinks at historic Leeds brewery, the Tetley, to high profile keynote talks on cutting edge sedimentology, and everything between!

This diverse programme is thanks to the excellent range and quality of submitted abstracts, demonstrating the strength and diversity of the research community. In particular, talks from early career researchers across a range of topics, from field sedimentology, to its application in the energy transition show that the future is bright for the BSRG!

We look forward to debates and discussions, including at the *Industry* and *Post-Grad lunchtime forums*, which will forge new connections and reinvigorate existing networks, and generate ideas for new areas of sedimentological research and applications.

We ask that you remind yourselves of the BSRG code of conduct and support us in delivering a conference that is constructive, safe, and enjoyable for all.

Thanks to everyone who has supported the conference, including fieldtrip leaders Arka Sakar and Joe Kelley, core workshop leader Richard Collier, Leeds post-grad helpers, and our sponsors – the *International Association of Sedimentologists, Geosolutions Leeds*, and *GeoTek*.

Enjoy the conference!

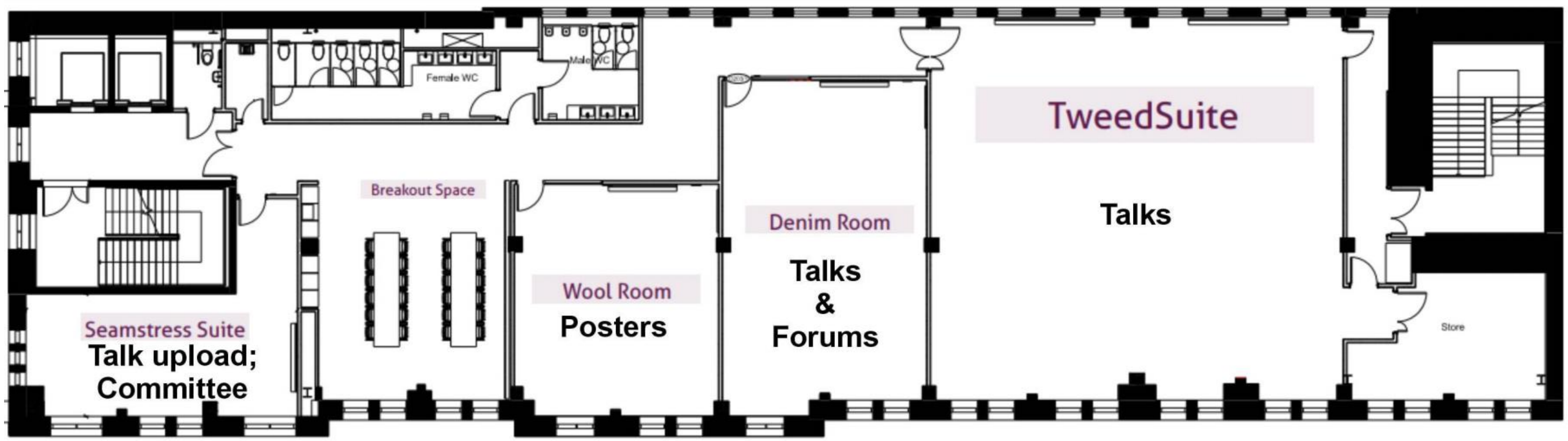
Adam McArthur, Dave Hodgson, Jeff Peakall & Steven Andrews

(the organising committee)

BSRG AGM 2024 - University of Leeds - Agenda

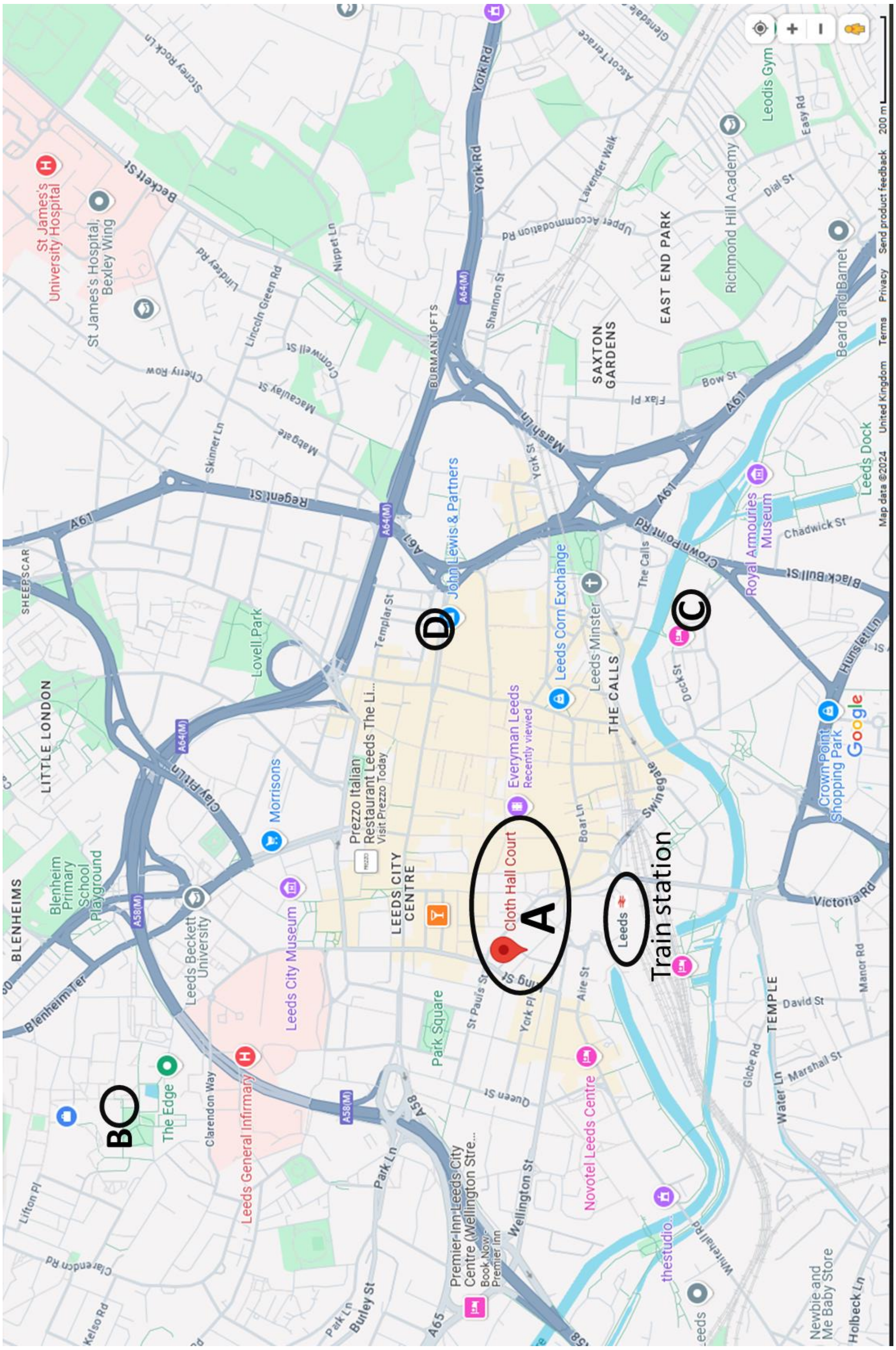
Time	Monday December 16th	Tuesday December 17th	Wednesday December 18th
08:00		Registration / Arrival tea, coffee & danish	
08:30			Arrival tea, coffee & danish
09:00	Fieldtrip & Core workshop	Opening and Plenary talks (Tweed) Chairs: Jeff Peakall & Yan Li	Seds & humanity (Tweed) Chairs: Adrian Hartley & Carys Simpson Digital seds (Denim) Chairs: Dave Hodgson & Lydia Brown
09:30			
10:00		Coffee Break & Posters (Wool)	Coffee Break & Posters
10:30		Deep-water 1 (Tweed) Chairs: Ian Kane & Meg Davies Source to sink / Paleo^4 (Denim) Chairs: Alistair Robertson & Sheng Chen	Deep-water 3 (Tweed) Chairs: Adam McArthur & Max Bouwmeester Continental to shallow marine (Denim) Chairs: Paul Wignall & Lucy Kerr
11:00			
11:30			
12:00		Lunch inc. Post Grad Forum	Lunch inc. Industry Forum
12:30			
13:00		Keynote 1: Dr Esther Sumner	Keynote 2: Prof. Rob Gawthorpe
13:30		Carbonates (Tweed) Chairs: Cathy Hollis & Delia Kuye Geosolutions 1 (Denim) Chairs: Steven Andrews & Josh Marsh	Digital seds 2 (Tweed) Chairs: John Howell & Will Taylor Palaeo^4 (Denim) Chairs: Gary Hampson & Holly Mills
14:00			
14:30		Coffee Break & Posters (Wool)	Coffee Break & Posters
15:00		Deep-water 2 (Tweed) Chairs: Zane Jobe & Jewel Lee Foon Geosolutions 2 (Denim) Chairs: Nigel Mountney & Hazel Beaumont	Tectonics and seds (Tweed) Chairs: Rhodri Jerrett & Saulo Araujo Deep-water 4 (Denim) Chairs: Yvonne Spychala & Meg Baker
15:30			
16:00		Poster Session (Wool)	Poster Session (Wool) & Close
16:30			
17:00		AGM (Tweed)	
17:30			
19:00	Icebreaker @ the Tetley from 7 pm		
19:30		Conference Dinner @ Akbars from 7:30 pm	

Second floor: Cloth Hall Court



https://conferencesandevents.leeds.ac.uk/cloth-hall-court/#location

Conference localities



A. Conference venue: Cloth Hall Court, Quebec St, Leeds LS1 2HA, (0113) 3430005

B. Core workshop: University of Leeds, Woodhouse Lane, Leeds LS2 9JT

C. Icebreaker: The Tetley, Hunslet Rd, Leeds LS10 1JQ, 07519560310

D. Conference dinner: Akbar's Restaurant, 15 Eastgate, Leeds LS2 7LY, 01132456566

Day 1 Talk schedule

Timeslots	Room: Tweed		Room: Denim	
8.30-8.45	*Opening address*			
8.45-9.00	Depositional dynamics of carbonate megabreccias, Permian Bell Canyon Formation, Apache Mountains, Texas	*Miguez – Jobe**		
9.00-9.15	A comparison of modern and Miocene earthworm granules: Towards criteria for recognising ancient earthworm products	*Kerr*		
9.15-9.30	Continental weathering and the emergence of land plants	*McMahon*		
9.30-9.45	Big, bold, and bizarre: giant ooids in low-oxygen Neoproterozoic oceans	*O'Connell*		
9.45-10.00	In Defence of Parasequences – Quantification of parameters from the Book Cliffs of Eastern Utah	*Howell*		
BREAK		** Presenter*		
10.30-10.45	A universal deep-water bed-type classification based on the synthesis of many depositional systems	*Budai*	Can lithology beat tectonics in determining sediment export from catchments?	*Zhou*
10.45-11.00	Submarine channel complex evolution adjacent to a transform margin	*Araujo*	Probably Proximal Pebbles? Prediction of Heterogeneity in UK Triassic Strata	*Burgess*
11.00-11.15	Inception, bypass, and fill of submarine canyons on active margins	*Bouwmeester*	Provenance and paleodrainage evolution of the Northern Calabria forearc, southern Italy	*Feil*
11.15-11.30	Reworking and deeper sea transfer of sediment deposits in the Cassidaigne submarine canyon by upwelling events	*Jacinto*	Climate-driven eustatic controls on fluvial system development in the Triassic hothouse world of central Pangea	*Hartley*
11.30-11.45	Self-confinement by submarine debris flows: an example from offshore NW Australia	*Li*	Changes in C_{org} isotope signature in Palaeotethys area during the mid-Tournaisian anoxic event (Mississippian)	*Kucharczyk*
11.45-12.00	Decoding Submarine Fan Morphology: Multivariate Influences and Non-Unique Solutions in the Golo Fan	*Tahiru*	Grainflow geometry variation as a function of climate	*Davies*
LUNCH			Post-grad forum (Denim 12:30-13:00)	
13.00-13.15 / *13.15-13.30*	Keynote (Tweed): A virtual Fieldtrip to the Whittard Submarine Canyon - Esther Sumner			
13.30-13.45	Basin scale evolution of zebra textures in fault-controlled, hydrothermal dolomite bodies: Insights from the Western Canadian Sedimentary Basin	*McCormick - Hollis**	Submarine Canyons as pollutant pathways – an overview of interdisciplinary research areas for sedimentologists	*Kane*
13.45-14.00	Genesis of carbonate honeycomb buildups	*Houghton*	Untangling microfibres: Pervasive plastic pollution in submarine canyons	*Keavney*
14.00-14.15	Drown-but-Not-Out: Mechanisms of Carbonate Platform Backstepping	*Wang*	Ageing of clay suspensions and deposits	*Baas*
14.15-14.30	Ancient Oyster Beds: a Vastly Underrated Sedimentological Resource	*Noad*	Evolution of a multi-phase coarse-grained submarine slope channel-lobe system, influenced by bottom currents: Upper Cretaceous Cerro Toro Formation, Southern Chile	*Bozetti*
BREAK				
15.00-15.15	The stratigraphic record of sediment gravity flow transformations in submarine slope settings	*Taylor*	PilotSTRATEGY; Scaling up CO_2 storage - pilot studies in EU regions with promising geological resources	*Wilkinson*
15.15-15.30	Lithostratigraphic and structural mapping of Sand Injection Complexes using 3D Outcrop Models	Zvirtes	Characterisation of deep-marine depositional environments for CO_2 storage; Banastón System, Hecho Group, South Spanish Pyrenees	*Marsh*
315.30-15.45	Seabed topography shaping architecture and reservoir traps in deep-water systems	*Marques*	The May 2024 Porto Alegre extreme flooding event: case report and the importance of monitoring flow and sediments	*Manica*
15.45-16.00	Untangling a shallow to deep water syn-rift system in the Late Jurassic of East Greenland: a direct analogue to the northern North Sea?	*Andrews*	Quantifying the time, cost, logistic and environmental efficiency of virtual field trips	*Pugsley*
16.00-16.15 / *16.15-16.30*	Poster session (Wool)			
17.00-18.00	AGM (Tweed)			

Day 2 Talk schedule

Timeslots	Room: Tweed		Room: Denim	
9.00-9.15	Anthropocene Sedimentary Environments	*Russell*	CSI: Sedimentology; untapped opportunities for cross-pollination	*Noad*
9.15-9.30	Evaluating microplastic and macroplastic presence in the ephemeral fluvial systems	*Beaumont*	Understanding Reservoir Heterogeneity Through Variogram Extraction and Facies Distribution Analysis	*Aliyuda*
9.30-9.45	What happens when lahars enter the ocean?	*Clare*	Petrophysical Analysis of Architectural Elements – a database approach	*Bello*
9.45-10.00	Tsunami vs storms: diagnostic criteria in lacustrine deposits	*Sharrocks*	Upscaling of discrete analyses through integration with multi-sensor core scan data: A case study from the Ness Fm, Osprey Field, North Sea	*Emmings*
BREAK				
10.30-10.45	Evolution of syn-kinematic failure observed throughout the fill of a salt-influenced mini basin	*Foon*	Sedimentology and the evolution of arid terminal fluvial fans: implications for reservoir heterogeneity	*Bowler*
10.45-11.00	Lamination and Banding in Sand Injectites: A Cyclic Jamming Model	*Kelly*	The fate of terrestrial organic matter in syn-rift lacustrine and fan-delta systems	*Wang*
11.00-11.15	Vertical and longitudinal facies changes in hybrid event beds in confined basins: examples from the Peïra Cava Outlier, Gres d'Annot, SE France	*Davies*	Mechanisms of sediment transport across a coastal plain to submarine slope: outcrop analysis of a Carboniferous succession, northern England	*Chen*
11.15-11.30	Anisotropy of magnetic susceptibility (AMS) of turbidite sandstones and mudstones: sedimentary or tectonic origin? A case study from the Ventimiglia Flysch (NW Italy)	*Patacci*	Mechanisms of mouth bar growth and progradation in deltas building into "deep" water	*Heath*
11.30-11.45	Mineral-chemical stratigraphy and provenance analysis: refining intrusive vs in situ interpretation	*Luzinski*	Sequence Stratigraphic Architecture and Palaeogeography of a Mixed-Process, Siliciclastic-Carbonate Shoreline and Shelf (Tithonian strata, Weald Basin, southern UK and northern France)	*Kuye*
11.45-12.00	Quantifying the capillary seal capacity of Tertiary shales associated with injectite petroleum reservoirs	*Price*	Depositional environments and sequence stratigraphy of a tide- dominated basin – Insights from the Kalahari Copperbelt, NW Botswana	*Harlet*
LUNCH			Industry forum (Denim 12:30-13:00)	
13.00-13.15 *13.15-13.30*	Keynote (Tweed): The Corinth Rift: Syn-rift sedimentary insights into the interactions between normal fault growth, sea-level and climate - Rob Gawthorpe			
13.30-13.45	Comparative statistical and deterministic reservoir modelling of fluvial deposits using virtual outcrops: a case study from the Yorkshire Coast, Northeast England	*Kapustina*	MISS-identified FIDS: Reassessing the palaeo-environments and surface textures of the Ediacaran Longmyndian Supergroup, Shropshire	*Boddy*
13.45-14.00	Does size matter? A 3D digital outcrop perspective	*Burnham*	Comparing fluid-induced interfacial deformation structures (FIDS) with microbially-induced sedimentary structures (MISS)	*Wignall*
14.00-14.15	A forward stratigraphic modelling tool for predicting 3D lithofacies architecture of aeolian and fluvial successions: implications for modelling geothermal reservoirs and carbon capture and storage	*Yan*	A marine mosaic of stasis and traces: Spatial patterns in the sedimentology, ichnology, and fidelity of the Cambrian shallow-water record	*Veenma*
14.15-14.30	GeoXtract core database: Redefining data access and analysis	*Yousef*	Dry me a river: fluvial sedimentation, plant fossils and bioturbation through Permian aridification	*Craig*
BREAK				
15.00-15.15	Sedimentological contributions to understanding the S Laurentian continent-ocean transition zone and its emplacement (Highland Border Complex, Scottish Grampians)	*Robertson*	From outcrop to production profiles: the weird world of sand injectites	*Brettle*
15.15-15.30	Stratigraphic architecture and environmental response of shelf-slope margins to active tectonics in slow strain rate settings: examples from the Pyrenees and Offshore Cameroon	*Watkinson*	Wing-like sandstone intrusions: geometric and spatial analysis of outcrop examples	*Waltham*
315.30-15.45	Quantitative analysis of kinematic properties of fault zones, Jiyang Depression, NE China	*Gou*	Extreme erosion and bulking in a giant submarine gravity flow	*Böttner*
15.45-16.00	Sedimentological evidence for an Argentera palaeohigh during the Eocene	*Amy*	Challenging the turbidity current maximum run-up height paradigm: Insights from 3D unconfined physical experiments and numerical modelling	*Wang*
16.00-16.15	A Quantitative Definition of Accommodation: Implications for Understanding and Prediction of Strata	*Burgess*	New insights into deep-lacustrine architectural elements: Examples from the upper Triassic Yanchang Formation, Ordos basin	*Bozetti*
16.15-16.30 *16.30-17.00*	Poster session (Wool)			

Posters

Room: Wool

Characterization of Reservoir Facies to Evaluate CO_2 Storage Potential: Fram Field, Central North Sea, UK	*Abbasi*
Facies model of a heterolithic tide-influenced to tide-dominated succession – the Early Jurassic Tilje Formation in the Smørbukk Field, Halten Terrace, Mid-Norway	*Alain*
Sedimentary and petrologic characterization of sediment gravity flow deposits and seabed topography interactions: examples from the Eocene of the South Pyrenean Foreland Basin	*Alberjón-Peñas*
Uncertainties in the inverse modelling of suspension-dominated flows from their deposits	*Amy*
How are different types of particulate organic carbon transported and buried by turbidity currents?	*Baker*
Sedimentological Analysis of Deposits Formed by Turbidity Currents in the Presence of Obstacles: A Physical Experimentation Study	*Santos*
The planetary control on how long it took a Millstone Grit delta lobe to be deposited	*Brettle*
Geological and geotechnical ground models for sustainable offshore windfarm developments	*Brown*
Origin and depositional processes of volcanic matrix-rich sandstones in the Shanxi and Shihezi Formations, Ordos Basin, China: Implication for volcano-sedimentary systems	*Cui*
Sedimentology and magnetostratigraphy of the early Paleocene Fort Union Formation (Montana, USA)	*van Dijk*
The primary factors influencing failure mechanisms and evolutionary patterns of slow-moving subaqueous landslides: an experimental assessment	*Gao*
Part I - Facies diversity of a mixed carbonate-siliciclastic arid tidal flat: insights from the middle Jurassic Carmel Formation, Utah, USA.	*Hême de Lacotte*
Part II – The effect of scattered facies distribution on apparent stratigraphic disorder in low gradient paralic systems	*Hême de Lacotte*
Microplastic transport and settling in the ocean due to biofilm growth: an interactive online teaching model to communicate scaling in environmental pollution	*Hughes*
Characterisation of lithological heterogeneity in mixed fluvial-aeolian successions of the Triassic Sherwood Sandstone Group, NW England: implications for carbon capture, utilisation and storage	*Humphries*
The stratigraphic records of atmospheric microplastic transport in highland and lowland peat bogs	*Ji*
Modelling CO2 Flux Regimes Post-Injection – Diffusion, Convection and Gravity Slumping	*Kelly*
Debris flow-deposit interactions in submarine lobes: process insights from observation of physical experiments	*Li*
Hothouse hydrology: river dynamics in the Eocene Montllobat and Castissent Formations, southern Pyrenees	*McLeod*
Multi-scale characterisation of the lower Mercia Mudstone Group for enhanced understanding of microstructural variability	*Mills*
Quantitative characterisation of the Triassic Sherwood Sandstone Group: Suitability for long-term carbon capture and underground storage, Cheshire, United Kingdom	*Scott*
Analysis of topographic variations in the Lower Cretaceous of the Central North Sea: implications for reservoir distribution	*Simpson*
Partial remobilisation of aeolian dunes: implications for reservoir compartmentalisation	*Stephens*
Assessing autogenic evolution of unconfined vs. laterally confined submarine fans: Insights from a global database and numerical modelling	*Wang*
Subsurface storage assessment of the Permian Rotliegend Group in NE England	*Wijanarko*
Rapid transfer of per- and polyfluoroalkyl substances through submarine canyons: sources, pathways and implications	*Xu*
New perspectives on an ancient sediment routing system: the Triassic Sherwood Sandstone and Budleighensis River	*Yan*
Microplastics in Kaikōura Canyon and Hikurangi Channel, New Zealand	*Zhang*

Oral presentation

Understanding Reservoir Heterogeneity Through Variogram Extraction and Facies Distribution Analysis

Kachalla Aliyuda[1], Dimitrios Charlaftis[2], Charlotte Priddy[1], John A. Howell[1]

1.Virtual Outcrop Group, School of Geosciences, University of Aberdeen, King's College, Aberdeen, AB24 3UE, UK

2.Badley Ashton Geoscience, Winceby House, Winceby, Horncastle, Lincolshire, LN9 6PB, UK

The geometry, orientation and stacking patterns of sedimentary geobodies play a key control on fluid migration within subsurface reservoirs, aquifers, and repositories. Outcrops and more recently virtual outcrops are commonly used as analogues to characterise geobody architecture and stacking. Traditionally, both reservoirs and their analogues are described with respect to the bulk proportion of different facies and architectural elements within the system. These are combined with geometric measurements of the different geobodies to describe heterogeneity.

This study presents a new methodology for quantifying the range of facies proportions within architectural element panels taken from outcrop analogues. This method measures the facies proportions within a series of vertical profiles and considers the statistical distribution, rather than the simple mean across the entire panel. The basic premise being that within a layer cake system, the spread in facies proportions will be very narrow whereas in a more "jigsaw" type system the spread will be much wider.

To test this hypothesis, a series of nine virtual outcrops from a range of clastic depositional systems including fluvial, shallow marine and deep marine settings, have been analysed. Depositional facies (architectural elements) were interpreted in LIME and a series of depositional strike-orientated orthorectified panels were extracted. The panels were then analysed, and the extracted facies proportions were translated to "net sand" distribution. Results were then compared with conventional analysis of reservoir heterogeneity.

Different depositional systems show distinct patterns. When arranged in depositional dip order, there is a systematic decrease in sand distribution spread down dip with significant resets at the boundaries between the major gross depositional environments (continental, shallow marine/shelf, deep marine).

Oral presentation

Sedimentological evidence for an Argentera palaeohigh during the Eocene

Lawrence Amy[1], Gillian Apps[2], Conrad Childs[1], Emma Morris[3], Marco Patacci[4], Frank Peel[2], Vincent Roche[1]

[1]School of Earth Sciences, University College Dublin, Ireland.

[2]Bureau of Economic Geology, Austin, Texas. [3]Earth & Space Sciences, Lamar University, Texas.

[4]Department of Life, Health and Environmental Sciences, University of L'Aquila, Italy

The Argentera Massif, located in SE France and NW Italy, is one of a number of external crystalline massifs within the Alpine Arc composed of Variscan igneous-metamorphic units. The influence of this basement material on the structural and stratigraphic development of the southern Alps has been controversial, with a variety of models proposed over the last half century. Critically, thermochronology data indicates that the Argentera Massif was uplifted relatively late in the Alpine orogeny during the Late Oligocene and Miocene. This has supported the view that the Argentera Massif did not influence the early Alpine structural evolution nor foreland basin stratigraphic development; including the bathymetric configuration of the deepwater Eocene-Oligocene Grès d'Annot turbidite system. Here observations of Tertiary sequences located close to the southeastern margin of the Argentera Massif are discussed that support the view that the Argentera area was a palaeohigh during the Middle-Late Eocene, earlier than suggested from thermochronology data. Notably, Pre-Nummulite deposits preserve southward-directed fluvial-estuarine systems suggesting the presence of a high located to the north, with erosion of the basement cover down to at least the Triassic. Secondly, local deviations in palaeoflow recorded by Late Eocene turbidites show a flow direction parallel to basement structures also suggesting a palaeohigh to the north forming the northern distal margin of eastern parts of the Grès d'Annot turbidite system in SE France. These interpretations are consistent with those from several other studies in the Italian Maritime Alpes that suggest the Argentera area was a palaeohigh during the Jurassic and Cretaceous. These results have implications for both the depositional and structural evolution of the southern Alpine foreland basin.

Oral presentation

Untangling a shallow to deep water syn-rift system in the Late Jurassic of East Greenland: a direct analogue to the northern North Sea?

Steven D. Andrews[1], Ed Keavney[1], David M. Hodgson[1], Jeff Peakall[1], Ian A. Kane[2], Miquel Poyatos-Moré[3], Bonita Barrett[4] and Ian Sharp[4]*

[1] *University of Leeds, UK*

[2] *University of Manchester, UK*

[3] *Universitat Autònoma de Barcelona, Spain*

[4] *Equinor ASA, Bergen, Norway*

* *email: s.d.andrews@leeds.ac.uk*

Seafloor topography exerts a major control on deep-water sediment routeing patterns and can drive flow transformations, which in turn influence sediment distribution and depositional character. The impact of syn-rift faults and antecedent topography on Late Jurassic deep-water sedimentation patterns in the northern North Sea has been well documented. However, the fine scale controls on flow processes and the resultant deposits are hard to infer given the limited resolution of offshore seismic reflection datasets, and the bias of cored intervals. Direct outcrop analogues to these subsurface systems are exposed in East Greenland. These superb, but understudied exposures permit detailed investigation into the relationships between sediment gravity flows and syn-rift seafloor topography, and thus the resulting sediment routeing patterns and deposits. Palaeocurrents, architectural element analysis, and bed-scale observations, are used to elucidate the evolution of this system.

The Late Jurassic Olympen Formation was deposited during syn-rift extension in the Jameson Land Basin, a N-S oriented half graben. Outcrops can be traced north to south, from Traill Ø (72°30'N), where the Late Jurassic succession has been interpreted as shallow marine/delta deposits, to the shelf edge in central Jameson Land (71°20'N), and ultimately to the deep water dominated deposits in southern Jameson Land (70°40'N). In the distal regions of this system major sand injection has also been widely documented (Hareelv Fm).

The results show that during the earliest Oxfordian lowstand, axially sourced sediment dominated, resulting in southeasterly directed flows. Biconvex ripples and small-scale hummock-like bedforms identified within fine-grained deep water heterolithics provide evidence for combined transitional flows, recording reflection and deflection off the hanging wall slope. Mid-Early Oxfordian transgression resulted in the axial system being pushed back to the north and sedimentation being limited to more locally derived transverse systems. Regression during the Middle Oxfordian resulted in the interaction of flows originating from the axial system, in the north, and hanging wall margin, in the east. Late Oxfordian-Kimmeridgian transgression precipitated a switch of the dominant sediment input point to the shallower angled hanging wall basin margin, along which shallow marine systems could prograde rapidly. Reduced activity on the axial fault at this time may have contributed to this switch, with the axial sediment delivery system becoming less constrained to the faulted basin margin. This work highlights the importance of understanding the wider tectonic and eustatic setting when reconstructing sediment routeing and distribution in deep water systems, and offers a unique outcrop analogue for understanding the impact of flow interactions with seafloor topography in the syn-rift deep-water systems of the northern North Sea.

Oral presentation

Submarine channel complex evolution adjacent to a transform margin

S. A. C. Araujo[1] , D. M. Hodgson[1] , J. Peakall[1] and M. N. C. Araujo[2]*

[1] School of Earth and Environment, University of Leeds, Leeds, LS2 9JT- United Kingdom.

[2] Cenpes - Centro de Pesquisas da Petrobras, Av. Horácio Macedo, 950 - Cidade Universitária, Rio de Janeiro, 21941-915, Brasil

**eesaca@leeds.ac.uk*

The formation of a passive transform margin results in complex stepped-slope topographies. This physiography plays a critical role in shaping long-term deep-water sedimentation. However, the role of transform faults and subsidence patterns in the evolution of submarine channel pathways has not been documented previously. In this study, we use 3D seismic reflection data with well data over an 8.000 km2 area immediately to the north of the Romanche Fracture Zone in the South American Equatorial Atlantic. These data allow us to document the evolution of multiple 10s kmlong submarine channel complexes from the Upper Cretaceous to the Palaeogene and investigate their morphological relationship with dynamic changes in basin subsidence. We analysed and quantified key parameters, including length, width, orientation, sinuosity, diversions, confinement, avulsion nodes and angles, to quantify changes in geometric patterns in time and space. The early evolution of the submarine channel complexes is closely associated with a fixed entry point at the "inner corner" domain between the transform and rift border fault. These submarine channel complexes are characterised by numerous sharp (>90 degree) avulsions persistently to the east to follow an axial trend. Through time, the position of avulsion nodes moves basinward and decreases in number. This is followed by developing multiple entry points along the transform margin segment with straighter and more incised submarine channel complexes with transverse orientations. This stratigraphic trend in channel patterns is interpreted to record the evolution of slope relief from a topographically complex steppedslope profile with subsidence adjacent to the transform fault (Cretaceous), which promoted the formation of toe-of-slope fans, to a regionally simple slope profile (Palaeogene). This study documents for the first time the distinctive evolution of submarine channel complexes adjacent to transform faults, with characteristic highangle avulsions, and the associated development of splays. This challenges existing simple tectono-stratigraphic models and highlights the role that dynamic subsidence and sediment input location play during the evolution of the margin from a topographically complex to a simple slope profile.

Oral presentation

Ageing of clay suspensions and deposits

Jaco H. Baas[1], James L. Best[2], Leonardo P. Chamorro[3], Soohyeon Kang[4], Heesung Jung[4]

[1] School of Ocean Sciences, Bangor University, Menai Bridge, Wales, U.K.

[2] Departments of Earth Science and Environmental Change, Geography and GIS, and Mechanical Science and Engineering, and Ven Te Chow Hydrosystems Laboratory, University of Illinois at Urbana-Champaign, Urbana, U.S.A.

[3] Departments of Mechanical Science and Engineering, Earth Science and Environmental Change, Civil and Environmental Engineering, and Aerospace Engineering, University of Illinois at Urbana-Champaign, Urbana, U.S.A.

[4] Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, U.S.A.

Clay-laden flows and muddy deposits are common in many natural environments and in the sedimentary record. It is well established that clay minerals can form cohesive bonds, which leads to flocculation and gelling in flows and deposits. Consequently, clay minerals change the rheological properties of these flows and deposits, thus increasing their yield stress and viscosity. Less well known is that aqueous suspensions of clay minerals can be thixotropic, i.e., their rheological properties change with time. This 'ageing' behaviour of clays is hypothesised to affect the erodibility of muddy substrates, the transport behaviour of suspended clay, and the depositional signatures of muddy deposits in ways that are barely addressed in sedimentological literature. Novel laboratory experiments, as well as previous rheological research, show that the ageing behaviour varies for different types of clay mineral (here: kaolinite, bentonite, laponite), with changes in viscosity and yield stress occurring on times scales ranging from minutes to weeks and months. Our presentation will address key questions on clay thixotropy: How does thixotropy vary amongst clay minerals? Is thixotropic behaviour dependent on clay concentration and are there differences in ageing between clay suspensions and deposits? How do the time scales of deposit ageing compare to those of substrate consolidation? Can ageing transform turbulent clay flow into transient-turbulent or laminar clay flow? Which depositional environments are most susceptible to thixotropy, and how does this vary with clay mineral type, considering that the geographical distribution of dominant clay mineral type is partly controlled by latitude, and thus by climate zone? Finally, which aspects of clay mineral ageing should future process sedimentological research focus on?

Oral presentation

Evaluating microplastic and macroplastic presence in the ephemeral fluvial systems

Hazel Beaumont[1], Lisa Mol[2] and Mariem Ben Ameur[3]

[1] School of Engineering, University of the West of England, UK

[2] School of Architecture and the Environment, University of the West of England, UK

[3] *Department of Georesources and Environment, National Engineering School, University of Sfax, Tunisia*

To our knowledge this is the first study that looks at macro- and microplastics in ephemeral fluvial systems in deserts worldwide. By necessity, where formal waste disposal systems cannot be implemented, informal waste disposal takes place. Here, we investigate the hitherto poorly understood long-term ramifications of informal waste disposal within southern Tunisia. Our study was conducted to quantify the presence of macro- and microplastics in near-surface sediments, aiming to investigate the link between observed macroplastics on the surface and embedded microplastics in the subsurface determine whether anthropogenic or natural dispersal processes are most prominent. Therefore, semi-quantitative approaches for sub-surface microplastics sampling in conjunction with detailed random sampling of macroplastics provides a holistic insight into the behaviour of plastics entering this pristine environment.

Overall microplastic count across all 17 samples is 2188 with an average number of microplastics per sample is 128.8 with a standard error mean of 3.24, with fibres dominating sample counting, with the microplastic pollution index indicating intervention and restoration of the wadi environment is needed. The macroplastic count is 213 across the 40 tally locations where on average there is 5.3 pieces of macroplastic/m^2 throughout the southern Tunisian area with a standard deviation of 8.9. The dispersal of microplastics and macroplastics appears to be connected in the first instance by waste disposal patterns, such as proximity to the road network, and displays a strong link between population density and informal waste disposal. High plastic counts are also common near bridges and along secondary roads where accessible informal waste disposal sites can act as both a sink and a source of microplastics and macroplastics. These sites appear to be the primary dispersal sources of plastics into the natural systems. Secondary dispersal takes place through aeolian transport, where microplastics and macroplastics are slowly moved from the initial entry point through inter-dune areas. Topography breaks such as large areas of vegetation or step-downs within the wadi bed (e.g. gabions or small dams) act as traps for these transported plastics, facilitating storage and slow burial within the sedimentary sequence.

Oral presentation

Petrophysical Analysis of Architectural Elements – a database approach

Authors: G. Bello[1], J. Howell[1], A. Hartley[1], N. Naumann[1], J. H. Pugsley[1], K. Aliyuda[1]

[1]Department of Geosciences, University of Aberdeen, Scotland, United Kingdom.

Depositional facies are the fundamental control on petrophysical properties within subsurface reservoirs, aquifers and repositories. Outcrop analogues facilitate the recognition of facies within their constituent architectural elements, providing dimensional information expressed as cross-sectional geometries and used to predict the distribution of those properties in subsurface. However, heterogeneity increases with the multi-dimensional scales of sedimentology. From core to outcrop, this heterogeneity is effectively captured by an architectural component within the different depositional environments. Architectural elements and their subsequent facies can be interpreted from cores with a relatively high degree of confidence, but, due to the limited detail in wireline logs, their interpretation becomes more and more challenging, leading into an overlooked analysis of the heterogeneity. Given the cost and scarcity of core, being able to reliably and consistently interpret facies from wireline logs is highly desirable.

Our study addresses these challenges by developing a petrophysical database as a data-driven tool to predict subsurface petrophysical scenarios from virtual outcrops, including the generation of synthetic well logs. Using publicly available data from the UK and Norwegian sectors of the North Sea, the database is populated with gamma ray, deep resistivity, sonic and density-neutron parameters. In addition, it provides a comprehensive record of petrophysical log responses corresponding to the architectural element's classification defined within the SAFARI data standards. To achieve a detailed record of the petrophysical distribution at depth, each architectural element sample is derived by correlating facies interpretations from core and core images with their corresponding subsurface wireline logs intervals from different reservoir clastic formations in the North Sea.

Oral presentation

MISS-identified FIDS: Reassessing the palaeo-environments and surface textures of the Ediacaran Longmyndian Supergroup, Shropshire

Catherine E. Boddy[*1], Brennan O'Connell[1], Jeffrey Peakall[2], Alexander G. Liu[1]*

[1]Department of Earth Sciences, University of Cambridge

[2]School of Earth and Environment, University of Leeds

**ceb216@cam.ac.uk*

Ediacaran strata preserve the earliest large and complex multicellular organisms, providing key insights into the environments that supported early animal evolution. Macrobiota are abundant in the ca. 575–555 Ma deep-water strata of Charnwood Forest (UK) and Newfoundland (Canada), but no macrofossils have been found in the coeval Longmyndian Supergroup deposited in palaeo-geographic proximity. The Longmyndian Supergroup has been studied since Salter (1856) reported some of the first Precambrian life. The absence of macrofossils has led to hypotheses that these rocks formed in a shallow-marine environment inhospitable to the Ediacaran biota at the time. Previous interpretations in support of a shallow-water palaeoenvironment are in part based on surface textures observed in Longmyndian rocks, including reticulate structures and discoidal features (interpreted as microbially-induced sedimentary structures), longitudinal linear features (interpreted as *Arumberia* filaments), circular rimmed impressions (attributed to raindrop imprints), and thin mud cracks (interpreted as desiccation cracks).

We challenge the long-standing shallow water palaeoenvironmental hypothesis for the upper Longmyndian succession and present new sedimentological and stratigraphic evidence suggestive of deposition in deeper-waters. The succession, from base to top includes mudstone (Stretton Shale Formation), mud-sand turbidites, hybrid beds, and debrites (Burway and Synalds formations), mudstone and channels with slump features (Lightspout Formation), and wave-ripple cross laminated sandstone (top of the Lightspout Formation). These units are interpreted to reflect a shallowing upward deep-marine basin to lower shoreface succession. Critical evaluation of the surface features reveals that some surface textures, many originally interpreted as microbially-induced, can now be attributed to abiogenic flow-induced interfacial deformation structures (FIDS), most commonly known from turbidites. Our findings suggest greater palaeo-environmental overlap between unfossiliferous Longmyndian and fossiliferous Charnwood and Newfoundland strata, implying that physical palaeo-environments alone cannot explain variations in Ediacaran fossil distribution. Other factors such as seawater chemistry, water depth, sediment supply, and sediment recurrence rate likely placed additional controls on the presence and/or preservation of Ediacaran macrobiota.

Oral presentation

Extreme erosion and bulking in a giant submarine gravity flow

Christoph Böttner, Christopher J. Stevenson, Rebecca Englert, Mischa Schönke, Bruna T. Pandolpho, Jacob Geersen, Peter Feldens, Sebastian Krastel

Sediment gravity flows are ubiquitous agents of transport, erosion, and deposition across Earth's surface, including terrestrial debris flows, snow avalanches, and submarine turbidity currents. Sediment gravity flows typically erode material along their path (bulking), which can dramatically increase their size, speed, and run-out distance. Hence, flow bulking is a first-order control on flow evolution and underpins predictive modeling approaches and geohazard assessments. Quantifying bulking in submarine systems is problematic because of their large-scale and inaccessible nature, complex stratigraphy, and poorly understood source areas. Here, we map the deposits and erosive destruction of a giant submarine gravity flow from source to sink. The small initial failure (~1.5 cubic kilometers) entrained over 100 times its starting volume, catastrophically evolving into a giant flow with a total volume of ~162 cubic kilometers and a run-out distance of ~2000 kilometers. Entrainment of mud was the critical fuel, which promoted run-away flow growth and extreme levels of erosion.

Oral presentation

Inception, bypass, and fill of submarine canyons on active margins

Max Bouwmeester[1], Ian Kane[1], David Hodgson[2], Steve Flint[1], Will Taylor[2], Euan Soutter[1]

[1]University of Manchester; [2] University of Leeds

Large volumes of sediment are transferred across the continental slope by turbidity currents, shaping submarine fans as the largest sediment accumulations on earth. Submarine canyon heads capture particles at the shelf edge, intermittently store or buffer sediment, but ultimately transfer most material into deeper water settings. Submarine canyons and their head areas therefore form a crucial link between continental sedimentary systems and the deep-sea sink, but remain poorly understood. Recent direct monitoring efforts are rapidly increasing our understanding of present-day processes in submarine canyons, but their significance through geological time remains enigmatic due to a paucity of outcrop data, hindered by poor preservation potential and transient character of upper slope systems. This leaves a resolution gap between seismic-scale studies and observations in core needed to link direct measurements of modern submarine canyon processes to their deposits. We attempt to bridge these gaps using three well-exposed submarine canyon-fills and slope systems on tectonically active margins, the ocean facing Cretaceous-Paleogene Punta Baja and Rosario Formations of Baja California, and the Eocene Banastón Formation, NE Spain.

The extensive Punta Baja canyon-fill outcrops permit the examination of early phases of canyon evolution and the architecture of canyon axis and margin deposits, both across-strike and down-dip. The onset of aggradation in this and the other studied canyons is suggested to be aided by mass failure widening of the basal surface as well as their deposits obstructing conduits. Even during bypass-dominated stages, sediment storage is an important, if transient, part of canyon evolution. We demonstrate that sedimentary surfaces dominantly dip up-stream in the canyon fill, confirming that supercritical flow conditions shape canyon floors and are preserved in the stratigraphic record.

In the Banastón example, as overall bypass decreases down system, evidence for bypass is expressed at increasingly finer scales. In the Rosario Formation, the infill architecture and sedimentological features of deposits near the canyon head are described. Cryptic surfaces record cycles of conduit (re-)incision and exhibit common patterns of deepening and widening at multiple architectural scales. The unique configuration of confinement in canyons influences sedimentary sequences and patterns both across-strike and down-dip, producing deposits that are poorly organised but retain predictive value. This research highlights how the sedimentary organisation (or lack thereof) in canyon fills is characteristic of the highly dynamic environment and processes that shaped them.

Oral presentation

Sedimentology and the evolution of arid terminal fluvial fans: implications for reservoir heterogeneity

Bowler, B.J., Clarke, S.M., Davies, C.H.C. & Hême de Lacotte, V.J.P.

Basin Dynamics Research Group, Keele University, Staffordshire, ST5 5BG.

Spatial and temporal variations in the sedimentology of continental basins are preserved at both facies and stratigraphic scale, with the relationships between architectural elements and facies reflecting the evolution of the depositional system. Coeval aeolian and fluvial environments may interact and compete in such basins, forming heterogenous, complex sedimentary successions. Substantial research has shown that, individually, both aeolian and fluvial environments deposit sediments that, when preserved, have valuable reservoir potential. However, comparatively little research has been conducted into the implications of aeolian-fluvial interactions upon the preserved sedimentology, system evolution, and the resultant reservoir potential as spatial variability within continental arid fluvial systems is difficult to determine.

Detailed sedimentary logging with textural and structural sedimentological characteristics, palaeocurrent data and magnetic susceptibility data of the Middle Jurassic Carmel Formation across southern Utah have been combined to produce three-dimensional facies models of aeolian-fluvial depositional systems. These models are quantified with the addition of geometrical architectural element data derived from aerial drone photogrammetry. Statistical analyses of the quantitative data reveals spatial variation in the textural and compositional characteristics, and changes across the margin of these interacting systems.

Spatial and temporal variability within the palaeoenvironment, caused by changes in the dominance and relative balance of autogenic and allogenic processes, is reflected in the preserved architectures. Autogenic controls and processes can be interpreted from the sedimentary logs using facies-scale variation. However, allogenic controls are considerably harder to evaluate in these continental systems. Preliminary investigations suggest that by using magnetic susceptibility data for mathematical cyclostratigraphical analysis, larger scale allogenic controls can be evaluated alongside the autogenic factors to develop a better understanding of spatial variability within arid fluvial systems, how it is produced, and potentially how it can be predicted at multiple scales. Heterogeneity will impact hydrocarbon and CCS reservoir quality, which can be evaluated by using generalised models applicable to sub-surface analogues at a sub-seismic scale. Future work aims to produce these generalised reservoir models at multiple scales for an arid fluvial setting.

Oral presentation

Evolution of a multi-phase coarse-grained submarine slope channel-lobe system, influenced by bottom currents: Upper Cretaceous Cerro Toro Formation, Southern Chile

*Guilherme Bozetti**

**Institut Terre & Environnement de Strasbourg, EOST, CNRS UMR 7063, University of Strasbourg, Strasbourg, France*

Understanding variations in the sedimentary processes and resulting stratigraphic architecture in submarine channel-lobe systems is essential for characterising sediment bypass and sedimentary facies distribution on submarine slopes. In the Santonian to Campanian Cerro Toro Formation, southern Chile, a coarse-grained slope system developed in a structurally controlled environment, with complex and poorly established relationships with the surrounding mud-rich heterolithic deposits.

A detailed architectural analysis of the most continuous and best-exposed channel system in the Lago Sofia Member, the Paine C channel system, provides insights on lateral facies transitions from channel axis to margin, stacked in a multi-phase sequence of events marked by abrupt changes in facies, facies associations, and architecture. In a larger scale, the Paine C is part of a system that records abrupt changes from conglomeratic- (channelised) and sandstone-dominated (ponded, splays, lobes), with the latter showing clear influence of bottom currents during deposition through sediment-laden gravity-driven currents.

The Paine C channel system is incised into siltstones and claystones interbedded with thin-bedded very-fine sandstones, interpreted to be either channel-related overbank or unrelated background deposits. Its asymmetrically emplaced channelised conglomeratic unit can be subdivided into three phases: 1) highly depositional and/or aggradational, dominated by thick and laterally continuous beds of clast- to matrix-supported conglomerate, herein named transitional event deposits; 2) an intermediate phase, including deposits similar to those dominant in phase 1 but also containing abundant clast-supported conglomerates and lenticular sandstones; and 3) a bypass-dominated phase, which records an architectural change into a highly amalgamated ca. 45-m-thick package composed purely of lenticular clast-supported conglomerates with local lenticular sandstones. Between the conglomeratic phases, a metre-scale package composed of interbedded thin- to medium-bedded sandstone and mudstone deposits is interpreted to drape the entire channel, indicating periods of weaker gravity flows running down the channel, with no evidence of bedload transport. The asymmetric stacking pattern of the Paine C channel system resembles the one observed in the Enyenra channel system, offshore Ghana, interpreted to have been influenced by bottom currents.

In this study we propose a new depositional model for coarse-grained submarine channel systems, in which particular characteristics can provide significant insights into architectural heterogeneity and facies transitions in channelised systems, allowing substantial improvement in subsurface facies prediction for fluid reservoirs; as well as insights on the influence of bottom currents in shallow compressional slope systems.

Oral presentation

New insights into deep-lacustrine architectural elements: Examples from the upper Triassic Yanchang Formation, Ordos basin

Guilherme Bozetti, [a], Xiangbo Li [b], Zhanlong Yang [b], Huaqing Liu [b], Junping Huang [b], Zhiyong Li [b], Jingping Xu [a]*

[a] Department of Ocean Sciences and Engineering, Southern University of Science and Technology, No. 1088 Xueyuan Road, Nanshan District, Shenzhen, Guangdong 518055,
[b] China b PetroChina Research Institute of Petroleum Exploration & Development Northwest, Lanzhou 730020, China
** University of Strasbourg, CNRS, Institut Terre et Environnement de Strasbourg, UMR 7063, Ecole et Observatoire des Sciences de la Terre, Strasbourg 67084, France*

Deep-lacustrine systems are considerably less studied than their marine counterparts, mostly due to the low number of large and continuous outcrops worldwide. This study details outcrops and cores from Chang 7, Ordos Basin, China, which are composed dominantly of fine-grained deposits interbedded with amalgamated sandstones. Thick sandstone deposits, previously described as massive sandstones and interpreted as sandy debrites, are here re-interpreted as amalgamated sandstones, deposited by high-density turbidity currents associated with deep-lacustrine slope channels. Two outcrops composed of these deposits, which form intervals ranging from 6 to 20 m thick, laterally ranging from 600 to 1200 m, preserving evidence of sediment bypass such as erosional features and abundant trough cross-bedding, have been interpreted as lacustrine slope channels. Deposits composed dominantly of interbedded thin-bedded normal-graded sandstone and mudstone, with common occurrences of ripple cross-lamination (>70 % of the beds), interbedded with sporadic amalgamated medium-bedded sandstones have been interpreted as levee deposits. These deposits outcrop laterally to slope channel deposits, supporting the interpretation they are genetically and architecturally related. Similar deposits are also described in core, overlying channelised sand-prone deposits. Interbedded thin- to medium-bedded normal-graded sandstones and mudstones, which are not associated with a confining surface (non-channelised), nor an adjacent slope channel, have been interpreted as terminal splays. The re-interpretation of the sandstone-prone deposits of the Yanchang Formation as slope channel-levees to terminal splays provides a different approach to lateral and temporal distribution of architectural elements in intracratonic lacustrine basins, and therefore hydrocarbon exploration and production.

Oral presentation

From outcrop to production profiles: the weird world of sand injectites

Matt Brettle

University of Aberdeen, UK

Sand injectite systems are typically depositional units which have been highly dewatered, remobilised and injected into mudstone host rocks. In extreme instances, remobilised sand was transported through fractures, breached the palaeoseabed and was deposited as an extrudite. The study of sand injectites therefore requires an understanding of how the sediments were deposited, buried, compacted, liquified, translocated and deposited – both within the hydrofractures that formed conduits to the seabed (forming dykes, sills, wings and saucer forms) and at the seabed.

The resulting complex 3D relationships between subvertical dykes, inclined sills, wings and saucer-shaped forms can be difficult to conceptualize and model. Novel and practical methods have been developed to model sand injectite facies, based on outcrop derived data, interpretation and concepts. We show the application of those models to aid the further understanding of the production behaviour of sand injectite reservoirs.

More than 3.3 billion barrels of oil has been produced from sand injectite fields in the North Sea. Significant hydrocarbon exploration, production and possible CCS potential exists in formations impacted by sand injection. The presence of some injectite features (mainly dykes and wings) significantly increases vertical connectivity within the gross reservoir interval and is often the reason sand injectite reservoirs have large hydrocarbon column heights - when compared to structural or stratigraphically trapped reservoirs. This poses challenges with respect to how these fields can be optimally developed, but by integrating representative 3D models and the correct development strategy sand injectite fields can produce for long periods at low water cuts. This factor is potentially useful beyond the point we use oil as a combustible fuel, as sand injectite reservoirs can produce at lower carbon intensities than fields that rely on water injection for pressure support.

Oral presentation

A universal deep-water bed-type classification based on the synthesis of many depositional systems

Soma Budai[1,2], Luca Colombera[1], Adam McArthur[2] and Marco Patacci[3]*

[1]Dipartimento di Scienze della Terra e dell'Ambiente, Università degli Studi di Pavia, Via Ferrata 1, 27100, Pavia, Italy

[2] Turbidites Research Group, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, United Kingdom

[3] Dipartimento di Medicina Clinica, Sanità Publica, Scienze della Vita e dell'Ambiente, Università degli Studi dell'Aquila, Piazzale Salvatore Tommasi 1, 67010 L'Aquila, Italy

Geological analogues have long been utilized in the interpretation of sedimentary logs and in the assessment of reservoir properties of deep-water deposits such as channels, levees and terminal deposits. Such deposits are built up by sedimentary beds, such as turbidites, and intercalated muds. Categorizing these beds on their facies characteristics is important, since they represent key records of formative processes and have a significant impact on reservoir quality. However, different studies apply alternative bed-type classification schemes rendering the quantitative comparison of bed types and their properties from different deep-water systems difficult.

In this study a large sedimentological database of facies and beds from 27 turbidite-dominated systems, encompassing successions of Neoproterozoic to Holocene age, including >32,000 facies and >10,000 beds, has been applied to develop a universal deep-water bed-type classification scheme. The proposed scheme is applicable to discriminate and categorize lithological (sand and gravel) layers and is based on: (i) the proportion of sand, gravel and sandy-mud, muddy-sand in the bed, (ii) the presence and nature of vertical sharp grain-size changes, and (iii) the presence and thickness ratio of laminated sedimentary facies.

Based on this bed-type scheme, the bedding properties of deep-water terminal deposits, channel elements and levee elements stored in the database were compared. Results show that the three architectural-element types are characterized by differences in bed frequency and thickness, vertical transitions, vertical bed thickness trends, mud thickness and sand-gravel fraction values. Channel elements are characterized by the highest bed-thickness values for each bed-type except for fully laminated ones. Furthermore, channel deposits show much higher amalgamation ratios, and increased propensity for thinning-upward trend in bed thickness, in contrast with the studied terminal deposits, in which thickening-upward trends are markedly more frequent. Structureless sand beds dominate in channel elements and terminal deposits, while the overwhelming majority of the beds in levee elements tend to be fully laminated.

To illustrate a practical application of the proposed scheme, an algorithm was developed to stochastically generate geologically realistic synthetic sedimentary logs depicting deep-water terminal deposits, channel-fill and levee architectural elements. The method relies on the collected sedimentological dataset and is based on recognition of statistical differences in bedding properties of the discussed architectural elements. The one-dimensional facies modelling is governed by a series of input parameters, including total number of beds, sand-gravel thickness, and sand-gravel fraction. The approach can be tailored to produce synthetic logs for specified types of depositional systems (e.g., categorized according to coarseness of deposits, global climate or age). The algorithm enables the generation of a large number of synthetic sedimentary logs, which can be utilized as training datasets in machine learning algorithms developed to aid subsurface interpretations of clastic sedimentary successions.

Oral presentation

A Quantitative Definition of Accommodation: Implications for Understanding and Prediction of Strata

Peter M. Burgess[1], Brad Prather[2], Ron Steel[3], Oriol Falivene[4]

[1] Quantitative Experimental Stratigraphy Research Group (QuEST), University of Liverpool

[2] Department of Geology, University of Kansas

[3] University of Texas, Austin

[4] Shell International Exploration and Production

Accommodation, typically thought of as the space available for sediment to fill through deposition, is a central concept in stratigraphy, and much of what we understand and predict about strata follows from the accommodation concept. However, definition of accommodation is not entirely straight forward because existing qualitative definitions lack rigour, and because definition of the space available for deposition to fill requires consideration of how deposition might occur. Adopting a quantitative, probabilistic, process-based approach offers a potential solution. Accommodation can be quantitatively defined as the most likely thickness or volume of potentially deposited strata, calculated per unit time based on a vertical accumulation rate resulting from probabilities of deposition and erosion on a specified topographic gradient. Parameters can be varied to reflect different terrestrial and marine accumulation rates. Including topographic gradient in the definition introduces further simple but important physical process considerations. Testing this definition in a simple two-dimensional numerical forward model suggests the definition works well, producing reasonable stratal patterns. Significant processes such as sediment bypass can be considered an emergent and therefore perhaps predictive outcome of this new definition.

Oral presentation

Probably Proximal Pebbles? Prediction of Heterogeneity in UK Triassic Strata

Peter M. Burgess[1], Emma Dobromylskyj[1], James Lovell–Kennedy[2]

[1]Quantitative Experimental Stratigraphy Group, University of Liverpool

[2] Now at Reed in Partnership, 4 Renshaw Street, Liverpool, L1 2SA.

Unanticipated heterogeneity in Triassic fluvial and lacustrine strata that outcrop across England has important implications for practical subsurface prediction, for example related to proposed carbon and nuclear waste storage. Pebbles in the Lower Triassic Sherwood Sandstones are typically argued to originate mostly from the Armorican Massif, Northern France, and a single sediment source should mean grain size and heterogeneity of the strata decreases northwards. However, occurrence of pebble-rich strata in several basins across central and northern England suggest multiple sediment source areas, producing significant heterogeneity. To further test and constrain this multiple-source hypothesis pebble abundance data were used to constrain a simple source-to-sink exponential decay model predicting pebble abundance versus distance from source. The model was inverted on number and location of clast input sources to calculate best-fit matches. Results indicate three distinct pebble sources best fit these data, with one major tributary originating in the Welsh Massif, and a second in the London-Brabant Massif. This suggests a more complex than previously assumed multiple sediment source interpretation for the Early Triassic river system, and substantially increased prediction uncertainty that perhaps also extends to Upper Triassic strata if the complex sediment supply system was persistent through Triassic time.

Oral presentation

Does size matter? A 3D digital outcrop perspective

Brian S. Burnham[1], David Hodgetts[1], Georgina Heldreich[2]*

[1]VRGeoscience Limited, Manchester, UK

[2]Department of Earth and Environmental Sciences, University of Manchester, M13 9PL

Quantitative analysis of small-scale digital outcrops requires minimal time for data collection, processing, and interpretation, yet aids collection of substantial data volumes that can enhance or reshape our understanding of regional depositional systems. In this study, we investigate a small-scale outcrop (4 m wide x 1.5 m high) to characterise a fine-grained debris flow deposit within the Upper Jurassic Kintradwell Boulder Bed Formation in Scotland. The outcrop, capped by Pleistocene glacio-fluvial deposits, is one of the latest recorded submarine deposits in the formation.

Less than one day was required for collection of the data through to the final interpreted model. Terrestrial photographs were collected and used to generate a high-resolution photogrammetric digital outcrop model. This digital outcrop model facilitated precise measurement of the geometry and orientation of over 150 imbricated siltstone and very fine-grained sandstone clasts within the debris flow interval - a level of data granularity aided by improved outcrop accessibility that conventional field-based methods alone would struggle to achieve. The recorded palaeoflow orientations from the imbricated clasts align with previous observations of transport direction, corroborating sediment transport dynamics within the formation. Results from geometric analysis of deformed strata directly below, and partially *in situ* clasts identified at the base of the debris flow interval, suggests that the debris flow may have travelled only a short distance down the palaeoslope.

This study highlights that small-scale outcrops play an equally important role in elucidating depositional processes within sedimentary systems in broader regional studies. Digital outcrop modelling, now more accessible than ever, not only complements traditional field methods but also provides a powerful tool for field-based research that enables significant data volume collection in minimal time frames, especially in regions with limited outcrop accessibility.

Oral presentation

Mechanisms of sediment transport across a coastal plain to submarine slope: outcrop analysis of a Carboniferous succession, northern England

Sheng Chen[1], Adam D. McArthur[1], Nigel P. Mountney[1], Luca Colombera[2]

1 School of Earth and Environment, University of Leeds, UK

2 Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Italy

Sedimentary successions preserved with sufficient detail to demonstrate convincing evidence of coeval processes operating from river-dominated coastal plain, to shoreline, to shelf and submarine slope remain relatively poorly documented because of their limited preservation and exposure. Well-exposed outcrops of the Carboniferous Millstone Grit Group on the southeast shoulder of the Askrigg Block, North Yorkshire, England, record deposition from a fluvial plain, to deltaic, to slope environment. The aim of this study is to document the controls on sedimentation from fluvial to deep-water systems via shelf-edge deltas, and to determine why and how sediment is stored in each palaeoenvironment.

Twenty-three graphic sedimentary logs (~470 m cumulative length) and ten architectural-element panels record sedimentological and stratigraphical relationships of the studied succession. Lithology, sedimentary textures, sedimentary structures, bedding thicknesses, bedding contact relationships and fossil assemblages were recorded. Logs and architectural panels were tied to georeferenced photo-panels and recorded on 1:10,000-scale base maps. Log data were integrated with architectural panels and photo-panoramas to construct quantitative 3D geological models of the depositional system, with correlations constrained by marker marine bands and coal seams.

Nineteen facies types were classified. These occur in ten distinct facies associations, which record evidence for a suite of depositional processes in a range of settings; they form the facies make-up of ten types of architectural elements. In stratigraphic order, the studied units include the Cockhill Marine Band, Nidderdale Shale, Red Scar Grit (with the Woogill Coal interbedded), Colsterdale Marine Band and Scar House Formation. The two marine bands likely record maximum flooding surfaces. The Nidderdale Shales represent offshore deposits. The Red Scar Grit records deposition across a fluvio-deltaic plain as part of a lowstand systems tract; its lower bounding surface represents a sequence boundary. The Woogill Coal records overbank sedimentation on the delta plain. The lower part of Scar House Formation records a base of slope, with different types of turbidites. The middle part records a progradational delta front, with delta lobe switching. The upper part records the progradation of delta-edge distributary channel bodies, with adjacent interdistributary bays and overbank. Coal seams and palaeosols in the uppermost part of the Scar House Formation, indicate a paralic floodplain setting.

Analysis of architectural elements reveals relationships between coevally active neighbouring depositional environments. Determination of quantitative spatial relationships of architectural elements has enabled the construction of 3D multi-element models to explain the evolution of the depositional system. Results demonstrate mechanisms of sediment transport and delivery from a coastal fluvial plain, via a shelf-edge delta, to a submarine slope system. The findings have led to refined models to better explain and understand source-to-sink system dynamics from continental, to shelf, to basin-plain settings.

Oral presentation

What happens when lahars enter the ocean?

Clare, M.A.[1], Yeo, I.A.[1], Phillips, J.[2], Barclay, J.[2], Robertson, R.[3], Watt, S.[4], Hogg, A.[2], Wilkie, A.[5], Sheldrake, T.[6], Bailey, L.[7], West, M.[8]

[1]National Oceanography Centre, UK; m.clare@noc.ac.uk

[2]School of Earth Sciences, University of Bristol, Bristol, UK

[3]The University of West Indies Seismic Research Centre, Trinidad and Tobago

[4]Birmingham University

[5]Digicel, St Lucia

[6]University of Geneva

[7]University of Calgary, Canada

[8]OceanIQ, UK

Lahars are concentrated and fast-moving flows of volcanic sediment mixed with water. These are among the deadliest volcanic hazards and represent some of the largest volume sediment flows of any type on our planet. Their extreme runouts (up to 100 kms), and the often-close proximity of volcanic centres to coastlines, mean that lahars regularly reach the ocean, both coincident with and for months to years after explosive eruptions, often surpassing the 99th percentile of historic sediment yields for catchments. While many studies have characterised the behaviour and impacts of lahars on land, we lack a fundamental understanding (beyond a single conceptual model that does not match observations) of what happens when lahars reach the coastal zone and travel into the deep ocean, due to an absence of offshore observations. Here, we present new observations to address this gap that challenges the existing model for their offshore delivery and transformation. We report the impacts of lahars that entered the ocean during and following the 2020/21 eruption of La Soufriere, St Vincent. Satellite imagery reveals that lahars frequently and concurrently entered the ocean along multiple catchments forming buoyant surface plumes. The nature of offshore sediment delivery is often staged in time, as revealed by eyewitness accounts, wherein progradational deltas develop at river outflows (rather than connecting immediately offshore), and subsequently collapse into the ocean. Seafloor video from 600 m water depth reveals evidence of sediment flows that carried boulders and fresh vegetation tens of kilometres offshore, damaging and burying more than 50 km length of subsea telecommunications cables. Drawing on observations from St Vincent and for other historical ocean-entering lahars, we propose a new process-based model for ocean-entering lahars and discuss the implications for critical offshore infrastructure, fisheries and ocean ecosystems, and fluxes of volcanic ash that play an important role in biogeochemical cycling.

Oral presentation

Dry me a river: fluvial sedimentation, plant fossils and bioturbation through Permian aridification

[1]James A. Craig, [1]Neil S. Davies, [1]William J. McMahon

[1]Department of Earth Sciences, University of Cambridge

Pennsylvanian and Early Permian strata from Euramerica record a shift from lycopsid-dominated tropical 'coal swamps' to conifer-dominated dryland environments. One record of this interval is the Prince Edward Island (PEI) Group of Canada, a fluvial red-bed succession deposited in a semi-arid fluvial system during the latest Carboniferous to early Permian. In this talk, we describe sedimentary facies and plant and trace fossils from the PEI Group and outline their stratigraphic distribution. In the lower portion of the PEI Group, plant fossils are common but bioturbation is relatively sparse. Standing trees from in-channel and floodplain deposits are interpreted as walchian conifers that expand the sparse late Palaeozoic records of *in situ* coniferopsids. Fallen tree fossils up to 28 metres in length are found in association with charcoal deposits. The plant fossil record is complemented by vegetation-induced sedimentary structures, which provide evidence of plants mediating sedimentation and erosion. In younger strata, plant fossils are scarce, but bioturbation becomes more abundant. This trend may reflect evolutionary responses to continuing aridification through the Early Permian, as vegetation became sparser and animals increasingly used burrowing to adapt to new dryland niches. Alternatively, the trends could reflect changing extents of sedimentary stasis recorded in the succession, as aridification reduced flood recurrence. Lower in the succession, rapid burial of substrates may have protected plant material from decay and not allowed time for bioturbation, while in younger strata, greater time between depositional events may have favoured the inverse.

Oral presentation

Grainflow geometry variation as a function of climate

Chester H.C. Davies[1], Victor J.P. Hême de Lacotte[1], Stuart M. Clarke[1]

[1] Basin Dynamics Research Group, Keele University, Keele, United Kingdom

Ancient aeolian systems make great reservoirs due to their size and homogeneity, but the current characterization of reservoirs is equipped for hydrocarbon extraction rather than CO_2 injection and storage. The viscosity differences of hydrocarbons and supercritical CO_2 will result in different fluid-reservoir interactions with internal reservoir surfaces, and probably impact upon the rate of fluid migration, flow pathways, and sweep efficiency. Multiphase, two-dimensional simulations suggest that aeolian dune foreset characteristics are significant enough to do this. Aeolian dune foresets are generated through avalanche grainflow events, and suspended load deposition. Two different, water-table associated, 'primary' grainflow morphologies are recognised: 'hourglass' and 'slab'. The preserved architectures of these two distinct grainflow morphologies will have different characteristics and will result in variations of fluid flow characteristics. Ultimately proper characterization of internal reservoir fabrics (both in terms of thickness, size, and spacing) is required for efficient CO_2 injection and long-term storage.

This study uses preserved grainflow thickness to describe the role of water table in the formation of high-resolution bounding surfaces that act as internal reservoir fabrics in aeolian reservoirs. Grainflows are measured at the inflexion point, and midway between the inflexion point and termination of the dune toeset from foresets from Permian and Jurassic outcrops in Utah (Western United States) to reconstruct original dune heights. This work focuses on the role of relative water table on 1) preserved grainflow geometry, 2) inherent reconstructed average and minimum slipface height, 3) the formation of the two 'primary' grainflow morphologies, and 4) the preservation ratio of aeolian dunes.

Wet systems generally have a higher percentage of granular material reaching the toeset region, which could result in lower vertical CO_2 diffusion rates, whereas the thicker grainflow asymptote thickness in dry systems could result in lower horizontal CO_2 diffusion rates. This work emphasises the need to properly characterize reservoirs due to the effect of water table during deposition on grainflow morphology, preservation thickness, and subsequent impact on reservoir quality.

Oral presentation

Vertical and longitudinal facies changes in hybrid event beds in confined basins: examples from the Peïra Cava Outlier, Gres d'Annot, SE France

Meg Davies[1], Adam McArthur[1], Lawrence Amy[2], Marco Patacci[3], Mattia Marini[4], David Hodgson[1]

[1]University of Leeds, UK

[2]University College Dublin, Ireland

[3]Università degli Studi dell'Aquila, Italy

[4]Università degli Studi di Milano, Italy

Hybrid event beds (HEBs) are argillaceous deposits that preserve sediment gravity flow transformation from turbulent to laminar conditions. HEBs are known to develop due to changes in internal (e.g. sediment composition and concentration) and external (e.g. flow interaction with confining topography) factors and can compromise reservoir quality. Therefore, understanding their spatio-stratigraphic distribution and petrophysical properties are important when evaluating bed heterogeneity in the subsurface.

Here, we present bed-scale correlations from a 60 m thick stratigraphic interval from the Peira Cava Outlier (Gres d'Annot, SE France), which represents the preserved sandstone-rich fill of a confined and contained basin. The sheet-like architecture of the basin fill permits the investigation of longitudinal facies changes from proximal to distal zones of the basin and with varying proximity to the confining basin margins. Logs were collected at ten localities along the basin fill, totalling 640 m, and a correlation panel longitudinal to palaeoflow was constructed across ~9km, allowing the downstream variability of HEBs and related facies to be constrained.

HEBs are distributed throughout the stratigraphic interval and from proximal to distal and three typical facies tracts have been identified. Facies tract 1 can contain cross bedded facies in vertical succession and longitudinal correlation to a clast supported unit with a muddy matrix, which has been interpreted as the basal sandstone and debritic facies of a hybrid event bed, respectively. Facies tract 2 can contain cross bedded facies that longitudinally gives rise to a clast-rich HEB. Facies tract 3 has delaminated stratigraphy that transitions to a clast-rich HEB before transitioning into a conventional high density turbidity current deposit.

The close assessment of the vertical and longitudinal characteristics of HEBs in Peïra Cava provide insights into the distribution of HEBs in confined basins and their related sediment gravity flow dynamics, contributing to the discussion of flow segregation models and the development of HEBs. These insights will aid the prediction of sub-seismic scale properties of subsurface reservoirs (e.g. porosity and permeability) and in confined basins with hybrid event beds.

Oral presentation

Upscaling of discrete analyses through integration with multi-sensor core scan data: A case study from the Ness Fm, Osprey Field, North Sea

J. F. Emmings[1]

[1]*Geotek Ltd, 4 Sopwith Way, Daventry NN11 8PB*

The success of subsurface drilling operations in sedimentary basins – including hydrocarbon extraction, geothermal energy and carbon capture and storage - depends in part on our ability to upscale discrete bulk rock analyses, such as porosity and permeability measurements, to the decametre, reservoir scale. Here, we acquired high resolution 1-cm scale multi-sensor core logger (MSCL-S) data through legacy cored intervals primarily within the Ness Fm, Brent Group, in Well 211-23-8Z(8S1) located within the Osprey Field, UK Continental Shelf. The core scan dataset includes natural gamma ray, magnetic susceptibility, P-wave and S-wave velocity, resistivity, major and minor element geochemistry (XRF) and hyperspectral imaging. The same stratigraphic interval was also sampled for conventional/routine core analyses (CCA/RCA) for porosity and horizontal and vertical permeability. Thus, our objective is to explore methods for upscaling of porosity and permeability to the reservoir scale through integration with multi-sensor core scan data. We will explore signal processing, clustering and empirical modelling techniques, including machine learning, for the purpose of prediction of porosity and permeability properties beyond discrete analyses. Finally, we compared the core scan and well log gamma ray curves to apply depth corrections and thus correlate between the core and well log data. Robust correlation between core and well logs is critical to the success of many subsurface operations. From here, for example, we could explore further upscaling to the well log scale using this integrated dataset.

Oral presentation

Provenance and paleodrainage evolution of the Northern Calabria forearc, southern Italy

Sarah Feil[1], Hilmar von Eynatten[1], David Chew[2], Jan Schönig[1], István Dunkl[1], Luca Caracciolo[3], Francesco Muto[4]

[1] Georg-August-Unversität Göttingen, Göttingen, Lower Saxony, Germany D-37077

[2] Trinity College Dublin, College Green, Dublin 2, Ireland D02 PN40

[3] FAU Erlangen-Nürnberg, Erlangen, Bavaria, Germany D-91054

[4] Università della Calabria, Rende, Cosenza, Italy I-87036

Northern Calabria, located at the southern end of the Italian Peninsula, is geologically complex due to its position at the convergence of the Eurasian and African plates. It has experienced significant deformation with thrusting, folding, and extensive faulting related to the closure of the Tethys Ocean, and subsequent collisional and extensional tectonics. In terms of tectonostratigraphy, the Apennine carbonate platform is the structurally lowest unit, overlain by the Liguride oceanic complex, and then the Calabride complex, which also encompasses the Sila nappe stack. This basement block, referred to as the Sila Massif, is a distinct topographic high made up of an allochthonous segment of Variscan crust (Calabride complex). Thrusting during the Alpine orogeny led to a series of extensive nappe stacking over the Apennine platform. Further structural reorganization and exhumation of these nappe stacks took place during the Oligocene to Miocene, reflecting continued tectonic activity. Along the eastern side of northern Calabria, fore-arc basins formed in response to the retreating subduction zone that are termed from north to south: Rossano, Ciro, Crotone, and Catanzaro sub-basins. These basins preserve records of thrusting, uplift, extension, and sedimentation associated with the evolution of the Calabrian arc. Analysing the stratigraphic record of these basins in terms of provenance shifts and changing drainage patters, will aid in further characterising the main exhumation phase of the northern Calabrian Massif, including the Sila Massif and the Coastal Chain (Catena Costiera).

A multi-proxy provenance study was designed combining heavy mineral analysis (via semi-automated Raman spectroscopy), garnet chemistry (via electron microprobe), and apatite trace element analysis and U-Pb geochronology (both via LA-ICP-MS). A collection of siliciclastic samples spanning ~15 Ma from Aquitanian to Messinian from the four pre-mentioned sub-basins were selected for measurement. The results present a wide range of both high grade to low grade metamorphics and granitoids, with strong contrasts present through time and space. A high contribution of high-pressure metamorphic phases like lawsonite, glaucophane, and kyanite was identified in samples from the Rossano basin. Paired with the presence of garnets from greenschist/blueschist-facies rocks and apatite derived from mafic I-type granitoids, sourcing is likely from (north)western regions of northern Calabria (e.g. Catena Costiera). Presence of andalusite in the Serravallian/ Tortonian samples of the Ciro and Crotone basins points to sourcing directly from the Sila Massif plutonic rocks and/or its high-temperature metamorphic rims. Furthermore, large proportions of Ca-rich garnets in Crotone, and the oldest sample from Ciro, suggest metasomatic host-rocks also reflect this sourcing pattern. Apatite geochronology from Crotone shows one singular significant peak around 300 Ma, referring to the Variscan orogeny and further underlining a significant input from Sila granitoid rocks. Additional exploration will continue to foster our understanding about timing and mechanisms of Calabrian arc exhumation and changing sediment sourcing patterns.

Oral presentation

Evolution of syn-kinematic failure observed throughout the fill of a salt-influenced mini basin

Jewel Lee Foon[1], Professor Stephen Flint[1], Ian Kane[1], David Hodgson[2], John Howell[3], Aurelia Privat[2]

[1]University of Manchester, Manchester, United Kingdom.

[2] University of Leeds, Leeds, United Kingdom.

[3] University of Aberdeen, Aberdeen, United Kingdom

Knowledge of halokinetically induced failure and its impact on adjacent sedimentary packages is largely limited to deformation zones several hundred meters from the diapir's margin. During increased diapir activity, material on the diapir's roof is weakened and strata initially deposited on its flanks become over-steepened and collapse. This collapse can generate a range of gravity flows, with variable rheology, which travel downslope towards the basin depocenter; collectively these are termed 'mass-transport deposits' (MTDs). During the later stages of the mini basin's sedimentary fill, there is an observed decrease in the frequency of MTDs especially within its depocenter further away from the passively growing diapir. The absence of these deposits has been used as an indicator of limited halokinetic influence. Though useful for the seismic-scale understanding of structural trapping, sedimentary compartmentalization, and pinch-out geometries in salt-influenced deep marine environments, this model adopts a binary or static approach to understanding the salt sediment interaction. Instead, basins confined by passively growing salt structures should be viewed as highly dynamic depocenters throughout their sedimentary fill. The evolution of passive salt structures will gradually alter the basin's deformation patterns and its overarching subsidence regime. Therefore, the style and presence of MTDs identified within salt mini basins should be considered as a product of a continuum of halokinetic deformation, instead of an end member.

Confined by the Bakio and Bermeo Diapir, the Cretaceous-aged Burgoa depocenter within the North Biscay Anticlinorium of the Basque Cantabrian Basin, Spain offers a unique opportunity to identify how halokinetically induced failures evolve throughout the basin fill. The basin's depocenter is approximately 5.5 km east of the Bakio Diapir and is marked by deposition of The Upper Albian – Middle Cenomanian, Upper Black Flysch Group (UBFG). This unit comprises coarse-grained sandstones deposited as part of a deep-marine fan system. Our study reveals, within the UBFG, an area initially deemed to have undergone minimal halokinetic influence during its sedimentation, shows indicators for halokinetically influenced deformation. Syn-sedimentary subsidence related to the passive upwelling of the Bakio Diapir formed zones of weakness and triggered instabilities along the submarine slope. Continued failure led to NNW-SSE striking, meter-scale scarps on the palaeo-seafloor, parallel to the strike of Bakio Diapir. These scarps acted as topographical defects that interacted with overriding sediment gravity flows, altering flow processes and the local architecture of their deposits. These zones of weakness were further exploited during later regional tectonic deformation episodes, disrupting the stratigraphic organisation of the UBFG.

These minor scarps are below the scale of seismic resolution and would largely go undetected in the subsurface. It is important to understand their impacts on fluid flow and identification in core. This study highlights the need to consider a continuum of halokinetic deformation as a function of distance from the salt diapir.

Keynote presentation

The Corinth Rift: Syn-rift sedimentary insights into the interactions between normal fault growth, sea-level and climate

Rob Gawthorpe[1], IODP Expedition 381 Science Party and DeepRift Project Participants

[1]Department of Earth Science, University of Bergen, Bergen, Norway

The Corinth Rift is one of the fastest extending areas on Earth and research on the rift over the last ca. 50 years has led to significant developments in our understanding of rift tectonics, tectonic geomorphology and the interactions between tectonics and sedimentation. The rift is also an enclosed basin, with a largely intact rift hinterland drainage network that enables analysis of source-to-sink relationships within rifts. International Ocean Discovery Program Expedition 381 in 2017 drill three sites in the Gulf of Corinth that stimulated a new phase of research on the Corinth Rift focusing on the Gulf of Corinth and the sedimentary, palaeoenvironment and tectonic evolution of the rift, particularly over the last ca. 1 Myr. Research projects stimulated by IODP Expedition 318, such as the DeepRift project, have acquired new high-resolution 2D seismic data that is tied to the IODP boreholes, as well as ultra high-resolution AUV bathymetry and shallow sub-bottom profiles of the modern Gulf of Corinth depositional systems. As a result of these project, the Gulf of Corinth, and the Corinth Rift in general, is arguably one of the most data-rich rift basin on Earth.

In this presentation, I summarise some of the recent research using these data, focusing on:

i) The sedimentology deep-water syn-rift deposits.
ii) Factors controlling variations in sediment flux and syn-rift stratigraphic evolution.
iii) Characteristics of the modern deep-water canyon-channel systems revealed by AUV datasets.

At least 60-80% of the basin floor succession is deposited from fine-grained sediment gravity flows, as opposed to hemipelagic deposition. The majority of the sediment gravity flow deposits reaching the basin floor are mud-dominated and <2 cm thick. Such a result is perhaps not surprising in a relatively small, enclosed rift basin with limited sediment storage along the sediment routing system. However, distinguishing the triggering mechanisms responsible for the sediment gravity flows from their deposits is equivocal. Stratigraphic variations in sediment accumulation rates and turbidite activity are strongly correlated with climatic variations at orbital periodicities, but longer-term trends in sediment accumulation reflect changes in the evolution of the normal fault network, particularly the establishment of a major rift border fault system. The overall stratigraphy of the Gulf of Corinth is controlled by the interaction of global sea-level with structural sills or sedimentary barriers at the ends of the rift, or external to the rift. This interaction controls the influx of marine waters from the global ocean, which in turn drives basin-wide alternations of marine (interglacial) and lacustrine (glacial) conditions in the gulf.

Oral presentation

Quantitative analysis of kinematic properties of fault zones, Jiyang Depression, NE China

Qiwei Gou [a, b, c], Shuping Chen [a, b], Adam D. McArthur [c], Nigel P. Mountney [c]

[a] *State Key Laboratory of Petroleum Resources and Engineering, China University of Petroleum (Beijing), Beijing 102249, China*

[b] *College of Geosciences, China University of Petroleum (Beijing), Beijing 102249, China*

[c] *School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK*

The strike-slip displacement is essential to identify the kinematic property of a fault. However, it is difficult to calculate the strike-slip displacement of subsurface faults in basins (Mouslopoulou et al., 2007; Waldron et al., 2015; Lu et al., 2018; Yu et al., 2020). Some indirect calculation methods were developed to get the strike-slip displacements of master faults based on their relating secondary structures and their cutting dip beds. Two methods were applied in Jiyang Depression of Bohai Bay basin to achieve the identification of faults kinematics.

The study utilized 3D seismic data with well control, well logging data and structure contour maps, to describe the kinematic properties and structural development process of the fault zone in Jiyang Depression. For a master fault with branch faults limited by the master fault plane, combining on Riedel shear model and the right-lateral strike-slip strain ellipse model (Riedel, 1929; Harding, 1974; Dooley and Schreurs, 2012), quantitative determination of the kinematic property can be achieved by calculating the lateral angles of these faults through the geometric relationships between master faults and branch faults with detailed data of fault displacement components. Alternatively, if it is not possible to calculate displacement components via piercing points, stereographic projection analysis can alternatively be used for this purpose, if the strike and dip angle of each fault is known.

The lateral angles of the oblique-slip fault in Jiyang Depression, Bohai Bay Basin were calculated. Through the analysis of quantitative calculation results, the evolution of fault zones of the Jiyang Depression during the E_2s_3 period (about 42.0 - 38.0 Ma) have obvious sub-characteristics. The eastern part of the depression is an extension-strike-slip area influenced by the strike-slip motion of Tan-Lu fault zone. The middle part is the overlapped area between Tan-Lu fault zone and Lan-Liao fault zone, which is dominated by extensional action. The western part is the extension-strike-slip development area near the Lan-Liao fault zone. Additionally, the strike-slip movements occurred mainly in the depositional time of the E_2s_3 formation in the late Eocene. Most key fault zones rejuvenating from the pre-existing Oligocene - early Eocene normal faults displayed either strike-slip or oblique slip according to their strike directions. A few strike-slip faults were formed during this time. The strike-slip movements of the faults indicated a regional dextral wrench. This dextral wrench was related to the rejuvenation of the NNE Tan-Lu fault zone under a plate tectonic setting of the Pacific plate subducting toward the NWW direction and the Indian plate collision with the Eurasian plate in the NNE direction.

Moreover, these methods can also be used in the kinematic properties and the occurring time analysis of other fault zones where branch faults intersect a master fault.

Oral presentation

Depositional environments and sequence stratigraphy of a tide-dominated basin – Insights from the Kalahari Copperbelt, NW Botswana

Harlet, D.C.S.[1,2]*, Jones, S.M.*[1,2] *and Torremans, K.*[1,2]

[1] *School of Earth Sciences, University College Dublin, Belfield, Dublin 4, Ireland,deborah.harlet@ucd.ie*

[2] *Science Foundation Ireland Research Centre in Applied Geosciences (iCRAG), UniversityCollege Dublin, Dublin 4, Ireland*

The Kalahari Copperbelt (KCB) consists of Meso- to Neoproterozoic deposits where the basinwas formed during the Rodinia assembly at ca. 1.1 Ga. The basin was inverted during the Pan-African Damara Orogeny, ca. 550 Ma. Rhyolitic volcanics (Kwebe Formation) are overlainby ca. 5.5 km of siliciclastic to mixed carbonate paralic sediments forming the Ghanzi Group.This group is subdivided into the Kuke, Ngwako Pan, D'Kar and Mamuno formations. Here, focus is put on the Ghanzi-Chobe region, in the northwest of Botswana, where the upper partof the Ngwako Pan and lower part of the D'Kar formations are studied in detailed. The stratigraphic architecture and detailed sedimentology of the basin are poorly constrained in the region. Fifteen boreholes, up to ca. 800 m depth, were logged along two 150-200 km-long transects. Where available, outcrop mapping, magnetic susceptibility, and geochemical data were integrated. Identified facies associations and stacking patterns enabled the interpretation of depositional environments and the recognition of transgressive-regressive cycles. A preliminary sequence stratigraphic interpretation and correlative stratigraphic framework are proposed for the study area.

Five major facies associations were recognized from the Lower D'Kar Formation: (i) shales tosiltstones with rhythmites, (ii) alternation of thinly bedded sandstones and siltstones with current climbing ripple marks, (iii) fine-grained massive sandstones bearing subhorizontal to low-angle laminations, to massive in aspect (iv) fine- to coarse-grained sandstones bearing cross- to trough-cross bidirectional laminations, (v) evaporitic-bearing units and algal mats. Carbonated units are common. These facies associations depict the subtidal and intertidal zones of a tidal-dominated setting. Evidence of subaerial exposure (i.e. supratidal facies associations) is uncommon.

Two stacking patterns are recognized. The first and basal pattern in the D'Kar Formation is a transgressive to regressive cycle. From bottom to top, the transgressive cycle is composed oftidal flat deposits with evaporites, algal mats, shales to siltstones, overlain by heterolithic bedding, which deepens upward to tidal sand bars and subaqueous dunes. This is overlain bythe opposite regressive pattern. The second pattern is strictly regressive, where the base is sharp and erosive overlying siltstones. Both cycle types between ca. 50 and 200 m thick, withat least 4 to 5 cycles recognized in the Lower D'Kar Formation.

The Lower D'Kar is composed uniquely of sediments deposited in the tidal range over thick transgressive to regressive parasequences. Slow and steady subsidence where sediment supply would keep up with the generation of accommodation space modulated by relative sealevel change is hypothesized. Basin rifting and growth faulting probably ceased prior to the deposition of the Lower D'Kar Formation, and possibly before the underlying Ngwako Pan Formation deposition. The lateral continuity of facies associations and the consistent thicknessof the cycles could demonstrate the thermal sag phase of the basin with slow but steady subsidence.

Oral presentation

Climate-driven eustatic controls on fluvial system development in the Triassic hothouse world of central Pangea

Adrian Hartley, Doug Watson, Shaan Heydenrych & John Howell

University of Aberdeen

Definitive recognition and identification of global climatic signals in the continental geological record are often difficult to determine due to the interaction of tectonic and base-level changes as well as autocyclic processes. Recognition of such a global climate signal requires correspondence between a global indicator of climate change such as CO_2 or sea surface temperatures and identification of a corresponding signature in the continental sedimentary rock record. Whilst climate curves derived from palaeontological studies are an accurate record of change in specific regions and basins, however as the same climate event may have different responses at different latitudes (e.g. increased aridity or increased precipitation) these local climate curves will not be an accurate reflection of global climate change and distinction between specific climatic effects such as local orographic effects from global climate changes may not be possible.

During periods where ice is absent from the poles for example during hothouse, greenhouse times long-term, large scale climate signals cannot be driven by glacio-eustasy and an alternative driving mechanism must be found. During hothouse climates, it has been suggested that aquifer-eustasy is a dominant control on global sea-level and climate. However, despite large periods of Earth's history being effectively ice free and therefore not dominated by glacio-eustasy there are very few examples particularly in the continental realm where categoric responses of alluvial systems to aquifer-driven eustasy can be documented. Key criteria that would aid recognition of aquifer-eustasy are a correlation between sea-level rise and an increasingly arid climate and a decrease in sea-level and increase in humidity - inverse to what would be expected for a glacio-eustatic signal.

Here we analyse the Triassic stratigraphic succession in the northern arid belt of Pangea (Central North Sea) and clearly illustrate that the stratigraphic signature corresponds closely to Tethyan sea surface temperatures and hence to global climate events. We also documented a consistent correlation between sea-level fall and increased humidity and sea-level rise and increased aridity which we attribute to aquifer driven eustasy related to global climate change, which in turn can be related to volcanic activity associated with Large Igneous Provinces.

Oral presentation

Mechanisms of mouth bar growth and progradation in deltas building into "deep" water

Jack Heath†, Rhodri M. Jerrett*, Ian A. Kane*, Euan Soutter**

**School of Earth and Environmental Sciences, University of Manchester, Manchester, UK*
†Present address: British Geological Survey, Keyworth, Nottingham, UK (E-mail: jheath1@bgs.ac.uk)

Mouth bar morphodynamics control the loci of terrestrially-derived sediment fractions (including organic matter and pollutants), shoreline positions and coastal geomorphic change, and the stratigraphic architecture of whole delta systems. Existing studies show that, following a river avulsion, mouth bars form as lensoid or lunate-shaped bodies where the mouth of a river meets the receiving basin, initially aggrading and then expanding laterally and basinward. Growth of a mouth bar ultimately leads to decreasing flow efficiency at the river mouth as flow bifurcates around or shallows over the obstacle, triggering back-water sedimentation, superelevation and avulsion of the feeding distributary, with the mouth bar eventually becoming abandoned. Most models for mouth bar growth are based on deltas building out into relatively shallow-water "friction-dominated" settings (<10 m water depth). Here, we present architectural data from a well-exposed deltaic succession, the "Kinder Scout Delta" (Hebden Formation, Upper Carboniferous), of the Pennine Basin. The exposed succession is characterised by a c. 2 km long cliff on the northern side of the Kinder Plateau displaying, broadly, a set of SW-dipping delta-front mouth bar clinoforms 40-50 m in height and with a characteristic maximum inclination of 25-30 ^{o} at the foreset. The former sets a minimum height for water depths into which the delta was prograding. Architectural and sedimentological data show that the delta front mouth bars were dominated by bedload sedimentation of gravelly sand in the 1/3 of the mouth bar closest to the river mouth (in water depths of up to c. 15 m), and by rapid settling of a coarse sandy or gravelly suspended load, and grainflow either by avalanching or debris flows, in the most distal 2/3 (depth >15 m). Rapid progradation into water depth >50 m led to mouth bar lee faces exceeding their angle-of-repose, prompting, on at least four occasions, major mass-failure of the exposed mouth bar up to its crest. In each case, the generation of a failure scarp on the lateral or frontal margin of the mouth bar resulted in distributary avulsion and the incision of a distributary channel at the site of the mass failure within which mouth bars subsequently accreted. In this manner, the site of mass failure become the new loci of mouth bar growth at the delta front. We propose that this is an intrinsic mechanism of mouth bar growth and progradation in deltas building into "deep" water.

Oral presentation

In Defence of Parasequences – Quantification of parameters from the Book Cliffs of Eastern Utah

John Howell
School of Geosciences, University of Aberdeen, AB24 3UE
John.howell@abdn.ac.uk

Since the 1980's parasequences have been considered as the fundamental building blocks of sequences. In recent years, several publications (Catuneanu & Zecchin, 2020; Colombera & Mountney, 2020) have questioned their significance, even suggesting that the concept should be dropped. Key issues include: 1) the misbelief that all sequence stratigraphic components are "scale independent" and, 2) the misinterpretation of what is meant by the term flooding surface.

A parasequence is a unique phase of shoreline regression and subsequent progradation. Within a shoreline the deposits are controlled by series of processes such as depth to various wave bases, tidal scour etc. These fundamental controls vary between basins and even between specific parts of the shoreline but they are not scale independent.

A flooding surface is generated by an allocyclic rise in "relative sea-level". As such it must be associated with landward dislocation of the shoreline on a scale that is greater than a single feeder system. While superficial similar surfaces, at least in vertical section, are generated by autocyclic processes, such as lobe switching, these produce bedsets (ECSs of Ainsworth et al., 2018) not parasequences. Much of the ambiguity around the applicability of the parasequence concept has arisen from the historical misinterpretation at this scale.

A revaluation of the Cretaceous Blackhawk Fm in the Book Cliffs of Eastern Utah using over 170 logs and 70 km of virtual outcrop data has mapped out of 31 progradational events which have an average progradational extent of 10.7 km. The progradational length is strongly controlled by the landward offset at flooding (ave 7.0 km) and parasequences typically only prograde an average of 3.4 km beyond the shoreface break of the underlying parasequence. The number of bedsets is strongly controlled by the depositional process with wave dominated systems having less than their fluvial or tidally influenced counterparts. The average sea-level rise associated with a parsequence boundary is 11.1 m and the average calculated depths to wave base are 20.5 m (FFWB) and 50.7 m (SWB). Typical shoreline trajectories are 0.08 degrees.

While the parasequence may not be ideologically perfect, it is a useful and practical concept which is supported by field observation. If correctly applied the principals are applicable to understanding and predicting facies distributions and as a basis for correlation and modelling subsurface data.

Oral presentation

Genesis of carbonate honeycomb buildups

Thomas Houghton[1], Joyce Neilson[1], John Underhill[1], Rachel Brackenridge[1]

[1]Centre of Energy Transition, University of Aberdeen, Aberdeen, United Kingdom

Seismic interpretation has revealed a hitherto unreported honeycomb pattern of carbonate buildups within the Orchard Platform (Southern North Sea). The Z2 Stassfurt Halite Fm. onlaps the southern margin of the Orchard Platform and is also found infilling Z2 intra-platform lagoons to form salt lakes. Post Z2 evaporation, the deeper Z3 water column drowned the Orchard Platform inhibiting the platform recovery attempted by the Z3 Plattendolomit Fm. The palaeobathymetric variability of the drowned Orchard Platform was sufficient to bring parts of the seafloor into the photic zone allowing for the sporadic growth of the Z3 Plattendolomit Fm. However, the palaeobathymetric lows remained beneath the photic zone ensuring an incomplete regeneration of the Orchard Platform with the creation of a high-frequency network of intra-platform lagoons which mimic the polygonal texture of a honeycomb. Whilst previously accepted as collapse structures or karst systems, this study correlates the development of the honeycomb buildups to variations in seafloor palaeobathymetry which in turn mimic the structural lineaments of the Zechstein subcrop. Syn-depositional instability in the Zechstein subcrop caused the topsets of the Z2 salt lakes to become warped. The warped halite provided seed points for Z3 Plattendolomit Fm. growth which allowed for linear ridges of carbonate to traverse the Z2 salt lakes and eventually connect with the honeycomb buildups. Deposition in the Mesozoic lead to loading of the Zechstein. Halite-filled Z3 lagoons accommodated this loading, which caused a pinching effect on the Z3 honeycomb buildups. The sedimentological understanding provided by this study not only de-risks frontier exploration but also provides insight into carbonate growth in restricted platform recovery scenarios.

Oral presentation

Reworking and deeper sea transfer of sediment deposits in the Cassidaigne submarine canyon by upwelling events

R. Silva Jacinto and B. Dennielou

Geo-Ocean, Ifremer Centre de Bretagne, France

Submarine canyons are common morphological features incising continental slopes. They may start from shallow waters (*i.e.* submitted to wave action), littoral settings (*i.e.* submitted to rivers plumes) or even estuaries (*i.e.* exposed to turbidity maximum). They link continental platforms to the deep sea and are the major pathway for turbidity currents and hence sediment transport. These sediment-laden gravity flows are able to sculpt the continental margins, submarine canyons and eventually produce the large sediment accumulations in the deep-sea together with associated elements as organic carbon, oxygen, nutrients and pollutants.

The study of turbidity flows, much based on their deposits and sediment archives, have been neglecting the interaction with the highly dynamic ocean they are flowing through. The physical investigation of the way gravity-driven flows and oceanic circulation interact is an opening research field. Beside regional contour currents, canyons may locally trap energy and momentum: internal tides, quasi-inertial waves, denser water cascading and upwellings are canyon-specific flows that may modulate the sediment transfer to the deep sea.

Here, we are presenting monitoring data from the Cassidaigne submarine canyon (Gulf of Lions, French Mediterrannean) in order to identify how ocean flows may remobilise sediment previously brought by gravity-driven turbidity currents. The Cassidaigne canyon is used as a field-scale laboratory. From 1967 to 2015, exogenous residual red mud from the industrial treatment of bauxite ore was rejected in the canyon at 320 m of water depth. The estimated 35 mega-tonnes of red mud outflow generated an extended turbiditic system with characteristic deposits.

These red muds are now used as a proxy of how hydrodynamics in a submarine canyon, induced by regional ocean circulation, may eventually affect turbiditic systems and their deposits. Among others, results show that canyon internal energy is able to regenerate turbidity currents from previous deposits and preserve sediment transfer to the deep-sea with no active source.

Oral presentation

Submarine Canyons as pollutant pathways – an overview of interdisciplinary research areas for sedimentologists

Ian Kane[1], Bart van Dongen[1], Holly Shiels, Richard Kimber[1], Zesheng Xu[1], Ziqi Zhang[1] Mike Clare[3] [4]Mia Hughes

[1]Department of Earth and Environmental Sciences, The University of Manchester, Manchester, UK

[2] Division of Cardiovascular Sciences, University of Manchester, Manchester, UK

[3]OceanBioGeoscience, National Oceanography Centre, Southampton, UK

[4]School of Earth and Environmental Science, University of Leeds, LS29JT, UK

Humans produce a lot of waste material which is toxic and harmful to life, and a large proportion of that is not disposed of responsibly. Pathways for this waste material into and through the 'natural' environment are driven by wind, water and ocean currents. Our impact on the deep-sea is the least well-constrained of all environmental compartments, owing to its inaccessibility, but as submarine canyons are the most important conduit for moving sediment to the deep oceans we infer that they are also important for the transfer and (temporary) storage of anthropogenic pollutants. Knowing how these pollutants are distributed, and how that maps onto ecological niches, is critical to understanding the scale of environmental threat, with implications for ocean health and the blue economy. Marine pollutants include micro- and macro-scale solid waste, and solutes. Macro-waste, marine litter, has been documented in submarine canyons globally and may be derived from direct river input, shelf fed material, or maritime inputs (fishing, shipping, dumping). These larger objects have been documented in debris flow deposits, and arranged, or incorporated, into bars and bedforms created by turbidity currents according to their hydrodynamic properties. Micro-waste, such as microplastics and microfibers, may be generated by macro-waste breakdown, or fed directly from terrestrial sources, and has been shown to be transported by turbidity currents, and widely redistributed by bottom currents. Solutes, such as persistent organic pollutants, e.g. DDT, are often strongly hydrophobic and thus tend to sorb to sediment, and can therefore be carried in the same pathways as natural sediment and be distributed accordingly. We suggest that PFAS, highly toxic per- and polyfluoroalkyl substances which are incredibly widespread, and have affinities to certain mineral chemistries, will be distributed according to the hydrodynamic properties (shape, density, electrostatic charge) of the sediment with which they are associated. This overview is intended to highlight interdisciplinary challenges that sedimentologists can address in terms of environmental pollutant transport, distribution and fate, and how this information can be used in conjunction with mitigation efforts to address the growing environmental threat.

Oral presentation

Comparative statistical and deterministic reservoir modelling of fluvial deposits using virtual outcrops: a case study from the Yorkshire Coast, Northeast England

Iuliia Kapustina[1], Prof. John Howell[1], Dr. Kachalla Aliyuda[1], Dr. Jessica Pugsley[1]

[1]University of Aberdeen, SAFARI research group

The Yorkshire Coast of North-Eastern England presents a complex sequence of fluvial deposits that serve as valuable analogues for subsurface reservoir characterization of the Brent Group. This study explores the development of reservoir models based on virtual outcrops along the Yorkshire coast, focusing on the facies distribution, channel body dimensions, and their connectivity.

Two modelling approaches are applied to build reservoir models from virtual outcrops. The first is a deterministic approach, which replicates observed outcrop structures with spatially referenced grid, integrating field data, pseudo-wells, and surfaces extracted from the outcrop. Most reservoir models derived from virtual outcrops are built this way. The second is a statistical approach, which incorporates a coordinate-free three-dimensional grid populated with statistical data, object dimensions, and spatial trends. A comparative analysis of these models has been conducted to demonstrate that a statistical box reservoir model can effectively represent outcrops and capture the heterogeneity of complex fluvial systems, similar to a deterministic model.

This study aims to provide insights into how the fluvial deposits of the Yorkshire Coast can inform predictive models of similar subsurface reservoirs, thereby supporting more accurate forecasts of reservoir performance and aiding effective reservoir management strategies.

Oral presentation

Untangling microfibres: Pervasive plastic pollution in submarine canyons

Ed Keavney[1], Ian A. Kane[2], Michael A. Clare[3], David M. Hodgson[1], Veerle A.I. Huvenne[3], Esther J. Sumner[4], Jeff Peakall[1], Furu Mienis[5], and Jonathan Kranenburg[5]

[1] School of Earth and Environment, University of Leeds

[2] Department of Earth and Environmental Science, University of Manchester

[3] Ocean BioGeoscience, National Oceanography Centre

[4] School of Ocean and Earth Science, University of Southampton

[5] Department of Ocean Systems, Royal Netherlands Institute for Sea Research (NIOZ-Texel)

Submarine canyons are important conduits for microplastic transport to the deep sea via turbidity currents. However, other near-bed oceanographic flows and sub-seafloor processes may play an important role in the transport and burial of microplastics. This study uses sediment push-cores for microplastic and sediment grain-size analysis from two transects across the Whittard Canyon, UK, to show that complex process-interactions control the transport and burial of microplastics in the thalweg and on the canyon flanks. Microplastic pollution is pervasive across the canyon at both transects, from the thalweg and from 500 m higher on the flanks, despite hydrodynamic mooring data documenting turbidity currents being confined to the canyon thalweg. The calculated sediment accumulation rates from ^{210}Pb dating show that constant microplastic concentration with depth is irrespective of sediment age. This reveals that the huge global-increase in plastic production rates over time is not recorded, and that microplastics are present in sediments that pre-date the mass-production of plastic. The interaction of turbidity currents, deep-tidally-driven currents, and sub-seafloor processes shreds any potential signal that microplastics may provide as indicators of historical plastic production rates, which undermines the utility of microplastics as reliable markers of the onset of the Anthropocene.

Oral presentation

Lamination and Banding in Sand Injectites: A Cyclic Jamming Model

Sean Kelly & Matt Brettle

University of Aberdeen, UK

Sand injectites (dykes and sills) often display distinctive lamination and banding. These internal structures are key to understanding the dynamics of injectite emplacement. Lamination and banding typically occurs in mm-cm scale layers parallel or oblique to injectite margins, sometimes forming local sets or bundles. These layers exhibit varying grain alignment, packing density, and grain size segregation, often associated with later shear bands and fractures.

The Cyclic Jamming Model

Supported by observational evidence from outcrop and subsurface injectites, this conceptual model explains injectite lamination through the lens of discontinuous shear thickening (DST) and cyclic jamming of the dense injectite sand slurry.

Key Concepts:

- *Dense Granular Suspension:* Sand injectites behave as dense, non-Newtonian slurries with shear-thickening properties.
- *Confinement and Frustrated Dilatancy:* Surrounding host-strata restrict slurry expansion, elevating internal stress.
- *Force Chains:* Networks of contacting grains transmit stress, promoting grain alignment and efficient flow.
- *Discontinuous Shear Thickening (DST):* At a critical stress, viscosity increases sharply, leading to localized jamming.
- *Cyclic Jamming:* Repeated jamming and unjamming cycles generate alternating dense and less dense layers, forming the lamination.

Lamination Formation:

1. *Shear Thickening:* Increasing shear stress triggers DST and a rapid rise in viscosity.
2. *Jamming:* High viscosity, confinement, and frustrated dilatancy induce jamming, creating a dense layer stabilized by force chains.
3. *Stress Build-up:* Continued shear elevates stress within the jammed layers.
4. *Unjamming:* Stress overcomes the force chain network, leading to unjamming and a less dense layer.
5. *Cyclic Repetition:* This cycle repeats, producing the characteristic lamination.

Factors Influencing Laminae:

- *Shear rate:* Higher shear rates can result in thicker laminae.
- *Particle characteristics:* Particle size and concentration influence packing density and jamming.
- *Confinement pressure:* Higher pressure may favor thinner laminae due to restricted dilation.
- *DST cycle frequency:* Higher frequency: Thinner, more uniform laminae. Lower frequency: Thicker laminae with potential for grain size segregation.
- *Hydroclusters:* Dynamic particle aggregates contribute to shear thickening, influencing lamina thickness and grain size distribution.

This cyclic jamming model, integrating DST, force chains, and hydrocluster dynamics, offers a compelling explanation for lamination and microfabrics observed in sand injectites, emphasizing the dynamic interplay of shear-induced processes and transient jamming.

Oral presentation

A comparison of modern and Miocene earthworm granules: Towards criteria for recognising ancient earthworm products

Kerr, L. [1]*, Best, G.*[1]*, Hodson, M.* [2]*, Vinther, J.* [3]*, & Brasier, A.T.* [1]

[1]*School of Geosciences, University of Aberdeen, Aberdeen, Scotland, UK. AB24 3UE*

[2]*Department if Environment and Geography, University of York, Heslington, York, YO10 5NG*

[3]*School of Earth Science, University of Bristol, Wills Memorial Building, Clifton, Bristol, BS8 1RJ*

Here, we investigate the oldest known calcite earthworm granules which were deposited in the Wiesbaden formation of the Lower Miocene. We aim to identify key characteristics for identification and compare these to recent *lumbricus terrestris* granules produced under laboratory conditions. We hypothesis that these granules will demonstrate similar fundamental properties compared to modern-day calcite earthworm granules and will discuss potential diagenetic alteration which palaeo granules may have undergone. Here, we compared macromorphological traits through photomicroscopy and scanning electron microscopy (SEM), as well as micromorphological characteristics through cathodoluminescence (CL) and electron backscatter diffraction (EBSD) analysis. Initial observations suggest a high preservation of key internal characteristics such as a lack of internal crystal orientation and distinct internal crystal fabrics. However, the palaeo-granules did demonstrate a reprecipitated calcite rim which was not seen on the recent earthworm granules. This reprecipitation did not affect the macromorphology of the granules which appeared similar to the recent granules; demonstrating an oval-elliptic shape which range in size from 0.5-2.5mm. This work highlights the potential for earthworm granule preservation in the geological record and provides clear characterisation for discovery and identification in the rock record.

Oral presentation

Changes in C_{org} isotope signature in Palaeotethys area during the mid-Tournaisian anoxic event (Mississippian)

Jakub Kucharczyk[1], Michał Rakociński[1]

[1] *University of Silesia in Katowice, Faculty of Natural Sciences, Institute of Earth Sciences, Będzińska Str. 60, 41-200 Sosnowiec, Poland, e-mail: jakub.kucharczyk@us.edu.pl*

The detailed documentation of changes in C_{org} isotope signature was conducted based on material from two sections, Puech de la Suque (Montagne Noire, France) and Kronhofgraben (Carnic Alps, Austria). The investigated sections contain sediments correlated with the mid-Tournaisian anoxic event (also known as the Lower Alum Shale Event; LASE), and are developed in pelagic facies as black cherts and lydites in Austria, together with black and dark-grey radiolarian cherts in France. Generally, the Devonian-Mississippian time was characterized by elevated atmospheric CO_2 levels and high burial rates of organic matter in sediment. It was also a time of increased volcanic activity, significantly influencing climate changes and the development of anoxic conditions. The dynamic changes during this time led to numerous crises and global events manifested by distinct geochemical changes in the marine sedimentary record, primarily with short-term perturbations in the global carbon cycle. Positive carbon anomalies were often associated with oceanic water eutrophication, as emphasized by numerous studies. However some of recent studies provide new perspectives for decipher changes in $\delta^{13}C_{org}$ record. The influence of diagenesis on the carbon isotope signal seems to be much more limited than previously assumed, and several negative isotope anomalies have been reinterpreted as a primary signal associated with large-scale thermogenic degassing of light isotopically carbon – ^{12}C isotope, due to increased volcanic activity. Obtained from investigated sections, isotopic data reveals negative shifts in both profiles, up to -30.07‰ in Kronhofgraben, and -30.01‰ in Puech de la Suque. Additionally previous complex geochemical documentation of studied sections reveals enhanced volcanic activity at the time of Lower Alum Shale Event (e.g. anomalous Hg contents up to 3650 ppb in Carnic Alps, and >500 ppb in Montagne Noire). Negative $\delta^{13}C_{org}$ excursion in Kronhofgraben correspond closely with reported Hg anomalies. In contrast in the Puech de la Suque section values of $\delta^{13}C_{org}$ remain very low throughout the entire mid-Tournaisian cherts interval, which seems to confirm volcanically induced environmental changes during Middle Tournaisian, as well as volcanic impact on global carbon cycle at the time.

Oral presentation

Sequence Stratigraphic Architecture and Palaeogeography of a Mixed-Process, Siliciclastic-Carbonate Shoreline and Shelf (Tithonian strata, Weald Basin, southern UK and northern France)

Kuye, D. A[1] *and Hampson, G.J*[1]

[1] *Imperial College London*

d.kuye20@imperial.ac.uk

The Weald Basin, southern UK and northern France, is part of a chain of intracratonic basins which formed the Laurasian Seaway connecting the Tethys Ocean with the incipient Atlantic Ocean during the Jurassic. Tithonian strata, including the Kimmeridge Clay, Portland Sand Member and lower Purbeck Group, record the development of a mixed siliciclastic-carbonate shoreline and shelf along the northern basin margin, as the basin evolved from part of the Laurasian Seaway to an isolated, evaporate-bearing depocentre. These strata host several small hydrocarbon reservoirs, and have potential for CO_2 and H_2 storage. We use core, wireline-log and outcrop data to produce the first reconstruction of high-resolution (sub-seismic) sequence stratigraphic and palaeogeographic architecture of these Tithonian strata.

Core and outcrop data indicate that the Portland Sand Member largely comprises upward-shallowing facies successions (parasequences), consisting from base to top of: (1) offshore and offshore transition, (2) lower shoreface, (3) upper shoreface, and (4) carbonate tidal flat and lagoon. Six parasequences bounded by condensed mudstones and carbonate-rich bioclastic hardgrounds are correlated in core and wireline-log data, recording southward progradation of a W-E-oriented, wave-dominated shoreface that fronted a coeval carbonate-rich lagoon(s). Parasequence-bounding flooding surfaces can be tied to well-established ammonite biozones by correlation to basin-margin outcrops. NW-SE- to NE-SW-oriented fluvio-marine channels cut into the top of several parasequences and are interpreted to have supplied sand and granules to the shoreline. Channel locations differ between successive parasequences, implying that fluvially supplied sediment was sourced from multiple small catchments on the London Brabant Massif, to the north of the Weald Basin. Shoreface parasequences generally thin and pass seawards into offshore mudstones and condensed carbonates towards the south, but locally thicken in W-E-trending graben and half-graben depocentres bounded by normal faults. The upper two parasequences are truncated by a basinwide unconformity at the base of the Purbeck Group, with more pronounced erosion at the basin margins and locally on footwall highs. The origin of the unconformity is unclear, but erosion was modulated by tectonic subsidence.

The sequence stratigraphic and palaeogeographic interpretations summarised above provide a framework to predict the distribution of reservoir (sandstone) – seal (mudstone, marl or anhydrite) couplets within the Portland Sand play of the Weald Basin, with applications to CO_2 sequestration and hydrogen storage.

Oral presentation

Self-confinement by submarine debris flows: an example from offshore NW Australia

Yan Li, David Hodgson, Jeff Peakall

School of Earth and Environment, University of Leeds

Submarine landslides, especially debris flows, can entrain the substrate and bulk-up in volume considerably. However, the detailed process mechanics and the evolution of such flows are poorly understood. Our study uses 3-dimensional seismic reflection data from offshore northwest Australia to show that submarine debris flows can result in sequential basinward deposition of debrite lobes through self-confinement.

Multiple submarine landslides have been documented offshore NW Australia, and here we focus on a near seabed submarine landslide that is interpreted as a debris flow, and characterized by its elongated shape (60 km long and 10 km wide) and clear headwall evacuation zone. The ratio of deposited to initially evacuated sediment volume is up to 2.9, which suggests most of the landslide volume came from substrate entrainment during emplacement. The basal shear surface gradually cut downward and formed boundaries for debrite lobes. The existence of steep lateral margins shows that the submarine debris flows became self-confined and channelized, and eventually transformed to submarine lobes. Km-long and 100 m-wide grooves are formed on the basal shear surface, and are locally cut by other 100-meter-long grooves on the lateral margins. Their orientation, distribution and cross-cutting relationship indicate the progressive basinward stepping of debrite lobes, and deepening of the basal shear surface such that the oldest grooves are elevated ~60 m above the youngest grooves in the most proximal areas.

The evolving deposition topography provided by the stacking of debrite lobes progressively increases the confinement of the flow, and the entrainment of substrate allows the flow to lengthen farther into the basin. The grooves as spatially associated with megaclasts towards the fringes of debrite lobes, which are interpreted to be derived from the headwall and substrate entrainment during deepening and lengthening of the flow. The flow evolution and basinward propagation are also enhanced by the presence of diapirs with seabed expressions that further restrict the flow pathway to enhance self-confinement. It is important to understand how flows entrain the substrates to improve predictions of geohazard potential.

Oral presentation

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

Wiktor Marek Luzinski [1], Andrew Hurst [1] & Andrew Morton [1,2]*

[1]Sand Injectite Research Group, University of Aberdeen, UK

[2]HM Research Associates Ltd, Giddanmu, Musselwick Road, St Ishmaels SA62 3TJ, UK

[*]wiktor.luzinski@abdn.ac.uk

Sandstone intrusions represent both opportunities and risks in the subsurface. They can provide both vertical and lateral connectivity across sealing lithologies and increase storage capacity; however, they can compromise seal integrity and create complex migration pathways. Estimating the vertical extent of subsurface sand injection complexes including identification of main parent units which sources the intrusive sands is crucial for reservoir characterisation.

Sand injection diagnostics in the subsurface are often hampered by limitations of seismic detectability of small and steep features and reliance on accessibility of core or high-quality well-log data (image logs and Ultra-Deep Azimuthal Resistivity logs being most valuable). In cases where such data are unavailable, it is challenging to differentiate fully intrusive components (sandstone intrusions) from depositional sandstones remobilised *in-situ* (potential parent units).

This study presents how provenance analysis by way of conventional and varietal Heavy Mineral Analysis can be leveraged to differentiate sandstone intrusions from depositional sandstones remobilised *in-situ*. Our case study is the Gamma discovery (discovery well N24/9-3, South Viking Graben, Norwegian North Sea) which consists of a large intra-Balder sandstone body of enigmatic origin (henceforth referred to as Gamma Sst). While the seismic characteristics of the Gamma Sst indicate either high degree of *in-situ* sediment remobilisation or sand intrusion, the overall size and thickness of the sandstone body is much greater than what is reported from other injectites in the area (Frosk, Forkselar, Volund) or from outcrop studies.

In this study, we compare provenance signature of the Gamma Sst to those of known key depositional units in stratigraphic and geographic proximity (intra-Lista Heimdal Mbr, intra-Sele Hermod Mbr, intra-Balder Odin Mbr and Frigg Mbr). Overlap of heavy mineral indices and garnet compositions indicates possible correlation to Odin Mbr, Frigg Mbr and some examples of Hermod Mbr. However, correlation to either Hermod or Frigg Mbr is unlikely due to stratigraphic and spatial considerations. It follows that Gamma sandstone is best correlated to the Odin Mbr. As both Gamma sst and Odin Mbr occur within the Baler Formation, we can infer that Gamma sandstone occupies its original stratigraphic position and was remobilised *in-situ* or injected over very short distance.

Oral presentation

The May 2024 Porto Alegre extreme flooding event: case report and the importance of monitoring flow and sediments

Rafael Manica[1], Elírio E. Toldo Jr[2], José C. R. Nunes[2], Eduardo Puhl[1], Felipe Nievinski[2], Cristiano Fick[1], Fernando Scottá[2], Nilza Castro[1] & Tatiana Silva[2]: [1] Instituto de Pesquisas Hidráulicas - Universidade Federal do Rio Grande do Sul (manica@iph.ufrgs.br); [2] Instituto de Geociências- Universidade Federal do Rio Grande do Sul - Brasil

An extreme flooding event hit the Porto Alegre metropolitan area (historic record) and much of the state of Rio Grande do Sul, Brazil, in May 2024. It highlighted the critical importance of monitoring both flow and sediment transport, and reminder of the vulnerability of urban areas to extreme weather events. Personal experiences from those affected reveal the profound impact of the floods—homes submerged, livelihoods disrupted, and communities strained. The May 2024, Porto Alegre flooding exceeded the maximum water level reached in the previous worst event, of 4.76 m in 1941. This complex fluvial system, consisting of four rivers (Jacui, Cai, Sinos e Gravataí), flows into a delta that connects them and subsequently discharges into the Guaíba River, a water body measuring 40 km in length and 10 km in width. The Guaíba River, in turn, flows into the Patos Lagoon, the largest freshwater lagoons in the world, which spans over 320 km in length and 40 km in width, with its outlet to the sea at the port of Rio Grande city. Following an intense month of rainfall in April, 2024 within the watershed of these four rivers, five consecutive days of extreme rainfall (from 600 to 900 mm) occurred from April 26th to May 1st in their headwaters. In comparison, Porto Alegre's annual precipitation rate is around 1600 mm. The subsequent water runoff overcame the delta area. Consequently, the average water levels in the Guaíba River, typically 1.8 meters, surged to 5.37 meters by May 3rd, representing an increase of 2.37 meters above the city centre (3 m). The city's flood protection system, consisting of dikes, a floodwall and sluice gates, failed, affecting over 250,000 people. The impacts of the flooding lasted for more than 40 days, particularly in the central and northern zones of the city. After a flood warning was issued on May 1st, a strategy was developed to measure the historical flow rate in the Guaíba River during the peak of the event. An Acoustic Doppler Current Profiler (ADCP) was employed, and measurements indicated a flow of approximately 30 million liters per second, with velocity reaching around 4 m/s in certain locations (Toldo et al., 2024). In terms of sediment transport, we estimated that over 11,000 tonnes per day were transported during this event, compared with usually 2,000 tonnes per day (Toldo et al, 2024). In the proximal delta zone (northern Porto Alegre), more than 2 m of medium and coarse sand were recorded in the levee region of delta. This sedimentary material was subsequently transported to Patos Lagoon and discharged into the ocean. Monitoring of the fine sediment plume was conducted using satellite imagery, revealing that the flood wave reached the lagoon's outlet after 15 days. The impact of sediments on Patos Lagoon appeared to be minimal, predominantly consisting of fine sediments; however, field studies indicated significant effects in certain areas, particularly along the beaches on the west margin of the lagoon, where the combination of high water levels and waves (storm surges) have built up thick sandy washover deposits. (Secco da Silva, 2024). The data collected during the peak of the event served as inputs for numerical hydrodynamic models, enabling corrections to the flow rate data predicted by rainfall-runoff models. These flow and velocity data, along with level measurements, assisted government officials in decision-making and provided critical support and information to the affected population. Following the flooding, a wide array of research opportunities arose for further field studies and investigations. Nevertheless, the importance of in-situ measurements during extreme events must be appreciated and encouraged, even under adverse conditions. Effective monitoring during such crises is essential not only for immediate response but also for long-term planning and resilience building. Investing in such monitoring efforts is crucial, ensuring that communities are better prepared and can recover more swiftly when faced with nature's extremes.

Oral presentation

Seabed topography shaping architecture and reservoir traps in deep-water systems

Claudio Cesar S. Marques[1,2], Ian Kane[1], Mads Huuse[1], Stephen Flint[1], Daniel Ronald[1]

[1] *Department of Earth and Environmental Sciences, University of Manchester*

[2] *Exploration, Petrobras*

The effect of seabed topography on sediment distribution is well documented, yet the properties of the margins of sand-rich deposits are more difficult to characterise in the subsurface due to limited resolution of seismic data and lack of wells. This study investigates how seabed relief affects the evolution and architecture of deep-water channels, especially their pinch outs, which are critical for analysing stratigraphic traps and reservoirs. Using 3d-seismic and well logs from the offshore South American Equatorial Atlantic margin, we investigate the evolution of sinuous submarine channels within a 1500-meter-thick fan, characterized by compensational stacking and channel avulsions. This setting shows how inconspicuous seabed relief (such as gradient steps and buried basement ridges) can influence channel routes, avulsion, vertical stacking, and lateral distribution without significant tectonic deformation. We compare these findings with outcrop observations from the Barrême thrust-top basin in the Alpine belt, southeast France, where channels exhibit similar interactions with a more active topography at a bed scale. In the offshore setting, some channels follow structural trends, deflecting up to 90 degrees and developing straighter, vertically stacked segments with higher sandstone-to-shale ratios that contrast with typical sinuous patterns elsewhere. Slope variations and episodic instability add complexity to sediment dispersal and pinch-out configurations across the basin. Lower-density turbidites, capable of traveling over higher topography, tend to drape over steep slopes, while higher-density flows cause abrupt thinning when channels migrate closer to basin slopes. In both study areas, channel axis migration affects scour depth, bed amalgamation, and lateral thinning rates, resulting in distinct pinch-out characteristics and facies transition rates. These observations underscore how seabed relief (static or dynamically created through sediment stacking) modulates channel architecture and sediment distribution. Our findings provide insights for understanding sedimentary processes, basin palaeogeography, which may be applicable to reservoir modelling and trap analysis. This research highlights the importance of subtle topographic variations in predicting sediment distribution patterns in deepwater slope and basin-floor settings.

Oral presentation

Characterisation of deep-marine depositional environments for CO_2 storage; Banastón System, Hecho Group, South Spanish Pyrenees

Joshua Marsh[1], Ian Kane[1], Miquel Poyatos-Moré[2], Lin Ma[3], Kevin Taylor[1], Anna Pontén[4], Daniel Ronald[1]

[1]*Department of Earth and Environmental Sciences, University of Manchester*
[2]*Departament de Geologia, Universitat Autònoma de Barcelona*
[3]*Department of Chemical Engineering and Analytical Science, University of Manchester*
[4]*Equinor ASA, Research Center Rotvoll, NO-7005, Trondheim, Norway*

When selecting reservoirs for CO_2 storage, heterogeneity is a key criterion. Lithological heterogeneity dictates the flow of a CO_2 plume, where low vertical permeability baffles facilitate physical and residual trapping, as well as causing lateral spread of the plume and potentially enlarging the CO_2-resrvoir-brine reaction front for mineral trapping reactions. For such reactions, understanding the distribution of host-rock mineralogical heterogeneity will be key to quantifying the scale of chemical reactivity. Deep-marine reservoirs are voluminous and offer excellent storage potential but also feature abundant lateral and vertical heterogeneity, due to a spatial variation of facies distribution, governed by flow processes, and stacking patterns of depositional elements (channels/lobes). Here, the Middle Eocene Banastón System of the Hecho Group, within the Aínsa and Jaca depocentres of the South Pyrenean Foreland Basin is utilised as a subsurface reservoir analogue for down-fan characterisation. A well constrained down-dip transect was produced, identifying slope channel, channel-lobe transition, and proximal, medial, fringe lobe and basin plain sub-environments. Channel and channel-lobe transition reservoir geometries consist of thick complexes (up to 16 meters) of vertically interconnected sandstone bodies with a high degree of lateral thickness variation (up to 30 cm/m) resulting from channel erosion, sandstone scouring and abundant bed amalgamation and re-separation. From the proximal lobe, geometries transition distally to increasingly tabular, interbedded with a progressively higher proportion of siltstone and mudstone, producing compartmentalisation. Deposited facies show evolution from lithic-rich and arenaceous proximal coarse-grained scour and channel fill sandstones and massively bedded high-density turbidites towards increasingly structured and graded, finer-grained and more dilute low-density turbidites. At lobe fringes, hybrid beds are first observed and the preservation of mudstone and hemipelagic calcilutite bed tops increases abruptly. At frontal fringes, hybrid beds consist of basal medium grained mudclast-rich high-density turbidites and upper sandy laminar deposits, interpreted as transitional flow deposits resulting from turbulent flows incorporating distal carbonate-rich muddy substrate material. At lateral fringes, hybrid beds consist of underlying coarse lithic-rich high-density turbidites and upper thickly bedded chaotic textured bioclast-rich laminar deposits with very thick mudstone caps (up to 4.6 meters), interpreted as lateral slope collapse linked-debrites. We use petrographic analysis to quantify and compare the mineralogical heterogeneity of facies within these environments, establishing a relative reactive mineral index to compare with traditional reservoir quality parameters. Reactive mineralogy is concentrated in the more distal environment deposits, as well as on traction structures, at the expense of reservoir quality and therefore net storage potential. Both the lithological homogeneity and degree of vertical amalgamation of proximal deposits might pose a risk to seal integrity. Considering this, as well as increasing physical and chemical trapping potential distally, a medial lobe reservoir target may be preferred for effective and safe long-term storage.

Oral presentation

Basin scale evolution of zebra textures in fault-controlled, hydrothermal dolomite bodies: Insights from the Western Canadian Sedimentary Basin

Cole A. McCormick[1], Hilary Corlett[2], Matthieu Clog[3], Adrian J. Boyce[3], Romain Tartèse[1], Matthew Steele-MacInnis[4] and Cathy Hollis[1].

[1] Department of Earth and Environmental Sciences, The University of Manchester, UK

[2] Department of Earth Sciences, Memorial University of Newfoundland, Canada

[3] Scottish Universities Environmental Research Council, UK

[4] Department of Earth and Atmospheric Sciences, University of Alberta, Canada

Structurally controlled dolomitization typically involves the interaction of high-pressure (P), high-temperature (T) fluids with the surrounding host rock. Such reactions are often accompanied by cementation and recrystallization, with the resulting hydrothermal dolomite (HTD) bodies including several 'diagnostic' rock textures. Zebra textures, associated with boxwork textures and dolomite breccias, are widely considered to reflect these elevated P/T conditions. Although a range of conceptual models have been proposed to explain the genesis of these rock textures, the processes that control their spatial and temporal evolution are still poorly understood. Through the detailed petrographical and geochemical analysis of HTD bodies, hosted in the Middle Cambrian strata in the Western Canadian Sedimentary Basin, this study demonstrates that a single genetic model cannot be applied to all the characteristics of these rock textures. Instead, a wide array of sedimentological, tectonic and metasomatic processes contribute to their formation; each of which is spatially and temporally variable at the basin scale. Distal to the fluid source, dolomitization is largely stratabound, comprising replacement dolomite, bedding-parallel zebra textures and rare dolomite breccias (non-stratabound, located only proximal to faults). Dolomitization is increasingly non-stratabound with proximity to the fluid source, comprising bedding-inclined zebra textures, boxwork textures and dolomite breccias that have been affected by recrystallization. Petrographical and geochemical evidence suggests that these rock textures were initiated due to dilatational fracturing, brecciation and precipitation of saddle dolomite as a cement, but significant recrystallization occurred during the later stages of dolomitization. These rock textures are closely associated with faults and carbonate-hosted ore deposits (e.g. magnesite, rare earth element and Mississippi Valley–type mineralization), thus providing invaluable information regarding fluid flux and carbonate metasomatism under elevated P/T conditions.

Oral presentation

Continental weathering and the emergence of land plants

William J. McMahon[1], Neil S. Davies[1], Stefan C. Löhr[2], Cassandra Wheeler[3], Mohd Tarique[4], Sean T. Herron[1], Yorick Veenma[1], Edward T. Tipper[1], David Wilson[5], Sean T. Murray[3]

[1]Department of Earth Sciences, University of Cambridge, U.K

[2]Discipline of Earth Sciences, University of Adelaide, Australia

[3]School of Natural Sciences, Macquarie University, Australia

[4]National Centre for Polar and Ocean Research, Goa, India

[5]Department of Earth Sciences, University College London, London, United Kingdom

In this presentation we link apparent changes in continental weathering processes with novel physical stabilizing effects caused by expanding Paleozoic land plants. It has long been noted that Precambrian sediments appear to be composed of less weathered materials than their younger counterparts, suggesting a long-term shift in continental weathering, but there have been few recent attempts to pin-point this change systematically. We have done so by coupling mineral identification and textures at the micron-scale to measure the ratio of mechanically ground clays to reworked neoformed clays within several Proterozoic and Paleozoic lacustrine mudrocks. We find an increase in neoformed clay content coincident with expanding land plants and suggest this reflects more frequent repeated weathering reactions across vegetated landmasses. Additional evidence for a change in weathering intensity is recorded by a marked shift in the δ^7Li values of 42 continental mudrocks. Today clay formation through neoformation in soils is intensified by plants and their symbionts, a process we suggest was underway at the onset of the 'Devonian landscape factory'.

Oral presentation

Depositional dynamics of carbonate megabreccias, Permian Bell Canyon Formation, Apache Mountains, Texas

Maximiliano Miguez[1], Zane R. Jobe[1], Arnoud Slootman[1], Marat Ibagarov[1], Lesli Wood[1], James Bishop[2], Brooks Ryan[2], Ted Playton[2]

[1]Colorado School of Mines, Golden, CO, USA

[2]Chevron, Houston, TX, USA

Carbonate megabreccia deposits are common on carbonate slopes and host conventional and unconventional hydrocarbon reservoirs. Many studies have documented carbonate megabreccias using outcrop and subsurface datasets, but few focus on the depositional processes and spatio-temporal flow evolution, which affect reservoir properties and geomechanical anisotropy. Megabreccia flows transport large, lithified clasts and occur on slopes much greater than in any siliciclastic slope system and thus the flow dynamics may be quite different from siliciclastic turbidity-flow and debris-flow depositional models. In this study, we use well-exposed outcrops of the Permian Bell Canyon Formation, Apache Mountains, Texas to characterize the multi-scale heterogeneity of carbonate megabreccia deposits. Using data derived from drone models, direct-outcrop measurements, polished slabs, and thin sections, we quantify the (1) internal architecture of the megabreccia, (2) spatial variability in megabreccia thickness, (3) vertical distribution of grain size, and (4) the composition and texture of the matrix that surrounds the clasts.

Distinct segmentation within the megabreccia is characterized by a 5-12 m thick clast-supported basal zone with large clasts and a 1-3 m thick cap. Analysis of clast-size distribution reveals an overall fining upward trend, with distinctly larger (D_{50} of 50 cm) and more rounded clasts in the basal zone. The cap is much finer-grained, with clasts rarely larger than 10 cm. Outsized raft blocks up to 15 m thick and 50 m long are also present in the deposit and create mounding of the upper surface, suggesting seafloor topography was created during deposition. Paleocurrent data indicates a source area to the south-southwest, indicating at least a 10-15 km runout distance. We interpret this megabreccia as a single event bed that had a transitional flow rheology with both Newtonian and non-Newtonian flow characteristics (i.e., a hybrid event bed). This is distinctly different from most large-volume 'mass-transport-deposits' in siliciclastic systems that are predominantly debris-flow like and chaotic. Comparisons with other large event beds, such as the nearby Rader unit in the Guadalupe Mountains and the Cerro Toro Formation in Chile, underscore similarities in depositional mechanisms. Data from this study can be utilized to not only for the prediction of reservoir properties of carbonate megabreccias, but for the assessment of geohazards associated with reef collapses and megabreccia deposition in the modern ocean.

Oral presentation

Ancient Oyster Beds: a Vastly Underrated Sedimentological Resource

Jon Noad[1]

[1]Stantec Consulting; University of Adelaide

Fossil oyster beds outcrop in a wide variety of locales and over a timespan of 200 million years. They are usually restricted to shallow marine, turbid conditions, meaning that their presence in the fossil record provides valuable evidence of a truly coastal setting. Oyster shells are also extremely robust, making them resistant to erosion, often resulting in monospecific assemblages. Their sturdy shells mean that they are rarely broken down into particles too small to identify as oysters in even high energy, subaqueous environments.

Over thirty occurrences of both ancient and modern oyster beds have been studied, from localities in Alberta, the USA, the United Kingdom (including the famous "devil's toenail"), Spain and elsewhere, and a classification system erected to categorize these by depositional setting and sequence stratigraphic context. Examples include several significant marine incursions into otherwise terrestrial settings (so-called "marine tongues"); storm generated beach ridges; calci-turbidites and a Cretaceous estuarine oyster bed deposit that has been mined commercially. The presence of shell borings indicates a sub-tidal depositional setting, allowing deeper marine settings to be delineated. These settings are usually muddier with broader, thinner shelled oysters.

A sedimentologist can never have enough tools to help interpret depositional settings and sequence stratigraphic context, and in this case, the world really can be your oyster.

Cored Cretaceous oyster bed from Springbank, Alberta

Oral presentation

CSI: Sedimentology; untapped opportunities for cross-pollination

Jon Noad[1]

[1]*Stantec Consulting; University of Adelaide*

Shows involving homicides and associated crime scene investigation (CSI) are among the most popular on television. The public are fascinated by the work that goes into collecting and analysing data from crime scenes in the field, whether it be DNA, wounds and bloodstains, footprints, tyre tracks or even evidence of arson. Skeletal analysis can provide a detailed profile, and even a life history, of the victim and there is almost always a way to estimate time of death (TOD).

As sedimentologists, our fieldwork has very similar objectives, using data from the "scene" to estimate depositional setting, flow velocities and water depth, and the nature of deposition. Grain size, sedimentary structures and bed thicknesses, sediment colour and composition, provenance and most importantly context allows us to build up a picture of the "scene" at the time of deposition. Palaeontological data can tell us a great deal about our "victims" - AKA fossils, while trace fossils record their behaviour, sometimes immediately prior to death. Stratigraphy, index fossils and correlation can be used to determine TOD (time of death/deposition).

There is undoubtedly a cross-over between forensic science and sedimentology. Both use data collected at the crime scene to understand what happened at the time of death/deposition. There is a huge opportunity for the two branches of science to learn from one another and this will be explored in this presentation. New forensic techniques are being developed all the time and have the potential to be applied to sedimentological conundra. Finally, I see no reason why sedimentology related TV series cannot attract a similar audience to NCIS and Criminal Minds.

Oral presentation

Big, bold, and bizarre: giant ooids in low-oxygen Neoproterozoic oceans

Brennan O'Connell[a,b], Malcolm W. Wallace[a], Ashleigh v.S. Hood[a]

[a]*School of Geography, Earth and Atmospheric Sciences, University of Melbourne, Vic., Australia*

[b]*Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EQ, UK*

Ooids are concentric, abiotic, shallow-marine carbonate grains that contribute to calcium carbonate production in the oceans. They are important paleoenvironmental indicators of water depth, pH, temperature, and depositional energy. Most modern and ancient ooids are small (<1–2 mm in diameter), but the Neoproterozoic Era has an enigmatic abundance of giant ooids (>2mm). The mechanisms driving giant ooid formation are not well understood, particularly their growth rates, growth processes, and links to marine ocean chemistry. This study investigates giant ooids from the Cryogenian Angepena and Trezona formations in South Australia using sedimentological observations and trace element geochemical data (iron, rare earth elements + yttrium; REE+Y). Giant ooids have strange non-spherical forms, including elongate, triangular, and capsule-like shapes. These forms are likely caused by frictional abrasion via sliding and rolling during bedload transport. Some ooid laminae show thin-thick couplets of iron-oxide-rich and iron-oxide-poor laminae which progressively thicken and thin outward. These couplets may represent tidal rhythmites(?), suggesting rapid ooid growth during daily and neap-spring-neap tidal cycles. Rapid growth rates likely required extremely carbonate-supersaturated ocean conditions. Intervals of rapid(?) growth are interrupted by erosional surfaces/unconformities, corresponding to intervals of ooid erosion, abrasion, and/or non-deposition. Shale normalized REE + Y profiles of giant ooids show enrichment in middle rare earth elements, a conspicuous Europium peak, and depletion of heavy rare earth elements. There is no negative cerium anomaly in averaged REE+Y profiles, unlike the strong negative cerium anomaly seen in ooids that precipitate from modern oxic seawater. REE+Y patterns suggest giant ooids formed in low-oxygen Cryogenian oceans. Ocean anoxia is associated with extreme carbonate supersaturation, which may explain the rapid growth and unusual abundance of giant ooids in the Neoproterozoic.

Oral presentation

Anisotropy of magnetic susceptibility (AMS) of turbidite sandstones and mudstones: sedimentary or tectonic origin? A case study from the Ventimiglia Flysch (NW Italy)

Patacci M.[1], Marini M.[2], Cifelli F.[3], Mattei M.[3], Muttoni, G.[2]

[1] *Department of Life, Health and Environmental Sciences, University of L'Aquila, Italy*

[2] *Department of Earth Sciences, University of Milan, Italy*

[3] *Department of Geological Sciences, Roma Tre University, Italy*

The anisotropy of magnetic susceptibility (AMS) is the property of materials whereby identical magnetic fields applied in different directions produce different intensities of induced magnetisation. It is a tensor defined by a set of three constants called the principal susceptibilities: K1 (max), K2 (int.) and K3 (min). These values can be represented by an ellipsoid, with the K1 axis parallel to the magnetic lineation and the K3 axis perpendicular to the magnetic foliation plane. In deep-water successions in weakly deformed basins, the interpretation of the origin of magnetic lineation (palaeoflow vs tectonic) remains debated. The study area is located inland of Ventimiglia (NW Italy), in the Eocene fill of the foreland basin of the southwestern Alps, which is represented by the Ventimiglia Flysch Fm. This deep-water sequence is >1 km thick and it is characterised by turbidites with thick mudstone caps, a high proportion of hybrid event beds and high bed continuity at the km-scale. It is interpreted as the medial part of a confined basin-plain. Palaeoflow directions are relatively consistent throughout the stratigraphy and the study area, and are directed toward the north. From a structural point of view, the area can be divided into two domains: a southwestern one with cleavages and fold axis striking N-S and a northeastern one with orientations NW-SE.

Oriented samples were collected at thirteen locations across an area of roughly 30 Km^2 and spanning most of the stratigraphy (209 samples; 68% mudstones, 13% sandstones, 13% siltstones, 5% marlstones) and bed types. They were cut into 313 standard specimens for magnetic analysis and AMS was measured at room temperature with an AGICO Kappabridge KLY-3 susceptibility bridge in the paleomagnetic laboratory of Roma Tre University. Magnetic foliation has generally higher values than magnetic lineation. While the amount of magnetic foliation is correlated to lithology, with mudstones and siltstones displaying values 2-3 times higher than sandstones, the amount of magnetic lineation does not appear to correlate with lithology. The direction of magnetic lineation is also not correlated with lithology. However, it clusters spatially and four areas can be defined, each comprising a number of sampling localities. The areas in the SW and in the N are the most different, with an area in the middle showing intermediate values. In each area, the direction of magnetic lineation is parallel to the directions of cleavages and fold axis, but not always to palaeoflow, which is relatively uniform across the entire study area. The magnetic lineation recorded in both mudstones/siltstones and sandstones is therefore interpreted as the result of tectonic modification. This study illustrates that in a weakly deformed deep-water succession – even in areas where cleavage might not be directly observed – the magnetic lineation of AMS might be the result of tectonic modification. Any interpretation of the AMS being a proxy for palaeoflow should therefore require independent pieces of evidence, especially in areas where the direction of tectonic stresses and palaeoflow are parallel due to basin geometry.

Oral presentation

Quantifying the capillary seal capacity of Tertiary shales associated with injectite petroleum reservoirs

Nick Price, Mathew Brettle & Rene Jonk

University of Aberdeen, Sand Injectite Research Group.

This project (MSc) presents a method for testing and applying the relationship between the capillary seal capacity of shales associated with sand injectite reservoirs and the buoyancy pressures exerted by the original oil and gas columns in order to develop a predictive model for column heights where pressure data is unavailable. The area of study is the Northern North Sea block 9, with a focus on the sedimentology of the Beryl Embayment. The fields included in this study are: Gryphon, Leadon, Maclure and Harding with discovery well 9/15a- 2 used as a proof of concept in predicting a possible gas column where the pressure RFT data is lacking. This investigation ultimately aims to be able to test the applications of estimating unknown hydrocarbon column heights from sample derived threshold pressures. Alongside this, the study will also test supercritical CO_2 column heights for hypothetical CCS endeavours in the region.

Using mercury injection capillary pressure testing (MICP), x ray fluorescence, x ray diffraction, RFT data and wireline data, the threshold pressures were calibrated using VShale curves and used to calculate estimated threshold pressure data for each wireline log. Threshold pressures were converted from the Hg- Air domain to the HC- Water domain during this process calibrated for both the oil and gas found within each field. These were compared with buoyancy pressures from RFT derived pressure depth plots to establish the classification of trap based on the Sales 1997 spill/ leak model.

Results show that all wells used in this study fall within the criteria for a class 2 trap based on the Sales model, leaking gas through the crest and spilling oil from the base of the trap, the exception being the Leadon well, which may have a charge limited gas cap due to a higher than expected capillary seal. Discovery well 9/15a- 2 was used for an experiment in reversing the method, attempting to build fluid contacts down from a sealing capacity derived from MICP testing to see how it interacts with the existing albeit limited fluid pressure data. The results of this exercise suggest that the P50 average sealing capacity of the discovery well is insufficient to support any significant gas cap, however modelling suggests that it is possible to generate a gas cap within the limits of the known reservoir characteristics. More porosimetery data would be required to define the sealing capacity of this injectite and proof this application of the model.

Future steps of this project are to incorporate data from the Norwegian graben with well data and samples from Volund and Froskaler being incorporated into the database and model.

The conclusions drawn from this investigation are a promising demonstration of a method to predict column heights where pressure data is absent, and with further testing of this practice it may be used to accurately predict columns in other wells lacking pressure data.

Oral presentation

Quantifying the time, cost, logistic and environmental efficiency of virtual field trips

Pugsley J.H.[1], Howell J.A.[1], Hartley A. J.[1], Buckley S.J.[2], Chmielewska M.[1], Naumann N.[2], Schofield N.J.[1], Brackenridge R.[1]

[1] Department of Geology and Geophysics, University of Aberdeen, Aberdeen, AB24 3EU
[*jessica.pugsley@abdn.ac.uk*](mailto:jessica.pugsley@abdn.ac.uk)

[2] Fonix Geoscience, 5034 Bergen, Norway

Field trips are a core part of education in sedimentology and wider geosciences. The efficiency of virtual field trips (VFTs) compared to physical field trips (PFTs), is regarded as one of their main advantages. VFTs are generally more time-efficient, cost-effective, environmentally sustainable, and logistically simpler to organise and execute, primarily due to the absence of travel requirements. However, the specific nature and extent of these efficiencies, which are critical for determining the suitability of virtual, physical, or blended field trip formats, have not previously been quantified. This study presents a quantitative assessment of multiple efficiency metrics using data from a 10-day VFT and equivalent PFT conducted in Utah, USA, by the University of Aberdeen, UK. The findings demonstrate that VFTs outperform PFTs across all evaluated categories: time, cost, environmental impact, and logistics. In addition to air travel days at the beginning and end of the PFT, a further 33.3% of the PFT's duration was spent traveling (e.g., walking or driving). This time saving enabled VFT participants to visit 16 more localities than those visited during the PFT. Furthermore, VFTs allowed the locality order to follow the geological narrative, unconstrained by geographic proximity, unlike the PFT. In terms of environmental impact, the PFT generated approximately 4 tonnes of carbon dioxide equivalent (CO_2e) per student from flights and vehicle travel, whereas the VFT produced less than 1% of that amount, comparable to a typical week of classroom-based teaching. Financially, the VFT incurred negligible costs, resulting in savings of up to £3000 GBP per student compared to the PFT. These findings were evaluated alongside the achievement of learning outcomes, assessed primarily through student questionnaires. The results indicate that perceptions of learning outcomes were generally comparable between the PFT and VFT. However, efficiency alone does not define the success of a field trip. There are additional considerations, such as social cohesion and immersion in outdoor environment. Therefore, the authors emphasize that this study does not advocate for the replacement of physical field trips but instead aims to provide a foundational framework for quantifying efficiency to inform decision-making in field training design.

Oral presentation

Sedimentological contributions to understanding the S Laurentian continent-ocean transition zone and its emplacement (Highland Border Complex, Scottish Grampians)

Alastair H.F. Robertson[1], William G. Henderson[2]

[1]***School of GeoSciences,*** *University of Edinburgh, Grant Institute, James Hutton Road, Edinburgh, EH9 3FE, UK*

[2]*Balnashinar, Kettlehill, Cupar, KY15 7TW.*

The variably deformed, greenschist facies Highland Border Complex (HBC) can be interpreted as a former continent-ocean transition (COT). The adjacent Dalradian to the N (Late Precambrian-Cambrian Southern Highland Group) culminates in thick-bedded terrigenous, high-density turbidites and mass-flow deposits. The HBC includes thick basaltic sequences. In the River North Esk section, an 8 m-thick fault-bounded basaltic conglomerate with some very well-rounded clasts (a 'high-energy' deposit) is succeeded by c. 320 m of fault-bounded pillow lavas, massive flows, volcaniclastics and lenticular cherts; a 30 m-thick unit of well-bedded volcaniclastics, fine-grained terrigenous mudrocks and red cherts follows. The c. 160 m-thick Stonehaven basaltic section (to the NE) includes laterally continuous thin (< 2 m) intercalations of red and black siliceous mudrocks and chert. Localised massive sulphides and associated Fe-oxide sediments (5-20 cm) represent hydrothermal black smoker and oxide fall-out deposits. Geochemical evidence is consistent with a distal COT setting for the North Esk and a more oceanic setting for Stonehaven. In addition, in the North Esk section, there are two fault-bounded sequences of relatively proximal slope, to base-of-slope terrigenous gravity-flow deposits and mudrocks, together with Lower Ordovician (based on conodonts) dark, organic-rich marine carbonates (up to ca. 500m-thick Margie unit). The sandstones have a bimodal texture of well-rounded grains and more angular matrix grains pointing to redeposition. Monocrystalline quartz (of debatable provenance) exceeds polycrystalline quartz of metamorphic (e.g. gneissic) origin. Laurentian continental sources are inferred based on published detrital zircon geochronology. Lower Ordovician limestones with diverse fauna are also documented in the SW (Dounans Limestone, Aberfoyle). Terrigenous clastics, also in the SW (e.g. Loch Lomond), include conglomerates and sandstones with serpentinised ultramafic clastic debris (e.g. with high Ni and Cr), of either COT or oceanic (ophiolitic) provenance.

In the proposed reconstruction, the rifted Laurentian margin passed downslope across the COT from proximal (Dalradian), to more distal (North Esk), and then into marginal oceanic crust (Stonehaven). The Margie clastics relate to Early Ordovician reactivation of the rifted margin prior to emplacement (i.e. a possible foreland basin). Complementary structural data suggest that the COT was emplaced as fault-bounded blocks in a left-lateral stress regime, prior to final covering by the post-orogenic Lower Old Red Sandstone.

Oral presentation

Anthropocene Sedimentary Environments

Catherine Russell[1]

[1]*Department of Geography and Environment, Loughborough University, Leicestershire, LE11 3TU, UK*

All materials that move across Earth’s surface, whether natural or human-made inevitably undergo sedimentary processes, eventually accumulating in depositional environments that may themselves be natural or human-made. Whilst we know that humans have become the dominant agents in developing and distributing materials, notably plastic, there is not enough sedimentological study undertaken regarding the sedimentary environments that we have influenced or created: i.e., Anthropocene sedimentary environments.

The landscapes that we have shaped and continue to alter, from polluted rivers to landfill sites, are so abundant and diverse that dedicated study is warranted under the new sub-discipline of Anthropocene Sedimentology. Traditional sedimentology relies on comparatively well-understood cause-and-effect relationships within natural systems over geological timescales. Whilst Anthropocene Sedimentology and the understanding of Anthropocene sedimentary environments shares foundational concepts with traditional sedimentology, such as sediment transport dynamics and depositional mechanisms, there are marked additional challenges underpinned by complex, human-induced factors that necessitate more nuanced and multi-disciplinary approaches. As such, there are countless challenges and opportunities in studying human-dominated sedimentary environments; activities such as urbanization, industrialization, resource extraction, and land-use change, alter the sediment sources, transport pathways, pollution, and depositional settings of sediments.

Understanding human-involved cause and effect mechanisms demands moving beyond a broad-brush approach of "human impact" to dissect the nuanced interactions between various human activities and sedimentary processes. Interdisciplinary collaboration beyond traditional science may include incorporating socio-economic, technological, and cultural perspectives to decipher the full scope of ongoing changes. Embracing the study of Anthropocene Sedimentary Environments will enable us to: i) develop new classification frameworks that accommodate novel materials and processes; ii) better predict the behaviour of altered sedimentary systems amid rapid environmental change; iii) inform strategies for environmental management and policy-making, and iv) better understand the formational mechanisms of Earth’s future geological record.

Oral presentation

Tsunami vs storms: diagnostic criteria in lacustrine deposits

Patrick Sharrocks[1]; Jeff Peakall[1]; Natasha Barlow[1]; David Hodgson[1]

[1] School or Earth and Environment, University of Leeds

Around 650 million people live less than 10 m above sea level and are highly vulnerable to coastal hazards (tsunamis and storms) coupled with rising sea levels. However, the historical record is too short to accurately estimate where and how often future events may occur, necessitating research into sedimentary deposits of past events that extend the record across millennia. Our ability to identify past events in the geological record remains clouded by an inability to unequivocally differentiate between a storm and tsunami origin. Currently, a range of proxies are required to attribute a deposit to a given event type including contextual, sedimentological, microfossil and geochemical evidence. Here, we take an alternative approach of using the deposits to infer the processes involved using a large dataset of tsunami and storm deposits from lakes and lagoons. This dataset integrates records of modern events, where the event dynamics and environmental conditions are known, with the palaeo record. The results show that tsunami deposits comprise three groups: i) thick clast- and mud-rich deposits, ii) dense shell-rich layers, and iii) clean sands. From these deposits, we infer differing processes that correlate to common environments. In the case of tsunami, these processes include: i) the formation of a sediment gravity flow that transforms rapidly (100s of metres) into a hybrid flow as the tsunami flowed into a lake, ii) the progression of a dense, cohesionless flow head similar in composition to recent observations in turbidity currents, and, iii) the displacement of shallow lake water by a high energy and turbulent tsunami wave. In contrast, storms show little variation in their deposits with clean sands often only a few centimetres in thickness that contain little mud or organic inclusions. These deposits are inferred to have been deposited either by bedload under an overwash regime or through suspension from a dilute flow under a full inundation of the coastal lake or lagoon. This work implies that in many environments (>60% of the record) it is possible to differentiate between the two events based on the sedimentology alone. However, additional evidence such as contextual or microfossil data are required in other environments. The new approach adopted here also enables a better reconstruction of past events that determines why the deposits differ based on the event dynamics. This will enable more accurate recurrence intervals to be established.

Keynote presentation

A Virtual Fieldtrip to the Whittard Submarine Canyon

Esther J. Sumner[1]

[1]*School of Ocean and Earth Science, University of Southampton, Southampton, UK*

This year the BSRG AGM will have an additional fieldtrip; possibly the wettest in BSRG's long history. We will be taking a tour of Whittard Submarine Canyon; a land-detached dendritic submarine canyon in the NE Atlantic. We will start by using state-of-the-art oceanographic tools such as Autonomous Underwater Vehicles and Remotely Operated Vehicles to visualise what a modern submarine canyon looks like. We will visit a mooring and consider what a multi-year time series of velocity data reveals about the relative importance of turbidity currents versus internal tidal bores in moving sediment around the canyon. We will take a look at the diverse range of bedforms in and around the canyon and consider whether these can be used to map the direction of flows caused by internal tides and turbidity currents. Finally, we will look at some of the habitats within the canyon, such as the spectacular cold water coral communities that cling to the canyon walls and are reliant on the delivery of nutrients by sediment transport processes for their survival.

Oral presentation

Decoding Submarine Fan Morphology: Multivariate Influences and Non-Unique Solutions in the Golo Fan

Ibrahim Tahiru and Peter Burgess

Quantitative Experimental Stratigraphy Group, Jane Herdman Laboratory, Department of Earth, Oceans and Ecological Science, University of Liverpool, Brownlow Street, Liverpool, L69 3GP, United Kingdom.

Traditional sequence stratigraphy has primarily linked submarine fan formation to accommodation changes, often driven by variations in sea level. However, research over recent decades has highlighted the importance of multiple interacting controls in shaping fan morphology. This study employs Lobyte3D, a reduced-complexity stratigraphic forward model, combined with genetic algorithm optimization techniques to explore key parameters: turbidity flow volume, threshold deposition velocity, acceleration coefficient, flow height, and sediment concentration. Multiple best-fit models, distributed across distinct regions of the parameter space, underscore the non-uniqueness of observed stratal geometries. Sensitivity analyses reveal that sediment volume, basin confinement, and input periodicity critically influence fan morphology, affecting avulsion timing, channel formation, and overall architecture. These findings challenge simplistic interpretative paradigms in sequence stratigraphy by demonstrating the equifinality of depositional processes. This work highlights the inherent uncertainty in isolating singular controlling mechanisms, emphasizing the need for multivariate and probabilistic approaches in practical predictions of fan development.

Oral presentation

The stratigraphic record of sediment gravity flow transformations in submarine slope settings

William J. Taylor[1], David Hodgson[1], Jeff Peakall[1], Ian Kane[2], Stephen Flint[2], Max Bouwmeester[2], Euan Soutter[2], Ed Keavney[1], Joshua Marsh[2], Miquel Poyatos Moré[3], Adam McArthur[1], Rufus Brunt[2], Victoria Valdez Buso[4]*

[1]School of Earth and Environment, University of Leeds, Leeds, UK

[2]School of Earth and Environmental Sciences, University of Manchester, Oxford Road, Manchester, UK

[3]Departament de Geologia, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

[4]Universidade Federal do Paraná, Brazil

eewjt@leeds.ac.uk

Sediment gravity flows are sensitive to variations in seafloor topography and substrate character. Flows in mud-prone submarine settings with inherited topography can undergo rapid and significant changes in character as cohesive forces increase relative to turbulent forces. The resulting flow transformations have been shown to generate distinctive deposits in distal submarine fan settings, which challenged existing models of sediment gravity flow processes. However, the present understanding of the stratigraphic distribution and lateral variability of flow transformation deposits in proximal slope settings remains poorly understood. Here, we present new process-based conceptual models that account for different flow transformations in a variety of submarine slope settings. Outcrop and core datasets from the Karoo-Laingsburg depocentre (South Africa), Peninsular Ranges Forearc (Mexico), and Aínsa depocentre (Spain), reveal a range of bed types that record the evolution of flow transformations and complex interactions with different topographic configurations. Mixed grain-size bedform sequences demonstrate spatio-temporal flow transformations from turbulent to laminar states, and are common in incised slope valley-fills and canyon-fills, within channel margins, internal levées, and channel mouth settings. The length-scales of bedform transitions point to abrupt flow transformations (100s of metres), which are particularly rapid in successions with increasing confinement and/or slope gradient where flows are forced to entrain mud and decelerate. Sand-rich hummock-like structures, and associated mixed grain-size bedforms are further interpreted as combined flow deposits, resulting from reflection, deflection and ponding processes. These can be used as a new criterion to interpret flow confinement and the presence of erosional and depositional relief. Our results demonstrate that deposits of flow transformations characterise highly diverse, heterogenous successions that vary substantially with respect to slope position, degree of confinement and tectonic setting. Mixed grain-size bedforms are not a diagnostic criterion for bottom currents, because such flows cannot account for the high mud content in laminasets, or the interlamination of sand and mud. Therefore, palaeoenvironmental reconstructions of submarine slopes require consideration of individual flow behaviours and their topographic interactions, rather than a sole assessment of depositional environment, which can hinder palaeogeographic reconstructions.

Oral presentation

A marine mosaic of stasis and traces: Spatial patterns in the sedimentology, ichnology, and fidelity of the Cambrian shallow-water record

Yorick P. Veenma[1], Neil S. Davies[1], Anthony P. Shillito[2]*

[1] Department of Earth Sciences, University of Cambridge, Cambridge, CB2 3EQ, United Kingdom

[2] Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 5E2, Canada

The shallow-marine realm was the main evolutionary arena of the Cambrian Explosion, but its variety of depositional environments created spatial variability in the record of this episode. Trace fossils are valuable tools for understanding this variability, as their abundance and diversity are influenced by the sedimentary interplay of erosion, deposition, and stasis. Consequently, ecosystems of even moderate diversity, when combined with favourable sedimentary conditions, can appear as an "ichnological optimum". We illustrate this using Cambrian successions from Wales and Norway and with reference to the offshore transition zone (between storm and fairweather wave-base), which formed the marine ichnological optimum during the Cambrian Explosion. In contrast, quartzite successions deposited in littoral settings are often unfossiliferous, a feature previously attributed to ecological limitations and the prevalence of erosional surfaces in outcrop. New results from the Carnedd-y-Filliast Grits (Furongian, North Wales) reveal that, besides erosion, surfaces also commonly registered intervals of sedimentary stasis, though their duration is often short. This short-stasis signature, driven by high sedimentation frequencies and pervasive wave action, implies that Cambrian littoral ecosystems were more biodiverse than their known record suggests. The contrast between the littoral zone and the offshore transition zone highlights how the Cambrian shallow-marine record can variably under- or overrepresent Earth-historic signals.

Oral presentation

Wing-like sandstone intrusions: geometric and spatial analysis of outcrop examples

Robert Waltham[a], Gustavo Zvirtes[a], Brian S. Burnham[a,b], Andrew Hurst[a]*

[a] School of Geosciences, University of Aberdeen, Aberdeen, AB24 3UE, U.K.

[b] VRGeoscience Limited, Manchester, UK.

robert.waltham@abdn.ac.uk

Wing-like intrusions are some of the largest individual architectural elements within sand injectite complexes. Wings predominantly consist of discordant inner wings and bedding concordant outer sills, crosscutting hundreds of meters of stratigraphy and extending laterally for several kilometres. Outcrops of two wing complexes exposed within giant injection complexes in the San Joaquin Basin, have been digitally mapped, ground-truthed, and utilised for geometric, quantitative, and spatial analysis.

The Dosados Canyon wing complex of the Panoche Giant Injection Complex (PGIC), consists of a singular 14 m thick inner wing which crosscuts 300 m of mudstones and bifurcates laterally to outer sills for >1.6 km. Up to 64% of the net sandstones are defined by a network of thin intrusions (>2m thick).

The Tumey Hill wing complex, located within the Tumey Giant Injection Complex (TGIC), intrudes vertically ca. 200 m of mudstones and extends laterally for >1.3 km. Its architecture comprises of a series of stacked wing intrusions (individually up to 12m thick) which transitions to an outer sills section. A total of 225 intrusions (0.15 m to 8 m thick) are identified between the stacked wings, adding sand volume and providing excellent connectivity.

In the subsurface, wings are among the few structures discernible on seismic data and thus frequently serve as primary targets for well drilling. Comparison to wings in Subsurface (Volund and Varadero fields in the North Sea), shows that the outcrop examples present similar scale and geometry. The study demonstrates the value of outcrop characterization to use as analogues for subsurface analysis of wing-like intrusions. Additionally, the lack of seismic detection capacity for the associated smaller intrusions which frequently represents half of the net reservoir, often results in an underestimation of reserves and presents challenges in predicting production behaviour.

Oral presentation

The fate of terrestrial organic matter in syn-rift lacustrine and fan-delta systems

Qianyou Wang [a], Yaohua Li [b], Hamed Sanei [c], Joe Gardner [a], Bei Liu [d], Arka Rudra [c], James E. P. Utley [a], Richard H. Worden [a]

[a] Department of Earth, Ocean and Ecological Sciences, University of Liverpool, Liverpool L69 3GP, UK; qianyou.wang@liverpool.ac.uk (Q.W.)
[b] Oil and Gas Survey, China Geological Survey, Beijing 100083, China
[c] Lithospheric Organic Carbon (L.O.C) Laboratory, Department of Geoscience, Aarhus University, Aarhus 8000C, Denmark
[d] School of Earth Resources, China University of Geosciences, Wuhan, Hubei 430074, China

Organic matter (OM) burial in lakes has been identified as an efficient sink in the global carbon cycle. Abundant input of terrestrial OM leads to high variability in terms of the origin and composition of total organic carbon. However, the production, transport, and deposition of terrestrial OM on geological timescales have been overlooked in prior studies. This study examined the sources and concentrations of OM in the Lower Cretaceous Shahezi Formation (Songliao Basin, NE Asia) within the context of tectono-sedimentary and paleoclimate changes. Multi-independent proxies (maceral composition, pyrolysis indices, $\%R_o$, TOC/TN, and $\delta^{13}C_{org}$) reveal a dominance of terrestrial OM (gas-prone, type III/IV kerogen) in the highly mature mudstones. The prevailing warm, humid, and boreotropical climate promoted terrestrial primary productivity and hydrologic cycle in the rift lake catchment, which, in turn, led to a sufficient source of terrigenous OM around the lake. Syn-rift tectonic activity, characterized by rapid subsidence and the development of fault-bounded syncline, facilitated the terrestrial OM influx by creating sediment transfer zones and expanding lake accommodation space. The fan-delta progradation, forming along the steep syn-rift basin slopes, served as a key pathway for transporting terrestrial OM debris from the hinterland towards the lakeshore to deep-water settings. Additionally, lake shoreline transgression and high-energy flooding events, amplified the input of lant plant detritus into littoral to profundal sediments through submergence of coastal peat swamps. This is evidenced by the common dispersal of clay- to granule-sized terrestrial OM particles within finely laminated black mudstones. This study presents a basin-scale model of terrestrial OM production, transport, and deposition in active rift lake basins. As the results also speak to the effectiveness of carbon burial in mudstones, this study may contribute to a better understanding of the global carbon cycle and fine-grained sedimentology.

Oral presentation

Drown-but-Not-Out: Mechanisms of Carbonate Platform Backstepping

Yang-Jun Wang[1], Peter M. Burgess[2]

[1]School of Earth Science, Yangtze University, Wuhan 434023, China, yang-jun.wang@liverpool.ac.uk

[2]Quantitative Experimental Stratigraphy Group, University of Liverpool, pmb42@liverpool.ac.uk

Drowning carbonate platforms often have a backstepping geometry with several apparently sharp drops in platform top area. Casual mechanisms for this backstepping geometry remain unclear; does it represent unsteady sea-level forcing, or is there some autogenic mechanism that causes an unsteady response to continuous forcing? Magnitude of backstepping can be measured in CarboCAT models of an isolated carbonate platform across a range of sediment production, sediment transport and relative sea-level rise rates in turn generating a range of platform types from keep-up to rapidly drowning. Analysis of the parameter space indicates that backstepping occurs across a narrow range of accommodation-supply ratios, and changes sharply to rapid drowning as the rate of relative sea-level rise increases. Backstepping is also strongly dependent on platform top sediment transport. In the absence of significant sediment transport pinnacle geometries are produced, but sediment transport allows a drowning platform to maintain broader platform top areas until a threshold is passed and the platform size decreases rapidly one or several times before the platform drowns. Backstepping during platform drowning is thus likely to be consequence of a complex mix of allogenic forcing and autogenic responses.

Oral presentation

Challenging the turbidity current maximum run-up height paradigm: Insights from 3D unconfined physical experiments and numerical modelling

Ru Wang[1], Mia Hughes[1], David M. Hodgson[1], Jeff Peakall[1], Ed Keavney[1], Helena C. Brown[1] and Gareth M. Keevil[1]*

[1] School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK

Turbidity currents are a primary mechanism for transporting sediments, pollutants, and organic carbon into the deep ocean. They are strongly influenced by seafloor topography because of their relative bulk density and associated gravitational influence being 3-4 orders of magnitude smaller than in terrestrial systems. Marked run-up of turbidity currents on slopes poses a hazard to seafloor infrastructure, and leads to distinctive depositional patterns, yet the prediction of run-up heights remains poorly understood because the present calculations are derived from 2D experimental configurations and/or numerical modelling and merely limited to scenarios in which the flow strikes the topographic barriers orthogonally.

Here we present the results of 3D experiments in unconfined settings that are used to develop a new analytical model that improves the prediction of maximum run-up heights of turbidity currents that encounter topographic slopes of varying gradients and flow incidence angles. We show that existing predictive models based on 2D confined flows focusing on frontal topographic configurations underestimate the run-up heights of turbidity currents by approximately 15-40%. Our new analytical model highlights the importance of considering the energy contribution from internal pressure in the fluid and lateral flow expansion and divergence in unconfined flows. Our results reveal that intermediate slope gradients (ca. 30°) and (near-)perpendicular flow incidence angles generate the highest run-up heights, up to 3.3 times the flow thickness. Novel analytical models are presented subsequently for predicting maximum run-up height as a function of both the gradient and incidence angle, comparing the models to the newly observed data. Such models provide realistic estimates of run-up heights for flows on three-dimensional slopes typical of natural systems.

These findings are critical for improving sediment transport models, predicting the distribution of sediments, pollutants, and organic carbon in deep-sea environments, assessing seafloor geohazards, and reconstructing ancient deep-water basin palaeogeographies.

Oral presentation

Stratigraphic architecture and environmental response of shelf-slope margins to active tectonics in slow strain rate settings: examples from the Pyrenees and Offshore Cameroon

Matthew Watkinson[1], Ashley Ayckebourne[2], Rhodri Jerrett[3], Michel Poyatos-More[4] & Mark Enfield[5]

[1]School of Geography, Earth and Environmental Sciences, University of Plymouth, Drake Circus, Plymouth, Devon, UK
[2]Equinor ASA, Harstad, Norway
[3]School of Earth and Environmental Sciences, University of Manchester, Manchester, UK
[4]Departament de Geologia, Universitat Autonoma de Barcelona, Cerdanyola del Vallés, Spain
[5]Tower Resources, London, UK.

Active deformation of the seafloor constantly perturbs the bed from its graded profile in shelf-slope environments, triggering a response through cross-slope sediment redistribution by submarine landslides, sediment gravity flows, deposition or erosion. In modern settings (e.g. SW California margin) such processes are a significant source of hazards such as landslide triggered tsunami and threats to offshore infrastructure. Hazard and facies distribution varies strongly depending on the structural setting and especially between areas of high to low strain rate.

We present results from the integration of two Cenozoic 'slow strain rate' case studies which demonstrate the stratigraphic architecture of slope successions from regional to grain-size scale. Both are in lateral ramp settings of major fold and thrust belts, with consequently stepped slopes. They were near the sites of major river delta systems, which fed turbidity current sand transport predominantly parallel to the tectonically generated slopes. The Eocene succession of the Ainsa Basin, Spanish Pyrenees provides field-exposures documenting the impact of the onset of active thrusting and folding in generating and deforming a shelf-slope transition. The Rio del Rey Basin, offshore Cameroon is on the western margin of the Niger Delta and where 3D seismic data demonstrates the large-scale architectural evolution such settings. Both examples illustrate how the interplay between tectonics and slope failure impact sediment gravity flow routing and deposition and can be used to explain and predict facies distributions from bed to basin scale.

In these examples, thrust and associated fault propagation folding show slow strain rates and rates of basinward propagation. Stepped, low gradient, mildly out-of-grade slopes resulted, with relatively low rates of accommodation change and slope gradients. As a result, slope mud deposition and axially derived turbidite systems could almost keep pace accommodation creation. This enabled slope parallel turbidity currents to onlap the upper slope and, at times, flow onto adjacent shelf. Slope failure in these settings is often characterised by creeping submarine landslides, which modify slope accommodation and focussed and trapped sand-rich turbidites in extensional growth fault hanging-walls and down-slope growth fold synclines. The presence of relay structures between thrust-related folds is also shown to be important in these settings as conduits for flow from source regions to slope deposition. Because upper slope deposition is possible in these slow-strain rate settings, the slope is almost able to maintain grade. Creeping failures clearly present a lower risk for tsunamic generation than more rapidly moving failures which are more typical of high strain rate and steeper slopes (e.g. frontal thrusts).

Oral presentation

Comparing fluid-induced interfacial deformation structures (FIDS) with microbially-induced sedimentary structures (MISS)

Paul B. Wignall[1], Jeff Peakall[1], Jim Best[2] and Jaco H. Baas[3]

[1]School of Earth and Environment, University of Leeds, Leeds LS2 9JT.

[2]Department of Earth Science and Environmental Change, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA.

[3]School of Ocean Sciences, Bangor University, Menai Bridge LL59 5AB.

Fluid-induced interfacial deformation structures (FIDS) are common in turbidite successions where they form in soft, cohesive substrates beneath sediment gravity flows, but their significance has only recently been recognised. They occur in a diverse range of forms and in sizes that can span several orders of magnitude. Smaller varieties, with dimensions measured in millimetres, are the most common, and these have morphologies that encompasses most of the morphological types attributed to microbially-induced sedimentary structures (MISS) thereby raising the possibility that the two can be conflated. Variants of FIDS include longitudinal ridges and furrows identical to the linear wrinkle marks assigned to MISS, and polygonal networks, a common form of MISS, together with polygonal and mamillated forms which have both MISS and FIDS representatives. Even the distinctive MISS form with flat-topped ridges and furrows that forms anastomosing networks called Kinneyia is also seen amongst the FIDS spectrum. Distinguishing FIDS from MISS in hand specimen is difficult, but their environmental context is important. MISS are common in shallow-water and intertidal environments where photosynthetic microbial mats can thrive whereas FIDS are unlikely in such settings because sediment gravity flows are rarely encountered. Furthermore, there are ample modern analogues for microbial structures in these environments. However, MISS are frequently recorded from turbidite settings and these could alternatively be ascribed a FIDS origin. One of the few distinctions occurs when textured surfaces are overlain by hemipelagic sediments (rather than a turbidite); in this case a microbial origin is likely.

Oral presentation

PilotSTRATEGY; Scaling up CO_2 storage - pilot studies in EU regions with promising geological resources

Mark Wilkinson

School of Grant Institute, King's Buildings, James Hutton Road, Edinburgh EH9 3FE

PilotSTRATEGY is a Horizon2020-funded project investigating geological CO_2 storage sites in industrial regions of Southern and Eastern Europe to support development of carbon capture and storage (CCS). We are focusing on deep saline aquifers with sandstone and limestone reservoirs which promise a large capacity for storing CO_2.

Detailed studies are being carried out on deep saline aquifers in the Paris Basin in France, the Lusitanian Basin in Portugal and the Ebro Basin in Spain. We will also enhance our knowledge of CO_2 storage options in West Macedonia in Greece and Upper Silesia in Poland. In three countries (France, Portugal, Spain) a single site will be studied to the point that pilot-scale injection could begin immediately after the conclusion of the project – this includes geological characterisation; modelling of injection; risk analysis and permitting from the relevant authorities.

Public engagement is key, especially for onshore storage. PilotSTRATEGY is also engaging with citizens and stakeholders and ensure that community perspectives are fully represented in the project.

PilotSTRATEGY is funded by the European Union's Horizon 2020 programme and involves 16 research partners from seven European countries and builds on research carried out by the EC-funded STRATEGY CCUS project.

Sedimentological work has included field study and sample collection of reservoir and seal analogues, facies analysis and the building of conceptual geological models. These feed into static and then dynamic digital models, into which digital CO_2 can be injected to study CO_2 migration and pressure buildup. Characterising the reservoir and seal has included measuring petrophysical and geomechanical properties. For CO_2 injection, work undertaken includes geochemical testing, to attempt to quantify any chemical reaction between CO_2, in-situ brine and the host rocks. The relative permeability of the reservoir rocks to water and CO_2 has also been measured.

Portugal: The reservoir is the Early Cretaceous Torres Vedras Group, deposited in a fluvio-deltaic shoreline environment with primarily sandstones and intra-reservoir claystones. This is capped by a seal unit of the Cacém Formation (Cenomanian-Turonian), composed of limestones, marls, and clays.

Spain: The reservoir is the fluvial Buntsandstein Formation (the Bunter Sandstone!) overlain by the Muschelkalk formations. The main regional seal is the Keuper Formation.

France: Middle Jurassic prograding carbonate ramp with the development of a shallow-water oolite-dominated barrier in the mid-ramp position. The main seal is Callovo-Oxfordian Marl with reservoirs in the Dalle Nacrée and the Oolithe Blanche formation.

Oral presentation

A forward stratigraphic modelling tool for predicting 3D lithofacies architecture of aeolian and fluvial successions: implications for modelling geothermal reservoirs and carbon capture and storage

Na Yan[1], Luca Colombera[2], Nigel P. Mountney[1], and Grace E. I. Cosgrove[1]

1 Fluvial, Eolian & Shallow-Marine Research Group, School of Earth and Environment, University of Leeds

2 Fluvial, Eolian & Shallow-Marine Research Group, Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Italy

Aeolian and fluvial sedimentary systems record past climate changes due to their sensitivity to environmental variables, such as changing rates of sediment supply, climate, wind regime and palaeoflow, the action of physical, chemical and biogenic stabilizing agents, and also interactions with other coeval sedimentary systems. Due to the interplay of allogenic and autogenic controls, the preserved sedimentary record of aeolian and fluvial systems is highly complex, and exhibits a variety of sedimentary architectures and spatial heterogeneities in facies distributions that are challenging to constrain quantitatively from field-observations alone. Meanwhile, the accumulated deposits of aeolian and fluvial sedimentary successions form important potential subsurface geothermal reservoirs and underground repositories for large-scale carbon caption and storage in both depleted and repurposed hydrocarbon reservoirs, and in very large saline aquifer bodies. This is the case for Triassic mixed aeolian and fluvial successions in the Cheshire Basin of England. However, quantitative reconstruction of detailed 3D aeolian and fluvial sedimentary facies architectures remains challenging due to limited available data. To address this, a novel rule-based forward stratigraphic model, the Dune Architecture and Sediment Heterogeneity model (DASH), has been developed to reproduce three-dimensional sedimentary bodies, bounding surfaces and associated facies distributions formed by a wide range of bedform morphologies and morphodynamic behaviours of aeolian and fluvial sedimentary systems. The DASH model is a geometric-based model that can reproduce different hierarchies of sedimentary architectures and bounding surfaces of aeolian dune and interdune and fluvial dune, barform and sheet-like deposits. The model can be applied to systems for which limited data are available to predict likely sedimentary structure and facies distribution in three dimensions. The model can assist reconstruction of subsurface architectures and can be employed to predict petrophysical heterogeneity, for example to guide models to assess geothermal reservoir potential and to model carbon capture and storage scenarios.

Oral presentation

GeoXtract core database: Redefining data access and analysis

Yousef Abu Yousef [1]

[1] University of Aberdeen, UK

As the demand for digitalization and advanced data management grows in both industry and academia, it becomes crucial to utilize the right tools for data storage, visualization, and analysis. The Sand Injectite Research Group (SIRG) at the University of Aberdeen has developed an extensive core database, which stores raw and interpreted data for 2,699 cored wells, primarily from the UK Continental Shelf (UKCS). This dataset, which includes over 595,000 Conventional Core Analysis (CCA) samples, has undergone rigorous standardization and modification to support petrophysical and reservoir engineering applications.

The database encompasses a wide range of data, including:

- UKCS CCA/Special Core Analysis (SCAL), including porosity, Kh, Kv, grain density, Klinkenberg corrected permeability, overburden corrected permeability and porosity, grainsize and sorting data, Dean Stark analysis, fluid summation porosity, formation pressure, and stratigraphic/lithostratigraphic data for 90% of the wells. We have recently included capillary pressure and relative permeability data for those sand injectite wells with SCAL data. Fluid property data and petrographic analysis is also to be added.
- Original and recent (BGS) core images. BGS core images are concatenated into a single report rather than individual photo plate downloads to enable easy data integration.
- Sand injectite field data (published STOIIP, production volumes, creaming curves of HIIP/reserves per field classification, country, reservoir age and more.
- The database is visualized on Power BI - with a GIS enabled dashboard.
- CCA/SCAL data for 80 wells within sand injectite fields from the Norwegian Continental Shelf (NCS), with the aim of including similar data for all 1775 cored wells from NCS by year end 2024.
- We have commenced incorporating core derived lithofacies interpretation of the 185 UKCS cored sand injectite wells, to provide an additional lithofacies classification to the petrophysical parameters, and to provide a standardised facies interpretation/ library. This dataset is being used to build a ML model to characterize the core facies.

Initially developed to assist SIRG's industrial consortium members, this initiative has now evolved into an academic spin-off called **GeoXtract.** We aim to transform the way geological data is accessed and utilized in industry and research. Our ongoing work aims to incorporate advanced data extraction techniques that eliminates the need to spend time on data collection and transformation and more time spent on use of data and analysis.

Oral presentation

Can lithology beat tectonics in determining sediment export from catchments?

Ziqiang Zhou[1], Alexander C. Whittaker[1], Rebecca E. Bell[1], Gary J. Hampson[1], Reha Chandresh[2], Stephen E. Watkins[3], Jesse R. Zondervan[4]

[1] Department of Earth Science and Engineering, Imperial College London, London SW7 2AZ, UK

[2] Department of Earth Sciences, University of Florence, Florence 50121, Italy

[3] JBA Consulting, 1 Broughton Park, Old Lane North, Skipton BD23 3FD, UK

[4] Department of Earth Sciences, University College London, London WC1E 6BS, UK

Hillslope and channel processes combine to erode topography and release sediments in response to external forcing, such as active faulting. In principle, tectonics can be translated into topography and hence also the sediment grain size exported from landscapes to basins; however, the link between tectonic forcing and sediment grain size is mediated by channel and hillslope processes and is further complicated by lithological variations. Here, we focus on two catchments in the Gulf of Corinth, Greece, which have different tectonic and lithological frameworks, to probe how active normal faulting is propagated through lithologically heterogeneous catchments and into sediment grain size. Topographic analysis reveals that bi-directional hillslope-channel couplings enable both tectonic forcing and lithological variations to be translated into topography. In catchment 1, normal faulting initiated >600 ka is manifested by steepened hillslopes and concentrated mass wasting downstream of knickpoints. In catchment 2, which is perturbed only by active faulting <100 ka, the stronger and mass-wasting-prone bedrock steepens hillslopes and triggers pervasive mass wasting. Combined with the observation that mass wasting produces coarser grains, our data therefore show that both tectonic and lithological forcing are expressed in hillslope sediments in terms of grain size. However, if the bedrock is friable, tectonically induced coarsening of hillslope sediments can be erased by intense abrasion after they reach river channels. This is well-illustrated in catchment 1, where sandstone-siltstone-dominated tributaries do not export coarse sediments, despite intensive mass wasting driven by knickpoints. In contrast, lithologically controlled coarsening of hillslope sediments is preserved in catchment 2, as the sediments in this catchment are resistant to abrasion. In both catchments, selective transport filters out hillslope sediments coarser than the threshold for entrainment, but its impact attenuates rather than obliterates the forcing imprinted in coarse sediments. This non-obliteration effect arises because coarse sediment input itself can increase the entrainment threshold by influencing channel steepness. Finally, we explore how these tectonically and lithologically induced grain size variations in exported sediments may impact hangingwall basins. Consequently, our data show that lithology can overwhelm tectonics in determining the characteristics of sediment exported to basins in areas of active faulting.

Oral presentation

Lithostratigraphic and structural mapping of Sand Injection Complexes using 3D Outcrop Models

Gustavo Zvirtes[1], Matthew Brettle[1], Felipe Guadagnin[3], Robert Waltham[1], Ruy Paulo Philipp[1,2], Andrew Hurst[1]

[1] University of Aberdeen, School of Geosciences, King's College, Aberdeen, AB24 3FX.

[2] Universidade Federal do Pampa, Av. Pedro Anunciação, 111, Caçapava do Sul - RS, Brazil

[3] Universidade Federal do Rio Grande do Sul, Department of Mineralogy and Petrology, Porto Alegre, Av. Bento Gonçalves 9500 - RS, Brazil.

Giant Sand Injection Complexes (GSICs) are a significant component of sedimentary basins, with the potential to profoundly influence reservoir architecture and characteristics in hydrocarbon systems, as demonstrated in fields from the North Sea.

GSICs form by the development a series of process including: (1) deposition of sandy units overlain by low-permeability strata (e.g. mudstone), (2) development of overpressure within the buried sands, (3) hydrofracturing induced by fluid overpressure, (4) fluid escape, leading to sediment fluidization and injection into the resulting fracture network, and eventual extrusion on the surface. These processes can deeply modify depositional sandy units and create extensive intrusive networks of permeable sandstone dykes, sills, and injection breccias, which can extend laterally for tens to hundreds of kilometres and vertically transect hundreds of meters of stratigraphy. The complex and irregular geometries, however, make the mapping and characterization of GSICs highly challenging, especially in subsurface due to limited seismic detectability of small and steep features, and spatially restricted well dataset. To address these challenges, outcrop studies are essential for better understanding GSIC architecture and reservoir characteristics, thereby supporting subsurface seismic interpretation, well data analysis, and reservoir modelling.

This study focuses on the use of Digital Outcrop Models (DOMs) to visualize and interpret the depositional and intrusive architecture of the Tumey Giant Injection Complex (TGIC), a GSIC developed in the marine slope succession of the Kreyenhagen Formation within the forearc basin setting of the San Joaquin Basin, Central California.

The research targeted two key areas, the Tumey Hills and Monocline Ridge, where slope channel complexes successions were heavily deformed by sand fluidization and injection, resulting in large-scale interconnected stepped intrusions (saucers and wing-like intrusions) and injection breccias. High-resolution DOMs (0.5–2 cm/pixel) were created and analysed with the following objectives: (1) mapping of large-scale lithostratigraphic boundaries and structures, (2) defining depositional and intrusive facies and cross-cutting relationships, (3) characterizing external geometries and internal features, and (4) extraction of information for reservoir characterization (e.g., Net/Gross and connectivity), (5) ground-truthing interpretations from pre-fieldwork DOMs analysis, and (6) building of accurate realistic geological model concepts.

The integration of the fieldwork data and the analysis of DOM`s of the TGIC proved to be a powerful and essential method for a robust and detailed mapping of injectites. This integrated approach provides a robust framework for understanding GSIC development, geometry, and its implications for subsurface reservoir modelling. The study not only demonstrates the effectiveness of DOMs for detailed outcrop analysis of complex architectural elements and also highlights their value in bridging the gap between field observations and subsurface datasets.

Poster presentation

Characterization of Reservoir Facies to Evaluate CO_2 Storage Potential: Fram Field, Central North Sea, UK

Muhammad Faisal Abbasi

University of Manchester, UK

This study investigates the CO_2 storage potential of the Fram Reservoir in the Central North Sea through a detailed analysis of reservoir facies, structural heterogeneity, and mineral distribution. Using a multi-scale approach, the research integrates core samples, CT scans, X-ray diffraction (XRD), scanning electron microscopy (SEM), and petrographic analysis to characterize the geological and petrophysical properties crucial for effective carbon capture and storage (CCS). Analysis of a 37.19-meter core from Well 29/3C-8 reveals fine-grained sandstones interbedded with mudstones, underscoring significant lithological and mineralogical heterogeneity within the Forties Sandstone Member. Ten distinct geological zones were identified, each with unique lithological and petrophysical characteristics, providing a refined understanding of the Fram Reservoir's suitability for CCS.

Facies analysis indicates the presence of thick-bedded, well-sorted sandstones with porosities of up to 27.7% and permeabilities of up to 90.76 mD, making these zones ideal candidates for CO_2 injection. Additionally, the heterolithic medium-bedded facies, with porosities reaching 26.6% and moderate permeability, offer supplementary storage capacity. Conversely, clay-rich thin-bedded facies act as natural CO_2 seals and baffles due to their low permeability (as low as 0.002 mD) and higher clay content, which ensures vertical containment and lateral migration of injected CO_2 respectively.

Mineralogical analysis of the Fram Reservoir identifies critical minerals such as quartz, Clinochlore, and Clinoferrosilite, which enhance structural integrity, while clay minerals like chlorite and kaolinite improve sealing efficiency. Variations in permeability across the identified facies direct CO_2 flow and pressure, promoting stable long-term storage. High-quality injection zones, combined with robust sealing layers, underscore the Fram Reservoir's suitability for geological carbon sequestration.

This research underscores the importance of lithological and structural heterogeneities in optimizing CO_2 storage potential. The Fram Reservoir presents a viable model for CCS initiatives, contributing to the UK's carbon reduction efforts and climate change mitigation goals. By highlighting the reservoir's key geological features and petrophysical properties, this study supports the development of effective carbon capture and storage strategies in complex subsurface environments.

Poster presentation

Facies model of a heterolithic tide-influenced to tide-dominated succession – the Early Jurassic Tilje Formation in the Smørbukk Field, Halten Terrace, Mid-Norway

Lucie Alain[1], Christian Haug Eide[1] & Agustin Argüello Scotti[1]

[1]University of Bergen, Norway

Tidal systems are relatively less understood compared to fluvial and wave systems. This is partly because they are characterized by complex heterolithic successions due to frequent changes in flow velocity. Furthermore, tidal successions often make complex reservoirs because thin-bedded heteroliths result in drastic changes in porosity and permeability even at the lamina-scale. The Tilje Formation was deposited in the narrow Early Jurassic Seaway during the opening of the North Atlantic. It is a highly heterogeneous tidal succession from which reservoir properties have been preserved down to 6 km due to the occurrence of chlorite coats. However, the sedimentological controls on the distribution of chlorite coats are poorly understood. The aim of this study is to develop a facies model for the Tilje Formation in the Smørbukk field to unravel the complex depositional patterns caused by the shifting influence of tidal processes. The dataset consists of four cores and wireline logs from the Smørbukk Field that have been used for detailed description of facies and facies associations. Sedimentary facies, depositional sub-environments and architectural elements are correlated across the study area. The lower part of the formation was deposited in low-relief valleys during a period of sea-level fall by tide-dominated estuaries and aggrading deltas. The upper part of the formation is characterized by mixed-energy deltaic deposits showing the influence of tide, wave and fluvial processes. This study is part of an effort to develop more comprehensive models for tidal systems, as well as to advance the understanding of the controls of sedimentary processes on the occurrence of chlorite coats in the subsurface.

Poster presentation

Sedimentary and petrologic characterization of sediment gravity flow deposits and seabed topography interactions: examples from the Eocene of the South Pyrenean Foreland Basin

Alberjón-Peñas, T.[1], Poyatos-Moré, M.[1], Roigé, M.[1], Kane, I.A.[2], Peakall, J.[3], Andrews, S.D.[3] and Hodgson, D.M.[3]

[1]Universitat Autònoma de Barcelona, Spain
[2]University of Manchester, United Kingdom
[3]University of Leeds, United Kingdom

In tectonically-active deep-water settings, the grain size, shape, and mineralogy (and hence reservoir quality) distribution of sediment is controlled by interactions of gravity flows with seabed relief. Thick amalgamated sands tend to deposit in syn-tectonic axial fairways, but marginal (lateral and fringe) areas generally show more heterogeneous successions. These thin-bedded and heterolithic packages are critical to understand, as they can record sediment bypass/ponding, act as stratigraphic traps against confining slopes, inform about likely distribution of reservoir sands in adjacent, up- or down-slope positions, and influence diagenetic patterns.

Interaction of gravity flows with muddy substrates also controls heterogeneity in these successions, because entrainment of mud increases cohesion and induces flow transformations. A range of resulting bed types, such as hybrid event beds, banded sandstones, and mixed grain-size bedforms, result in complicated patterns of reservoir quality and cement distributions. This type of bed-scale heterogeneity is below seismic resolution and conventional well-log scales, and therefore image log or core data analysis, complemented with outcrop analogue studies, are required to improve reservoir evaluation and reduce uncertainty and risks in production and storage.

This project will document bed-scale heterogeneities in the Eocene deep-water succession of the South Pyrenean Foreland Basin (Hecho Group), which comprises excellent exposures of submarine slope, basin floor fan and basin-plain deposits. These deposits accumulated in a structurally-confined foreland trough, with a complex seabed topography, and contain evidence of flow interaction with dynamic slopes and muddy substrates. Previously, a wide range of bed types and bedforms have been documented from a range of environments. However, their detailed bed-scale geometry, textural and lithologic transitions have not yet been constrained.

The objectives of this research project are to: a) document facies, textural and compositional transitions in different bed/bedform types from a range of sub-environments, and establish the position and orientation of deposits with respect to syn-tectonic structures/slopes; b) analyse and compare bed/bedform variability at different stratigraphic positions to address how primary processes differ spatially and geographically; c) develop an extended recognition criteria matrix (sedimentary and petrologic) of thin-bedded deposits across deep-water systems to include mixed grain-size bedforms, in order to calibrate for different grain size ranges and process regimes.

Poster presentation

Uncertainties in the inverse modelling of suspension-dominated flows from their deposits

Lawrence Amy[1], Robert Dorrell[2] & Jaco Baas[3]

[1]School of Earth Sciences, University College Dublin, Ireland.

[2]Energy and Environment Institute, University of Hull, Hull, HU6 7RX, UK.

[3]Bangor University, School of Ocean Sciences, Menai Bridge, Anglesey, LL59 5AB, UK

Previously a variety of modelling approaches have been used to attempt to estimate the properties of sediment-transporting flows from their deposits. Here, the uncertainties associated with inverse modelling of suspended-load dominated flows (e.g., sand-bed rivers and turbidity currents) from their deposit grain size are examined. A flow-power flux-balance (FPFB) model that equates the net rate of sediment entrainment with the net rate of deposition and describes flow capacity and competence under equilibrium conditions is applied to the problem. Firstly, the FPFB model is validated against laboratory data by showing that the forward model accurately predicts deposit particle size distribution given a known transported-bulk particle size distribution, particle concentration, shear velocity and flow depth. Secondly, application of the FPFB model is used to show that a unique inverse solution is not possible i.e. multiple combinations of flow conditions and transported bulk particle size distributions provide a significant goodness of fit to a specified deposit particle size distribution. The uncertainty in estimated transported particle sizes, shear stresses and slope are quantified. The results have implications for the reconstruction of historical and geological flows from their deposits highlighting the limitations in prediction.

Poster presentation

How are different types of particulate organic carbon transported and buried by turbidity currents?

Megan L Baker[1], Joris T Eggenhuisen[2], Pelle Adema[2]

[1]Department of Geography, Durham University, Durham, DH1 3LE, UK

[2] Faculty of Geosciences, Utrecht University, P.O. Box 80021, 3508 TA Utrecht, Netherlands

The burial of organic carbon in marine sediments over geological timescales leads to a net drawdown of atmospheric CO_2, aiding regulation of the long-term climate. It is increasingly recognised that the mass of particulate organic carbon (POC) transported by turbidity currents and buried in submarine fans (e.g., Bengal Fan, Congo fan) can be significant. However, it is vital to understand how turbidity current flow behaviour controls the transport and burial of POC to constrain the organic carbon burial efficiency of these flows. Moreover, POC consists of many different fractions, with varying densities, shapes, and sizes, that may control how it is transported and deposited by turbidity currents.

Experimental turbidity currents containing 250µm and 1000 µm leaf and wood fragments were produced in an 11-m long flume to understand how different POC fractions are vertically segregated within a low density (5% volume concentration), decelerating turbidity current. Ultrasonic Doppler Velocity Profilers at 4 m and 10 m were used to measure the flow velocity profiles and combined with syphon sampling to produce sediment and POC concentration profiles. The flow deposits were sampled every 2 m at 5 mm vertical resolution to measure the vertical and along-flow POC burial distribution. To determine the POC content, the sediment samples were measured for total carbon percentage using an Analytik Jena Multi EA (Elemental Analyser) 4000 and normalised by the total carbon percentage in the mixing tank to determine total carbon (TC) content. Settling velocity measurements in a settling column established the average particle settling velocity of the four POC-types.

The flow deposit contained a clean basal sand layer which thinned from 5 mm-thick at 2 m along the flume to pinching out at 6-8 m along the tank. A 2 mm-thick silt layer above the sand extended along the length of the flume. For all POC types, bar the 1000 µm wood, the POC was deposited in the silt bed above a clean sand bed, matching observations of POC distribution in natural sand-rich turbidite systems (e.g., Bute Inlet). The 1000 µm wood was the POC-type deposited in the greatest amount within the silt bed, with an average total carbon (TC) of 3.8. This was followed by 1000 µm leaf (average silt-bed TC = 2.2), 250 µm wood (average silt-bed TC = 2.0), and 250 µm leaf (average silt-bed TC = 1.7).

The measured particle settling velocities of the different POC types can aid interpretation of the results. The 1000 µm wood has the highest particle settling velocity of 24.8 ± 4.4 mm s^{-1}. This resulted in strong POC vertical stratification in the flow, with a low depth-average TC content of 0.55 at 4 m along the flume, and the highest deposition of this POC-type. In contrast, the flow carried the largest amount of 250 µm leaf, which had a low particle settling velocity of 6.4 ± 2.2 mm s^{-1}, resulting in a depth-average TC content of 1.79 at 4 m along the tank. The 1000 µm leaf and 250 µm wood had relatively similar particle settling velocity values (12.6 ± 3.5 mm s^{-1} and 9.4 ± 3.0 mm s^{-1}, respectively) with similar average silt-bed TC contents and vertical distribution of material within the flow.

These results suggest that the settling velocity of different POC-types may be a useful tool to predict trends in the transport and deposition of particulate organic carbon along turbidity current flow paths and across submarine fan architectural elements.

Poster presentation

Sedimentological Analysis of Deposits Formed by Turbidity Currents in the Presence of Obstacles: A Physical Experimentation Study

Larissa Bergamini Santos[1], Ricardo Giumelli Marquezan[1], Daniel Bayer da Silva[2] & Rafael Manica[2]*

[1] Centro de Engenharias - Universidade Federal de Pelotas - Brasil

[2] Instituto de Pesquisas Hidráulicas - Universidade Federal do Rio Grande do Sul - Brasil

*engeolarissa@gmail.com

Deep marine environments exhibit geological features, such as mini-basins, that create obstacles to turbidity current deposition. To investigate the impact of these obstacles on the sedimentological record of turbidites, this study employed physical experiments in a flume (500 cm x 20 cm x 50 cm) with three simplified topographies. Three triangular obstacles of 6 cm (labeled 1) and 3 cm (labeled 0) in height were positioned along the flume at 220 cm, 270 cm, and 320 cm. Four experiments were conducted: one to test the methodology and three with obstacles arranged in different configurations (101, 100, and 001). The turbidity current was generated using a sediment mixture of 90% mineral coal (1400 kg/m³) and 10% kaolin (2600 kg/m³), with a bulk volumetric concentration of 10% and a mean particle size (Dmean) ranging from 15 to 80 µm. A discharge rate of 10 L/min over 10 minutes was injected into the flume. The experiments were recorded laterally to assess the hydrodynamic behavior of the currents under the proposed configurations, and the thickness of the resulting deposits was measured. Sediment samples were collected after one hour of deposition. The flow dynamics were notably affected by the obstacles, leading to partial blocking of the turbidity current and the formation of hydraulic jumps downstream of the taller obstacles. In configurations where taller obstacles were positioned distally (101 and 001 setups), backwater effects on the turbidity current were observed. A comparison of deposit thickness and median particle size (Dmean) revealed that the region between the obstacles, at sampling points 245 cm and 295 cm, displayed similar deposit thicknesses (varying by 0.1 to 0.3 cm) and grain sizes (Dmean = 15 to 31 µm), corresponding to medium silt. Coarser silt (Dmean = 31 to 63 µm) was predominantly deposited upstream of the first obstacle (at the 215 cm sampling point) and downstream of the last obstacle (at the 345 cm sampling point). The obstacle configurations influenced sediment accumulation, with higher blockage regions acting as significant sediment traps, particularly near the tallest obstacles.

Poster presentation

The planetary control on how long it took a Millstone Grit delta lobe to be deposited

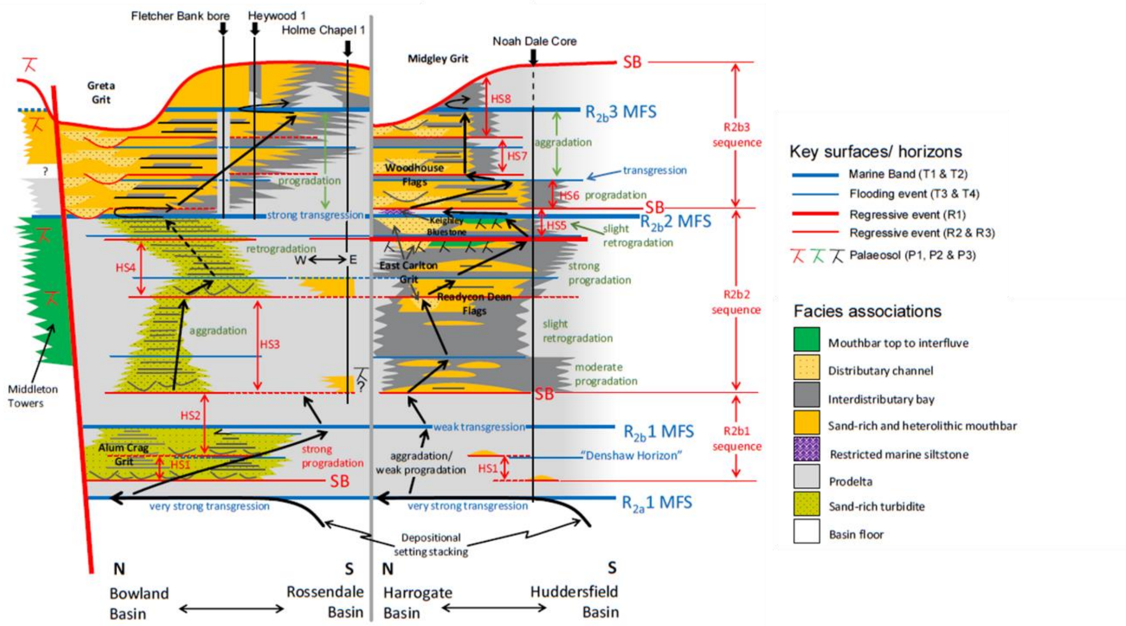
Matt Brettle

School of Geosciences, University of Aberdeen, UK

The early Marsdenian substage (Millstone Grit Group) of the Pennines (partly in Yorkshire) comprises repeated deltaic cycles separated by ammonoid-bearing marine bands. This cyclicity, controlled by the combined forces of glacio-eustasy and modulations in sediment supply, provides a field laboratory - within which the length of time it took these deltas take to be deposited can be estimated.

A sequence stratigraphic correlation framework has been developed and two orders of sequence are identified: (1) a low-order sequence, within which marine bands ($R_{2a}1$, $R_{2b}1$, $R_{2b}2$ and $R_{2b}3$) represent a maximum flooding surface, and (2) high-order sequences nested within the low-order sequences. By integrating and correlating key exposures, historic well boreholes and field mapping, lateral changes in facies and facies association are observed, and palaeogeographic trends mapped. This allows the complex variation in sequence and systems tract stacking patterns to be interpreted.

It is assumed the ammonoid bearing marine bands - which can be correlated across Europe - are glacio-eustatically controlled, and the fluctuation in icehouse/greenhouse conditions are controlled by Milankovitch cyclicity. Three orders of Milankovitch cyclicity are inferred to control the sequence stacking patterns seen in the Marsdenian substage; with long-duration (c. 400 ka) eccentricity oscillation controlling maximum flooding events represented by the $R_{2a}1$ and $R_{2b}2$ marine bands. Sub-100 ka obliquity oscillations probably control the $R_{2b}1$, $R_{2b}2$ and $R_{2b}3$ marine bands and intervening low-order sequence boundaries, while precessional frequencies (c. 25 ka) may have controlled the periodicity of the high-order sequences.



Chronostratigraphic chart of Bowland, Rossendale, Harrogate and Huddersfield basins during the early Marsdenian sub-stage.

Poster presentation

Geological and geotechnical ground models for sustainable offshore windfarm developments

Lydia Brown, David M Hodgson, Natasha Barlow Mark Thomas

School of Earth and Environment, University of Leeds, Leeds, UK, LS2 9JZ

Detailed investigations of offshore wind industry site survey datasets in the North Sea have revealed submerged landscapes and stratigraphic architectures at the foundation of developments, demonstrating an unexpectedly high degree of variability in substrate properties. In northern Europe, this is the result of multiple advances and retreats of large ice sheets. To support a sustainable offshore wind industry, 3D ground models need to capture this complexity, and be dynamic in two senses. Firstly, legacy data is often revealed to be misleading as new state-of-the-art site-specific data is collected. Initial ground models need to be able to incorporate these new insights and constraints on ground conditions through iterative modelling approaches. Secondly, the seabed can be modified through changing patterns of sediment erosion and deposition, which means that the top surfaces of offshore wind models are not static.

An iterative modelling approach means building ground models with a flexible framework that can integrate new geological and geotechnical data during site evaluation and development stages. Next-generation ground models need adaptable geological and geotechnical surfaces bounding stratigraphic units that have distinctive geological and/or geotechnical characteristics. The ground models need the ability to be populated with increasing complexity, and with increasingly empirical constraints, as new data are acquired and palaeoenvironmental interpretations are refined. Developing this workflow to allow iterative model development is crucial to improve windfarm array design, and to avoid over- and under-engineering monopiles, cable routes, and associated infrastructure. It will also position windfarm operators favourably in future repowering opportunities, increasing offshore wind sustainability. Nonetheless, there are many challenges to this iterative approach, such as software, data quality, and timescales, and scenario modelling examples are needed to demonstrate the value.

A sediment mobility modelling approach is critical for offshore windfarm ground models as, distinctively, the character of the upper surface changes in time and space. Repeat bathymetric surveys have demonstrated that the seabed is often highly dynamic. The extreme variability in the erodibility and mobility of shallow substrate sediments needs to be captured l in models to help to forecast changes in erosion and deposition over the lifespan of an offshore windfarm array. Including a dynamic top surface in models is an aspirational approach but would improve cost effectiveness and minimise environmental impacts of siting seabed infrastructure. Currently, capturing the variability in geological and geotechnical properties in the shallow subsurface (~5-10m) is a crucial first step, and due to their unique properties, peats are important to document.

In summary, offshore wind operators face such short timescales to evaluate and develop sites that a proper documentation and interpretation of foundation conditions is not feasible in ground models without external support. This is to the detriment of the industry as a whole, and to medium-term energy transition goals. New workflows are needed that facilitate the construction of ground models that are dynamic both in having an iterative framework, and in accommodating a non-static top surface.

Poster presentation

Origin and depositional processes of volcanic matrix-rich sandstones in the Shanxi and Shihezi Formations, Ordos Basin, China: Implication for volcano-sedimentary systems

Hang Cui[1,2], Nigel P. Mountney[1], Adam McArthur[1], Shifa Zhu[2]

[1]*School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK*

[2]*College of Geosciences, China University of Petroleum, Beijing, 102249, China*

Complex interconnections exist among topography, depositional systems, and volcanic activity within volcanically active regions, creating an intricate web of interactions that influence the geological evolution of these areas. Moreover, volcanic eruptions have the capacity to supply substantial quantities of material that may be reworked into sediment, while simultaneously exposing fluvial valleys and lakes to catastrophic flood events. The Permian fluvio-deltaic system in the Longdong Region, situated southwest of the Ordos Basin, offers a unique 'natural laboratory' for the study of volcanism-related hyperpycnal flow deposits. This system not only showcases abundant evidence of synsedimentary volcanism but also provides insights into the tectonic evolution of the orogenic belt surrounding the basin.

In this investigation, 794.5 m of cores extracted from 32 wells in the Shanxi and Shihezi Formations of the Longdong Region were examined. Depositional processes identified in cores were described in detail, including lithology, grain-size variations, sedimentary structures, and colour. Analyses of flow types and processes were performed through lithofacies classification and interpretation, followed by the determination of sedimentary environments. Subsequently, more than 300 volcanoclastic matrix-rich sandstone samples were collected for various petrographic and geochemical analyses to elucidate the provenance of volcanogenic materials, as well as to unravel their depositional processes.

Detrital zircon geochronology and geochemical characteristics suggests that the volcanogenic materials were not sourced from the Yinshan-Yanshan Orogenic Belt as previously hypothesized, but rather points towards a southwestern origin from the North Qinling Orogenic Belt. Integrating these findings with the mapped distribution patterns of volcanogenic materials and the regional tectonic setting, it is inferred that the crater may have been situated in the western or southern regions of the Longdong Region. The volcanogenic materials, having accumulated in the sediment source area during the intense volcanic activity, were rapidly transported into the basin via a fluvial system shortly following each eruptive event. Based on the color, sedimentary structure, and grain size attributes of volcanic matrix-rich sandstones, thirteen distinct lithofacies were identified through core observations. According to the conceptual schema associated with hyperpycnal systems, Lithofacies 1 to Lithofacies 6 can be attributed to Facies B (bed load) and Lithofaices 7 to Lithofacies 13 can be attributed to Facies S (suspended load). These predictive facies are widely applied to the identification of sustained turbulent (noninertial) hyperpycnal flow deposits caused by flood events. Therefore, it is inferred that the sedimentary sequences associated with volcanic matrix-rich sandstones were the result of the formation and development of an ancient hyperpycnal river-delta system. Insights from this study permit the delineation of a refined depositional model for the volcanic matrix-rich sandstones.

This study puts forward the hypothesis of previously uncharted tectono-thermal events occurring in the North Qinling Orogenic Belt during the Permian. Such events serve to validate and bolster the existing theoretical work on volcanism-related hyperpycnal flows. Furthermore, this research offers new perspectives into the depositional processes in lacustrine basins with comparable tectonic settings.

Poster presentation

Sedimentology and magnetostratigraphy of the early Paleocene Fort Union Formation (Montana, USA)

Gijs van Dijk, Hemmo Abels**, Marieke Cuperus*, Frits Hilgen***, Wout Krijgsman***, Jasper Maars**, Sam de Vries***, Klaudia Kuiper**

**Department of Earth Sciences, VU University Amsterdam*

*** Department of Geosciences and Engineering, Delft University of Technology*

**** Department of Earth Sciences, Utrecht University*

The Paleocene Fort Union Formation (Williston Basin, Montana, USA) is a well-exposed paralic sedimentary sequence, with meter-scale alternations between coals and clastics. These alternations appear cyclic and can be traced over 10's of km's without significant interruption. In 2018, two conceptual models were developed to explain the observed cyclicity in the Fort Union by astronomically-forced climatic variations. Further testing of the validity of these conceptual models can fundamentally improve our means to disentangle internal and external controls on alluvial stratigraphic architecture. Moreover, it can provide ways to quantify global peatland carbon storage in the terrestrial biosphere, during past hothouse climates.

Here we present new field-based (photogrammetric, sedimentologic, paleomagnetic) data that enables to upscale the correlation of a sequence of several coal-clastic alternations in the Ft Union Fm from 10 km to 200 km, using a facies model, magnetostratigraphic reversals, and volcanic ashes. We demonstrate the isochronous nature of at least two basin-wide environmental changes at 400kyr time scale, and we show progress in dating and documentation of coal-clastic alternations at the 100kyr time scale.

Poster presentation

The primary factors influencing failure mechanisms and evolutionary patterns of slow-moving subaqueous landslides: an experimental assessment

Weijian Gao[1,2], Yan Li[3], Wei Li[1,2], David Hodgson[3], Jeff Peakall[3], Gareth Keevil[3], Helena Brown[3]

[1]CAS Key Laboratory of Ocean and Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, P.R. China

[2]University of Chinese Academy of Sciences, Beijing 100049, P.R. China

[3]School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK

Slow-moving subaqueous landslides (SMSLs) are primarily gravity-driven and very low velocity mass movements, which deform substrate above (or without) well-defined glide planes. SMSLs can be categorised into four distinct process-based types: creep, spread, slow mudflow and slow flank slump. When the shear stress exceeds the cohesion and yield strength of the strata, SMSLs can evolve into rapid slope failures. However, the failure mechanisms and deformation styles of SMSLs are not well characterised, and the evolutionary transition between SMSL types is poorly understood. Physical experimental models on SMSLs have been conducted to quantify and assess complete slope failure events, and to determine factors influencing clay-rich SMSL events.

Here, all experiments were performed with kaolin clay and glass micro beads. The water content and ratio of glass beads to clay control the initial physical properties of sediments. The variations of glide plane include thickness, composition, and lateral extent. We systematically vary the sediment composition, slope gradient and glide planes to condition the initial material prior to failure. Each model was triggered by pre-loading sediments within the lock section of the slope flume and then rapidly pulling out the gate. We documented the evolving morphology of the entire failure slope, and the style and velocity of sediment transport (extensional area to downslope compressional area).

The experiments show that multiple phases of SMSLs can be generated by inserting a siliceous glide plane when the medium shear strength sediments are pre-placed on a gentle slope (~15°). The frontal sediments underwent small-scale slumps, spreading processes occurred above the glide plane within the middle region of the failed slope, and the head area experienced long-lasting cracking and creeping processes. The different slide styles may indicate variations in the capability of the strata to adapt to excess shear strains. Once a failure event starts at a critical effective stress, its velocity is regulated through dilation and pore expansion within the glide plane, temporarily increasing effective stress within/above a narrow glide plane and suppressing rapid shear failure. This experimental study sheds light on the diverse effects of sediment composition and the nature of the glide plane on failure mechanisms of SMSLs, providing crucial insights for hazard assessment in offshore engineering.

Poster presentation

Part I - Facies diversity of a mixed carbonate-siliciclastic arid tidal flat: insights from the middle Jurassic Carmel Formation, Utah, USA.

Victor J.P. Hême de Lacotte[1], Chester H. Davies[1], Stuart M. Clarke[1], Briony J. Bowler[1], Douglas A. Sprinkel[2]

[1]Keele University, United Kingdom

[2]Utah Geological Survey, United States of America

Ancient aeolian deposits are considered as potential 'deep saline aquifer' targets for carbon sequestration. In such scenarios, reservoir sealing relies upon the stratigraphical and sedimentological relationships between aeolian sediments and those deposited by the surrounding contemporaneous systems. By documenting the record of marginal tidal environments bordering coastal aeolian systems, this work aims to investigate the facies diversity, depositional processes and inherited stratigraphical heterogeneities for lateral aeolian reservoir seals. Ultimately, this work will produce a generalised model for mixed carbonate-siliciclastic arid tidal flat environments.

This study is the result of extensive fieldwork focusing on the facies distribution and the stratigraphical arrangement of a middle Jurassic shallow-marine succession cropping out along the Colorado Plateau, USA. Regional-scale sedimentary logging has been conducted through the tidally-dominated units of the Carmel Formation (San Rafael Group) deposited during a full transgression-regression sequence of a restricted epicontinental seaway incursion - Sundance Sea - along the Utah-Idaho Trough structural low. Detailed facies analysis of 25 sections enabled basin-scale correlations across several hundred kilometres and identification of key sedimentary architectures for arid tidal flats.

Results show sedimentary signatures of intricate coastal driving forces with variable relative influences of swell and tide, as well as the coexistence of locally produced carbonate grains and externally sourced siliciclastic material. Subtidal deposits include bioclastic-rich oolitic tidal bars, wave-dominated shoreface to foreshore transitions and tidal channel fills. Intertidal deposits comprise a mixture of purely siliciclastic and mixed carbonate-siliciclastic heterolithic flats bordered by microbial mats in the upper intertidal zone. Evaporitic sabkha units and regularly flooded aeolian dunes are observed in the supratidal zone. Although two shallowing upward sequences are observed on a regional scale, correlating facies associations between sections remain challenging due to strong autogenic signal overprints (*cf.* Poster 2). The work illustrates the importance of considering complex facies heterogeneities at aeolian margins for evaluating stratigraphical sealing of deep saline aquifer targets for CO_2 sequestration.

Poster presentation

Part II – The effect of scattered facies distribution on apparent stratigraphic disorder in low gradient paralic systems.

Victor J.P. Hême de Lacotte[1], Chester H. Davies[1], Stuart M. Clarke[1], Briony J. Bowler[1], Douglas A. Sprinkel[2]

[1]Keele University, United Kingdom

[2]Utah Geological Survey, United States of America

Modern tidal flat environments show complex morphodynamic characteristics driven by a large spectrum of autogenic controls. Predictions of global sea-level rise have promoted active research focusing on the sedimentary response of low-gradient systems to larger-scale allogenic forcing, but our understanding of their expression in the rock record is challenged by the strong autogenic overprint potential of such systems. Understanding plan-view geomorphological complexities inherent in the erratic nature of tidal flats is crucial in discriminating preserved allocyclic patterns from 'autogenic noise' in equivalent stratigraphic successions.

The mixed carbonate-siliciclastic tidal succession of the middle Jurassic Carmel Formation (San Rafael Group) exposed in southeastern Utah, USA is associated with a low-gradient shallow marine to sabkha sedimentary system deposited along the shore of the Sundance Sea. This sea represents a restricted epicontinental seaway flooding the North-South trending Idaho-Utah Trough, bordered by the contemporaneous aeolian deposits of the Page Sandstone. Modern tidal sediments of the Adair Bay, Mexico have been assessed in order to document spatial distribution complexities of systems analogous to the preserved strata of the Carmel Formation.

Deposits of the Carmel formation are characterised by high facies diversity (*cf.* Poster 1) arranged in an apparent stratigraphic disorder which is suggested to be governed by a combination of autogenic processes controlling the spatial distribution of sediments at a high-resolution. Mapping the comparable facies associations of Adair Bay using satellite imagery highlights a scattered and disconnected distribution of coexisting sedimentary facies within tidal system tract belts due to the near zero gradient of the depositional slope of such paralic systems.

Similarly to tidal resonance stratigraphic overprint (*Zuchuat et al., 2019*), high resolution facies scattering on low gradient slope coastal environments should be accounted for when interpreting preserved strata of such kind. Linking the stratigraphic record of tidal flats to plan-view sedimentary processes can help predict the sedimentary response of modern equivalents to base-level change(s) affecting vulnerable urbanised coastal plains.

Poster presentation

Microplastic transport and settling in the ocean due to biofilm growth: an interactive online teaching model to communicate scaling in environmental pollution

Mia J. Hughes[1] and Ian A. Kane[2]

[1]*School of Earth and Environmental Science, University of Leeds, LS29JT, UK*

[2]*Department of Earth and Environmental Sciences, University of Manchester, UK*

Microplastics pervade the sea surface, the water column, and the deep seafloor. They are vectors for other pollutants, such as heavy metals, pesticides and PFAS. A question remains as to how microplastics reach the seabed, over what time scales, and where they will end up. Many plastics initially float due to their low density, or to being incorporated into items with air cavities, but this buoyancy can reverse over time due to the growth of biofilms, or mineralisation of surfaces, and the breakdown of larger plastic objects. Understanding the spatial and temporal scales of ocean pollution is challenging, e.g., how can we understand the behaviour of a single microplastic bead in an ocean the size of the Pacific? Traditionally, particle settling is expressed using simple equations to express terminal settling velocity in 1D. Here we present an interactive online model for students to investigate the fate of microplastics subject to biofilm growth, using applets, to replicate a 1D laboratory setting with seawater or fresh water, and a simple 2D ocean setting model. The model animates the trajectory of a plastic particle on which biofilm is growing at a constant rate, incorporating: i) Gravitational force (weight of plastic plus biofilm); ii) Buoyancy; iii) Stokes drag (proportional to velocity); and, iv) Form drag (proportional to velocity squared). The 2D model incorporates a surface current to demonstrate how far microplastics may travel on the surface prior to sinking due to biofilm growth. Students can vary microplastic densities and sizes to observe how long biofilms need to grow before the onset of sinking occurs. Simple exercises can be developed for classroom teaching allowing students to test these parameters in a fun applet-based platform. Depending on the pedagogical objectives, students can use a range of provided parameters, or perform research to find their own. This active learning model has clear pedagogical benefits over simple passive learning approaches, communicating environmental pollution and the scales of earth systems, for students from high school to university levels and in classroom, hybrid or remote teaching scenarios.

Link to 1D (laboratory model): https://www.geogebra.org/m/refpu3kc

Link to 2D (ocean model): https://www.geogebra.org/m/xgkuaugk

Poster presentation

Characterisation of lithological heterogeneity in mixed fluvial-aeolian successions of the Triassic Sherwood Sandstone Group, NW England: implications for carbon capture, utilisation and storage

Jack P. Humphries1, Nigel P. Mountney1, Adam D. McArthur1, Samuel A.R. Scott1, Na Yan1, Grace I.E. Cosgrove1, Luca Colombera2 and Vern Manville1

[1]*School of Earth & Environment, University of Leeds, UK*
[2]*Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Italy*

Understanding stratigraphic heterogeneity in continental sedimentary systems is crucial for assessing the viability of reservoirs of fluvial-aeolian affinity for carbon capture, utilisation, and storage (CCUS). However, most subsurface targets for CCUS lack the data resolution to effectively characterise multi-scale lithological heterogeneities that influence reservoir injectivity and fluid-flow. Assessment of the origin, distribution and controls on the development of such heterogeneities remain poorly constrained. As such, high-resolution studies of outcrop analogues are essential for quantitative lithological characterisation.

Here, we utilise the Sherwood Sandstone Group (SSG) in northwest England as analogues for CCUS reservoirs in the East Irish Sea Basin (EISB) and North Sea. The SSG is represented by mixed fluvial-aeolian successions with complicated architectural geometries, variable stacking patterns and a range of facies that dictate stratigraphic heterogeneity. Detailed high-resolution studies are key to assessing reservoir properties, including porosity, permeability, reservoir capacity and injectivity. The architecture of baffles, barriers and top-seals that dictate fluid-flow pathways, are also important to assess as they mitigate the risk of unwanted fluid migration from the subsurface host.

This study employs and integrates multiple methods to produce high-resolution, quantitative geological models that can be applied to predict the flow behaviour of CO2 in analogous reservoirs of the EISB and North Sea. Outcrop-based lithofacies analysis involved the construction of graphic sedimentary logs and architectural panels collected across well-exposed outcrops of the SSG. Key stratal relationships were established and referenced using drone-acquired photogrammetry of large and prominent outcrops (e.g. Runcorn, Helsby Hill, Farndon and Grinshill). The use of photogrammetry enabled the construction of quantitative 3D models and the precise analysis of facies distribution and connectivity in otherwise inaccessible sections of outcrops. Integration of this data with geological maps and results from previous studies allowed for multiple models to be developed that characterise the successions at a range of scales from smaller facies units, to architectural elements, to larger depositional elements, to entire stratigraphic units. Heterogeneities were identified that arise in response to depositional processes operating across a range of fluvial-aeolian system types.

Results demonstrate significant lithological heterogeneity within the SSG, from the scale of individual beds to entire reservoirs. These heterogeneities represent, for example, the complex interactions between dune and interdune facies in aeolian units, and between different types of channel and overbank facies in fluvial units. Further work is to integrate photogrammetry models and to extend the study area further north to the Wirral, Lancashire, Cumbria, and south to Shropshire, and east to Staffordshire.

This study comes at a critical time for the development of practical solutions to mitigate climate change, given the UK government's recent commitments to heavily invest in CCUS over the coming decade. These results enhance our understanding of heterogeneity in mixed fluvial-aeolian reservoir types, and how this will impact fluid-flow properties in CCUS reservoir successions.

Poster presentation

The stratigraphic records of atmospheric microplastic transport in highland and lowland peat bogs

Ji, X.

Department of Earth and Environmental Sciences, University of Manchester, Manchester, M13 9PL, UK.

This study investigates the stratigraphic records of atmospheric microplastic transport in highland and lowland peat bogs, aiming to understand the sources, migration, and deposition of microplastics. Recent studies have shown that microplastics are widely dispersed across global ecosystems, with varying residence times in the atmosphere, oceans, cryosphere, and terrestrial environments. However, limited understanding of their sources and pathways has resulted in significant uncertainties regarding their environmental impacts. Atmospheric deposition is considered a primary source of microplastics in remote areas, making it a critical component of the global plastic cycle.

Peat bogs, especially ombrotrophic types, provide a unique opportunity to explore the historical deposition of microplastics. Ombrotrophic bogs, which receive inputs solely from atmospheric deposition, offer a direct link to atmospheric pollution and preserve environmental records in a way that other continental archives cannot. These bogs are distributed across diverse geographic regions, allowing for comparisons of microplastic pollution across different environmental contexts. The low temperatures, water saturation, and low microbial activity in peat cores help preserve the integrity of microplastics, providing high-resolution records of atmospheric pollution over centuries.

Although peat cores have been used to reconstruct past environmental and climatic changes, microplastic pollution in peat bogs remains understudied. This research focuses on improving the extraction methods for microplastics from peat bogs, addressing challenges such as organic matter interference, particle separation, and procedural contamination. By refining these methods, we aim to gain insights into the long-term deposition trends and the potential risks of microplastic pollution to ecosystems and water resources.

This research will contribute to understanding the pathways of atmospheric microplastics and their deposition in peat bogs, shedding light on the historical patterns of this emerging pollutant. It also provides a novel perspective on using microplastic records as stratigraphic tools to reconstruct past environmental changes, offering valuable insights into the impact of human activity on the environment and climate change.

Poster presentation

Modelling CO_2 Flux Regimes Post-Injection – Diffusion, Convection and Gravity Slumping

Sean Kelly

University of Aberdeen

Dynamic modelling of CO_2 injection into saline aquifers reveals distinct regimes of CO_2 flux, each with varying durations and magnitudes. These regimes, critical for predicting long-term CO_2 fate and optimizing storage strategies, describe the evolution of CO_2 dissolution and migration. *Reservoir geology and properties* (structure, thickness, heterogeneity & permeability) and groundwater flow significantly influence these regimes, impacting long-term dynamics and behaviour.

The following flux regimes (in an ideal sequence) can be identified:

Early Diffusion (ed): In this initial regime, CO_2 dissolves into the brine *primarily through diffusion.* There is *negligible convective enhancement* of the dissolution.

Fingering (f): As dissolved CO_2 increases in the brine near the CO_2 plume, it leads to a density inversion. The denser CO_2-rich brine sinks in the form of *fingers*, while relatively unsaturated water rises, *enhancing the dissolution rate* compared to the diffusion regime.

Shutdown/Fingering (sf): As the system evolves, three distinct zones develop:

- *Inner Zone (iz):* Dissolved CO_2 from the sinking fingers recirculates back to the top of the CO_2 plume, *reducing the concentration gradient* and *slowing down the dissolution*. This is similar to the *convective shutdown* observed in closed systems.
- *Outer Zone (oz):* Relatively fresh water from outside the CO_2 plume region flows in along the top of the aquifer. This water is unsaturated and leads to *continued fingering and high dissolution fluxes.* This inflow is a countercurrent to the flow of denser, CO_2-rich fluid migrating away from the CO_2 plume along the bottom of the aquifer.
- *Middle Zone (mz):* The dissolution flux transitions between the inner and outer zones.

Shutdown/Slumping (ss): As the CO_2-rich gravity current migrating along the bottom of the aquifer grows in extent, the flux of CO_2 out of the plume region *decreases with time*. This causes the dissolution flux into the outer zone to also *decrease with time*, in contrast to the constant flux observed in the shutdown/fingering regime. The gravity current exhibits a *sharp boundary* with the overlying, counter-current flow of unsaturated water.

Shutdown/Taylor Slumping (sT): Similar to the shutdown/slumping regime, dissolution *is limited by the migration of the CO_2-rich gravity current*. However, in this regime, the boundary between the gravity current and the overlying unsaturated water flow becomes *diffuse* and the dissolution flux in the outer zone decreases *sub-diffusively in time.*

Taylor Slumping (Ts): Dissolution at the edge of the CO_2 plume continues to be *limited by the migration of the diffuse gravity current*. However, *convective shutdown ceases in the inner zone* due to nearly complete saturation of the aquifer layer.

Late Diffusion (ld): In this final regime, *convection becomes negligible* relative to diffusion. Dissolution is limited by *lateral diffusion through the aquifer*.

Poster presentation

Debris flow-deposit interactions in submarine lobes: process insights from observation of physical experiments

Yan Li, Weijian Gao, David Hodgson, Jeff Peakall, Helena Brown, Gareth Keevil

School of Earth and Environment, University of Leeds

Submarine debris flows can destroy seafloor structures and trigger tsunamis, posing a significant threat to coastal communities. Our research based on the observation of 3-dimensional seismic data from offshore NW Australia shows that submarine debris flows can self-confine, which results in sequential basinward deposition of debrite lobes. Previous research on submarine lobes has focused on turbidity currents, consequently the importance of debris flows in the formation of submarine lobes has been little studied. Such flows can incise the underlying substrate along the path, bulk up, and thus undergo extreme increases in volume during emplacement. However, the debris flow-deposit interaction processes governing this evolution of submarine lobes, are hard to disentangle from seismic reflection data.

Previous work on subaerial debris flows has used physical experiments to analyse the erosion processes of debris flows, however, there remains a lack of equivalent work on subaqueous debris flows, and their entrainment of water-rich substrates. Our aim is to further understand how the flow interacts with the underlying substrate and an evolving depositional relief through analysing the process interactions of subaqueous debris flows and their deposits through physical experiments. Physical experiments were carried out and monitored in the Sorby Environmental Fluid Dynamics Laboratory, using a layered protolith with different characteristics (e.g., clay percentage, grain size) in order to explore how coherent flow interacts with substrates.

Poster presentation

Hothouse hydrology: river dynamics in the Eocene Montllobat and Castissent Formations, southern Pyrenees

Jonah S. McLeod[1], Alexander C. Whittaker[1], Gary J. Hampson[1], Rebecca E. Bell[1], Marine Prieur[2], Luis Valero[3], Oliver G. Fuller-Fields[1], Xiang Yan[1], Jeffery M. Valenza[4]*

1 Department of Earth Science and Engineering, Imperial College London, SW7 2AZ London, UK

2 Department of Earth Sciences, University of Geneva, 1205 Geneva, Switzerland

3 Departament de Dinàmica de la Terra I de l'Oceà, Universitat Barcelona, Facultat de Ciències de la Terra, Martí I Franquès s/n, 08028, Barcelona, Spain

4 Department of Geography, University of California, Santa Barbara, 1832 Ellison Hall, Santa Barbara, CA, 93106, USA

Rivers are highly sensitive to climate and tectonic change, and understanding how fluvial systems respond to greenhouse climates is vital to projecting landscape change in the near future. We look to the Early Eocene Climatic Optimum (EECO) of the southern Pyrenean Tremp-Graus basin, specifically the fluvial deposits of the Montllobat and Castissent formations. This succession records a unique shift in geomorphology and a 20 km progradation of the clastic wedge in < 0.8 Myrs. Using field-based quantitative palaeohydrology, we reconstruct the evolving morphometry and hydrodynamics of these ancient river systems. The transition from the Montllobat Fm. into the Castissent Fm. at c. 50.5 Ma is associated with a sharp change in hydrology: a statistically significant shift in cross-set height, channel slope, and water and sediment flux. This intensification in hydrological regime is compounded with a switch in fluvial planform morphology: we show Montllobat and Castissent rivers were multithreaded, and interpret a transition from anastomosing to a more dominantly braided planform in the Castissent interval. We suggest that the transient hydrologic signature of the Castissent Fm. was driven by an increase in tectonic uplift rate at c. 50 Ma superimposed on a shift towards more strongly seasonal rainfall. We holistically reconstruct the dynamics of ancient rivers formed during the Eocene hothouse, and in conjunction with isotope and exhumation records, reveals the potential to extract complex tectono-climatic signals from fluvial stratigraphy.

Poster presentation

Multi-scale characterisation of the lower Mercia Mudstone Group for enhanced understanding of microstructural variability.

Holly Mills[1], Kevin Taylor[1], Lin Ma[2], Joshua Griffiths[3,4], Nick Smith[3,4], Dan Faulkner[4], Richard Worden[4]*

[1]Department of Earth and Environmental Sciences, The University of Manchester, Oxford Road, Manchester M139PL, UK.
[2]Department of Chemical Engineering, The University of Manchester, Oxford Road, Manchester M139PL, UK.
[3]National Nuclear Laboratory, Chadwick House, Birchwood Park, Warrington WA3 6AE, UK.
[4]Department of Earth, Ocean, and Ecological Sciences, The University of Liverpool, Brownlow Hill, Liverpool L69 7ZX, UK.
**holly.mills@manchester.ac.uk*

The Triassic Mercia Mudstone Group (MMG), which is present across Europe (Kueper Marl, Haisborough Group, etc.) including onshore and offshore in the British Isles, is being considered as a potential host rock for a geological disposal facility (GDF) on the eastern margin of the East Irish Sea Basin (EISB). Whilst the MMG is a proven caprock to oil and gas fields in the EISB, it is highly heterogenous (spatially and temporally) and contains a mixture of clay-rich mudstones, evaporites, and thin-beds of siltstones and sandstones. To guarantee the long-term (hundreds of thousands) containment of higher-activity radioactive waste it is therefore essential to understand and predict heterogeneity, and its potential impact on fluid flow and contaminant transport, at multiple scales.

The aim of this project it to develop a method capable of characterising, quantifying, and upscaling heterogeneity at the nanometer to metre-scale. To do this, the heterogeneous Saughall Massie borehole (onshore, NW England), which contains the Tarporley Siltstone and Singleton Mudstone Formations (basal sections of the MMG), was logged and subsampled for petrographic analysis (optical, SEM, and CT). Sedimentological indicators suggest the two formations of the lower MMG represent an environmental change from the aeolian/fluvial Sherwood Sandstone Group into drier playa-lacustrine (saline) mudstone deposits that were affected by frequent evaporation and desiccation. The core shows prevalent cross stratification, which contain abundant finely laminated and mud-draped siltstones with fine sand-sized material, indicating some fluvial systems were active during deposition; later disturbed by soft sediment deformation, water injection features, and desiccation cracks. Increasing frequency of desiccation from the Tarporley Siltstone Formation into the Singleton Mudstone Member suggests an increase in frequency of periods of evaporation. Carbonate nodules and cements occur locally throughout the mud-dominated lithofacies but are more prevalent in the siltier and sandier lithofacies. The proportion of carbonate nodules and cements appears variable within single lithofacies, but there appears to be a relationship where dissolution of the carbonate nodules becomes more prevalent in the transition from Tarporley Siltstone into the Singleton Mudstone Member. The interpreted climatic change from wetter playa-lake to more arid and desiccated playa-lake system could account for the increased abundance of carbonate nodules and cements in the Singleton Mudstone Member (due to increased precipitation), but they tend to have been dissolved, leaving vuggy porosity. The primary minerals are quartz, orthoclase, plagioclase, muscovite, biotite, pyrite, and various clay minerals. The secondary minerals are quartz overgrowths and the dolomite/calcite cements. The primary structure is often lost to desiccation and the rocks are rubbleised by these processes. In thin section, macro-pores (>50 nm, elongate) are abundant in many of the quartz-rich samples, when not filled by carbonate cements. The microstructures observed in these mudstones consist of artificial fractures, small syn-sedimentary faults, centimetre-scale sand-injection features, soft-sediment deformation, and carbonate cements and nodule fabrics. These observations highlight the high level of heterogeneity in the MMG, and the need for a more detailed understanding of the fundamental controls on primary depositional and burial diagenetic heterogeneity in the MMG, and their potential impact on subsurface fluid flow.

Poster presentation

Quantitative characterisation of the Triassic Sherwood Sandstone Group: Suitability for long-term carbon capture and underground storage, Cheshire, United Kingdom.

Samuel A. R. Scott, Nigel P. Mountney, Adam D. McArthur, Jack P. Humphries, Na Yan, Grace Cosgrove, Luca Colombera

Fluvial, Eolian & Shallow-Marine Research Group, University of Leeds, LS2 9JT

The Triassic Sherwood Sandstone Group (SSG) is prospective for carbon capture, utilisation and storage (CCUS). Both depleted hydrocarbon reservoirs and regional-scale saline aquifers are targets for very large-scale permanent storage of liquid CO_2, as part of the UK's commitment to reduce emissions into the atmosphere. This research aims to quantitatively characterise the detailed sedimentary architecture, facies and heterogeneity of the SSG, and predict lithological heterogeneity at multiple scales, which will enable geologically realistic modelling of flow pathways of liquid CO_2 in such heterogeneous successions.

To achieve this aim, outcrop and subsurface sedimentological datasets are collated within purpose-built relational databases (FAKTS and DASA) to provide parameters with which to constrain three-dimensional stratigraphic forward models (PB-SAND and DASH) for fluvial and aeolian successions. Outcrop datasets were acquired from the Cheshire, Needwood and Stafford basins, comprising 50 1D graphic sedimentary logs (total length ~600 m), 320 palaeocurrent readings from sedimentary structures, and 20 architectural panels measured from type-section outcrops acquired digitally using photogrammetry. Additional subsurface datasets from cores and well-logs are from the Cheshire Basin, East Irish Sea Basin (EISB) and North Sea.

Twenty-four facies types are identified in successions of the Chester Formation and Helsby Sandstone of the Cheshire Basin, and in equivalent successions of the neighbouring Stafford, Needwood and EISB basins. Fluvial successions record a variety of architectures, including pebbly bedload-dominated channel belts, ribbon-like isolated channel fills and sheet-like sandstone bodies of overbank origin. Fluvial floodplain, mid-channel, point-bar deposits, and rare debrites are also identified. Fluvial palaeoflow was generally towards the north. Aeolian successions record the evolution of fields of dominantly sinuous-crested oblique dunes, with bedforms separated by a range of dry, damp and wet (flooded) interdunes. Aeolian dune migration was dominantly towards the west with local variations to different degrees.

Primary lithological heterogeneities occur at five distinct scales: lamina-scale textural variability, internal bed-scale variability arising from combinations of sedimentary structures, alternating facies units, architectural elements with associated bounding surfaces, and large-scale depositional elements. Accounting for heterogeneities at different spatial scales is important in modelling resultant 3D lithofacies architecture, distribution and for predicting flow pathways, which is critical for planning of CCUS projects.

Poster presentation

Analysis of topographic variations in the Lower Cretaceous of the Central North Sea: implications for reservoir distribution

Carys Simpson[1], Adam McArthur[1], David Hodgson[1], Peter Haughton[2], Stuart Archer[3], Miquel Poyatos-More[4], Aurelia Privat[1].

(1) School of Earth and Environment, University of Leeds (2) School of Earth Sciences, University College Dublin (3) Harbour Energy, Aberdeen (4) Department of Geology, Universitat Autonoma de Barcelona.

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

To examine post-rift deep-water sedimentary systems, 3D seismic reflection data covering approximately 3,000 km^2 were used to map the Lower Cretaceous interval in the NW sector of the Central North Sea, specifically around the Brodgar and Leverett fields. Structure and isopach mapping of the interval indicates that some major structures, such as the offshore projection of the Highland Boundary Fault (HBF) had a topographic expression in the Lower Cretaceous, contemporaneous to deposition of the Valhall and Sola Formations. Seismic interpretation, together with well and core data, permitted mapping of the Base Cretaceous Unconformity and Base Chalk reflections to constrain the study interval. Horizons in the stratigraphic package between these markers were mapped with the aim of constraining the stratigraphic evolution within this interval, which includes the Britannia Sandstone Formation. The lower section of this formation is characterised by thick bedded, amalgamated sandstones, that are predominantly found in the eastern area of the Leverett reservoir, up dip of the HBF. Contrastingly, closer to the HBF comprises contemporaneous thin-bedded heterolithics, implying infill of topography behind the HBF. In the younger Sola Formation, thicker amalgamated beds and conglomerates were deposited, interpreted to be channel-fills, implying topographic healing to facilitate bypass further downstream over the HBF. Furthermore, the system is capped by thick mass transport deposits (MTD's) which indicate the system shutting down. These MTDs include a mixture of Jurassic aged shallow-marine and Lower Cretaceous clasts that may have been sourced from degradation of the Renee Ridge or Rattray High, implying these were gravitationally unstable during the Aptian.

This stratigraphic sequence implies the filling of upstream accommodation and progressive downstream bypass of reservoir quality sands to other depocentres. Hence, even in post-rift settings, relict underfilled topography may have a significant role in sediment distribution and a variety of scales of reservoir heterogeneity.

Poster presentation

Partial remobilisation of aeolian dunes: implications for reservoir compartmentalisation

Tara L. Stephens[1,2], Brian S. Burnham[1,3], Gustavo Zvirtes[1], Andrew Hurst[1]*

[1] University of Aberdeen, School of Geosciences, King's College, Aberdeen, AB24 3FX.

[2]British Geological Survey, The Lyell Centre, Research Avenue South, Edinburgh. EH14 4AP.

[3] VRGeoscience Limited, Manchester, UK.

**taras@bgs.ac.uk*

Large-scale soft-sediment deformation (collapse) of aeolian dune systems is typically reported from outcrops that provide mostly vertical cross-sections through the deformed sequence, limiting understanding of the lateral extent of deformation. Dune collapse can result in disruption to the grain sorting and fabric, which may in turn affect the petrophysical properties of the sandstone. Aeolian dune systems form a significant component of hydrocarbon reservoirs in the North Sea. Understanding permeability, fluid flow, and the geometry and distribution of baffles through these systems is critical for efficient well placement and production.

Here we present an outcrop characterisation of the Permian aeolian dune and interdune sequence at Hopeman, southern Moray Firth, Scotland. The foreshore between Burghead and Lossiemouth records a ~7.5 km lateral section of aeolian dune deformation. The study area between Hopeman and Clashach Cove provides an exceptional ~1 km plan-view section with several cross sections through this sequence, which highlight the vertical and lateral transition from undeformed to deformed strata. Multiple dune collapse events are recorded, highlighted by interdune surfaces which truncate deformed strata in the sequence.

Deformation occurs within dune sets, and deformation surfaces locally truncate multiple sets. The deformation sequence comprises a lateral and vertical transition from (1) undeformed aeolian foresets to (2) oversteepened to overturned foresets, before (3) a "breakdown zone" is reached that comprises sheared and locally fluidised foresets, (laminated clasts are offset against low-angle shear bands and surrounded by structureless well sorted sandstone), and ending in (4) structureless sandstone (with fluidisation fabrics sometimes present). These zones are interpreted to represent progressive shearing and fluidisation within the set. Throughout zone 3, the proportion of structureless sandstone increases, and clast size and continuity decrease until zone 4 is reached. The sequence then reverses into the overlying undeformed set. Large-scale fluid escape structures (~5 m height) form above the deformed sets and have cores of structureless sandstone. Sandstone intrusions (cm- to m-length) are locally associated with the structureless sandstone zones and cut across relatively undeformed aeolian dune foresets. Results from optical microscopy indicate that the structureless (fluidised) strata is better sorted and finer grained, but is more cemented than the undeformed aeolian and interdune deposits.

Our study highlights that although sand fluidisation likely acts to increase porosity and permeability in the remobilised deposits, these areas are preferentially cemented and form zones of low permeability. The zones of fluidised sandstone, consequently, create vertical and lateral baffles throughout the dune sequence. Understanding the geometry and distribution of fluidised sandstone within collapsed aeolian dune systems is therefore crucial to accurate reservoir characterisation.

Poster presentation

Assessing autogenic evolution of unconfined vs. laterally confined submarine fans: Insights from a global database and numerical modelling

Ru Wang[1], Adam McArthur[1], Luca Colombera[2]

[1] Turbidites Research Group, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK
[2] Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy

Elucidating the controls on submarine-fan downdip migration patterns and constraining avulsion dynamics of submarine channels are critical for predicting the distribution of sediment, organic carbon, and pollutants in deep-water settings, and the sedimentary heterogeneity of deep-water stratigraphies. The role of topographic confinement as a control on the autogenic evolution of fluvio-deltaic systems (delta accretion patterns, channel avulsions) has recently been recognised. However, whether a similar organisation will occur in submarine fans subject to variable degrees of confinement, created by external basin configurations, remains to be explored. Furthermore, the effect of surface morphodynamics on preserved subsurface stratigraphy (e.g., channel and lobe stacking patterns) has yet to be fully elucidated.

Here, we utilise an integrated approach of database-driven quantitative analysis and numerical geometric models, to realize a step change in our understanding of the autogenic evolution of unconfined submarine fans versus fans confined within antecedent topography. A global database of many modern to late-Quaternary submarine fan systems from different settings (15-20) is developed, using remote-monitoring datasets and datasets from the published literature. Information from the database is subsequently used to inform numerical modelling with a large, geologically realistic range of values, which is carried out in Matlab. Results indicate that interplays of antecedent topography (basin configurations) and sediment mass balance expressed in resultant submarine-fan geometries can result in autogenic changes in submarine-fan migration patterns and channel avulsion dynamics even under constant boundary conditions. Close relationships are identified between degree and style of basin confinement versus rates of submarine-fan downdip migrations, rates of vertical aggradations and channel avulsion frequency, respectively.

This study highlights complexities in submarine sedimentary systems that evolved under different topographic configurations. The findings provide insight into future submarine-fan downdip migration behaviour and channel avulsion hazard on submarine fan systems, and for decoding the stratigraphic record.

Poster presentation

Subsurface storage assessment of the Permian Rotliegend Group in NE England

Rifky Wijanarko[1], John R. Underhill[1], Rachel E. Brackenridge[1]

[1]Centre of Energy Transition, University of Aberdeen, Aberdeen, United Kingdom

The growing interest in subsurface hydrogen storage as a low-carbon energy solution, geological CO_2 storage to decarbonise hard-to-abate industries, and the need for increased methane gas storage to enhance energy security has underscored the importance of subsurface storage in the UK. The Permian Rotliegend Group is an offshore reservoir for many UK gas fields and is the storage unit for the Viking CCS project. However, this is not the case towards the west in onshore NE England. Using a play-based approach, analysis of a variety of subsurface datasets has revealed that Rotliegend reservoir facies is restricted to the East Midlands Shelf and is absent in the Cleveland Basin. However, the East Midlands Shelf is a benign structure absent of structural traps with the exception of its northern margins where it is crosscut by the Flamborough Head Fault Zone. One of these structural traps is the Caythorpe field which has produced from the Rotliegend. The Caythorpe reservoir is also sealed by a thick overlying layer of Zechstein salt. We suggest that the culmination of a Rotliegend reservoir, thick Zechstein salt caprock, and a structural closure makes the Caythorpe field a suitable site for subsurface storage. This study improves our understanding of the Rotliegend as a storage unit and explains why it was not a major gas reservoir onshore.

Poster presentation

Rapid transfer of per- and polyfluoroalkyl substances through submarine canyons: sources, pathways and implications

Zesheng Xu[1], Ian Kane[1], Bart Van Dongen[1], Holly Shiels[2], Richard Kimber[1], Michael Clare[2]*

[1] *Department of Earth and Environmental Sciences, The University of Manchester, Manchester, UK*
[2] *Division of Cardiovascular Sciences, University of Manchester, Manchester, UK*
[2] *National Oceanography Centre, Southampton, UK*
* *zesheng.xu@postgrad.manchester.ac.uk*

Submarine canyons are important conduits for the transfer of terrestrial materials, including pollutants, into the deep ocean, yet their role in mediating the distribution and fate of persistent pollutants remains underexplored. Per- and polyfluoroalkyl substances (PFAS), are globally pervasive 'forever chemicals', which pose significant ecological and health risks due to their persistence, bioaccumulation, and toxicity. The deep sea is potentially an important sink for PFAS but the pathways, processes, and ecological implications of PFAS transport via submarine canyons remain understudied. This study aims to address critical knowledge gaps regarding the transport and distribution of PFAS in submarine canyons, focusing on the significant influence of canyon morphology and sediment dynamics on PFAS transport and deposition patterns. The project will integrate field sampling, laboratory sorption experiments, and advanced geochemical analyses across three representative canyon systems with varying sediment feeder mechanisms. By elucidating PFAS-sediment interactions and mapping PFAS distribution in sediments and benthic organisms, the study seeks to assess the role of submarine canyons as PFAS sinks and transfer zones, identify sorption mechanisms, and evaluate potential ecological risks. The outcomes will not only advance scientific understanding of PFAS behaviour in the deep sea but also support policy-making and mitigation strategies for addressing these persistent pollutants in critical marine environments.

Poster presentation

New perspectives on an ancient sediment routing system: the Triassic Sherwood Sandstone and Budleighensis River

Xiang Yan, Gary Hampson, Alex Whittaker

Department of Earth Science and Engineering, Imperial College London

It is well known that sediment grain size and mineralogical composition change in a sediment routing system from source to sink. Bulk sediment properties are continuously modified by sediment deposition in basins, as well as the downstream addition of sediment via tributaries or erosion. A better understanding of source-to-sink sediment routing therefore allows improved predictions to be made of the volumetrics and bulk mineralogical composition of sandstone-reservoir fairways for carbon capture and storage (CCS). The Triassic Sherwood Sandstone Group (SSG) and lowermost Mercia Mudstone Group (MMG) of the British Isles were deposited by a major, north-flowing river system, the Budleighensis River. The SSG is a significant target for CCS because of the unit's desirable reservoir properties, presence of the thick overlying MMG seal, and its previous characterisation for hydrocarbons, geothermal energy, and groundwater.

The Budleighensis River was sourced in the Variscan Mountains of northern France, and flowed through a series of linked extensional basins from the Wessex Basin in the south, to the East Irish Sea Basin in the north. Deposition occurred under an arid climate, with substantial fluvial-aeolian interaction in the SSG of the East Irish Sea Basin. The MMG was laid down in lacustrine and playa environments and represents the downstream termination and progressive retreat of the Budleighensis River.

Despite much recent and ongoing interest in the SSG, source-to-sink sediment routing has remained unappraised for the past three decades. We present a new source-to-sink synthesis of the Budleighensis River system that integrates recent developments in quantitative provenance analysis, geological mapping, chronostratigraphy, source characterisation and paleoclimate to characterise sediment sources and downstream trends. There are substantial differences in sediment bulk-mineralogical composition between the south and north of the sediment routing system, probably indicating substantial input by tributaries that drained non-Variscan sources. We visualise our synthesis using a new source-to-sink map of the Budleighensis sediment routing system created with the aid of borehole and outcrop data, and for the first time reconstruct source-to-sink sediment volumetrics for the Sherwood Sandstone Group.

Poster presentation

Microplastics in Kaikōura Canyon and Hikurangi Channel, New Zealand

Ziqi Zhang[1], Ian Kane[1], Katie Maier[2], Mike Clare[3], Rhodri Jerrett[1] and Peter Ryan[1]

[1]Department of Earth and Environmental Sciences, University of Manchester, UK

[2]National Institute of Water & Atmospheric Research Ltd, Wellington, NZ

[3]National Oceanography Centre, Southampton, UK.

Submarine canyons are the main conduit for transporting continental sediment from shorelines to the deep sea. Microplastics, as tiny particles, can easily pass through or accumulate in canyons transported by turbidity currents. The most common triggers of submarine turbidity currents are gravity and anthropogenic activities (e.g., trawling and petroleum industry). However, natural disasters, such as river flooding and earthquakes, can change the canyon's morphology then re-distribute the microplastics.

Kaikōura Canyon is a geologically active submarine canyon, located on the east coast of the South Island of New Zealand. In 2016, the Mw 7,8 earthquake triggered a submarine landslide estimated 850 metric megatons of sediment transported through the canyon and out along the Hikurangi channel, which entirely reshaped the morphology of canyon and the microplastics accumulation. Therefore, this research focuses on the changes of microplastics distribution in canyon and channel caused by earthquake, it is also the first study about microplastic in this region. Our preliminary result founds microplastics' number, shape and colour are various along canyon and channel.