BSRG 2020 Abtract Volume

20th - 23rd December 2020

University of Liverpool and SedsOnline

December 18, 2020

Day	Time GMT	Local time	Presenter Family name	Presenter First name	Institution/Company	Research presentation title	Session
Sunday 20th December	10:00 AM					**Morning virtual field trip/s**	
	12:00 PM		Lunch break				
	1:00 PM					**Afternoon virtual field trip/s**	
	4:00 PM		End of virtual field trips				
Monday 21st December	8:30 AM		**Welcome and introduction**				
	8:45 AM	19:45	Hansen	Larissa	University of Leeds	Mixed axial and transverse deep-water systems: The Cretaceous post-rift Lysing Formation, offshore Norway	Siliciclastic - deep marine
	9:00 AM	21:00	Brooks	Hannah	University of Melbourne	Quantifying lateral and distal variability within hybrid beds, case studies from Central and Northern Italy	
	9:15 AM	10:15 AM	Spychala	Yvonne	Leibniz University Hannover	Proximal to distal grain-size distribution of basin-floor lobes: A study from the Battfjellet Formation, Central Tertiary Basin, Svalbard	
	9:30 AM	10:30	Wigan	Timothy	Imperial College	The curious case of the missing thin beds: reflectance spectroscopy analysis of deep-water deposits, Angel Fm., NW Shelf, Australia	
	9:45 AM		Break				
	10:00 AM		Clare	Michael	National Oceanography Centre	But I thought you were dead? A canyon that refuses to play by the rules	Siliciclastic - deep marine
	10:15 AM		Dodd	Thomas	BGS	Hybrid event beds in the context of ancient deep-lacustrine fan models	
	10:30 AM		Tek	Daniel	University of Leeds	Bridging the gap between seafloor geomorphology and subsurface architecture: how mass-transport deposits and knickzones build channelised de	
	10:45 AM		Ayckbourne	Ashley	University of Manchester	Creeping mass transport deposits on submarine slopes: examples from the Eocene Al-Hsa Basin (Spain)	
	11:00 AM		Boulesteix	Kavin	University of Manchester	Sedimentological and stratigraphic criteria to distinguish between basin-floor and slope mudstones: Implications for the delivery of mud to deep-	
	11:15 AM		Break				
	11:30 AM		Baas	Jaco H.	Bangor University	Rapid gravity flow transformation revealed in a single climbing ripple	Siliciclastic - deep marine
	11:45 AM		Martanez-Donate	Ander	The University of Manchester	Anatomy of an Exhumed Debrite and Impact on Stratal Architecture	
	12:00 PM	1:00 PM	Pszonka	Joanna	Polish Academy of Sciences	Application of mineral liberation analysis (MLA) for grain size distribution in submarine gravity flow deposits	
	12:15 PM		Cumberpatch	Zoe	University of Manchester	Flow-process controls on grain-type distribution in an experimental turbidity current deposit: Implications for signal-preservation and microplasti	
	12:30 PM		Lunch break				
	1:30 PM		Richardson	Janet	University of Leeds	Making sediment count: translating river catchment science into economic and societal benefits for the Yorkshire Region	Seds and the city
	1:45 PM		Emery	Andy	University of Hull	Turbulence and turbines: Impacts of offshore wind on seabed sediment dynamics revealed by satellite-derived bathymetry	
	2:00 PM		Keavney	Edward	University of Leeds	Microplastic contamination in the Mersey Estuary and Liverpool Bay: sedimentological constraints on distribution and concentration	
	2:15 PM		Andrews	Billy	University of Strathclyde	Collapse processes of abandoned pillar and stall coal mines	
	2:30 PM		Break				
	2:45 PM		Lomas	Simon	Durham University	Gender Balance at Annual General Meetings of the British Sedimentological Research Group	Seds and the city
	3:00 PM		Howell	John	University of Aberdeen	Virtual Fieldtrips in a time of global lockdown	
	3:15 PM	8:15	Noad	Jon	Sedimental Services	Sedimentology: Human Impact on Deposition	
	3:30 PM		Brackenridge	Rachel	University of Aberdeen	Tsunamigenic submarine landslide risk in Indonesia: Learnings from a high-impact press release.	
	3:45 PM		Break				
	4:00 PM	8:00	Yang	Bo	Northwest University	Sedimentary Facies and Diagenesis Control on High-quality Tight Sandstone Reservoir: A Case Study of the Southern Sulige Gas Field, Central China	Siliciclastic - diagenesis
	4:15 PM		Borello	Stefano	GEPlan Consulting srl	Reservoir characterisation and petrophysical properties analysis of Cenozoic siliciclastic sediments in the Kura Basin to understand porosity trends	
	4:30 PM	8:30	Jie	He	Northwest University	Microscopic characteristics and evaluation of tight sandstone gas reservoirs in Ordos Basin	
	4:45 PM		End of Day 1 oral presentations				
	4:00 PM		Posters by Vladimir Krivtsov, William Taylor, Elena Scacchia, Jonathan Wilkin, Lauren Clarehugh				Poster Session
	5:00 PM		BSRG 2020 online social event				
	6:00 PM		End of Day 1				

Day	Time GMT	Local time	Presenter Family name	Presenter First name	Institution/Company	Research presentation title	Session
Tuesday 22nd December	8:30 AM		Bailey	Lewis	University of Southampton	Turbidity Current Triggers and Timing: A New Predictive Model for Active Submarine Channels	Siliciclastic - deep marine
	8:45 AM		Soutter	Euan	University of Manchester	What controls the morphology of modern submarine canyons?	
	9:00 AM		Heijnen	Maarten	National Oceanography Centre Southar	First detailed time-lapse surveys of a major submarine canyon-channel system reveal a complex step-wise transfer of sediment to the deep sea	
	9:15 AM		Zulkifli	Muhamad Zaki	National Oceanography Centre, Southa	Controls on the variable nature of submarine channel evolution revealed from repeated seafloor mapping.	
	9:30 AM		Break				
	9:45 AM		Ireland	Mark	Newcastle University	A forcing template between bottom water currents and differential compaction	Siliciclastic - deep marine
	10:00 AM		Cumberpatch	Zoe	University of Manchester	Salt-influenced stratigraphy: tales (and tails) of turbidity currents around topography	
	10:15 AM		Hunt	James	National Oceanography Centre	Inefficient carbon burial on continental abyssal plains	
	10:30 AM		Bouwmeester	Max	University of Manchester	No Cretaceous oceanic anoxia in the Pacific: Preservation of organic matter during equatorial crossings of seamounts	
	10:45 AM		Break				
	11:00 AM		Hernandez-Molina	F. Javier	Royal Holloway University of London	Ancient and modern contourites bigradational sequences: a record of intermittent bottom currents on contouritic drifts	Siliciclastic - deep marine
	11:15 AM		Hernandez-Molina	F. Javier	Royal Holloway Univeristy of London	Seismic characterization of contouritic and mixed depositional systems	
	11:30 AM		Hutton	Rhona	Heriot-Watt University	Surface-Based Modelling of Deep-Water Sediment Waves: Field Example from Torres del Paine, Patagonia	
	11:45 AM		Stanbrook	David	Murphy Oil	The Annot Confined Fill & Spill Turbidite System: From Transgression to Termination	
	12:00 PM		Lunch break				
	1:00 PM		Zammit	Raymond	Cardiff University	Tectonically driven climate instability during the Early Miocene, evidence from the shelf carbonates of Malta	Carbonates & evaporites
	1:15 PM		Smrzka	Daniel	University of Vienna	A Neoproterozoic, shallow marine, anoxic stromatolite habitat from the mixed carbonate - clastic Horse Thief Springs Formation, Death Valley	
	1:30 PM	3:30 PM	Abou Awad	Heba Allah	Geology Department, Faculty of Scienc	Depositional model and sequence stratigraphy of the Middle - Upper Eocene succession, Northern Plateau of the Bahariya Depression, Western D	
	1:45 PM		Mioukie	Eleni	University of Aberdeen	Sedimentary Carbonate Rocks: A virtual outcrop study of primary depositional geometries and architecture.	
	2:00 PM		Break				
	2:15 PM		McCormick	Cole	The University of Manchester	Microstructural evolution of fault-controlled dolomite bodies in Middle Cambrian strata, Western Canadian Sedimentary Basin; implications for sy	Carbonates & evaporites
	2:30 PM	3:30 PM	Alzoubi	Nour	University of Szeged	Using CT data for statistical and heterogeneity analysis of non-marine Dolomites in Danube-Tisza interfluve, Hungary.	
	2:45 PM	6:45 AM	Wadood	Bilal	Northwest University	The diagenetic studies of shallow late Permian carbonate deposits in northern Pakistan: implications for reservoir quality	
	3:00 PM		Utley	Rachel	The University of Edinburgh	Tunisite: A diagenetic proxy for high-CO_2 concentrations?	
	3:15 PM		Break				
	3:30 PM	8:30 PM	Asad Ali	Asad Ali	QUAID I AZAM UNIVERSITY ISLAMABAD	Investigation of dolomite in the Kawagarh Formation Southern Hazara Basin: Iinsight from field observations, petrographic studies and geochemic	Carbonates & evaporites
	3:45 PM		Veenma	Yorick	Utrecht University	Reconstruction of Late Triassic to Early Jurassic Biosiliceous Sedimentation in the Outer Ramp Environment of the McCarthy Formation, Alaska	
	4:00 PM		Tayeb	Ahmad	University of Abeerdeen	Bedding-parallel silica layers in Jurassic carbonates: the Hanifa Formation, Central Saudi Arabia	
	4:15 PM	10:15 AM	Peel	Frank	BEG University of Texas at Austin	Rediscovering the lost world: spectacular definition of a Jurassic paleo-landscape in the Gulf of Mexico, and its implications for salt deposition	
	4:30 PM		Di Lauro	Lorenzo	University of Aberdeen	The influence of salt tectonics on the distribution of the Triassic Skagerrak Formation in the Ula Field, Central North Sea, Norway.	
	4:45 PM		End of Day 2 oral presentations				
	4:00 PM		Posters by Janique St Prix, Connor Doyle, Kirstie Wright, Daniela Vendettuoli				Poster Session
	5:00 PM		BSRG Annual General Meeting				
	5:30 PM		End of Day 2				

Day	Time GMT	Local time	Presenter Family name	Presenter First name	Institution/Company	Research presentation title	Session
Wednesday 23rd December	8:00 AM		Posters by Laura Bührig, Tony Reynolds, James Hardwick, Sean Herron, Elena Bellizia, Zhufu Shao				Poster Session
	9:00 AM		End of poster session				
	8:00 AM		Brewer	Chris	Imperial College London	The missing sediment dilemma? Understanding issues facing volumetric analysis of source-to-sink systems.	Siliciclastic - source to sink
	8:15 AM		Van Yperen	Anna	University of Oslo	From river to delta: diachronous key stratigraphic surfaces in low-accommodation settings (Dakota Group, USA)	
	8:30 AM		Barrett	Bonita	Equinor	Syn-rift footwall degradation complex and hangingwall-fill architecture: volumetric and geometric analyses in the northern Carnarvon Basin, NW S	
	8:45 AM		Beaumont	Hazel	UWE Bristol	Provenance and origin of Lower Cretaceous quartz arenites from the northern Indian Plate : tropical weathering or a multi-cycled sediment source ?	
	9:00 AM		Break				
	9:15 AM		Amblas	David	University of Barcelona	Hydro-sedimentary modelling of high-latitude dense shelf water cascades	Siliciclastic - source to sink
	9:30 AM		Lyster	Sinead	Imperial College London	River discharge variability in the rock record: quantitative insights from Late Cretaceous North American fluvial systems	
	9:45 AM		Guglíotta	Marcello	University of Bremen	Sediment distribution, channel morphology and depositional processes along the fluvial to marine transition zone of the Mekong River delta,	
	10:00 AM		Break				
	10:15 AM		Prasojo	Octria Adi	University of Glasgow	Fundamental morphometric boundaries of the global modern deltas	Siliciclastic - shallow and marginal marine
	10:30 AM		Zuchuat	Valentin	University of Oslo	Does it still make sense to apply classical, sequence-stratigraphical concepts to tide-dominated basins?	
	10:45 AM		McGhee	Claire	Newcastle University	Stratigraphy and sedimentary evolution of a modern macro-tidal incised valley: an analogue for reservoir facies and architecture	
	11:00 AM		Cosma	Marta	University of Padova	Lidar time-series and sedimentary core data reveal sedimentology of a hypertidal point bar (Mont-Saint-Michel Bay, France)	
	11:15 AM		Break				
	11:30 AM		Collins	Daniel	Shell International Ltd	Sedimentary evolution of a delta-margin mangrove in Can Gio, northeastern Mekong River delta, Vietnam	Siliciclastic - shallow and marginal marine
	11:45 AM		Poyatos-Mora	Miquel	University of Oslo	Architecture and controls of thick, intensely bioturbated, storm-influenced shallow-marine successions	
	12:00 PM		Hamlyn	Rhys	The University of Manchester	Sedimentology and architecture of a mudstone parasequence, Book Cliffs, Utah.	
	12:15 PM	4:15 AM	Bai	Jinli	Northwest University	Sedimentary Characteristics and Evolution of the Middle-Upper Proterozoic in Ordos Basin	
	12:30 PM		Lunch				
	1:30 PM	12:30 AM	McMahon	William	University of Hull	Siliciclastic deposition on unvegetated planets: partial analogues from the pre-vegetation Earth inform interpretations of Mars' stratigraphic recor	Siliciclastic - fluvial, terrestrial & glacial
	1:45 PM		Kettler	Christoph	University of Vienna	Microfabric analyses of Neoproterozoic diamictites from the Valjean Hills, California (USA)	
	2:00 PM		Vandyk	Thomas Matthe	Royal Holloway University of London	Ancient glaciation or recent erosion? Reassessing classic evidence for Cryogenian striated pavements from the Mineral Fork Formation, Utah, USA	
	2:15 PM		Le Heron	Daniel	University of Vienna	Ice-rafted dropstones in "post-glacial" Cryogenian cap carbonates	
	2:30 PM		Break				
	2:45 PM	6:45 AM	Li	Zhaoyu	Northwest University	Evolution of sedimentary environment of the early Pleistocene in Weihe Basin, Central China	Siliciclastic - fluvial, terrestrial & glacial
	3:00 PM		Ghinassi	MASSIMILIANO	University of Padova	Flow divergence in mid-channel and bank-attached fluvial bars: implications for the analysis of stratigraphic records	
	3:15 PM	7:15 AM	Tong	Qiang	Northwest University	The spatiotemporal evolution of single sand bodies architectural element controlled by allocyclicity and autocyclicity in the shallow-water braided	
	3:30 PM	9:30 AM	Clift	Peter	Louisiana State University	The Accretion History of the False River Point-Bar Constrained by Geophysical Logging Data	
	3:45 PM		Behrendsen	Sophie	University of Aberdeen	Facies Models for Aeolian Systems in Rift Basins	
	4:00 PM		End of Conference				

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Depositional model and sequence stratigraphy of the Middle - Upper Eocene succession, Northern Plateau of the Bahariya Depression, Western Desert, Egypt

Ehab M. Assal (1), Hamdalla A. Wanas (2,3) & Heba A. Abou Awad (1)

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This study aims to reconstruct a depositional model and establish a sequence stratigraphic framework of the exposed Middle-Upper Eocene succession along the northern escarpment of the Bahariya Depression, Western Desert, Egypt. This has been done via field observation and microscopic investigation of the representative rocks. Twenty - one sedimentary facies are identified and grouped into five facies associations that are attributed to middle ramp, ramp crest, shoreface/foreshore, lagoon and tidal flat depositional environments. The stacking pattern of the recognized sedimentary facies enables us to subdivide the studied stratigraphic succession into three 3rd order depositional sequences (S1, S2 and S3) bounded regionally by subaerial unconformities corresponding to sea-level falls. These depositional sequences have a long-term transgressive-regressive evolution, which was mainly controlled by eustatic sea-level changes, tectonics and sediment supply. Sequence S1 includes the carbonate-dominated middle to inner ramp of the Qazzun Formation. Sequence S2 comprises the mixed siliciclastic-carbonate middle to inner ramp of the lower part of Hamra Formation. It is made up of two medium-scale sequences separated by a transgressive surface. Sequence S3 represents the mixed siliciclastic-carbonate inner ramp of the upper part of Hamra Formation. It consists of a number of shallowing-upward small-scale cycles that stacked to form four medium-scale sequences bounded by wave ravinement surfaces. The recorded small-scale depositional cycles were a result of an interaction of short-term climatic and sea-level variations and changes in sediment supply.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Using CT data for statistical and heterogeneity analysis of non-marine Dolomites in Danube-Tisza interfluve, Hungary.

Alzoubi Nour, Gulyas Sandor & Geiger Janos.

University of Szeged

Abstract The formation of dolomite especially in lacustrine environments is a unique phenomenon and the outcome of various geochemical, climatic, environmental factors. The general model of carbonate mineral formation in freshwater lakes has been defined in the 1970s, where the stability of the water level, pH, dissolved mineral content and ratio of Ca to Mg were all important components leading to the formation of calcite (Ca/Mg ratio ¡2), high magnesium calcite, proto-dolomite, dolomite (Ca/Mg ratio 2-7, 2-12) or dolomite, magnesite, huntite (Ca/Mg ratio ¿ 12).(Müller, Irion, and Förstner 1972) Extensive freshwater carbonate sequences with a composition of dolomitic limestone and dolomite formed in interdune alkaline ponds of the Danube-Tisza Interfluve in the middle part of the Carpathian Basin during the Holocene. These lakes are generally fed by groundwater, which dissolved Mg from the bedrock of windblown sands corresponding to reworked alluvial fan deposits of the Danube. During the summer because of extensive draughts water level drops, pH reaches values above 11 and dissolved mineral concentration ranges between 8-11,000 ppm. These conditions favor the precipitation of high magnesium calcite syngenetically turning into protodolomite, dolomite forming carbonate mud in the lakebed. Fall precipitation brings Ca-rich water into the desiccated ponds contributing to the diagenesis of carbonate mud leading to the formation of dolomite rocks. To understand the cyclicity present in the carbonate sequence we need quantitative information on the composition and physical properties of members of the sequence. This work presents preliminary results gained via the statistical analysis the physical properties of the freshwater carbonates by using CT technique. Heterogeneity of block samples was visualized and assessed based on Hounsfield units corresponding to density values gained from the CTs. Definition of the range boundary and distribution for carbonates was made using statistical, geostatistical tools.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

Hydro-sedimentary modelling of high-latitude dense shelf water cascades

David Amblas & Ricardo Silva Jacinto

CRG Marine Geosciences, Department of Earth and Ocean Dynamics, University of Barcelona, Barcelona, SPAIN

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Multiple mechanisms work together to increase the ocean surface waters density to the point that these can sink to abyssal depths. In temperate margins cold and dry winds are the responsible to cool down the continental shelves surface waters and to increase evaporation rates and, thus, the water density. In high-latitudes cold winds are even able to freeze the ocean surface and produce sea-ice that forces out the salt. Once denser than surrounding waters, the cold and salty water sinks to the seafloor, overflows the shelf edge and cascades downslope just as rivers on land flow downhill towards the sea. This important oceanographic process is called dense shelf-water cascading (DSWC). During the last decades we have observed a progressive weakening of dense shelf water formation and export (Amblas and Dowdeswell, 2018), which reflects the variability of these complex ice-ocean systems and their vulnerability to climate change. Within this fragile context it is necessary to understand the physical processes involved in the concentration and propagation of DSWC. We tackle this question using a process-based depth-integrated numerical model, which was initially developed for turbidity currents (Nixes-Tc model, developed at IFREMER, Jacinto and Burel, 2003). Our modelling analysis, based on Antarctica field observations, show the importance of flow confinement features (i.e. coast capes, cross-shelf troughs, canyons and gullies) to concentrate and propagate dense shelf water and, ultimately, to renew the oceans deep water. We also study the capacity of individual DSWC events to transport sediment, and provide insight into the cumulative effect of repeated DSWC events in shaping the seafloor. In this presentation we will show different model runs using a set of flow parameters, boundary conditions and generic terrain models that allows us to discuss also on the differences in erosion and sediment transport capacity between DSWC and turbidity currents.

Online oral presentation with slides: Seds and the city, Monday PM

Collapse processes of abandoned pillar and stall coal mines

Billy J. Andrews, Zoe A. Cumberpatch, Zoe K. Shipton, & Richard Lord

BJA, ZKS & RL = University of Strathclyde, ZAC = University of Manchester

Heating represents 45% of the energy use and 32% of CO2 emissions in the UK and poses a significant barrier to achieving the UKs governments aim of becoming carbon neutral by 2050. Extracting heat from flooded coal workings is a potential way to decarbonise heat, however, predicting their collapse state and hydrogeological properties in advance of drilling can be challenging. To aid this we investigated the internal structure of an exposed section of collapsed pillar and stall mine workings near Whitley Bay, NE England, using a sedimentological approach. We found that the exposed workings consisted of eight distinct facies, with lithology, kinematics, stacking patterns and structure consistent with the mechanical understanding of mine collapse processes. Based on the collected data we propose a five stage model of stall collapse, with each stage acting to decrease the overall permeability of the mine. Stage 1 represents the methods used in initial coal extraction, and provides the initial framework for the rest of the collapse. During this time small fragments of coal were deposited on the seam floor. When the seam was abandoned (Stage 2) the size of fragments of coal increased and these were redeposited around pillars during flood events. When the seam was abandoned the roof began to spall (Stage 3), gradually collapsing. At this site there is evidence for multiple events (at least 19 at Whitley Bay), and indications that acid mine water began to form. In Stage 4 it is interpreted that the presence of hypersaline brines led to the cyclical deposition salty muds. Finally (Stage 5), the roof collapses along several normal faults, which led to the subsidence of the overlying stratigraphy. The last section to collapse was closest to the pillar. The reduction in permeability will affect the draw-down and long term feasibility of a shallow mine geothermal energy project. Conversely, the well-connected fault and fracture network which develops above the workings as collapse progresses could enhance, through increased flow pathways, or degrade, through communication to shallower cool groundwater, the geothermal potential of a site. The use of a sedimentological approach for the classification of mine wastes represents a useful tool that could be used to build up a dataset of similar deposits exhumed through open cast workings.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Investigation of dolomite in the Kawagarh Formation southern Hazara Basin: insights from field observations petrographic studies and geochemical signature

1..Asad Ali 2...Muhammad Asim mujtaba 3...Muhammad rehan

1...QUAID I AZAM UNIVERSITY ISLAMABAD PAKISTAN 2..UNIVERSITY OF MALAKAND 3..UNIVERSITY OF MALAKAND

This studied rock is the part of Kawagarh Formation exposed in Darra Haripur near Gharbi Mosque, Khanpur Dam, which is geologically located on the footwall of Nathia-Gali Thrust in southwest portion of the Hazara Basin. The lithology of formation varies across the country but the studied part having alteration in rocks. In the present studies, attempt has been made to understand degree of diagenetic alterations, diagenetic history and to know the probable source of dolomitization within limestone. Different types of dolomite were recognized which reflect different types of dolomitization patterns. A) completely dolomitized horizons, b) fracture associated dolomitized horizons. The dolomite presents in the form of veins and massive bed in the upper part. The studied Formation has different verities of dolomite based on color and texture, with addition it has diagenetic features too, brecciation, stylolites, cavities and meteoric calcite. The Petrographic studies show partial and complete dolomitization of the precursor limestone. Based on crystal size and geometry four different types of dolomite are identified, Coarse crystalline planner dolomite (D-I), coarse crystalline non planner dolomite (D-II), Fine crystalline planner dolomite and saddle dolomite. The selected samples of dolomite shows a wide range of δ18O values ranging from -12.79 to -2.56 V-PDB. Stable isotope signatures demonstrate that D-I dolomite displayed comparatively less depleted δ18O values, D-II dolomite show comparatively more depleted δ18O values, D-III dolomite displayed most depleted δ18O values whereas saddle dolomite shows highly depleted δ18O values. Lead zinc deposits and pyrite also present which is clue of fluid-rock interaction phenomenona.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Creeping mass transport deposits on submarine slopes: examples from the Eocene Ainsa Basin (Spain)

Ashley Ayckbourne, Rhodri Jerrett & Miquel Poyatos-More

University of Manchester, Universitetet i Oslo

Slope failure events are common on prograding shelf-slope margins. Relief is generated on the seafloor by these events, which form intra-slope depocentres, topographic barriers and conduits that trap, re-route and channelize subsequent sediment gravity flows. Relief generated by these events include, evacuation scars, and in the mass transport deposit, topography over normal faults, thrusts, slump folds, rafted blocks and debrites. The controls these features exert on subsequent slope deposits have been recorded in 3D and 2D seismic, multibeam bathymetry and sonar imaging studies. However, due to their large size (100s m to 10s kms) and 3D complexity, these features, and their impact on subsequent SGFs remain relatively poorly described at sub-seismic (i.e. outcrop) scale. In this study, deposits overlying three types of MTD-related kinematic features (evacuation scars, normal faults and thrust-and-folds) are documented from an Eocene slope succession in the Aínsa Basin (Pyrenees, N Spain). The deposits were characterised via the construction of stratigraphic architectural panels, supplemented by sedimentary logs, palaeoflow readings, and soft sediment deformation vergence readings. The panels were traced on 3D digital outcrop models constructed using high resolution drone imaging. Deposits overlying evacuation scars exhibit growth towards, and dip towards the headwall scar, and those in the hanging wall of normal faults show growth towards and drag against the fault scar. In-fill by coarse-grained sandstones is common in hanging walls of half-grabens. Deposits draping thrusts-and-folds exhibit growth strata that thicken and coarsen towards the synclinal hinge and 'pinch out' towards the apex of anticlines where the deposits are finer grained and thinner. The results of this study show that these deposits cannot be readily separated into an "initial" MTD whose topography is filled and healed by younger strata. Instead, slope failure is characterised by a more protracted "creep" event, where topography is generated by the gradual formation of an evacuation scar, and growth of normal faults in the up-dip domain, and amplification of fold and thrusts in the toe region. SGFs deposited in bathymetric lows become gradually incorporated into the MTD deposit as it continues to creep down-slope. The results of this study suggest that major slope failure deposits observed in modern submarine slope settings may have a similar gradual, than catastrophic origin.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Rapid gravity flow transformation revealed in a single climbing ripple

Jaco H. Baas, Jim Best, Jeff Peakall

School of Ocean Sciences, Bangor University, Menai Bridge LL59 5AB, UK Departments of Geology, Geography and GIS, Mechanical Science and Engineering, and Ven Te Chow Hydrosystems Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA

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

Sediment gravity flows possess a wide range of rheological behaviors and past work has shown how transformations between flow types generate spatiotemporal changes in the resultant sedimentary successions. In this presentation, the rate of flow transformation within a sediment gravity flow is revealed by analysis of bedform size, grain size and the microstructure of cross-stratification within a single climbing ripple set. Based on data from the Seathwaite Fell Sandstone Formation (Ordovician, Elterwater Quarry, UK, 54.435N, 3.046W), we demonstrate that an initially turbulent flow that is aggradational and generates climbing ripples, begins to develop large ripples in turbulence-enhanced transitional flow or lower transitional plug flow, as the flow decelerates. These large ripples are generated by increased turbulence in the ripple trough that causes additional scour that may also form small backflow ripples. The large ripples are also characterized by heterolithic deposition on the ripple leeside, as fallout from suspension becomes more dominant than sand and silt avalanching down the leeside slope. Further flow deceleration, and increases in clay concentration, cause more rapid aggradation, and higher angles of climb, of the clay-rich current ripple, which also becomes smaller due to the dampening of turbulence in upper transitional plug flow or quasi-laminar plug flow, thus forming low-amplitude bed waves. Further analysis reveals that such flow transformation, from turbulent to quasi-laminar plug flow, was rapid and occurred over a period of tens of minutes, suggesting that the spatial distance over which such transformation took place was hundreds of meters to several kilometers. Quantification of the microstructure of similar climbing ripple sequences may hold untapped potential for reconstructing the temporal fluid dynamics of clay-laden SGFs in many sedimentary environments.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Sedimentary Characteristics and Evolution of the Middle-Upper Proterozoic in Ordos Basin

Jinli Bai, Junfeng Zhao, Zhanli Ren, Wenhou Li, Ke Wang, Xuan Li

Northwest University

Paleozoic-Mesozoic occupies the important position in exploration and development of oil and gas field in Ordos Basin. With the rapid increase of the demand for oil and gas resources, Meso-Neoproterozoic has become a focus in the field of petroleum geology. The Meso-Neoproterozoic in Ordos Basin are well exposed, and many scholars have done a lot of work here. However, there is still a lack of study on the stratigraphic distribution and sedimentary characteristics of the whole basin, which may provide theoretical guidance for the subsequent exploration and development. Using the latest drilling data, seismic profiles, outcrops to characterize the stratigraphy and sedimentary characteristics in Ordos Bain, the results show that: the basin characterized by widely deposited and large thickness in Changcheng period, developed four NE trending rift troughs, deposited a set of quartz sandstone and volcanic rock formation dominated by paleorift facies and littoral-neritic sea facies. Tidal flat facies with carbonate rock was widely developed in Ordos Basin in Jixian period, it is characterized by the development of dolomite with stromatolite. In the Sinian period, glacial deposits are developed in the basin, and the lithology is mainly tillite. The Meso-Neoproterozoic in the basin is characterized by thickness in the southwest and thinning in the northeast. Source rock developed in Changcheng System of Ordos Basin, and the TOC in the northern margin of the bain is high. The emphasis should be placed on the evaluation of residual primary reservoirs and high-over maturation source rocks.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Turbidity Current Triggers and Timing: A New Predictive Model for Active Submarine Channels

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Seafloor flows of sediment, known as turbidity currents, dominate the global transport of terrestrial sediment, organic material and pollutants to the deep-sea. Individual turbidity currents can travel for thousands of kilometres and damage critical seafloor infrastructure. Technological advancements have recently enabled the direct monitoring of turbidity currents at field-scale. Direct monitoring offshore from river deltas has revealed that a combination of multiple forcing mechanisms, such as tidal elevation and river discharge, are more common triggers for turbidity currents than isolated external triggers, such as earthquakes. However, the limited number of turbidity currents recorded at previous monitoring sites has only permitted the use of univariate statistics. Such approaches are used test the significance of individual triggering factors in isolation, but do not allow us to investigate multiple coincident environmental factors that combine (often in a non-linear manner) to trigger flows. Here, we analyse a large monitoring dataset from an active submarine channel in Bute Inlet, British Columbia, where 95 turbidity currents were recorded. Turbidity currents preferentially occur during low tide during periods of elevated river discharge. We use multivariate statistics to quantify the relative roles played by tidal elevation and river discharge on the triggering of turbidity currents. We then train a statistical model on a subset of the monitoring data, and develop a predictive model that successfully hindcasts almost 90% of turbidity current activity (i.e. timing of flows and non-events). This model is then tested against two other similar seasonally river-fed sites (Squamish and Fraser Deltas, both British Columbia) at which we did not train the model; remarkably predicting ¿84% of turbidity current activity. We conclude by discussing how this model may be used to predict turbidity current activity in other river- and tide-affected systems worldwide, potential limitations, and the implications for geohazard assessment and quantification of deep-sea sediment fluxes.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

Syn-rift footwall degradation complex and hangingwall-fill architecture: volumetric and geometric analyses in the northern Carnarvon Basin, NW Shelf, Australia

Bonita J. Barrett, David M. Hodgson, Christopher A.-L. Jackson, Christopher Lloyd, Junia Casagrande & Richard E. Ll. Collier

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Current tectono-stratigraphic conceptual and numerical models do not sufficiently capture the complex architectures arising from interactions between footwall-, hangingwall- and axially-derived depositional systems. Furthermore, in the absence of provenance or borehole data, it can be challenging to distinguish sediments derived directly from fault crest degradation versus those from catchments beyond the fault crest. Here, an individual fault block (Thebe-2) in the northern Carnarvon Basin, NW Shelf, offshore Australia, is analysed through geometric assessment of depositional systems, and volume balancing between footwall degradation and hangingwall infill. Along-strike variability of footwall-derived fans (forming two of twelve stratal units defined in the stratigraphic framework) is assessed and compared to measured values of fault throw, and vertical and headward erosion. Depositional systems prograding down the hangingwall dip-slope and from the fault tips are observed to interfinger, abruptly downlap, build up the flanks, and route around their footwall-derived counterparts. Volume balancing across ten quadrants along the fault highlights areas of sediment bypass and the positions of fixed, through-going sediment input points. Consequently, a quantitatively-informed interpretation reveals four basinal evolutionary phases of the Thebe-2 fault and parallel, antithetic faults. Exposure of the Thebe-2 fault footwall and adjacent fault terraces allowed small catchments beyond the fault crest to develop. One such sediment route persisted throughout hangingwall infill, and its position coincides with a fault throw minimum, topographic high, peaks in vertical and headward erosion, and sustained clinoform development in the immediate hangingwall. The origin of the basin entry point is attributed to the development of two early fault segments that promoted sediment transport through their relay zone. It was later locked in the landscape, continuing to supply sediment beyond the establishment of the fault's final length.

Typical subsurface challenges are the limited preservation and imaging of erosional landscapes. Our quantitative approach alleviates these challenges through independent identification of through-going sediment input points, which could be applied to other basin-fills and used to identify areas dominated by sediment bypass.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

Provenance and origin of Lower Cretaceous quartz arenites from the northern Indian Plate: tropical weathering or a multi-cycled sediment source?

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Lower Cretaceous sediments of the north-western Indian Plate margin deposited in the Barmer, Cambay, Narmada, Kachchh and Jaisalmer basins of the West Indian Rift System (WIRS) and in the Lower and Middle Indus Basins (LMIB) are dominated by mineralogically mature quartz arenites. Such an extreme quartz-rich detrital mineralogy is surprising given that the local highs flanking the WIRS and LMIB comprise a variety of Precambrian basement terrains including the Malani Igneous Suite, Delhi Supergroup, Aravalli Belt and the Bundelkhand Craton with a varied igneous and metamorphic mineralogy. Most published studies assume that the overall provenance is the Aravalli Mountain Range although there is little palaeogeographical or mineralogical evidence to support this. Presented here are new mineralogical data for the fluvial Ghaggar-Hakra Formation of the Barmer Basin and a compilation of published detrital mineralogies of the sandstones across the WIRS and LMIB to better constrain their provenance. For the Lower Cretaceous Ghaggar-Hakra Formation 99 thin sections from both outcrop and cores were point-counted for grain size, Trask sorting and detrital and authigenic mineral composition. All the samples are quartz-arenites or sub-lithic arenites with little or no detrital feldspar preserved in thin section, consistent with published data for the WIRS. Most detrital grains are well rounded monocrystalline quartz. Early diagenesis in these sandstones comprises dolomites and other altered carbonate cements which are interpreted to be pedogenic in origin and are commonly grain replacive. This together with the presence of common oversized pores suggests that the sandstones were more feldspathic at deposition, but have lost most detrital feldspar through grain dissolution processes. Recalculated detrital mineralogies indicates that the sandstones were originally quartz-arenites or sub-arkoses. Such mineralogies remain more mature than would be expected from first-cycle sandstones derived from granitic and metamorphic basement, even allowing for in-situ early diagenesis and weathering in the Early Cretaceous Epoch. Our developing inference is that much of the Lower Cretaceous alluvium in the WIRS and LMIB originates

from erosion of late-Cambrian and Lower Palaeozoic sandstones which were exposed across the north-western Indian Plate margin throughout the Cretaceous, with only minor contributions from the basement highs.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

Facies Models for Aeolian Systems in Rift Basins

Sophie Behrendsen, John Howell, Adrian Hartley, Florian Bremer

(Howell, Behrendsen, Hartley) Univeristy of Aberdeen, Wintershall DEA (Florian Bremer)

Aeolian systems are a common feature in arid rift basins, both modern and ancient. Existing facies models for aeolian systems typically focus on deposits laid down in unconfined settings and while the basic depositional elements such as dunes, interdunes, sandsheets etc are similar, their distribution, proportions and geometries are different in confined systems. Such confined systems are for example rift basins created by extensional tectonics. These basins are typical elongate and relatively narrow. There is significant topography around the margins of the basin that create local wind flow patterns. Sediment derived from the reworking of alluvial fans on the basin margins and axial fluvial systems entering through the depo-centre will be reworked by aeolian processes and fluvial systems will flow to topographic lows reworking dunes. Many arid basins contain semi-permanent playa lakes which are endoreic and as such as prone to significant climatically driven lake level fluctuations which shift depo-centres within the basin. These basin specific factors will control the distribution of dunes and dune types and the ultimate preservation of the aeolian systems.

This study captures the distribution of different aeolian deposits within several modern systems which will then help to understand similar subsurface basins. The study evaluates the distribution of arid facies, particularly dunes, in 26 dominantly extensional, arid modern basins from the western US, Mexico and central Asia. That data were analysed to build a conceptual model for confined aeolian systems which ideally predicts the distribution and proportion of facies, as well as the scale and morphology of dunes in different parts of the basin and dune system. The model includes the structural topography, orientation with respect to dominant wind direction, the size of the outlying fluvial drainage area and whether systems are endorheic or open.

As aeolian deposits are major reservoirs and aquifers in the subsurface, the resultant model has implications for the analysis of aeolian systems in the subsurface where the basin structure can be mapped from seismic data but individual facies are below the resolution of the seismic.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Flow-process controls on grain-type distribution in an experimental turbidity current deposit: Implications for signal-preservation and microplastic distribution in submarine fans

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Deep-water depositional systems are valuable archives of tectonic and climatic change and are the ultimate sink of sediment, including organic carbon and anthropogenic pollutants. Understanding of the distribution of these grain-types and the preservation of tectonic and climatic signals is limited due to the general inaccessibility of the modern systems, and incomplete nature and the challenges of correlating individual flow deposits in ancient systems. Here, the deposit of a physically modelled turbidity current was sampled (n=49) to determine how grain-size and grain-type vary spatially. The turbidity current had a sediment concentration of 17%. The sediment consisted of, by weight, 65% quartz-sand, 17.5% silt, 7.5% clay, and 5% each of sand-grade garnet and microplastic particles. Grain-size and composition of samples was determined using a Malvern Mastersizer and density separation, respectively. The results show that: 1) grain-size coarsened axially downstream on the basin-floor, whilst garnet concentration decreased downstream. This challenges the notion that basin-floor deposits fine radially down dip upon becoming unconfined; 2) no sample composition matched the input composition of the flow, indicating that allogenic signals can be autogenically shed and spatially variable in deep-water deposits by discrete depositional processes; and 3) microplastic particles were concentrated in levee and lateral basin-floor fringe positions. However, the overall concentrations were lower than input, suggesting that microplastics bypassed the sampled positions. These findings have implications for understanding how signals are preserved and how microplastics are distributed in deep-water systems.

E-poster: Siliciclastic - fluvial

An integrated approach to investigate intra-point bar grain size variability: an example from the Holocene alluvial succession of the Venetian Plain (Italy)

Elena Bellizia, Jacopo Boaga, Davide Tognin, Alvise Finotello, Marta Cosma, Alice Puppin, Giorgio Cassiani, Andrea D'Alpaos, Massimiliano Ghinassi

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Fluvial and fluvio-tidal meandering channels generated deposits hosting most of the modern surficial aquifers of coastal areas. These aquifers are largely exploited by agricultural and industrial activities and are also commonly affected by salt-water intrusion and pollutant contamination. Predicting sedimentary facies distribution within these deposits is essential to predict groundwater flow and has relevant implications for aquifer management. This study focuses on deposits accumulated by late Holocene meandering rivers of the Venetian Plain (Northeast Italy). Integrating satellite images, geophysical data and sedimentary cores, this work aims to define geometries and sedimentology of two adjacent point-bar bodies, with a specific focus on along-bar sediment grain-size distribution. The study paleochannel is ca. 30 m wide and its planform evolution was reconstructed by analyzing the scroll-bar pattern, which is visible from satellite images. The two channel bends, namely B1 and B2, progressively expanded during their evolution, and B1 was affected by a marked downstream rotation of the bend apex during its final stage of growth. Geophysical investigations (Frequency Domain Electro-Magnetometer) provided vertically stacked conductivity maps depicting 3D geometries of the studied sedimentary bodies. These maps show a marked conductivity contrast between less conductive bar bodies and more conductive overbank deposits. Within the B1 point-bar body, conductivity data brings out the scroll-bar pattern and reveals that the lowest conductivity values are located in the upstream and the pool zones. The B2 point-bar body exhibits almost uniform conductivity values. Sedimentary cores reveal that the two point bars consist of well-sorted sands, ranging from fine to very coarse sand, with no heterolithic deposits. Bar deposits cover a basal lag consisting of very coarse sand with granules and shell fragments. Channel-fill deposits are made of fine to very fine sand with some muddy intercalations. Overbank deposits consist of massive mud, which is locally organic-rich. The combination of

core analysis and FDEM maps provides information about the spatial distribution of grain size at different depths. This integrated approach provides a link between planform evolution of fluvial bends and grain-size distribution within the related bars, with implications to predict subsurface flow propagation within alluvial sedimentary bodies.

Online oral presentation with slides: Siliciclastic - diagenesis, Monday PM

Reservoir characterisation and petrophysical properties analysis of Cenozoic siliciclastic sediments in the Kura Basin to understand porosity trends and fluid circulations within the reservoirs (onshore Georgia)

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The Kura Basin extends from Central Georgia eastward to the Caspian Sea in the so-called Transcaucasian intermountain valley which separates the Greater Caucasus to the north and the Lesser Caucasus to the south. The basin is described as a flexural foreland basin, confirmed by NE-SW-trending seismic sections that indicate a typical foreland geometry, in which Cenozoic siliciclastic sediments are 5-8 km thick near the Greater Caucasus range front and then gradually thin southward toward the Lesser Caucasus. Stratigraphy in the Kura Basin records the evolution from extensional (Cretaceous-Upper Eocene) to compressional (Oligocene-Pleistocene) regimes where the generation of the basin is associated to the convergence between the Arabian and Eurasian plates and secondly to the Caucasus thrust-belt evolution. In the Kura foreland basin, the transition from marine to continental deposition occurred between the late Miocene and Pleistocene. During the Upper Miocene and Pliocene, the Lesser Caucasus and Greater Caucasus were the source area of continental deposits in the Kura basin. The Kura foreland syn-tectonic deposits are represented by shallow-marine (Middle Miocene and lower parts of Upper Miocene) and thick continental (Upper Sarmatian, Meotian-Pontian and Pliocene-Pleistocene) sediments. The main reservoir rocks span from Mesozoic to Cenozoic and include terrigenous and carbonate deposits where production relies on both matrix porosity and fractures. A reservoir characterisation was conducted in two field campaigns (2018-2019) with the objective to describe the main reservoir intervals and collect samples for petrophysical analysis in order to understand the

porosity and permeability trends, the fractures network and how matrix and fractures contribute to fluid circulations in the reservoir intervals. Overall the porosity measured in laboratory analysis on samples collected are similar but the permeability is characterised by high variability so it is possible to postulate that in some of the sequences the matrix porosity is not the only type of porosity that allows fluids circulation. A secondary mechanism of porosity such as fracturing should be invoked in order to explain these anomalous permeability values. Porosity maps were generated by using the data collected in order to asses porosity trends and observe whether changes in porosity may be associated to their proximity with mapped damaged/faulted zones that could indirectly increase the porosity.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Sedimentological and stratigraphic criteria to distinguish between basin-floor and slope mudstones: Implications for the delivery of mud to deep-water environments

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Deep-water mudstones overlying slope and basin-floor sandstone-prone deposits are widely interpreted as hemipelagic drapes deposited during extended periods of sand starvation beyond the shelf edge. However, the processes of mud transport and deposition, and the resulting facies and sedimentary architecture of mudstones in different deep-water environments, remain poorly understood. Here, we present sedimentological, stratigraphic, and ichnological data from basin-floor and slope mudstone units intercalated with the sandstone-prone deposits of the Laingsburg depocentre (Karoo Basin, South Africa). The mudstone units have been mapped for 2500 km2 and investigated using macroscopic and microscopic descriptions from a continuous core dataset. Basin-floor mudstones consist of a repeated and predictable alternation of bedsets dominated by low-density turbidites, and massive packages dominated by debrites, with evidence of turbulent to laminar flow transformations. Slope mudstones exhibit a similar facies assemblage, but the proportion of low-density turbidites is higher, bioturbation is more pervasive, and no repeated or predictable facies organisation is recognised. Regional mapping demonstrates a gradual basinward tapering of all mudstone units, consistent with the distal part of basin margin clinothems, and suggests a dominant line-source of mud delivery beyond the shelf edge. However, the well-ordered and predictable facies organisation of the basin-floor mudstones also suggest the presence of local point sources from active slope conduits, responsible for the deposition of compensationally-stacked muddy lobes. The lack of a predictable facies organisation in the slope mudstones suggests deposition took place in a more variable range of sub-environments. For the first time we present a set of sedimentological and stratigraphic criteria to distinguish between submarine slope and basin-floor mudstones, which may provide an important tool to refine palaeogeographic reconstructions of other deep-water

successions. This study suggests that deep-water mud delivery is dominated by sediment gravity flows through both line- and point-source supply, during periods of up-dip sand storage, challenging the idea that mud accumulates by slow rainout from suspension in quiescent environments.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

No Cretaceous oceanic anoxia in the Pacific: Preservation of organic matter during equatorial crossings of seamounts

Max Bouwmeester, Lydian Boschman, Nienke Berends, Jeremy Owens, Ben Gill, João Trabucho Alexandre

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Although anoxia is rare in modern oceans, the marine stratigraphic record is punctuated by sedimentary and geochemical evidence for episodes of widespread oceanic anoxia. The last time in Earth history that a large volume of the ocean became anoxic was in the middle Cretaceous: black organic-carbon-rich muds were repeatedly preserved on the deep seafloor during oceanic anoxic events (OAEs). Sedimentary and geochemical evidence for oceanic anoxia during OAEs comes mainly from the Atlantic and Tethys Oceans. Data from the Pacific Ocean, which was the largest ocean basin in the middle Cretaceous, is scarce and equivocal. Based on black shales deposited at depths of about 500–1500 m on seamounts, Monteiro et al. (2012) have suggested that at least 50 vol% of the ocean was anoxic at the climax of Cretaceous oceanic anoxia during the late Cenomanian. They also included a single black shale at DSDP Site 585 in the Mariana Basin as evidence for anoxia in the deep Pacific. We will show, however, that this is a mud turbidite reworked from shallower water. For this study, we reviewed all available data and publications from scientific drilling that recovered Cretaceous sediments in the Pacific Ocean. The little available Cretaceous record from the Pacific consists mainly of well-oxidized sediments. The exceptions are black shales that occur at depths of about 500–1500 m on seamounts. Takashima et al. (2011) have shown that the Asian and North American continental margins of the Pacific were indeed oxic for most of the late Cenomanian OAE. We used a new paleomagnetic reconstruction of the Pacific plate back to 150 Ma to show that all investigated Cretaceous organic-carbon-rich sediments in the Pacific Ocean were deposited while the site was located in the Equatorial Divergence Zone (10°S to 10°N). We therefore argue that organic matter deposition in the Pacific Ocean might not have been directly related to OAEs, but rather be associated with the passage of seamounts beneath the equatorial belt of high productivity. Several authors have challenged suggestions that OAEs were characterized by globally pervasive anoxic deep water and pointed to the difficulty in sustaining whole-ocean anoxia, even in warm oceans. We

agree and our results show that oceanic anoxia in the Pacific is a local phenomenon superposed on a global trend of expanded oxygen minima in the ocean.

Online oral presentation with slides: Seds and the city, Monday PM

Tsunamigenic submarine landslide risk in Indonesia: Learnings from a high-impact press release.

Rachel E. Brackenridge, Uisdean Nicholson, & Kirstie A. Wright

Brackenridge: University of Aberdeen. Nicholson & Wright: Heriot Watt University

A number of significant (¿100 km3) mass transport deposits (MTDs) have been identified within the Quaternary section of the Makassar North Basin, SE Asia. The scale and nature of these MTDs suggests they were formed by submarine landslides with possible tsunamigenic potential. This area is seismically active and prone to tsunamis, however we identify a disparity between historic fault rupture-triggered tsunamis (located along the Palu-Koro faultzone to the NE) and the distribution of palaeo-MTDs located in the SW of the Basin.

The largest and most frequent MTDs were sourced from the south of the Mahakam pro-delta. We see clear evidence for current erosion, lateral transport and deposition across the upper slope by a branch of the Indonesian Throughflow (ITF), including contourite drifts and terraces. This suggests that the ITF is instrumental in preconditioning the slope for failure by causing preferential deposition to the south of the delta, where rapid sedimentation rates and over-steepening result in recurrent submarine landslides.

If these newly-identified submarine landslide events were tsunamigenic, they may represent a previously overlooked tsunami hazard in the region. Phase I concluded in early 2020, and results saw significant media interest due to the recent announcement of the proposed site for a new Indonesian Capital City. It is now expected that the Capital will relocate from Jakarta to East Kalimantan in 2024, close to our newly identified tsunamigenic submarine landslide risk zone. Phase II of this research is underway to quantify any potential risk.

Media attention highlighted the importance of a clear, consistent, science-driven communication strategy used by all project partners. Additional open-source information proved highly beneficial to ensure misinterpretation or sensationalization by media outlets was minimized. This was done through the open access release of the final research paper, and through the publication of a complementary blog article translating the science into manageable information for non-specialists. All interviews and media enquiries were directed to these sources to minimize miscommunication of the results and their implications. But despite best efforts, sensationalist headlines still emerged, and a number of learnings on media engagement were made. This study shows the importance of carefully managing the dissemination of research results, and the value in providing open-access research outputs.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

The missing sediment dilemma? Understanding issues facing volumetric analysis of source-to-sink systems.

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Source-to-sink analysis, sediment mass balance and characterisation of grain-size fining trends can be combined to interpret sediment supply controls on the stratigraphic architecture of ancient sedimentary deposits. However, even with regional high resolution seismic data, it is rare to capture the full sediment routing system from source to sink. This leaves a problem in comparing estimates of sediment flux from the catchment using a variety of empirical methods to sediment volumes measured from seismic or field data. How reliable are such comparisons, and what approaches can be used to assess whether sediment routing systems are closed (i.e. estimated sediment volume supplied from source balances with measured sediment volume in sink) or open (i.e. with net export or net import of sediment)? We use the Early Eocene Dornoch-Hermod sediment routing systems of the East Shetland Platform, Northern North Sea, UK to show how sediment mass balance can be used to highlight potential imbalance between the estimated sediment volume supplied from source and the measured sediment volume in the sink. The Dornoch-Hermod sediment routing system delivers sediment eastward from the East Shetland Platform into the North Viking Graben. The system is exceptionally well preserved from source to sink due to the rapid, high-amplitude uplift and burial as a far-field response to Iceland plume activity. Using high resolution 3D seismic data tied to well data (wireline logs, core, cuttings), the sediment volumes preserved in each segment of the sediment routing systems are characterised. Estimates of sediment flux generated by various empirical methods (BQART, hydrological “fulcrum” method, and geomorphological scaling relationships) are 2-14 times greater than measured sediment volumes in the sink. Downsystem trends in grain-size fining, supported by seismic-geomorphological mapping, imply that this discrepancy is explained by net export of sand and mud along the shoreline by longshore currents. The sediment routing systems are not closed, and the sediment volumes transferred between them may be an order of magnitude greater than sediment volumes retained within them.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Quantifying lateral and distal variability within hybrid beds, case studies from Central and Northern Italy

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Hybrid beds are deposits that form under bi- or tri-partite flows, involving both turbulent and laminar flow conditions. Often, hybrid beds occur with distal or lateral flow transformation following significant entrainment of a muddy substrate and/or declining turbulent energy. They have been noted to make up a significant proportion of deposits within basin floor setting worldwide, most commonly within lobe fringes. The study examines down-dip and along-strike variations in facies and architecture of hybrid beds using facies analysis of sections within the Castagnola, Marnoso-Arenacea, and Gottero formations, deposited within 3 different basins in central and northern Italy. Sections were selected where beds could be traced out laterally/ down-dip for several m's to km's. In total 407 samples were taken at 20 cm intervals for laser-diffraction grain-size analysis. Layers within beds were classified into facies divisions, which were ran through End Member Modelling Analysis (EMMA), which split beds into an optimum number of end members that, when combined, highlighted the trends found in the dataset. This method was utilized to establish along-strike and down-dip patterns of changes within beds, which were otherwise difficult or too complex to be quantified from field data alone. Quantifying the amount of mud within the matrix and clasts at any one time within the flow helped identifying how and when turbidites and hybrid beds eroded and incorporated sediment from the underlying substrate. Initial results from EMMA indicate that using 3 end members for each formation is optimal for observing trends within beds. These end members include a sand-rich unimodal end member, a silt-rich unimodal end member, and a bimodal end member, interpreted to represent a high-density turbidite, a low-density turbidite, and a debrite, respectively. Recognised trends within the data include an along-strike decrease in the sand-rich unimodal end member within the Marnoso-Arenacea section, interpreted as an increased distance from the flow input or the presence of a lateral basin slope. Through application of this method in basins with well-established bed correlation it is possible to provide novel understanding that will augment traditional field techniques.

E-poster: Siliciclastic - source to sink

Evolution of shelf-edge deltas in a source-to-sink context

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Shelf-edge deltas constitute important sedimentary systems for the transport of sediment to the deep-marine environment. Their genesis is often associated with relative sea-level fall and the extension of rivers across emergent shelves; few modern deltaic systems occur along shelf margins in the present highstand. Yet modern and ancient shelf-margin deltas reveal that a range of factors can control their evolution: the geomorphology of the continental shelf (e.g. width, depth, gradient and relief); hydrodynamic processes (e.g. tides, longshore currents, storm waves) through their influence on sediment transport to the shelf edge and onto the continental slope; river hydrology and sediment budgets, themselves influenced by factors like climate and catchment characteristics. Shelf-edge deltas can feed sediment into submarine canyons and to deep-water systems. However, despite constituting an important link between the shallow- and deep-marine environments, they are commonly not specifically considered in source-to-sink system (S2S) models. Therefore, to gain a fuller understanding of the controls on shelf-edge deltas and their depositional products, their evolution should be viewed in this larger-scale context. Here, the sedimentary record of shelf-edge deltas is characterized in terms of depositional architecture (e.g. delta lobes, distributary mouth bars) and facies properties (e.g. lithology, sedimentary structures). These properties are investigated in a quantitative study of globally distributed successions by utilizing literature-derived data compiled into a database. Parameters of the S2S system – including attributes of the terrestrial hinterland (e.g. fluvial system and catchment attributes), shelf-configuration (e.g. width, depth and gradient) and environmental factors (e.g. margin type, bathymetric- and latitudinal setting) – are specifically considered to enable investigation of the role of external controls and S2S system configuration on shelf-edge delta evolution. From this work: (i) new facies models for shelf-edge deltas types are developed, placed in context of the S2S system; (ii) the role of external controls and the effects of interactions between S2S systems attributes can be considered; and (iii) a workflow for the identification and classification of shelf-edge deltas and identification of associated environmental conditions is proposed that can be applied both at outcrop and in subsurface data.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

But I thought you were dead? A canyon that refuses to play by the rules

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Understanding the processes that dominate sediment transport within submarine canyons is important, as they control the pathways, fate and burial efficiency of organic carbon, nutrients and pollutants, and consequently affect the distribution of benthic biology. It is assumed that canyons that do not incise close to shore are relatively inactive with respect to turbidity current activity during the present sea level highstand. Highstand-dominant canyons, including those where multiple turbidity currents have been measured in one year, are directly connected to river-supplied sediment or occur where shelf-incising canyons intersect along-shelf transport cells. Therefore, shelf-disconnected canyons such as the Whittard Canyon in the NE Atlantic (whose head lies 300 km from shore) should feature low or no turbidity current activity. Such presumed lowstand-dominant canyons may feature regular sediment transport, but are instead thought to be dominated by oceanographic processes such as tidal-frequency currents (internal tides) trapped by the canyon topography. Here we present preliminary results from the direct measurement of currents using detailed ADCP measurements made over 12 months at 1500 m water depth to test this model. As anticipated, vigorous internal tides (often ¿0.5 m/s at seafloor) periodically resuspend seafloor sediment, with a cumulative net up-canyon direction. Unexpectedly, a total of six powerful down-slope-moving turbidity currents were observed within the year; an equivalent frequency to that of highstand-dominant canyons such (e.g. Monterey and Congo Canyons). The first turbidity current delivered sufficient sediment to fill a sediment trap located 10 m above seafloor and was powerful enough to transport the 1 tonne mooring anchor down canyon. One of the turbidity currents attained peak velocities of almost 5 m/s, rivalling the speeds of the fastest directly measured turbidity currents to date. We will explore the extent to which these gravity-driven flows control sediment transport within the canyon, whether they outcompete the background net up-canyon transport by internal tides, and what may have triggered them. These new measurements challenge existing models, showing how even lowstand-dominant canyons can come alive with powerful and frequent turbidity currents.

E-poster: Siliciclastic - deep marine

Recognising internal and external flow structures of injected and remobilised sands and the implications for core and outcrop analysis

Lauren Clarehugh, Ian A. Kane, William J. Taylor, David M. Hodgson

University of Manchester (Clarehugh and Kane), University of Leeds (Taylor and Hodgson)

Sand injection occurs where overpressured sand bodies become fluidised and are forcibly injected into the surrounding host rock. The Hind Sandstone Member, part of the Upper Bowland Shale Formation of the Craven Basin is laterally impersistent and appears as isolated bodies within the structure of the Sykes Anticline. These sediments are interpreted as an injectite network, with the studied localities displaying a gradient from injected, partially remobilised and injected, to potential deformed depositional sandstones. Blue Scar displays a complex network of sills, interconnected by smaller dykes, all connected to a central focal point in the form of a sedimentary laccolith. Internal and external flow structures can be observed, with undulations on the surfaces of some injectites indicating the direction of fracture propagation and scours providing insight into the peak flow of the injectites. The undulations on the bedding surfaces are perpendicular to the scours superimposed on them. Propagation direction of cracks was perpendicular to the undulations, with the divergent nature of the striae suggesting that at peak flow, expansion was occurring within the injectite flow. Internal features picked out by diagenetic mineralisation may exhibit the waning stages of the fluidised sand flow. The Hind Clough locality demonstrates some similar features of injected sands, however some sand beds appear to be less affected by remobilisation, with structures such as grading present. Petrographic and geochemical analyses of samples collected will give a greater insight into flow processes which have influenced the studied sandstones. The mudstones of the Upper and Lower Bowland Shales, which encase the Hind Sandstone, are heavily brecciated and deformed. This, in combination with minor faults recognised by a combination of fieldwork and drone image analysis, and other more major faults interpreted in the area, can give some indication of fluid flow pathways of the migrating petroleum and mineralising fluids which potentially led to the generation of pore fluid pressure and drove injection in the area. Recognition of fully injected, partially and non-remobilised sands in core is challenging, given the lack of 3D context, so outcrop work is key for developing comprehensive recognition criteria that can be applied to any core or outcrop study.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

The Accretion History of the False River Point-Bar Constrained by Geophysical Logging Data

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Point bar deposits are the building blocks of meandering fluvial stratigraphy and can form hydrocarbon reservoirs of significant economic value. Large-scale (¿10 km wide, ¿30 m thick) point bars are comparatively more complex than those in smaller systems (100–1000 m across, ¡10 m thick). In this study we use a combination of coring, natural gamma ray, electrical conductivity (EC) and hydraulic pressure tool (HPT) logging to define the variation in sediment type and permeability laterally and vertically in the False River point-bar, a major point bar of the lower Mississippi River. EC logging shows the best alignment with lithology. Interbedding of fine-grained and coarse-grained sediment in the point bar stratigraphy forms inclined heterolithic strata (IHS). We find that the fine-grained portion of IHS thickens downstream and towards the tip of the terminal apex, in the upper point bar stratigraphy. Such thickening of the fine-grained portion of the IHS was found to occur across distances of 10's of meters, and the muddy IHS is generally thicker after the establishment of a compound bar morphology. In general, the early apex, upstream parts of the bar have the thinnest IHS. There is a general clustering observed between higher-quality reservoir areas and low-quality ones preferentially deposited during the latter stages of point bar accretion after a compound meandering geometry has been established. Significant changes are seen over distances of just 10's of m, especially immediately after point bar reorientation, generally following a flooding event. Geophysical logs showed promise to being able to define sediment type and reservoir quality, although laterally correlating beds, even over relatively short distances (ca. 30 m) may be impossible.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Sedimentary evolution of a delta-margin mangrove in Can Gio, northeastern Mekong River delta, Vietnam

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Mangroves deliver important socio-economic benefits and store significant volumes of carbon along tropical coastlines, but their distribution is controlled by complex geomorphologic, hydrodynamic and salinity conditions, as well as human-related pressures. In the Mekong delta, Vietnam, the interaction of tide, wave and riverine hydrodynamic processes impacts sedimentation and mangrove distribution. Extensive mangroves presently occur along the northeastern delta margin (Can Gio, located 40 km southeast of Ho Chi Minh City), in an embayed, back-barrier environment with a high tidal range (c. 4 m) and away from major fluvial channels. This study aims to constrain the sedimentary evolution of the Can Gio mangrove system during the Holocene based on stratigraphic, palynological and geochronological analyses of sediment cores. Two deep borehole cores (15 and 30 m deep) and four short auger cores (up to 4 m deep) were taken in the modern mangroves to characterize a 20-km-long shore-normal cross section dated with radiocarbon and optically stimulated luminescence (OSL) ages. The cores consist of a thick (¿ 20 m) subtidal mud from the base of the Holocene unit to the level of 3–4 m deep below the ground level, overlain by carbonaceous, intertidal mud. Chronological data reveal a major episode of subtidal mud aggradation from 6 to 3.5 ka, forming the topography for mangrove development. Radiocarbon ages in the overlying intertidal mud range from 4 ka to modern and show some inconsistencies with the stratigraphy, suggesting mangrove root penetration and sediment mixing. The beach-ridge structure and OSL ages of the Can Gio barrier indicate that barrier formation initiated just before 3.2 ka. The transition from subtidal to intertidal mud aggradation and initiation of barrier formation, are broadly correlated with the onset of the

subaqueous delta progradation and shift to a wave-dominated regime in the central delta. However, after 3.5 ka, the Can Gio shoreline had negligible sediment accretion while the central delta prograded up to 50 km seawards. Reduced sediment supply to Can Gio is consistent with more asymmetric, southwestward-dominated longshore drift after 3.5 ka. The negligible progradation at Can Gio also indicates minor sediment supply from the nearby Dong Nai River, which prevented upper intertidal accretion and conversion of mangroves into fluvial flood plain.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Lidar time-series and sedimentary core data reveal sedimentology of a hypertidal point bar (Mont-Saint-Michel Bay, France)

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Complex spatio-temporal interactions between hydrodynamics, vegetation, and sediment transport govern the morphodynamic behavior of tidal meanders and affect the internal architecture of related point-bar deposits. Despite this complexity, tidal point bars are usually simplistically described as sedimentary bodies characterized by inclined heterolithic strata, abundance of fine-grained sediments, and occurrence of tidal rhythmites. Their facies models still lack a 3D perspective and overlook the along-bend variability of sedimentary processes. This knowledge gap can have a direct impact on the understanding of intra-point-bar heterogeneities and connectivity, with implications for reservoir production. The present study focuses on a 3 m deep tidal meandering channel located in the salt marshes of the hypertidal Mont-Saint-Michel Bay (France) and investigates the sedimentology of a 3D time-framed bar accretionary package by means of Lidar topographic data, geomorphological field surveys, and sedimentary cores. The studied accretionary package was accreted along the bar between 28/03/2012 and 29/11/2012. Integration between Lidar and sedimentary-core data shows that over this time the bar expanded alternating depositional phases along its seaward and landward side. The maximum thickness of deposits was accumulated in the bar apex zone, and just landward of it, where the largest amount of mud was also stored. The high accretion rate of the bar apex zone also favored a better preservation of rhythmites, which are almost missing from deposits accumulated along the bar sides (i.e. close to riffles). We suggest that alternating depositional loci and high sediment accretion at the bend apex zone emerge due to a combination of factors, including: i) the spatio-temporal asymmetric nature of tidal currents, which influenced deposition and preservation of flood and ebb deposits along the bend; and ii) the development of low-energy conditions at the apex due to ebb and flood flow configuration, which also promoted mud settling.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Salt-influenced stratigraphy: tales (and tails) of turbidity currents around topography

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Submarine sediment-gravity-flows can be influenced by seafloor topography associated with salt structures, and the interaction between the two ultimately controls the depositional architecture of their deposits. Due to poor-imaging in the subsurface, and a scarcity of exhumed systems, these relationships are challenging to investigate. We present a multi-scalar analysis of deep-water salt-influenced sedimentary successions, integrating subsurface data from the UK North Sea, outcrop data from the Bakio diapir, northern Spain, a novel discrete element model (DEM), and flume tank experiments. Integration of these datasets demonstrate that: 1) Small-scale sedimentological features (e.g. hybrid beds, abrupt pinch out and palaeocurrent patterns) provide evidence for syn-depositional topography. 2) Bedding orientations and thinning rates vary spatially and temporally around syn-depositional topography. 3) A range of mass failure-type deposits (e.g. debrites) develop in salt basins, with these typically decreasing stratigraphically and basinward as halokinesis wanes. 4) The geometry and fill of salt-influenced basins is more complicated than their 'unconfined' counterparts, being characterised by isolated depocentres (i.e. minibasins) bound by salt-cored highs, and depositional patterns being controlled by a mix of autocyclicity, halokinesis and allocyclicity. Our integrated approach, which couples natural examples, and both physical and numerical experiments, allows us to gain multi-scalar insights into the evolution and final stratigraphic architecture of salt-influenced depositional systems.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

The Influence of salt tectonics on the distribution of the Triassic Skagerrak Formation in the Ula Field, Central North Sea, Norway.

Lorenzo Di Lauro, Adrian Hartley & Jon Duncan

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The Central North Sea (CNS) is a mature oil and gas province that has been strongly affected by salt tectonics from the early Triassic to the late Cenozoic. Although the CNS has been studied extensively, due to the stratigraphic and structural complexity associated with halokinesis, detailed understanding, particularly of the Triassic succession, has still to be fully established in some areas. To contribute to a more complete understanding of the CNS, this work focused on the effects of halokinesis on the development of the Triassic Skagerrak Formation in the Ula Field area, of the Norwegian sector. In the CNS, the Triassic is the primary reservoir in many fields, but also forms an important secondary target beneath producing Jurassic reservoir intervals such as in the Ula Field. Here we focus on documenting the development of the Skagerrak Formation in the Ula Field area using seismic, wireline and core datasets. Seismic interpretation within the Ula area has revealed the internal geometries and stratigraphic complexity of salt minibasins. The relationship between salt movement and minibasin development has been reconstructed through time and palaeogeographic maps have been produced. Sediments in minibasins were divided into lower and upper Triassic intervals separated by a widespread unconformity. Salt movement and the influence of fault-bounded basement highs affected deposition and preservation of Triassic sediments within the area. In addition, indications of Early Triassic salt movement can be documented, as well as evidence supporting differential loading and extension as triggers of halokinesis. Finally, this study proposes a paleogeographic reconstruction of the area revealing a general flat topography throughout Triassic time despite ongoing halokenesis.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Hybrid event beds in the context of ancient deep-lacustrine fan models

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Ancient deep-lacustrine fan systems and their internal lobes form as complex heterogeneous sedimentary successions in the subsurface. Subaqueous sediment gravity flows are responsible for transporting much of the coarse-grained material into these settings, depositing excellent-quality reservoir lithologies within otherwise mud-prone deep-lacustrine facies. However, certain flow types (e.g. hybrid flows) are often responsible for the transportation and deposition of non-reservoir finer grained sediments (i.e. mudstones and siltstones) within fan systems. In deep-marine settings, hybrid event beds (HEBs) are well-known in terms of their ability to form complex baffles and barriers in reservoirs, but are perhaps less-well characterised in the context of deep-lacustrine basins. Consequently, understanding the relationship between the variety of subaqueous sediment gravity flow processes and products is critical to any project that utilises the ancient deep-lacustrine subsurface. This study examines subsurface data from the North Falkland Basin in the South Atlantic. 3D seismic-based interpretations of three deep-lacustrine fan systems and their internal lobes are geologically constrained by sedimentary facies analysis of c. 100 m of core samples, supported by high-quality wireline data. Deep-lacustrine fan systems and internal lobes comprise lobe axis, lobe fringe and lobe distal fringe facies associations, each of which are characterised by a variable suite of high-density turbidites, low-density turbidites, HEBs and hemi-limnic mudstones. The well locations are evaluated with respect to their location within the fan system (as imaged in 3D seismic data), and interpreted sedimentary facies are used to assess the spatial distribution of HEBs within deep-lacustrine fans. Through this, the character and distribution (both spatial and temporal) of HEBs is explored, placing these deposits in the context of overall deep-lacustrine fan models. In these examples, as well as being found in lobe fringe areas, HEBs are also observed preserved in quite active, axial or lobe axis (channelised) positions, often at the base of each lobe during the fan initiation phase, or at the top of the lobe in the abandonment phase. To explain this, the occurrence of HEBs is also considered throughout a single fans lifetime, in the wider context of fan initiation, growth, by-pass, abandonment and termination phases.

E-poster: Carbonates

Carbonate-evaporitic hypersaline lakes and microbial mats - Sedimentology, Geochemistry and Practicality as Archives of Palaeoenvironmental Information

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Hypersaline lakes demonstrate a spectrum of physicochemical characteristics which generate small-scale temporal and spatial environmental variations and thus contain sedimentary sequences which display significant spatial and temporal microfacies variability (Valero-Garcés and Kelts, 1995) and are often host to unique assemblages of laminated microbial mats (Guerrero et al., 1992). These mats and lakes are dynamic ecosystems with strong biogeochemical gradients, actively forming and dissolving minerals, and distinct ecological niches (Dupraz et al., 2004).

The primary aims of this study were to verify the suitability of hypersaline lakes and microbial mats as palaeoenvironmental archives and to determine the effects of diagenesis acting upon microbial mats in order to validate their use as a tool for the investigation of biogeochemical processes in saline-alkaline lakes. Sedimentological and geochemical characterisation included microfacies analyses, CT scanning, X-ray diffractometry, µXRF and ICP-OES. Examination of the sedimentary sequences associated with several Iberian saline-hypersaline lakes using these techniques revealed complex sedimentological features and facies associations, downcore fluctuations in geochemistry and a wide range of petrographic textures and fabrics. CT scans allowed for sub-millimetre scale logging and facies analysis, revealing a range of siliciclastic (bedded clays, silts and sands) evaporitic (aragonitic and gypsum-rich laminae), and organic-rich (microbial mats and charophytic mudstones) examples which correspond to key environmental fluctuations. Additionally, the intensity of major elements and mineralogical abundances determined from µXRF and bulk geochemical analysis provide insights into the interplay between environmental processes such as evaporite precipitation (Aragonite, Hexahydrite, Gypsum, S, Sr,), detrital input (Phyllosilicate minerals, Quartz, Ti, Fe, K, Mn, Si, Al, Zr/Rb), redox (Mn/Fe), and organic productivity (TOC, Br, Inc/Coh). The results of the study highlight how such settings may act as high-resolution palaeoenvironmental archives that allow for the reconstruction of environmental change over centennial to decadal timescales. The importance of these findings is highly significant for the future construction of high resolution palaeoenvironmental models not only within the Iberian Peninsula but other locations where saline-hypersaline lakes are the primary source of environmental information.

Online oral presentation with slides: Seds and the city, Monday PM

Turbulence and turbines: impacts of offshore wind on seabed sediment dynamics revealed by satellite-derived bathymetry

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The impact of offshore wind turbine installations on seabed and suspended sediment dynamics has been observed from in-situ measurements, such as scour monitoring and ADCP measurements. Satellite imagery has also been used to identify changes in suspended sediment plumes caused by turbines. Satellite data can be used to derive bathymetry in shallow seas (generally ¡ 20 m). The advantage of satellite data is that it can offer good resolution (up to 10 m) over large spatial extents, and potentially highly repeatable bathymetric datasets over a multi-year period. In this study, we use Sentinel-2 data to produce bathymetric datasets that cover the Race Bank offshore wind farm, located 30 km east of the UK east coast. Comparison between gridded single-beam echosounder data, acquired in 1993, with satellite-derived bathymetry from May 2020, shows that there has been a general northward migration of sand waves and sand banks, although rates differ spatially, with generally faster migration at the edge of the topographic high of Race Bank. Since installation of the Race Bank offshore wind farm began in 2016, there is some indication within the high-resolution satellite-derived bathymetry of the influence of turbines on the seabed. Narrow, linear tails, up to 1.5 km long, are present, aligned towards northwest from the turbines and substations in the southeast. These tails are parallel to the main current flow and perpendicular to the crests of the sand waves. The tails are also potentially draped on top of the sand waves. This modification of seabed sediment movement could have potential implications over the lifespan of an offshore wind farm (usually 30 years). For example, changes in suspended sediment concentrations can alter marine habitats and sediment supply rates to coastal areas that may alter geomorphic responses to sea-level rise and storm events. Our work highlights the need to understand these seabed sediment dynamics to mitigate against any negative effects of offshore wind installations.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

Flow divergence in mid-channel and bank-attached fluvial bars: implications for analysis of the stratigraphic record

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Understanding of ancient fluvial-channel bars informs predictions of sedimentary facies distribution, and therefore of morphodynamics of alluvial channels through time. The characterization of ancient fluvial-channel bars is a fundamental tool of traditional facies models, and is widely used to interpret paleochannel patterns. Sediment storage within fluvial channels can basically occur either along the banks or along their axial portion, generating bank-attached and mid-channel bars, respectively. Basing on this mark, we introduce a metric of flow divergence (f), measured as the angle between the azimuths of bar accretionary slopes and local dune migration. Specifically, we explore the distribution of flow divergence in clear-water active sand-bedded channel by analysing a dataset of 103 channel reaches, that includes both mid-channel and bank-attached bars. Study sites are from low-variable peak discharge rivers of Russia and Brazil, and are analysed by means of high-resolution satellite images acquired when null suspended sediment allowed to image spatial distribution of dunes along the channels. Measurements shows that dune migration transverse to the dip azimuth of bar slopes (90¡f¡110 degrees) occurs both in mid-channel and bank-attached bars. This evidence challenges the tenet that paleoflows nearly orthogonal to the dip azimuth of large-scale inclined strata are diagnostic for sinuous, single-thread paleochannels. Only f values significantly higher (¿ 140 degrees) or lower (¡ 60 degrees) than 90 degrees discriminate between bank-attached and mid-channel bars, since these values occur only in mid-channel bar heads and tails, respectively. Comparisons between f values and bar-accretionary styles points out that mid-channel bars formed by high- and low-variable discharge rivers tend to preserve axially and laterally accreting deposits, respectively. Measurement of flow divergence provides a quantitative approach to better discriminate fluvial bars from sedimentary successions. Nevertheless, we stress that similar approaches needs

strongly to be integrated with additional data from high-quality, 3D outcrops.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

Sediment distribution, channel morphology and depositional processes along the fluvial to marine transition zone of the Mekong River delta,

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The area of coastal rivers with a combination of fluvial, tidal and wave processes is defined as the fluvial to marine transition zone and can extend up to several hundreds of kilometres upstream of the river mouth of deltas and estuaries. This study shows sediment distribution, channel morphology and depositional processes along the fluvial to marine transition zone of the Mekong River delta. Based on sediment-type associations, this fluvial to marine transition zone was subdivided into an upstream tract and a downstream tract; the boundary between these two tracts is identified 80 to 100 km upstream of the river mouth and coincide with an area of morphological change of the channels. The upstream tract is characterized by gravelly sand and sand and occasional heterolithic rhythmites, suggesting bedload supply and deposition mainly controlled by fluvial processes with subordinate tidal influence. The downstream tract is characterized by heterolithic rhythmites with subordinate sand and mud, suggesting suspended-load supply and deposition mainly controlled by tidal processes with subordinate fluvial influence.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Sedimentology and architecture of a mudstone parasequence, Book Cliffs, Utah.

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The exceptional exposures of the Book Cliffs (Utah, USA) provide an opportunity to analyse the down-dip mudstone expressions of shallow-marine parasequences within a well-established sequence stratigraphic framework. This study documents the local-scale, three-dimensional variability in facies and depositional architecture in parasequence 4 of the Grassy Member of the late Campanian Blackhawk Formation over 48 km2 of continuous exposures. Sixteen sections, logged at millimetre scale, define three 2.5 m to 7.6 m thick coarsening-upward bedsets that stack to form one parasequence that ranges in thickness from 13.55 m to 19.10 m. Bedsets are composed of a repeated, well organised internal stacking pattern of discontinuous, millimetre thick fine-grained mudstone laminae/beds at the base that thicken- and coarsen-upward into well-preserved, millimetre to centimetre thick normally-graded, coarse-grained mudstone beds. These packages are capped by very-thin to thin (0.5 cm to 15 cm) very-fine to fine-grained, normally-graded sandstone beds. Samples collected from measured sections often display a disorganised texture interpreted to be a result of sediment reworking by wave-action and/or faunal activity. However, identifiable normally-graded sedimentary structures in the field and in thin-section suggest turbidity currents were the primary delivery source of sediment. The parasequence and each constituent bedset typically display a down-dip thickening and thinning trend over 8 km, producing sigmoidal geometries that are interpreted as clinoforms. The parasequence and each constituent bedset also show across-strike thickness variations over 6 km, which may indicate some rugosity to the palaeoshoreline in this parasequence. The spatio-temporal thickness variability of the parasequence and bedsets produce a complex morphology that was unlikely to be generated by simple widespread suspension settling. This has implications for the reconstruction of ancient shallow-marine, mud-prone environments as prograding muddy clinoforms may be more prevalent in these settings than previously thought.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Mixed axial and transverse deep-water systems: The Cretaceous post-rift Lysing Formation, offshore Norway

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Deep-water stratigraphic successions from syn- to post-rift stages are an archive of evolving physiographic configurations, and can record axial and transverse sedimentary sources. The healing of topography decreases the influence of syn-rift structures on sedimentation patterns and transport processes over time, which leads to a long-term transition from dominantly axial to transverse dispersal patterns. The Halten and Donna terraces, offshore mid-Norway, comprise a series of rift-related sub-basins established during the Jurassic, which were infilled with sediments during the Cretaceous.

This study is based on 14 cored (a total of 344 m of core) and 92 uncored wells from the Lysing Formation on the Halten and Donna terraces. A combination of core, well logs, biostratigraphy and seismic stratigraphy were used to classify sedimentary facies, bed types and architectural elements to interpret the depositional environment of the Lysing Formation. Whilst the Lysing Formation is composed of over 60% mudstone, the sandstone prone part of the formation is dominated by turbidites and hybrid beds. A regional trend from proximal lobe related architectural elements in the north to more distal lobe related architectural elements in the south indicates the presence of a large north-to-south oriented axial submarine fan system. However, the juxtaposition of architectural elements interpreted as channel-lobe-transition zone deposits highlights the presence of coeval locally-sourced transverse sediment sources. The axial submarine fan system was active throughout the post-rift stage due to subtle inherited topography from syn-rift structures, which interacted with locally sourced transverse sediment sources. This led to a complicated stratigraphic architecture, with lobe fringe deposits of the axial fan system juxtaposed with channel-fills and channel-lobe transition zone deposits of transverse systems.

The refined palaeogeographic reconstruction of the Lysing Formation illustrates how subtle topography can impact sediment routing patterns many millions of years after the end of rifting and can be used for palaeoenvironmental interpretations in other post-rift settings.

E-poster: Siliciclastic - fluvial

Untangling Vegetation Characteristics in Terrestrial Systems

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University of Leicester

Since the greening of the continents in the Devonian Period, vegetation has been an important component of terrestrial sedimentary systems. Vegetation is a key geomorphologic agent; it modulates landform morphology by affecting sediment erosion, transportation, and deposition, and influences 84% of the land surface today. Vegetation can be exploited as a geomorphic agent to engineer increased slope stability and coastal storm protection. The relationship between vegetation and sedimentation is marked in deep time, most clearly expressed as the Palaeozoic Facies Shift, which coincided with a major vegetation evolutionary radiation. Human activity and climate change causes the loss of surface topsoils, particularly in farmland and engineered slopes (e.g. roadside embankments). Vegetation based engineering works to negate soil erosion and focuses on specific plant species, to increase soil resistance to degradation. However, strategies may be detrimental to the wider landscape due to interdisciplinary disconnections. Within classical sedimentology, approaches have diverged in to either considering vegetation with a simplified approach, or as focused on specific species. Key morphologic and environmental characteristics of individual plants are important to consider in such approaches and studies may include growth form, plant height, canopy size, roots (tensile strength, depth and lateral spread), precipitation rate, and soil texture. In this study, we seek to reduce the generalisations that occur regarding how vegetation characteristics laterally vary by considering the interrelationships of vegetation characteristics. We have found that root tensile strength varies by growth form, and evergreen shrubs have the highest on average (55 MPa). Additionally, we have found that root depth varies by growth form and biome, whereby evergreen broad leaf tree are deepest rooted (6.5 m), and tropical grassland show the greatest range (0.3 - 19.5 m). Untangling the relationships between characteristics will ultimately influence sedimentological processes and aid management considerations for both slope engineers and geomorphologists alike.

Online oral presentation with slides: Siliciclastic - diagenesis, Monday PM

Microscopic characteristics and evaluation of tight sandstone gas reservoirs in Ordos Basin — Taking Yan'an Gas Field as an example

Jjie He, YuShuang Zhu

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Abstract: In order to clarify the reservoir characteristics of tight sandstone of Yan'an Gas Field in Ordos Basin, the rock type, pore types, diagenesis types and physical properties of the reservoir were studied through thin section observation, scanning electron microscopy and cathodoluminescence analysis, and high pressure mercury test, etc. The pore structure and seepage characteristics of the reservoir were studied by NMR test and oil-water phase infiltration. Finally, the types of the reservoir were divided, and combining with oil test and production test data, the influence of reservoir types on oil productivity was analyzed. The results show that: there are 3 gas production horizons in Yan'an gas field. The Benxi formation is dominated by quartz sandstone, the second member of Shanxi Formation is dominated by quartz sandstone and lithic sandstone, the first member of Shanxi Formation is dominated by lithic quartz sandstone and lithic sandstone, and the eighth Member of Xiashihezi Formation is dominated by quartz sandstone and lithic quartz sandstone. The pore types are mainly secondary solution pores and intercrystal pore; the reservoir porosity is mainly between 2.0% and 12.0%, and the permeability is between 0.01mD and 10.0mD. There are five types of reservoirs in the study area, and they are mainly type 2 and type 1. Type 2 reservoir has better physical properties, which mainly distributes in the areas with thick sand body of distributary channel, and the pore-throat assemblage is mainly characterized by small pore-medium-fine throat, the oil yield of the single well under the control of type 2 reservoir is generally greater than 1 t/d. The physical properties of type 1 reservoir are worse than that of type 1, and the pore-throat assemblage is mainly small pore-fine throat, which mainly distributes in the small-thickness part of distributary channel or its lateral border, the oil yield of the single well under the control of type 1 reservoir is generally 0.5 1.0 t/d.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

First detailed time-lapse surveys of a major submarine canyon-channel system reveal a complex stepwise transfer of sediment to the deep sea

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Large submarine canyon-channel systems are the main pathway for sediment transport to the deep-sea and are now recognised as important conduits for transporting organic carbon, nutrients, and pollutants to abyssal depths. The time-scales over which these particles are conveyed to channel termini, and the effectiveness of their burial along different reaches of deep-sea submarine channel systems, remains unclear. This uncertainty stems from a lack of repeat seafloor surveys that document when, where and how sediment is transported. Here we present the results of a high resolution bathymetric seafloor survey performed in 2019 along 475 km of the Congo Canyon, offshore West Africa, covering the upstream canyon and distal channel. We compare this survey to bathymetric data acquired between 1992 and 1998 to provide the first ever repeat mapping across a full ocean scale submarine canyon-channel system. These timelapse surveys enable identification of morphological change, transport processes and quantification of eroded/deposited volumes over decadal timescales. We identify three morphodynamic zones along the canyon-channel that are typified by distinct erosional-depositional patterns across this time period: 1) The upstream canyon is dominated by canyon flank collapses that can reach 0.1 km3, locally plugging the canyon axis, where sediment becomes temporarily stored, or driving meander bend cut-off, where sediment may be suddenly released; 2) The intermediate channel is dominated by expansion and downstream translation of channel bends, similar to that seen in meandering rivers; 3) The most distal part of the channel is dominated by knickpoints that migrate upstream up to

700 m/yr. We highlight how the transition from the canyon to meandering regime is structurally controlled via salt tectonics and the broader shape of the continental margin. The limits of these morphodynamic zones correspond to these underlying structural controls (zone 1-2) or the location of recent channel avulsion (zone 2-3). The spatiotemporally complex variations in sediment accumulation, exhumation, and down-slope transport, show that: 1) sediment flux to the deep-sea involves several cycles of storage and release, which are dominantly controlled by autogenic events; and 2) long-term (¿decadal) burial efficiency can be highly spatially variable over different morphodynamic regimes.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Ancient and modern contourites bigradational sequences: a record of intermittent bottom currents on contouritic drifts

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We have identified the standard bigradational sequences for contourites deposits on the ancient record (Cyprus, Morocco and Angola) and compared with analogue deposits in modern / recent deep-water environments the modern deep-marine environments (in the Gulf of Cadiz, The Mozambique Channel and the Corsica Trough). Sedimentological, microfacies and ichnological studies reveals that all studied show a long-term variations within the sequence from finer (muddier) deposits to coarser (sandier deposits) and then back again to finer grain sizes (muddier deposits). This trend is related to an increase in current velocity from the bottom to the middle of the sequence, where the maximum velocity is associated with the central, sandier interval, followed by a decreasing velocity towards the top. The studied sequences allowed us to identify smaller grain-size variations, small-scale hiatuses, and other evidences which determine higher frequency variations in sedimentary processes, current velocity and sedimentation rates. Intermittency appears more significantly across the middle part of the sequence, especially when bioturbation allows us to identify primary sedimentary structures. In this work we present evidence of intermittent behaviour at different scales of bottom current processes, which shape contourite drifts, and evaluate its scientific and economic significance.

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Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Seismic characterization of contouritic and mixed depositional systems

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Seismic criteria for discriminating contourite and mixed depositional systems have been established on deep-marine environments around the Iberian Peninsula, Morocco, Argentina, Uruguay, Mozambique Channel, NW Australia, and the South China Sea. Both systems are composed by a hierarchy of depositional and erosional morphological features related to different oceanographic processes. Futhermore, these systems display common long-term evolutionary stages comprising an erosional basal surface of the onset/initial phase, which transitions into growing and maintenance stages before being fossilised by younger deposits. This long-term variation denotes both, the interplay between gravitational and bottom current processes and the enhancement of oceanic circulation throught time. Based on the analyses of 2D and 3D seismic reflection data on contourite and mixed depositional systems, we present evidences for the long-term variations at different geological ages, and along continental margins with different tectonic settings, discriminating the dominant sedimentary processes and discussing its conceptual implications. This work can help advance the understanding of how to differentiate contourite and mixed depositional systems and how bottom currents influence the morphology and the sedimentary processes along continental margins and abyssal plains.

This project was funded through the Joint Industry Project supported by BP, ENI, ExxonMobil, TOTAL, Wintershall Dea and TGS, within the framework of "The Drifters" Research Group at Royal Holloway University of London (RHUL), in conjunction with the projects CTM 2012-39599-C03, CGL2015-66835-P, CTM2016-75129-C3-1-R, CGL2016-80445-R (AEI/FEDER, UE) and B-RNM-072-UGR18. D.D. thanks the FCT (Fundacao para a Ciencia e a Tecnologia) - the Portuguese Science Foundation through the PhD grant SFRH/BD/115962/2016.

E-poster: Siliciclastic - fluvial

The Sedimentary context of stellate bosses in the 1 Ga Diabaig Formation: Macroalgal holdfasts in a late Proterozoic lake system?

Sean Thor Herron, Neil Davies

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The Diabaig Formation of Northwest Scotland is well known for its microfossils and microbial sedimentary structures (MISS) and was deposited in a lacustrine environment around 1 Ga. Previous authors have reported abundant and varied forms of reticulate MISS on bed surfaces. Some of these contain stellate bosses; polygonal, three-dimensional pipe-like structures 1-4mm across intruding at least 2-3mm into the sedimentary horizon below its ridge junction. These bosses have a distinct sediment composition to the host sediment. Here, the first detailed description of the stellate bosses is presented and they are examined in terms of their morphology, distribution and depositional context to provide insight into their possible origins. It is most likely these represent macroalgal holdfasts, with implications for the stability of depositional surfaces within late Proterozoic lakes.

Online oral presentation with slides: Seds and the city, Monday PM

Virtual Fieldtrips in a time of global lockdown

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The Covid-19 crisis has significantly changed the nature of geoscience education. Sedimentology is a subject that is heavily routed in the field, for both teaching and for research. The shutdown has forced a radical rethink about how we teach our science and communicate our subject. The replacement for a conventional fieldtrip is a Virtual Fieldtrip (VFT) and these can take a variety of formats. VFTs range from fully immersive Worlds, based on gaming platforms such as Unity. At the other end of the spectrum is a VFT in which students are lead, in real time by a tutor from one virtual locality to the next. We recently completed two such Virtual Fieldtrips for our MSc students, to Utah and to Spain. We also participated in a number of trips for Undergraduates and have prepared VFTs for the oil industry. Our VFTs are all heavily based on virtual outcrops, augmented with a variety of additional data. They run on software developed in house with occasional input from GoogleEarth. Preparation of these trips involves scoping learning outcomes, auditing data, storyboarding, building and delivery. Feedback suggests that the vast majority (97%) of students would still rather go to the field and who can blame them? However, that may not be the correct question. If we look at other metrics, such as the learning outcomes, student engagement with the trip, even team building then the virtual fieldtrips were comparable to and in some cases actually out performed the real world trips. VFTs do well for a variety of reasons, there is less time spent sitting in minibuses and walking to outcrops. It is possible to visit outcrops in an optimal succession that best follows the trip narrative. It is easy to switch between up-close views and regional overviews. It is very easy to view outcrops next to satellite imagery of modern analogues and subsurface data. There are other advantages of VFTs, such as cost saving HSE and the reduced environmental impact of travel. Not everyone wants to be outside all day walking up big hills and for some people it's simply not possible. VFTs provide an opportunity to broaden the appeal of geosciences to a wider spectrum of people. Virtual fieldtrips did not appear because of Covid-19, it merely accelerated their progress. And for better or worse, it seems likely that they are here to stay. Embracing the developments will improve our teaching and open geology to a potentially wider audience.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Inefficient carbon burial on continental abyssal plains

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Significant quantities of carbon can be buried in turbidites. Turbidity current systems and canyons directly connected to terrestrial pathways, such as the Bengal Fan and Ganges-Brahmaputra delta and the Congo canyon and river, are often efficient at transporting, burying and preserving carbon. Although delivering large quantities of both organic and inorganic carbon, turbidity current systems instead fed by open slope failures, such as NW Africa or W Europe, are relatively inefficient at burying carbon. Here, previously buried organic carbon (marine algae) and inorganic carbon (coccoliths) on the continental slopes below areas of high ocean productivity are remobilised in submarine landslides, transformed into turbidity currents and redeposited in adjacent abyssal plains. This study investigates million-year sediment records of Madeira (7 Myr) and Iberian abyssal plain (1.9 Myr) turbidites. These deposits show the volumetric importance of the delivery of carbon to the deep sea and abyssal ecosystems by turbidity currents sourced from infrequent but voluminous open slope failures. Here, turbidity currents deliver an order of magnitude more organic carbon than settles from ocean column productivity over seven million years, while also delivering twice as much inorganic carbon. However, redox fronts that develop during early diagenesis lead to oxidative loss of buried organic carbon (5-10%) and resulting dissolution of inorganic carbon (15-20%); thus, representing inefficient burial. Comparing multiple systems shows the relative importance of the redox fronts. These redox fronts are accelerated by bioturbation and lead to further mobilisation of metals; while increased frequency of turbidity currents and local syn-depositional processes can improve efficiency in carbon burial in abyssal plains.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Surface-Based Modelling of Deep-Water Sediment Waves: Field Example from Torres del Paine, Patagonia

Rhona Hutton, Dan Arnold, Tom Buckle, Andy Gardiner, Matt Jackson, Carl Jacquemyn & Uisdean Nicholson

Imperial College London (Carl & Matt), Heriot-Watt University (everyone else)

In this study, we demonstrate the novel Surface Based Modelling (SBM) approach to accurate modelling of complex geological features observed in sediment wave deposits. SBM is an approach to subsurface modelling that uses grid-free surfaces to model multiple scales of heterogeneity, without encountering issues such as stair stepping, upscaling and lost connectivity that are ubiquitous in grid-based methods. These grid-based modelling limitations are particularly relevant when modelling complex geometries, with highly variable bed dips, orientations and numerous pinch-outs, all of which are abundant in deep-water sediment wave deposits. Deep-water sediment waves of the Cretaceous Cerro Toro Formation are well exposed in Torres del Paine, Patagonia and provide a challenging set of geometries to model. Drone photogrammetry surveys were used to construct high resolution 3D digital outcrop models (DOM), enabling interpretation and measurements such as sediment wave amplitudes and wavelengths as well as bed thicknesses and lateral persistence to be made from 10cm to 100m-scale features. Sedimentary logs and field observations were added to investigate smaller-scale heterogeneities and to ground-truth DOM observations. A key observation from this study is the presence of erosional-based thick beds (up to 1m) of sandstone confined to the troughs of the sediment waves. These accumulations pinch out abruptly on the lee side and more gradually towards the stoss over a length of 50 m and are associated with sharp erosive bases. They typically consist of massive (Ta) sand with dewatering structures, transitioning upwards into laminated (Tb) sand and convolute laminations (Tc) and are interpreted as hydraulic jump deposits. We combined field work data with other published data sources to generate a flexible sediment wave template, described by parameters such as stoss and lee width, crest height, pinch-out angles and crest curvature. Models were constructed by manipulating, linking and stacking this template to assemble varied 3D architectures, including the observed geometries of the Cerro Toro outcrop. Our results have shown that the SBM approach has enabled the construction of geologically realistic geometries associated with deep-water sediment waves and can be used to derive useful geological descriptors such as connectivity and spatial facies distribution.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

A forcing template between bottom water currents and differential compaction

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Newcastle University

The interaction between bottom water current sediment reworking and differential compaction is investigated as a potential forcing mechanism for the development of regular and repeated patterns of erosion and deformation. This process is demonstrated through observations from 3D seismic reflection data on the Exmouth Plateau, Australia. The key observations are: 1) regularly spaced meter scale erosive furrows with vertical to sub-vertical discontinuities immediately above, 2) a second, shallower interval of erosional furrows, hundreds of meters wide, co-located above underlying discontinuities, with an identical spacing and trend. The observations indicate a coupling between the sedimentary processes and deformation. The erosional furrows result in differential compaction due to subtle thickness changes which culminated in the formation of restricted faults. A later period of acute bottom water reworking exploits the subtle topography created by the faults resulting in a series of kilometer scale linear erosional furrows. This leads to repeated and regularly spaced kilometer scale patterns observed across a geological interval spanning several millions of years. This study provides the first clear evidence of how, at the kilometer scale, initial sedimentary discontinuities can initiate forcing templates between sedimentation and deformation in deep water settings dominated by bottom water currents.

Online oral presentation with slides: Seds and the city, Monday PM

Microplastic contamination in the Mersey Estuary and Liverpool Bay: sedimentological constraints on distribution and concentration

Edward Keavney, Ian A. Kane

Edward Keavney - University of Leeds and University of Manchester, Ian A. Kane - University of Manchester

Microplastics are increasingly recognized in the sedimentological record; however, there is still much uncertainty about the processes that transfer microplastics from terrestrial to marine settings, and how they control microplastic distribution and concentration. Previous studies have identified microplastics in rivers, and others in the deep sea, yet few have focused on estuaries - a critical transition zone between the two. Using new sediment samples, we show how sedimentological processes and geomorphology control microplastic transfer and accumulation in estuarine settings. We find that the Manchester Ship Canal sequesters large amounts of microplastics between the heavily contaminated catchment upstream and the Mersey Estuary. In addition, complex hydrodynamic and geomorphological processes active in the Mersey Estuary inhibits the long-term storage of high concentrations of microplastics, resulting in microplastics being flushed into the shelf (Liverpool Bay) component of the system. The new data demonstrate the importance of characterizing fundamental properties of microplastics, as they play a strong control on whether microplastics will become locally concentrated or more widely dispersed at the transition zone from fluvial to marine transfer. These results underline the importance of sedimentology in characterizing and quantifying the global microplastic cycle.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

Microfabric analyses of Neoproterozoic diamictites from the Valjean Hills, California (USA)

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Rocks from the Kingston Peak Formation (KPF) in the Valjean Hills (USA) expose a succession of diamictites associated with major glacial events taking place during the Cryogenian, approximately 700 million years ago. Within any glacial period, diamictites are widespread and in addition, their mechanics of deposition are highly variable. Some are massive in appearance at outcrop or in hand specimen, and apparently lacking any information that allows their mode of emplacement to be elucidated. Yet the correct interpretation for deep time successions is especially important, since it is debated whether diamictites have a tectonically driven, gravitational (Mrofka & Kennedy, 2011) or direct (sub)glacial origin (Le Heron et al. 2016).

In this contribution we determine origin of the diamictite based on its internal fabric and associated microstructures. We base our method on the technique of Philips et al (2011) for Quaternary sediments. By tracing the longest axes of clasts (ranging from fine-grained sand to fine-grained pebbles) in oriented thin sections and reconstructing their orientation in a 3D space, we could identify a strong signal in the orientation of the longest axes. In subglacial diamictites, clasts tend to align themselves to a stress field, induced by the movement of the glacier. Macroscopic observations, microtexture- and structures as well as the reconstructed microfabric domains suggests a subglacial origin. This circumstance suggests temperate glacial conditions with wet based ice sheets. Moreover, the quantitative data allow confident flow directions to be extracted from seemingly structureless rocks.

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E-poster: Seds and the city

A study of suspended and sedimented particles in urban ponds: analysis of chemistry, size distribution, and implications for sedimentological processes in lentic environments

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Analysis of the particle size distribution and chemical composition of suspended particulate matter (SPM) and particles deposited in urban ponds is key to enhancing our understanding of sediment processes occurring in lentic environments and the interpretation of the anthropogenic influences on lake sediments. Our studies of 11 ponds (1, 2) reveal that a significant proportion of both suspended and deposited particles is finer than 100 microns, and that particles are of both biological and mineral origin. In many cases particle size distribution (PSD) was characterised by two or more modes, reflecting contributions from different sources. Many of the smaller particles appeared to be bonded together by detritus. Within the SPM chemical elements routinely detected in significant concentrations were Si,Al,Ca,Mg,Fe,K,Mn,P,Cl and S. In a number of cases, Ti,Y,Mo,Cr and even Au were also present. We hypothesise that these contaminants may be sourced from road runoff and/or industrial pollution. Samples of deposited sediment were analysed for up to 50 elements, and Co,Cu,Ni,Zn and As were detected in all the ponds. Statistical analysis revealed a number of significant relationships among elemental concentrations, the abundances of common minerals (calcite, feldspar and other types of silicates), detritus and biota, measures of particle size, and concentrations of SPM. These relationships helped to differentiate contributions from allochthonous and autochthonous sources. Elevated levels of trace elements in pond samples suggest the possibility of their recovery from the sediments of urban ponds, and the feasibility of harvesting these valuable materials may be a possibility. Pond dwelling micro-organisms, particularly diatoms and testate amoebae, play significant roles in SPM sedimentation and biogeochemical cycling. It is intended to use the fossilised remains of these organisms to aid interpretation of the bio-physical and bio-chemical processes that operate in these sedimentary environments. Current research efforts also focus on comparing the monitoring data on suspended sediments with sediment supply simulated by the model SHETRAN. References 1. http://www.urbanfloodresilience.ac.uk/documents/krivtsov-et-al.-iconhic-2019b.pdf 2. Characterisation of suspended and sedimented particulate matter in blue-green infrastructure ponds. Blue-Green Systems. 2020;2(1):214-36. https://iwaponline.com/bgs/article/2/1

of-suspended-and-sedimented

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Ice-rafted dropstones in post-glacial Cryogenian cap carbonates

Daniel P. Le Heron, Marie E. Busfield, Christoph Kettler

University of Vienna

Dropstones of ice-rafted origin are typically cited as key cold-climate evidence in Cryogenian strata, and according to conventional wisdom should not occur in post-glacial, warm water carbonates. In Namibia, the Chuos Formation (early Cryogenian) contains abundant dropstone-bearing intervals and striated clasts. It is capped by the Rasthof Formation, comprising laminites in its lower portion, and microbial carbonates above. These laminites are locally found to contain pebble- and granule-sized lonestones in abundance. At Omutirapo, metre-thick floatstone beds occur at the flanks of a Chuos palaeovalley, and are readily interpreted as mass flow deposits. At Rasthof Farm, however, the clasts warp, deflect and penetrate hundreds of carbonate laminations at both the outcrop and thin section scale. We propose that these are dropstones, and envisage an ice-rafting mechanism. Evidence for vestigial glaciation concomitant with cap carbonate deposition thus merits a reappraisal of the depositional conditions of cap carbonates and their palaeoclimatic significance.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

Evolution of sedimentary environment of the early Pleistocene in Weihe Basin, Central China

Zhaoyu Li, Yongxiang Li, Wenhou Li, Zhichao Li

Northwest University

Weihe Basin is a Cenozoic graben basin which is located in the southern margin of the Loess Plateau, and the conjunction of Ordos block and Qinling Orogenic Belt. It is not only rich in resources such as oil, gas, and geothermal, but also a transitional zone of climate and biological communities between North and South China. The basin preserves continuous continental strata of the Quaternary in which abundant mammalian faunas and invertebrate fossils are produced, containing important paleoenvironment and paleoclimate information. Based on previous work, combined with field outcrops, drilling data, we apply sedimentology and paleontology methods to analyze the early Pleistocene sedimentary environment of Weihe Basin. The results show that during the early Pleistocene (Sanmen Period), there existed various sedimentary types, including alluvial fan-fluvial-delta-lacustrine facies and aeolian deposits. Compared with the Pliocene, the sedimentary range of the early Pleistocene basin expanded eastward and the deposition center moved to Shanxi and Henan provinces; the west was uplifted, dominated by alluvial fan, fluvial and aeolian deposits. The fluvial sedimentary areas on the north and south margins enlarged, and the lake shrank sharply. At the end of the Pleistocene, the basin was relatively stable, and the loess began to deposit from the edge to the center. Since the early Pleistocene, China's paleoenvironment has undergone important changes, which is manifested in the periodic changes of monsoon intensity and climate fluctuations. Abundant fossils provide direct life evidence for paleoclimate fluctuations of the region. The lower member of the Pleistocene Sanmen Formation produced the famous Gongwangling Fauna (1.15 Ma), and the upper member is represented by Yangguo Fauna (1.05 0.98 Ma). Some new species appeared, such as Leptobos, Equus, Elaphodus, rodents are equally common in both faunas. From Gongwangling Fauna to Yangguo Fauna, proportion of forest animals declined whilst proportion of grassland animals increased. Besides, numerous ostracods, gastropods and bivalves are observed in the fluvial deposits; the pollen are mainly Abies, Picea, and Pinus. All of above indicate that the paleoclimate of Weihe Basin during the early Pleistocene was cool and humid, and it was mainly a forest-grassland environment distributed with waters.

Online oral presentation with slides: Seds and the city, Monday PM

Gender Balance at Annual General Meetings of the British Sedimentological Research Group

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Scientific progress and inspiration are enhanced by diverse perspectives and experiences. Scientific societies, such as the British Sedimentological Research Group (BSRG), are in a unique position to champion the success of all scientists, and actively promote diversity, equity and inclusion within their discipline. A "diversity audit", focusing on binary gender, was conducted for the BSRG Annual General meetings (AGMs) from 2005 to 2019, to establish current female participation. Data collected from AGM meeting records comprise name and affiliation of participants. Apparent gender of participants was determined primarily by personal contact but also from public-facing university or company webpages and professionally-oriented social media profiles. In addition, for ten of the studied AGMs, participants were categorised as student (PhD, MSc or BSc), academic staff or industry staff. For all BSRG meetings analysed, there were more male participants than female participants. Two distinct periods were identified: from 2005– 2009 female participation averaged 25%, whereas from 2010 - 2019, 34% of participants were women. The average percentage female: male split for students was 40:60, for academic staff 19:81, and industry staff 25:75. For all three groups, there has been a modest but significant increase in the proportion of women over time. When normalized by the total number of women or men attending the AGM, an average of 74% of women presented compared to 71% of men. Women presented an average of 30% all talks and 38% of all posters delivered at the studied BSRG AGMs, a 5-year moving average shows a gradual, steady increase in the percentage of talks presented by women. The average proportion of women as conference convenors, keynote speakers, and workshop leaders is 22%, 15% and 9%, respectively. The prestigious BSRG awards (Perce Allen, Roland Goldring, and Harold Reading) have been primarily awarded to men. The data presented in this study serves as a starting point to identify areas where change is needed. We highlight the need for BSRG AGMs to provide evidence of a diverse range scientists prospering, providing role models that early career researchers from minoritized groups or populations can aspire to. Vital aspects of diversity in addition to gender could not be analysed in this study as no data are available. We strongly recommend that anonymous, self-reported demographic information should be collected at future BSRG AGMs.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

River discharge variability in the rock record: quantitative insights from Late Cretaceous North American fluvial systems

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River discharge variability is a crucial control on the behaviour and evolution of fluvial systems, with impacts on fluvial morphodynamics, sediment transport capacities and stratigraphic architectures. However, palaeohydrologic reconstructions have typically relied on methods that assume steady-state flow conditions, and have often focused on reconstruction of mean flow properties. Here, we used field measurements to quantitatively assess discharge variability for Late Cretaceous fluvial strata in central Utah, USA. These strata represent palaeorivers that drained the Sevier mountains eastward towards the Western Interior Seaway. We measured the internal height distributions and grain-sizes of cross-sets in the Blackhawk Formation (n=81), Castlegate Sandstone (n=146), and Ferron Sandstone (n=190). Further, we measured maximum heights across populations of related cross-sets in the Blackhawk Formation (801 measurements across 26 populations), Castlegate Sandstone (1015 measurements across 27 populations) and Ferron Sandstone (1257 measurements across 21 populations).

We show low coefficients of variation in cross-set height distributions, spanning 0.2–0.4, across all three units. We consider the range of preservation controls that could lead to these observations and we conclude that our data are best explained by preservation of bedforms in disequilibrium conditions associated with flashy flood hydrographs. This is supported by the spread of maximum heights across cross-set populations, which have distributions typical of fast-flood stratigraphy. Assuming preservation in disequilibrium conditions, we estimated formative flow durations relative to bedform turnover timescales. Previous work has linked these Late Cretaceous fluvial systems with a monsoonal climate, yet our results suggest flood durations of order hours to days, which are more consistent with flooding related to storm events. This is corroborated by variable-discharge facies models which similarly suggest perennial discharge regimes in these localities, as opposed to monsoonal/subtropical discharge regimes. Our results show that quantitative sedimentary analyses offer increasingly sophisticated insights into the behaviour of fluvial systems in the geologic past, particularly the nature of individual discharge events.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Anatomy of an Exhumed Debrite and Impact on Stratal Architecture

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Submarine debrites generate complicated patterns of seabed relief which influence subsequent flow behaviour and depositional patterns. However, recognizing this interaction in subsurface data is challenging in seismic and well data. To bridge this resolution gap, large-scale outcrop analogues can be used. The early post-rift Middle Jurassic succession of the Los Molles Formation is well-exposed along a 10 km long and downdip-orientated W-E outcrop belt located the western Central Neuquén Basin, Argentina. We document the sedimentology and architecture of a 50 m thick and 10 km long mud-rich debrite with a correlation panel including 27 sedimentary logs constrained with marker beds. Our study documents the clast content (size, shape, lithology), the geometry of the basal-shear zone and upper surface of the debrite, and the distribution and sedimentology of foundered sandstones overlying the debrite. The sandstone deposits are characterized by deformed basal contacts indicative of foundering into the debrite, which developed as a result of density instabilities and uneven loading between the denser sand over the unconsolidated and fluid-saturated muddy debrite. The foundered sandstones (0.5-4.5 m thick) are composed of two divisions: i) a basal division of thick-bedded, structureless argillaceous sandstone with abundant cobble-size mudstone clasts and ii) an upper-division of banded sandstone. The juxtaposition of these two facies suggests that turbidity currents flowing over the top of the debrite underwent a transformation to laminar and transitional flow behaviour. However, the post-depositional foundering of sands and their resultant geometry and spatial distribution should not be misinterpreted as the result of confinement induced by a static rugose upper surface. We present recognition criteria for interpreting syn-sedimentary foundering processes: 1) Thickness changes associated with growth strata; 2) progressive rotation of laminae or banding in sandstones; 3) Deformed mudstone clasts in the sandstones, derived from the underlying debrite and sandstone detached load structures within the underlying debrite. While none are diagnostic, the combination

of these features suggests foundering processes. These characteristics can be useful in the understanding post-depositional processes above debrites, and prediction of the reservoir and seal complexity in carbon capture and storage (CCS) projects, aquifers and hydrocarbon exploration.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Microstructural evolution of fault-controlled dolomite bodies in Middle Cambrian strata, Western Canadian Sedimentary Basin; implications for synkinematic dolomitization models

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Although dolomite has been the subject of extensive research, uncertainty persists regarding its formation, particularly how it develops during fault-controlled, often-called "hydrothermal", fluid flow. In particular, the formation of certain rock textures in these successions have not been studied in depth and are inappropriately amalgamated as a single step in their paragenetic sequence. Zebra textures, for example, consist of alternating, mm- to cm-scale, planar to sigmoidal, dark host-rock (A) bands and light mineral-filled (B) bands that form symmetrical A-B-B-A patterns. Zebra textures are commonly considered evidence of fault-controlled fluid flow, particularly in ore- and hydrocarbon-bearing systems. Their presence is often used, justified or not, as proxies for high temperature/high pressure dolomitization. Although not universally agreed upon, the B bands in zebra textures are largely considered to be cement-filled fractures. There is further contention as to whether dolomitization, and the cementation of these fractures, was synkinematic or postkinematic. Of the studies that have been conducted, a comprehensive petrographic, geochemical, and geomechanical characterization has yet to be presented and these conceptual models have not been tested by iterative experimental analyses.

This study focuses on exposures of fault-controlled dolomite in the Middle Cambrian Cathedral Formation and the overlying the Middle Cambrian Eldon Formation in the southern Rocky Mountains, Alberta, Canada. The morphology of the zebra textures in these outcrops, which are closely associated with cement-supported breccias, have a clear relationship with fault proximity and include several features that have evidence of synkinematic cementation. Fragmented sheets of the host rock are entrained within the B-bands of these zebra textures and petrographic analyses suggest that the cement phase comprises elongate crystals that were syntaxially built by a succession of crack-seal increments. Crack-seal textures, which arise due to the competition between the rate of cement precipitation and the rate of

fracture opening, suggest that these fractures were not passively cemented and that the basin was tectonically active during dolomitization and cementation. The results of this study are substantiated by rock deformation experiments in axial extension that demonstrate the requirement for a local hardening mechanism to propagate multiple, closely spaced fractures.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Stratigraphy and sedimentary evolution of a modern macro-tidal incised valley: an analogue for reservoir facies and architecture

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Incised valley fills are complex as they correspond to multiple sea-level cycles making interpretation and correlation of stratigraphic surfaces fraught with uncertainty. Despite numerous studies regarding the stratigraphy of incised valley fills, few have focused on macro-tidal, tide-dominated, incised valley fills. This study was undertaken to address sediment architecture and facies distributions within a tide-dominated incised valley-fill. Here we have drilled 20 sediment cores through the Holocene succession of the Ravenglass Estuary in northwest England, UK. These cores have logged for facies and grain size with radiocarbon dates collected from key bedding surfaces. The Ravenglass incised valley complex formed during the Holocene transgression due to the drowning of an incised valleys carved in the Main Late Devensian, 28,000 – 11,500 years ago. We have constructed a facies and stratigraphic model of the Ravenglass incised valley complex to understand the lateral and vertical stacking patterns relative to the sea-level changes. Ravenglass formed in five main stages. The first was the incision by rivers (11,500-10,500 yrs BP) cutting through the shelf during lowstand (gravels). The second was transgression and reworking of marine sediments into the estuary and a landward migration of facies (10,500 to 6,000 yrs BP). The third was a highstand at 6,000 to 5,000 yr B.P, which created accommodation and significant backfilling of the valleys occurred. The fourth was minor falling sea-level (5,000 to 270 yrs BP) which forced the system to migrate basinward and in-channel bars became vegetated and abandoned. The fifth and final stage (270 yrs BP to present) involved the back-filling of the Irt, southward migration of the northerly (Drigg) spit and merging of the River Irt with the Rivers Esk and Mite. The final stage was synchronous with the development of the central basin resulting in the tripartite development of facies (sandy-marine tidal inlet and foreshore, muddy-central area, and sandy tidal channels). The coarsest and cleanest sands are found in the tidal inlet, on the foreshore and within in-channel tidal bars. As an analogue for ancient and deeply buried

sandstones, the best-connected reservoir sands in the Ravenglass Estuary are in the more stable channels.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

Siliciclastic deposition on unvegetated planets: partial analogues from the pre-vegetation Earth inform interpretations of Mars' stratigraphic record

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Orbital observation has revealed a rich record of fluvial landforms on Mars, with much of this record dating 3.6–3.0 Ga. Despite widespread geomorphic evidence, few analyses of Mars' alluvial sedimentary-stratigraphic record exist, with detailed studies of alluvium largely limited to smaller sand-bodies amenable to study in-situ by rovers. These typically metre-scale outcrop dimensions have prevented interpretation of larger scale channel-morphology and long-term basin evolution, important for understanding the past Martian climate. Here we give an interpretation of a far larger, 1500-m-wide, 190-m-thick sedimentary succession identified from satellite imagery and located in the NW Hellas Basin. The succession comprises stacked channel and barform packages which together demonstrate that river deposition was already well established ¿3.7 Ga. Models for siliciclastic deposition are largely based on sedimentary environments on Earth, where physical form and process is near ubiquitously influenced by biology in some way. To eliminate the influence of biology here, our interpretations of the sedimentary architecture at Hellas stem from tangible observations made from Earth's Precambrian (pre-vegetation) record. The deposits mirror partial terrestrial analogues subject to low-peak discharge variation, implying that river deposition at Hellas was subject to semi-perennial, or even perennial, fluvial flow. Furthermore, conceptual advances in our understanding of how time is preserved at outcrop suggest active water-conduits may have been maintained for 100,000 years or longer. These results strongly suggest a precipitation-driven hydrological cycle was operational on Mars by the mid-Noachian.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Sedimentary Carbonate Rocks: A virtual outcrop study of primary depositional geometries and architecture.

Eleni Mloukie, John Howell, Alexander Brasier, & Joanna Garland

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Virtual outcrops (digital 3D representations of outcrop surfaces) have grown in popularity as complementary to traditional geological field work. However, until recently they were mainly used for the study of clastic rocks, with few examples on carbonate rocks. Our project aims to compile and synthesise virtual outcrop case studies (on km to m scales), quantitatively examining depositional geometries and architectures from published research on carbonate sediments and rocks. The resulting database will cover the spectrum of Phanerozoic carbonate rocks across several spatial and temporal scales. The initial step was construction of a reference framework capturing the spectrum of carbonate depositional environments. Here the first discriminating criterion was marine versus terrestrial. Marine depositional environments were then further divided into shallow marine (i.e. inner and mid-ramp, and the shelf/platform margin) and deep marine (i.e. slope and basin), and these were again subdivided, e.g. attached vs isolated platforms. With data gathering framework in place, the first data to serve as case studies were collected using virtual outcrop and traditional field work techniques from the Zechstein successions (Late Permian) of NE England (Durham province). The acquired data derive from the Raisby Formation (a distally steepened carbonate ramp deposit); Ford Formation (a rimmed shelf, dominated by a shelf margin reef, constructed by bryozoans and calcareous and non-calcareous algae); Roker Dolomite (an oolitic shelf margin); and Concretionary Limestone Formation (the foreslope equivalent of Roker Dolomite). This study will help produce an interactive database in which sedimentary carbonate outcrops are searchable on the basis of primary depositional geometries and architecture, supplemented by virtual outcrop models as data sources. Individual case studies like those of the Zechstein rocks also sheds light on benefits of the usage of virtual outcrop techniques in combination with traditional field work techniques.

Online oral presentation with slides: Seds and the city, Monday PM

Sedimentology: Human Impact on Deposition

Jon Noad

Sedimental Services

There is no corner of Planet Earth that has not been impacted by human activity. While factors such as climate change and microplastics currently dominate the news, the simple constraints on sediment transport created by human infrastructure have dramatically affected deposition at all scales, particularly in settings ranging from mountain foothills to shallow marine environments.

Examples from source to sink will be utilised to show the resulting, often unexpected sedimentary depositional patterns that result from the construction of transport infrastructure such as roads and bridges. The diversion of rivers into manmade conduits, often constrained to linear flow paths with no opportunity to meander, also leads to unnatural types of depositional settings, as does sedimentation in canals, ditches and connectors. Outflow from drainage pipes and storm drains, and the resulting build ups, are also worthy of attention.

The building of dams has led to outbuilding of deltas, silting up of lakes and to an increasing frequency of crevasse splays. Coastal defences have also altered sediment pathways in both planned and eccentric modes. The knock on effects of drilling, including earthquakes, the controversial topic of mud volcanoes and manmade spills ranging from oil seeps to travertine build ups, can also be observed in diverse geographical locations.

Examining the various sedimentary architectural features that have evolved through the alteration of sediment transport patterns provides the opportunity to speculate on what sedimentologists can learn from these artificial sediment sinks. Examples of a wide variety of settings, including bayhead and arcuate deltas, deserts, meandering and braided systems and various types of mass movement can all be identified within Calgary's city limits, demonstrating an unmistakable human footprint on (un)natural settings, and enabling the study of almost any setting, even deep water deposits, within walking distance of most geologists' homes.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Rediscovering the lost world: spectacular definition of a Jurassic paleo-landscape in the Gulf of Mexico, and its implications for salt deposition

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The early history of continental breakup is commonly interpreted from deep seismic reflection data and exploration borehole data, and the interpretation of surface conditions during breakup can be uncertain. In the Gulf of Mexico, the early history (leading up to the deposition of a giant salt unit in the Middle Jurassic) is poorly constrained, because the pre-salt stratigraphy is deeply buried, poorly imaged, and lacking in borehole penetrations. Important question remained - was the pre-salt basin deep or shallow? Was it continental, lacustrine, or marine? Here we present 3D seismic images that reveal, in exquisite detail, a landscape surface 170 million years old, preserved by rapid flooding and burial by salt. On this surface, we see a rugged, eroded continental terrain, reminiscent of arid lands such as modern day Jordan. Incised rivers feed into a major meandering river system; a clear shoreline borders a major deep lake, at least 1km deep, occupying the centre of the basin. Structural restoration indicates that the lake surface lay at about 750m below sea level, disconnected from the world ocean. This world ended when ocean water broke through at 170MA, flooding the basin to sea level and setting the scene for salt deposition.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Architecture and controls of thick, intensely bioturbated, storm-influenced shallow-marine successions

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Thick (¿100 m), highly bioturbated storm-influenced shallow-marine deposits are not common in the stratigraphic record, but some examples have been described in aggradational to retrogradational successions. In these, individual event beds have typically low preservation potential, yet shoreface-offshore depositional settings are still largely characterized based on the inferred frequency or magnitude of storms. Here we present a sedimentological study of a thick, bioturbated exhumed succession deposited during the early post-rift phase of the Neuquen Basin (Argentina). We characterize it and compare its stratigraphic record with examples elsewhere, in order to discuss the potential factors controlling the total overprint of storm-event beds during several million years. In the study area, the Bardas Blancas Formation (170-220 m thick) is dominated by muddy sandstones and sandy mudstones, and it also includes subordinate clean sandstones and pure mudstones. These stack to form different facies associations of a storm-influenced shoreface-offshore system. The offshore transition and proximal offshore strata invariably comprise intensely bioturbated deposits, with only a few preserved HCS-sandstone beds. The succession shows for most of its thickness a long-term aggradational pattern spanning 7-10 Myr and is associated with low riverine influence. By combining the observations and interpretations of the Bardas Blancas Formation with other subsurface and exhumed intensely bioturbated, shallow-marine successions, we dispute the general assumption that these are associated with low frequency or low magnitude of storms. Alternatively, we argue that the long-term efficiency of benthic fauna to overprint most of the storm-event beds that reached the offshore-transition sector, results from the combination of several factors: deposition in relatively confined marine depocentres, persistent low riverine influence, and long-term aggradational stacking pattern. As these conditions can develop in a variety of basin styles, such as rift, early post-rift, and foreland settings, the recognition of thick, bioturbated successions can be used to infer more realistic constrains for depositional models and better predict facies distribution in such storm-influenced systems.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Fundamental morphometric boundaries of the global modern deltas

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Deltas across the globe have been facing major challenges due to the sea-level rise. Since almost half a billion people live on deltas, especially near river deltas and avulsion nodes on the delta tops, it is particularly crucial to understand what controls the evolution of these morphologies under the sea-level rise. Previous work from nine modern deltas suggested that the backwater length (Lb), the zone of decreasing river influence due to flow into a standing body of seawater, poses a strong role as a fundamental morphometric boundary in delta system. The channel width, migration, grain size and channel depth will systematically change downstream in this backwater zone. Existing literature also suggests that the ratio of avulsion to backwater lengths should be in the range of 1:1 to 1:2. In this study, we examine 105 deltas globally and find that there is a significantly strong scaling relationship between the upstream distance of knickpoints in the river long profiles (Lk) and avulsion nodes (La), and weaker correlations between these variables and the backwater lengths (Lb). We found that the avulsion length has a statistically more significant scaling relationship with the knickpoint length, with La:Lk = 1:2.5. We therefore suggest that the change in slope (i.e. knickpoint) is the principal control on modern delta development, rather than the hydrodynamic backwater length, even though they are correlated and result from interactions between the same sets of processes. Based on this scaling relationship, we propose a conceptual model for predicting how delta lobes and their stratigraphy will response to sea-level change. We suggest that different portions of a delta, namely the bedslope- and backwater-mediated zones, will respond to external forces differently. The allogenic forcing (i.e. sea-level rise) may be shredded in the bedslope-mediated zone due to longer timescales involved, while more frequent shoreline and avulsion node migration may occur more frequently in the backwater-mediated zone. Thus, changes in sea-level or subsidence may migrate the backwater-mediated avulsion nodes, but the bedslope-mediated avulsion node will remain constant due to its connection with the knickpoint. This conceptual model allows insight into how delta systems

will respond to change in conditions differently in future and how they may have responded in the rock records.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Application of mineral liberation analysis (MLA) for grain size distribution in submarine gravity flow deposits

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The aim of the study is an interpretation of depositional processes of sediments transported by submarine density flows based on their grain size distribution coupled with facies analysis. The automated measurement system Mineral Liberation Analysis (MLA) provided quantitative textural data for statistical parameters of grain-size distributions. The analyzed sediments represent a proximal locality of the Cergowa Beds lithosome in the Polish and Slovak Outer Carpathians; and represent deposition out of a steady flows, interpreted as hyperpycnal. MLA measurements displayed a divergence between maximum and mean grain size in waxing high density flow deposits, marked by an abrupt decline in sorting, because the coarser grain appearance in fine sandstones does not elevate mean values, as may be expected. On the contrary, an admixture of coarser grains brings a decrease in central tendency parameters. This supports an inference that turbulence development, and not flow velocity, impacts on grain size distribution. Therefore, the maximum grain size, rather than the average, is controlled by the competence of turbidity currents. Fluctuations in a relatively steady flow concentration are indicated by three types of grain-size breaks, namely: in high-density turbidity currents when (i) capacity-controlled conditions are changing so that high energy flow erodes the previously deposited material; (ii) at a sharp interface between a high-concentration basal layer and an overriding lower concentration suspension, and (iii) within deposits of low-density turbidity currents, probably at a transition between low- and high-density flows within the Bouma interval Tb or at the boundary between Tb and Tc. Application of MLA system is useful in obtaining textural data relevant for assessment of submarine depositional conditions, because it increases productivity, provides significant statistical representation, and reduces human errors, bias and tedious manual analyses. MLA measurements and the statistical parameters strongly supplement macroscopic observation on the facies analysis, detecting new sedimentary features in the studied material. This study was realised within the research project MINIATURA no. DEC-2017/01/X/ST10/00048 funded by the National Science Centre (NCN) in Poland.

E-poster: Siliciclastic - shallow and marginal marine

The Evolution of Delta lobes: Channel extension vs channel splitting and lobe switching

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In the standard model of delta lobe evolution, channels split around mouth bars forming narrower, shorter channel segments as lobes prograde, with new lobes and long channels developing by avulsion, commonly initiated at the backwater length. The model is predictive and appropriate for portions of many modern deltas. However, in its simplicity, it fails to describe several key aspects of delta lobe and channel evolution, including the role of channel extension. Analysis of the Mossy, Volga, Omo and Mississippi deltas reveals anomalously-long, straight channel stretches. Such stretches typically reflect the dominant thread of unequal flow splitting, and at their termini are interpreted to be characterised by inertia-dominated jets that erode through mouth-bar deposits, lengthening channels as they do, even while coeval channels bifurcate around friction-dominated mouth bars. Examples emphasise, the mixing, and transient nature of mouth bar processes across individual lobes. Long channel segments also form as dominant channels either extend across, or divert around lobes during abandonment.

Online oral presentation with slides: Seds and the city, Monday PM

Making sediment count: translating river catchment science into economic and societal benefits for the Yorkshire Region

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Communicating the problems and solutions of sediment erosion, transport, and deposition in drainage catchments is challenging when faced with a wide range of stakeholders. The Yorkshire Integrated Catchment Solutions Programme (iCASP) is a NERC-funded regional impact from science programme that aims to generate societal and economic benefits from existing catchment related research. Projects are designed to cover a wide range of catchment related disciplines, and themes include reduced flood and drought risk; improved regional resilience to climate change; restoration of valuable areas of peat in the moors; development of sustainable agriculture; and business case development for greening city developments and making more space for water. The headline goal of the programme is to generate over £50 million of economic benefits to the Yorkshire Region by translating research. In order to achieve this goal, communication of science, which commonly include sedimentological aspects, is key. Here, we share some of the key lessons learnt from the 3 years of iCASP, framed around relevant iCASP projects. We aim to demonstrate the processes in which iCASP has engaged with regional stakeholders to understand their problems and needs; co-designed and co-produced projects to develop effective solutions; and communicated sedimentological research to a range of audiences to make research outputs useable (including land owners, practitioners and policy makers). The pathways to impact established will be demonstrated using case studies of existing iCASP projects on diffuse pollution, modelling, invasive non-native species and, macroplastics. The major challenge we have identified with partners is the need to establish a valuation for sediment to help unlock investments across a catchment, and potentially into coastal areas. Another key message is the understanding of seasonality with regards to sediment, as demonstrated through an Industrial Mobility Fellowship with Yorkshire Water on the River Derwent, Yorkshire. In order to inform management and catchment spending, the longevity and seasonality of sediment and management interventions needs to be understood.

E-poster: Siliciclastic - deep marine

The influence of channel planform and slope topography on turbidity current overbank processes: the example of the Acquarone Fan (Southern Tyrrhenian Sea)

Scacchia E., Gamberi F., & Tinterri R.

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Turbidity currents can be deflected, reflected, or constricted, depending on the geometry of the bounding slope and the angle of incidence of the current. The aim of this paper is to understand how the interaction of different types of flow with seafloor morphology affects depositional processes and the distribution of small-scale bedforms. Our case study is the Acquarone Fan, located in the intraslope Gioia Basin in the southeastern Tyrrhenian Sea. The research is carried out through multibeam bathymetry and high-resolution chirp subbottom profiles. The study area has a complex physiography, mainly controlled by the presence of the Acquarone structural ridge, that results in the confinement of the left side of the channel-levee system. Five units (Unit I-V) record the recent depositional history of the fan; their thickness in the overbank area has been mapped. The analysis of seismic facies shows that Unit II and V are relatively coarser-grained than Unit I and IV while Unit III presents an intermediate facies. Extensive bedform fields develop in specific tracts of the right levee along the channel path. The first bedform field is located in the outer side of a bend in the channel and consists of elements that parallel the curvature of the channel. Further downslope, in a straight tract of the channel, confined to the left by the Acquarone high, a second train develops on the right levee with a trend oblique to the channel direction. Finally, along the distal straight unconfined channel segment, a third train of bedforms begins in coincidence to an abrupt knickpoint, which occupies the channel axis and trends subparallel/oblique to the channel axis. According to unit thickness maps, two main patterns of deposition are recognized on the overbank area. The first pattern (belonging to coarser-grained units) has depocentres in correspondence of the first and third bedform fields while the second pattern (belonging to finer-grained units) in coincidence of the second field. We suggest that the location of the depocentres is controlled by the prevalent flow-type and by its interaction with the surrounding morphology. In particular, the first thickness trend results from the deposition of high-density bipartite turbidity currents, with spillover of their lower portion

mainly reflecting variation in the channel path. The second thickness pattern is connected with low-density turbidity currents, more conditioned by the extent of flow confinement.

Online oral presentation with slides: Siliciclastic - fluvial

Liquefaction structures induced by the M5.7 earthquake on May 28, 2018 in Songyuan, Jilin Province, NE China

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An earthquake of magnitude M5.7 occurred in Yamutu village, Songyuan City, Jilin Province, NE China (45°16'12N/124°42'35E) on May 28, 2018, with a focal depth of 13 km. The epicenter is located at the intersection of the Fuyu/Songyuan-Zhaodong Fault, Second Songhua River Fault and Fuyu North Fault which lies northwest of Tancheng-Lujiang Fault (Tan-Lu Fault). The earthquake-induced widespread liquefaction structures and ground surface fissures within 3 km from the epicenter, caused serious disasters to the local surroundings. The visible liquefied structures include sand volcanoes, liquefied sand mounds, sand dikes and sand sills. Sand volcanoes can be divided into sand volcano with a crater, sand volcano without a crater and water volcano (no sand). Other soft-sediment deformation structures (SSDS) induced by the earthquake include deformation lamination, load and flame structures, deformation folds, dish structures, convolute bedding and water-escape structures. The formation process of the sand volcanoes comprises three stages: (1) building up excess pore-fluid pressure in the liquefied layer, (2) cracking of the low-permeable overlying layer, and (3) mixture of sand-water venting out of the ground surface. During the upward movement, the liquefied sand is injected into the low-permeable layer to form sand veins, sand sills and various types of deformation structures. Vertical distribution of seismic liquefaction structure can be divided into four zones: the thoroughly liquefied zone, the lower liquefied zone with SSDS, the upper liquefied zone with SSDS, and the ground surface liquefied zone. The liquefaction occurred at a burial depth of 2 to 5 m, and the thickness of liquefied sand is 2 m. NE-SW (35° to 215°) trending compressive stress is possibly the seismogenic trigger of the Songyuan M5.7 earthquake that caused the fault (Fuyu/Songyuan-Zhaodong Fault) to reactivate. The study of the Songyuan seismic liquefaction structures gives insight into the prediction of modern earthquakes and disaster-prone areas. Meanwhile it provides abundant basic material for studying earthquake-induced SSDS in both ancient and modern sediments. The research is obviously of great significance to reveal that the northern Tan-Lu Fault has entered a stage of active seismic activity since the twenty-first century.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

A Neoproterozoic, shallow marine, anoxic stromatolite habitat from the mixed carbonate-clastic Horse Thief Springs Formation, Death Valley

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The sedimentary record of the Pahrump Group in Death Valley comprises massive, well-exposed successions of carbonate and clastic deposits. The Tonian strata presage the intense glaciations of the Cryogenian, providing the preamble to one of the most debated and arguably important events in Earth History. The Tonian-aged Horse Thief Springs Formation was deposited in a shallow sea within a tectonically active basin and consists of a mixed carbonate-clastic succession. The carbonate intervals are dominated by dolostone, featuring varying degrees of clastic input. Petrographic and field observations point to a predominantly microbial origin. Spectacular examples of stromatolites are recognised, possibly of the genera Baicalia and Conophyton, exhibiting domal, wide mounds composed of wavy, crinkly, to planar lamination. Stromatolitic dolostones are exceptionally well preserved lacking typical diagenetic or metamorphic features such as late burial cements, recrystallized sparry carbonate fabrics, stylolites, or other features suggestive of high temperature of pressure alteration. In order to characterize the environment of precipitation of these Neoproterozoic stromatolites, phase-specific trace and rare earth element geochemistry was conducted on a high-resolution scale, identifying the composition of individual stromatolitic laminae composed of microcrystalline dolomite. Strong positive Eu anomalies and the lack of negative Ce anomalies indicate that the stromatolites grew in nearshore, shallow, yet anoxic and possibly euxinic epeiric seas. These results provide new evidence of widespread stromatolite proliferation in the Neoproterozoic, defying recurring pulses of terrigenous clastic sedimentation, and provide a new glimpse into shallow marine microbial habitats on the southern Laurentian margin during incipient stages of supercontinental rifting.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

What controls the morphology of modern submarine canyons?

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Submarine canyons incise into continental shelves and slopes, and act as important conduits for the transport of sediment, nutrients, organic carbon and pollutants from continents to oceans. Submarine canyons bear some morphological similarities to subaerial valleys, such as their longitudinal (long) profiles. Long profiles record the interaction between erosion and uplift, which is typically described by concavity. The external processes that govern concavity of subaerial valleys and rivers are well-documented on a global-scale; however, the processes that control submarine canyon concavity are less well understood. We address this problem by utilising global geomorphological datasets to measure the long profiles and concavities of 5891 modern submarine canyons. Key results show that: 1) the dominant control on submarine canyon long profiles is tectonic configuration, with passive margins hosting the most concave-up canyons, and convergent margins hosting the most convex-up canyons; 2) canyon position with respect to feeder system is less influential than tectonics, with river-connected canyons more convex-up than shelf- and slope-incised canyons, and 3) continental aridity appears to have a weaker influence on submarine geomorphology than subaerial geomorphology over similar time-scales, which has implications for the lag time between changes in climate and the stratigraphic record, and the resolution of climatic change in the stratigraphic record. The site specific configuration of individual canyons may amplify or subdue these first order controls; however we show that global canyon morphological patterns exist and may be applied to support investigations into the evolution of ancient canyon systems.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Proximal to distal grain-size distribution of basin-floor lobes: A study from the Battfjellet Formation, Central Tertiary Basin, Svalbard

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Documenting the grain-size distribution of deep-marine sedimentary bodies can also offer us an insight in the flows that deposited them. Submarine lobes are commonly assumed to linearly fine from an apex, meaning there should be a proportional relation between grain size and distance from the lobe apex. Recent studies reporting the complexity of lobe deposits suggest that grain-size distributions are more complex than previously thought. However, not much detailed quantitative work has been done to test this hypothesis. Exposure of a 5 km long dip-section of basin-floor lobes in Clinoform 12, Battfjellet Formation, Spitsbergen, enable the study of basinward grain-size evolution in lobe deposits. Furthermore, the dataset allows testing if there are any documentable grain-size differences between lobe sub-environments. For this purpose, the palaeogeography of Clinoform 12 was reconstructed and the youngest lobe chosen to be evaluated for its grain-size trends. Photographed thin-sections of 66 rock samples were analysed to obtain quantitative grain-size distributions. The results show that fining of lobe deposits occurs predominantly in the most proximal and most distal parts of the lobe, while the intermediate lobe, which is dominated by lobe off-axis deposits, is characterized by a relatively consistent grain-size range. Lobe sub-environments show statistically distinct grain-size distributions from lobe axis to lobe fringe. Data acquired from lobe fringe environments show a wider spread of grain-sizes, which is caused by the occurrence of sand-prone hybrid beds and thin-bedded, finer-grained deposits into one facies association. The suggested explanation for these trends is the interplay of capacity and competence driven deposition with the grain-size stratification of the flows. Overall, the coarser grain-size fraction is enriched at the base of the flow and

more prone to be deposited when capacity -driven deposition is evoked in the lobe axis. The lobe off-axis is suggested to be deposited from the more homogenously mixed part of the flow, whereas the lobe fringe is dominated by competence-driven deposition of the upper parts of the flow, resulting in the sand pinch-out in the lobe fringe. The outcomes of this study help to better understand the proximal to distal evolution of turbidity currents and their depositional patterns. They also provide important insights in reservoir potential of basin-floor fans at lobe scale.

E-poster: Carbonates

An Analysis of Oolitic Limestone Rocks to Illustrate How Porosity Evolution Plays A Role in The Quality of Reservoir Rocks

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Carbonate reservoirs hold approximately 50-60% of the world's oil and gas resources. A good reservoir rock has significant porosity and permeability to store hydrocarbons to let them flow. Finding these high-quality reservoir rocks is key to the oil and gas industry. The study defines the impact of depositional setting and geological history on a range of oolitic limestones from the Jurassic era and affects to reservoir quality. Three depositional settings were chosen and were formed in shallow marine environments (Ketton Limestone, Cleveland Ironstone, and Gloucester Limestone). Thin sections were prepared and analysed petrographically with a microscope and processed with the Image J software to create binary images for porosity calculation. Each sample was analysed based on their texture, fabric, mineralogy, compaction levels, and pore system. Followed by a paragenetic sequence formulated to show their diagenetic relationship. The three samples analysed have similar ooid developments, sphericity, and depositional environments, slightly varying in their diagenetic processes (i.e. micritisation, cementation, dissolution, compaction, porosity formation, and the formation of authigenic minerals) resulting in different final forms. To quantitatively analyse the porosity evolution, the porosity types found, pore constructing factors (dissolution), and pore destructive factors (cementation and compaction) were looked at. Clean oolitic grainstones have the best reservoir quality whilst muddier bioclastic packstones have lower porosities. Ketton Limestone would be the ideal reservoir rock out of the three, due to its moderate porosity interconnectivity, whilst GL and Cleveland Ironstone and Gloucester Limestone would poor reservoir rocks.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

The Annot Confined Fill & Spill Turbidite System: From Transgression to Termination

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In 2021 the authors plan to undertake either virtually, or hopefully, in the actual field an excursion to the Annot turbidite systems for BSRG post-grad members*. We wish to give a flavour of what to expect.

The classic, well exposed Grès d'Annot turbidite outcrop area in the French Alps is a good analogue for deepwater systems in structurally active slope and basin settings. We show the palaeotopographic development and fill history of a suite of linked, structurally confined deepwater mini-basins. It is possible to see how turbidity currents interacted with the topography of the basin floor and on sub-basin margins, and how this in turn controlled the distribution, thickness, quality and connectivity of turbidite sands.

A range of depositional styles can be observed, from thick, proximal units to more distal, thinner-bedded units. We can observe within each mini-basin facies and architectural changes from proximal to distal, from axis to margin and through time as the systems 'fills and spills' from one basin to the next. We can compare how these signals vary down depositional dip from one mini-basin into the next.

In this outcrop area, we can make observations from large (seismic) scale to small (core) scale. The detailed observations may be put into the mini-basin context, and we aim to show how we use this analogue information to better understand mini-basins in the subsurface in active settings, like deepwater fold and thrust belts, rift and early post-rift settings and salt provinces.

The Grès d'Annot includes a range of bed-scale deposits, such as low and high concentration turbidites, debris flows as well as slumps and slides. Deepwater elements include thin and thick bedded turbidite lobe elements, turbidite channels, seismic-scale mass transport deposits and onlap margin sediment bodies. The stratigraphic evolution of facies associations and architectural elements and stacking patterns and spatial distribution in one mini-basin can be compared with the next basin down-flow. An interesting fill and spill model emerges that reflects the complex 3D geometry of the mini-basins and the dynamic changes in degree of confinement.

*Look for announcements

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Bedding-parallel silica layers in Jurassic carbonates: the Hanifa Formation, Central Saudi Arabia

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The Jurassic (Late Oxfordian) Hanifa Formation of central Saudi Arabia is a significant hydrocarbon reservoir. Here we describe sections from Wadi Al-Ain, examined by field techniques (including 3d outcrop models) and petrography. The thickness of the Wadi Al-Ain section is about 120 m. The lower part of the stratigraphy was dominated by corals and stromatoporoids, and exhibits abundant grainstones. The upper part was dominated by argillaceous limestone with relatively abundant foraminifera. A bedding-parallel silica layer was found in the middle of the stratigraphy, located towards the western end of the wadi and thereby towards the Arabian Shield. This continuous silica layer is around 10 cm thick. We are examining this layer and attempting to ascertain its origin. The first hypothesis is that the silica was remobilized from spicules of sponges. Another suggestion would be that the silica derives from nearby clastic sources. We are examining specimens of the silica layer by optical and electron microscopy to help distinguish between these alternative hypotheses.

E-poster: Siliciclastic - deep marine

Process-based modelling of the sedimentology and stratigraphic architecture of submarine slope canyon margin systems, Baja California (Mexico)

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Submarine slope canyons and channels are erosional conduits that cut continental shelves and transport sediment to deep-marine basin floor environments. For the majority of a slope channel's lifetime, axial regions are dominated by sediment bypass and erosion. Crevasse splay, depositional terrace, and internal and external successions therefore provide a valuable depositional record of overspill and flow stripping from adjacent, bypassing channelised sediment gravity flows. Outcrop analogues tend to be biased towards channel axes, which are generally better exposed. The fine-scale sedimentary record of channel-margin and overbank successions require exceptional outcrops, and/or core to enable development of process-based models to unlock the potential of these settings as archives of palaeoenvironmental change.

The Punta Baja Formation, Baja California, is a well exposed submarine canyon-fill, which consists of coarse- and fine-grained domains that represent the canyon axis and overbank environments, respectively. Initial results from sedimentary logging and photogrammetric models support the presence of internal levees with distinct successions that fine- and thin-upwards. Laterally, beds decay in thickness away from the channel-belt axis according to a power law. Additionally, tractional structures, such as cross ripple lamination are observed and present a range of palaeodirections. Furthermore, the identification of potentially cyclical, hummocky-like bedforms may represent flow combination from reflection and deflection processes against pre-existing topography such as the canyon wall.

Future work will establish recognition criteria for the identification of thin-bedded depositional environments by developing geological models that quantify and predict facies distributions, thinning rates and bed thicknesses. Resultant 3D petrophysical and numerical models will be applicable across a range of subsurface analogues to refine interpretations on marginal depositional environments, such as internal levees and depositional terrace deposits.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

Bridging the gap between seafloor geomorphology and subsurface architecture: how mass-transport deposits and knickzones build channelised deep-water stratigraphy in the Hikurangi Channel (offshore New Zealand).

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Repeat bathymetric surveys of active deep-water channels have shown how features such as cyclic steps and knickpoints can generate and erode stratigraphy. However, to date, the preserved subsurface manifestation of these features at large architectural scales is poorly understood. The Hikurangi Channel, offshore New Zealand, provides an ideal opportunity to bridge this gap as the presently active channel provides a direct analogue for the immediate subsurface. Here, we integrate high-resolution bathymetry and three-dimensional seismic data to link seafloor features to subsurface deposits and surfaces. Knickpoints, knickzones, Mass-Transport Deposits (MTDs) derived from channel-wall collapse, and terraces are widely observed in the modern channel. In the subsurface, the identification of ten seismofacies and five seismic surface types allowed the categorisation of channelised deposits into four depositional elements: channel-fill, sheet or terrace deposits, levee deposits, and MTDs. Three-dimensional correlation and interpretation of relative ages were performed using MTDs as chronostratigraphic markers. Linking depositional elements and internal reflector variability to corresponding seafloor features revealed potential formative mechanisms of deposits and surfaces commonly observed in channelised stratigraphy. Upstream-migrating knickpoints generated and filled, high-amplitude reflector package (HARP)-bounding surfaces that are concave-up in cross-section and longitudinally continuous for tens of kilometres in their downstream wake. Multiple, closely spaced knickpoints form knickzones. Knickzones generate channelform surfaces, which are composite surfaces formed by multiple HARP-bounding surfaces. The response to MTD emplacement fundamentally controls channel deposit architecture in the Hikurangi Channel. After the collapse of a channel-wall, flow perturbation by channel damming MTDs causes deposition upstream of the MTD and formation of an upstream-migrating knickzone down-

stream. The knickzone incises first the MTD and then the weakly confined deposits formed upstream of it, leaving in its wake a filled channelform surface bound by a newly formed terrace. This mechanism provide an alternative to conventional models of channel deposit formation and may aid subsurface interpretation in systems lacking a contemporary analogue or with poor data coverage.

Online oral presentation with slides: Siliciclastic - deep marine WITHDRAWN

Heterogeneous thin-bedded turbidites on syn-depositional structures: interaction between allogenic and autogenic sedimentary process

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Middle East, Asia & Europe Project Division

Thin-bedded turbidites tend to show complex facies and thickness distribution, which are not enough captured by subsurface datasets such as 3D seismic data and standard resolution well logs. The reservoir rock in this study mainly consists of Pliocene to Pleistocene heterogeneous thin-bedded turbidites. The trap anticline is interpreted to be formed by syn-depositional folding on the basis of regional tectonic history. The reservoirs contain multiple volcanic ash beds, which enable chronostratigraphic correlation at a high confidence level, defining subunits (5–20 m) within the reservoir units (20–50 m). However, production pressure behavior indicates that the reservoirs still have significant heterogeneity and discontinuity within the subunits. This condition makes it challenging to perceive their correct architecture. In this study, the detailed correlation and subdivision of subunits into packages (0.5–5 m), utilizing integrated datasets are conducted to better understand the thin-bedded reservoirs and their depositional processes. The results show noticeable three types of package stacking patterns as followed. 1) In Type A pattern, the packages consist of thin-bedded (2-20 cm), discontinuous, and high lateral thinning rate. Remarkably they show abrupt thinning towards the present structural high area, which have patchy- to belt-shaped elongated geometry. 2) In Type B pattern, the packages consist of thin- to medium-bedded (5-50 cm), continuous, and low lateral thinning rate, which occasionally indicated a compensational stacking pattern. 3) In Type C pattern, the packages consist of thin- to thick-bedded (5-100 cm), discontinuous, and high lateral thinning rate. Thick-bedded sand packages are characterized by erosional base and associated with mudstone-clast. Thick sand distribution shows vertically heterogeneous and horizontally elongated geometry. Type A and B packages were observed in the lower and middle part of reservoir unit, whilst type C packages were seen in the upper part. These differences suggest that the type A packages were predominantly influenced by an allogenic process caused tectonic activities, whereas the type B packages were mainly controlled by an autogenic process characterized by compensational stacking. On the other hand, Type C package is interpreted to be deposited in higher energy environment like

channel, which means the change of depositional environment from lobe to channel-levee system.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

The spatiotemporal evolution of single sand bodies architectural element controlled by allocyclicity and autocyclicity in the shallow-water braided river delta front of the Ordos Basin, China

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Siliciclastic reservoirs are an important part of the large oil and gas resources in the Ordos Basin. With exploration and development, reservoir architecture has gradually become better understood, which provides guidance for sedimentology and reservoir geology. The Upper Triassic Yanchang Formation is characterized by development of a unique shallow-water braided river delta sedimentary system. Frequent lacustrine base level cycles affected the architectural evolution of reservoir sand bodies in the shallow-water deltas but they show evidence for both allocyclicity and autocyclicity. This paper uses core, well logging, test and production dynamic data to study the spatiotemporal evolution law of architectural elements composed of single genetic sand bodies. Results show that the Chang-8 sequence in Yanchang Formation can be divided into three ultra-short-term base level cycles, on which the shallow braided river delta front in the study area can be divided into three sedimentary evolution stages of “upper delta-front, middle delta-front and lower delta-front according to the temporal and spatial order of sedimentary evolution of deltas. Then, according to the research ideas that the level of sequence unit of architectural elements are affected by allocyclicity and the level of microfacies unit of these elements are affected by autocyclicity, these architectural elements is divided. Furthermore, the spatial combination relationships of various architectural units formed by the fluctuation of base level cycle in three sedimentary evolution stages are analyzed one by one, and then, according to the enrichiment degree of remaining oil and the waterflooding results, the comprehensive evaluation is divided into four levels. Finally, a complete architectural evolution mode is established, which is mainly characterized by a transform process from braided channels to branch channels, and the geometry of architectural elements is gradually decrease both in width and thickness.In addition, the allocyclicity mainly affect the architectural elements by deltas morphology and sedimentary microfacies classification and the autocyclicity mainly affect the architectural evolution by lake level fluctuation and

short term sedimentary environment changes. This paper will provide ideas for the study of shallow-water deltas reservoir and have guidance for exploration and development of oilfield.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Tunisite: A diagenetic proxy for high-CO2 concentrations?

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Carbon capture, utilisation and storage (CCUS) is an industrial scale, cost-effective mitigation strategy to reduce anthropogenic CO2 from entering the atmosphere. The large-scale sequestration of CO2 into geological formations has been demonstrated through major projects such as Equinor's Sleipner and Shell's Quest Projects. The UKCS hosts a plethora of depleting oil and gas reservoirs that could successfully be reutilised for this technology. Little knowledge exists however on how these reservoirs may geochemically react to late-stage CO2 injection. Previous work has shown that several carbonate minerals can form as a result of late stage CO2 injection, and these can permanently sequester CO2. Knowledge of how to differentiate these later stage precipitates from "normal", non CO2 sequestering diagenetic processes however is currently limited. To date, only dawsonite has been proven to be a distinctive diagenetic product of high CO2 concentrations in a handful of natural analogue settings. One mineral yet to be associated with high CO2 concentrations is tunisite, which is a rare carbonate bearing mineral. Here, we present the first known discovery of tunisite in the UK stratigraphic record, identified through novel studies of legacy core, and outline the potential implications this discovery has for future CCUS projects in the UK and beyond.

Online oral presentation with slides: Siliciclastic - source to sink, Wednesday AM

From river to delta; diachronous key stratigraphic surfaces in low-accommodation settings (Dakota Group, USA)

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The adequate documentation and interpretation of regional-scale stratigraphic surfaces is paramount to establish correlations between continental and shallow marine strata. In active depositional systems however, these surfaces are often composite and hence diachronous, which contradicts their original appreciation. This is particularly true in low-accommodation settings due to their amalgamated nature. This study utilizes the 400 km transect of the Cenomanian Mesa Rica Sandstone (Dakota Group, USA); an example of an exhumed depositional profile across a river-to-delta system. The near-continuous outcrop exposure allows mapping of down-dip changes in facies, thickness distribution, fluvial architecture and spatial extent of stratigraphic surfaces. The two sandstone units of the Mesa Rica Sandstone represent contemporaneous fluvio-deltaic deposition in the Tucumcari subbasin (Western Interior Basin) during two regressive phases. Multivalley deposits pass down-dip into single-story channel sandstones and eventually into distributary channel deposits and delta-front strata. Additionally, multi-storey channel deposits bound by erosional composite scours incise into underlying deltaic deposits. These represent incised-valley fill deposits. The erosional composite surface below fluvial strata in the continental realm represents a sequence boundary/regional composite scour (RCS) and can be mapped for ¿300 km. Basal distributary composite scours, composite surfaces bounding incised valleys, and basal surfaces below dispersed trunk channels incising into deltaic deposits occur at sub-regional scale. The RCS' diachronous nature demonstrates that its down-dip equivalent disperses into several surfaces in the marine part of the depositional system, which challenges the idea of a single, correlatable surface. Formation of a regional composite scour in the fluvial realm throughout a relative sea-level cycle highlights that erosion and deposition occur virtually contemporaneously at any point along the depositional profile. This contradicts stratigraphic models that interpret low-accommodation settings

to dominantly promote bypass, especially during forced regressions. Source-to-sink analyses should account for this in order to adequately resolve timing and volume of sediment storage in the system throughout a complete relative sea-level cycle.

Online oral presentation with slides: Siliciclastic - fluvial, terrestrial, glacial, Wednesday PM

Ancient glaciation or recent erosion? Reassessing classic evidence for Cryogenian striated pavements from the Mineral Fork Formation, Utah, USA

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Determining the extent and behaviour of ancient ice sheets is fundamental to accurate reconstructions of the Earth during the Cryogenian period. Subglacially striated pavements inform us of the presence, position and flow direction of past ice. They additionally provide unequivocal confirmation of a warm-based thermal regime, which exerts a fundamental control on almost every aspect of glacial behaviour. In the Cryogenian record, these pavements are more commonly found beneath younger Cryogenian ("Marinoan") glacial formations and only one uncontested pavement is known beneath an older Cryogenian ("Sturtian") glacial formation, namely the Mineral Fork Formation of Utah, USA (A further example occurs within, but not beneath, the "Sturtian" Ayn Formation, Oman). On the basis of detailed geomorphologic analysis, supported by high resolution terrestrial and unmanned aerial vehicle photogrammetry, we reinterpret this surface as a recent, non-glacial feature. With the underpinning evidence of a striated pavement removed, there remains little or no evidence supporting previous interpretations of glacial incision, subglacial deposition, westward ice flow or grounded ice in the study area. Instead, a combination of tectonic, climatic, geochemical and sedimentologic evidence suggest that incision beneath the Mineral Fork Formation was perhaps more likely fluvial than glacial. In addition to removing the only Cryogenian striated surface known from the North American continent, these findings raise the possibility that striated surfaces beneath Cryogenian formations are globally only known beneath "Marinoan" aged strata, hinting at a different set of glacial circumstances during the "Sturtian" glaciation.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Reconstruction of Late Triassic to Early Jurassic Biosiliceous Sedimentation in the Outer Ramp Environment of the McCarthy Formation, Alaska

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There is a growing body of literature that recognizes the complexity of deep-water siliciclastic systems. The distal environments of ramps, however, are less well understood. Here, we present the results of facies analysis of the McCarthy Formation exposed at Grotto Creek in the Wrangell Mountains, Alaska. The McCarthy Formation represents Late Triassic to Early Jurassic sedimentation in an outer ramp environment on the terrane of Wrangellia in the Phantalassan Ocean. We interpret the McCarthy Formation as a multiple-source outer ramp with both muddy and sandy lobes. Evidence for reworking by bottom currents is recognized across the outer ramp. After the Norian-Rhaetian, the ramp became increasingly siliceous and by Hettangian it had become a glass ramp. This evolution is similar to that of coeval ramps elsewhere in the world and represents the recovery of siliceous biota following the End-Triassic Mass Extinction. This biogeochemical transition coincides with an order of magnitude increase in sedimentation rates, which emphasizes the importance of siliceous sediment production on the evolution of the outer ramp. Stratigraphic variability in the McCarthy Formation can be attributed to changing biogenic sediment production in shallower water and the dynamics of sediment transport and deposition in the outer ramp. Such variability should be considered when using outer ramp successions as records of Earth's history.

Pico session presentation: Siliciclastic - deep marine

Global monitoring data shows grain size controls turbidity current structure

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The first detailed measurements from active turbidity currents have been made in the last few years, at multiple sites worldwide. These data allow us to investigate the factors that control the structure of these flows. By analyzing the temporal evolution of the maximum velocity of turbidity currents at different sites, we (1) aim to understand whether there are distinct types of flow, or if a continuum exists between end members; and (2) to investigate the physical controls on the different types of observed flow. Our results show that the evolution of the maximum velocity of turbidity currents falls between two end-members. Either the events show a rapid peak in velocity followed by an exponential decay or, flows continue at a plateau-like, near constant velocity. Our analysis suggests that rather than triggers or system input type, flow structure is primarily governed by the grain size of the sediment that is available for incorporation into the flow

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

The diagenetic studies of shallow late Permian carbonate deposits in northern Pakistan: implications for reservoir quality

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The late Permian carbonate succession (Wargal Formation) in the Trans Indus Ranges, North Pakistan was studied in detail to explore the impact of diagenetic modifications on reservoir quality of the shallow marine carbonate deposits. The current study integrates detailed geological field, petrographic, scanning electron microscopic, and energy dispersive X-ray spectroscopic data for the reconstruction of diagenetic history of late Permian carbonates and its impact in re-shaping the reservoir potential. The petrographic studies revealed various diagenetic features including micritization, neomorphism, dissolution, compaction (mechanical and chemical), dolomitization and cementation that have played a crucial role in the modification of reservoir quality of the rock unit. The detailed diagenetic characteristics show that the rock unit has undergone through different diagenetic phases i.e. marine, marine-meteoric mixed, meteoric and burial diagenesis. It is noted that the diagenetic modification has a negative effect on the reservoir quality of the grainstone microfacies. However, the mudstone and wackestone microfacies are diversely modified and porosity is enhanced. At outcrop, various large-scale dissolution activities and dense network of inter-connected fractures have further enhanced the reservoir potential of the studied strata.

Online oral presentation with slides: Siliciclastic - deep marine, Monday AM

The curious case of the missing thin beds: reflectance spectroscopy analysis of deep-water deposits, Angel Fm., NW Shelf, Australia

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The early post-rift Angel Formation, Dampier sub-basin, NW Shelf, Australia, is an enigmatic sand-rich deep-water lobe succession that has a bimodal character of high-density turbidites (¿5m thick), and a heavily bioturbated heterolithic interval (dm-m thick). The Angel Formation is poorly visualised in seismic data, so we are heavily reliant on well and core data for depositional context. Using reflectance spectroscopy, graphic and well logs from three wells (71 m) we investigate the texture and composition of the bioturbated heterolithic interval and how these properties relate to an apparent absence of thin-bedded turbidites (cm-mm scale), a facies association common in turbiditic successions worldwide. CSIRO's Hylogger-3TM is a rapid, non-destructive, drill core reflectance spectrometer capable of continuous mineral identification at 4 mm resolution. Measurements are taken across three bandwidths: visible-near infrared, shortwave infrared and thermal infrared (TIR). This three-bandwidth approach has been used in carbonate identification, and exploration and development for ore mining, but has rarely been applied to siliciclastic successions. Reflectance spectroscopy shows the heterolithic intervals are split into three types based on TIR quartz abundance and secondary minerals: Type 1 (70-85% quartz; 10-20% kaolinite; 0-10% feldspar) is characterised by the variation in quartz abundance and feldspar appearance, previously unobserved heavily bioturbated beds (2-5 cm thick), are identified by a sharp basal increase in quartz and a gradual-sharp quartz decrease and feldspar appearance at bed tops, which are interpreted as lobe fringe settings. Type 2 (45-70% quartz; 20-40% kaolinite; 10-20% feldspars) shows a smoother gradual increase and decrease in quartz abundance, suggesting a background silty mudstone succession associated with dilute turbidites or hyperpycnites, below our resolution limit. Type 3 (15-45% quartz; 45-90% kaolinite; 15-25% feldspars) are clay rich and interpreted to represent periods when sand delivery was shutdown. We conclude that the identification of thin-bedded turbidites in highly bioturbated successions is possible

using reflectance spectroscopy. The identification of a previously unobserved lobe fringe facies association and it's petrophysical properties, enables us to improve our depositional model and understanding of the effects of confinement on lateral variability.

E-poster: Siliciclastic - deep marine

Deposits of experimental turbidity current transitioning from a confined slope and unconfined basin floor environment.

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Experimental results are presented from initial laboratory tests that simulate scaled turbidity currents responding to a simultaneous loss of confinement (LOC) and break of slope (BOS). Low and high concentration homogenised mixtures of sediment (uniform sand, d50 to 120μm) were introduced into a flume channel at a constant rate via a pumped supply for a duration of 45 seconds. Upon entering the flume, the sediment-water mixture acted under its own density contrast to form a turbidity current that was initially confined within a 0.1 m wide, 0.3 m high, and 3.2 m long channel, set at a 10 degree bed slope. At the end of this channel, the turbidity currents entered a 2.0 m by 2.0 m horizontal-floored basin, surrounded by a trench to prevent reflections of the currents by the tanks walls. At the entry point to the basin, the turbidity currents underwent a LOC and BOS that resulted in a loss of momentum, causing them to rapidly dissipate and deposit sediments, which eventually generated an adverse topographic gradient in the downstream direction. These experiments are therefore more akin to complex systems where bed topography has an impact on both the flow properties and resulting deposits of turbidity currents. Systems where such complexities can be found include ponded mini-basins (Prather et al., 2012), channel choke points between salt walls (Howlett et al., 2020), and at the base of steep slopes (Lee et al., 2002; Schyder et al., 2018), which often cause unusual base of slope features, commonly termed plunge pools, to form.

Whilst there have been previous studies (e.g. Garcia and Parker, 1989; Gray et al., 2005, 2006; Alexander et al., 2008; Baas et al., 2004; Mulder and Alexander, 2001; Weill et al., 2014 (list not exhaustive)), detailing how turbidity currents transition between a relatively steep slope (up to 9 degrees) and horizontal basin floor, the mechanisms of plunge pool formation remain unresolved within the literature. Perhaps this is due to the prevalence of past laboratory experiments being net-depositional, with rapid sedimentation rates smothering out the deposit structure produced by experimental flows. This study, therefore, aims to produce flows capable of both erosion and bypass, in order to produce a more representative model of sedimentation in these complex systems.

E-poster: Siliciclastic - deep marine

Quantification of tsunamigenic submarine landslides through subsurface interpretation and numerical modelling, Makassar Straits, Indonesia

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This research expands on the study of Brackenridge et al., 2020, which identified a large number of mass transport deposits with volumes of ¿100 km3 within the Pliocene to Recent sedimentary sequence of the Makassar Strait of Indonesia, SE Asia. While tectonically active, the primary driver of submarine landslides is thought to be rapid sedimentation rates and associated slope oversteepening. Preconditioning also plays a significant role in slope failure due to the Indonesian Throughflow. The effect of the Indonesian Throughflow is evidenced by current erosion, lateral transport and deposition of contourite drifts and terraces, with the majority of landslides identified to the south and southwest of the Mahakam pro-delta.

Using an extensive 3D seismic reflection survey, we have characterized past landslides and mass transport deposits, identify potential areas of future failure, and aimed to quantify the risk and impact of landslide-generated tsunamis in the region. Interpretation of the seismic data has revealed geomorphological details of the location of landslide initiation along the coastline of East Kalimantan and associated mass transport deposits through a series of canyons and escarpments.

In addition, an extensive literature based morphometric database was compiled based on Clare et al., 2018 to aid in the quantification of landslide and tsunami parameters. Together with the seismic interpretation, numerical modelling of potential tsunamis is being undertaken using a combination of Python, NHWAVE and FUNWAVE-TVD. This analysis will provide beneficial in the urban planning and disaster mitigation stages of the development of the new capital city proposed in Balikpapan Bay region.

Online oral presentation with slides: Siliciclastic - diagenesis, Monday PM

Sedimentary Facies and Diagenesis Control on High-quality Tight Sandstone Reservoir: A Case Study of the Southern Sulige Gas Field, Central China

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The upper Paleozoic gas reservoir in the Southern Sulige Gas Field is a typical tight gas sandstone reservoir. Several sets of tight sandstone reservoirs are developed from in upper Paleozoic, such as Shan 2 interval and He 8 interval, which are characterized by low porosity and low permeability. Taking Shan 2 interval and He 8 interval in southern Sulige Gas Field as examples, the sedimentary settings, petrological characteristics and reservoir characteristics are analyzed by thin section petrography and scanning electron microscope. This work highlights the relationship between reservoir quality and sedimentary environment, explains the differences in reservoir properties in different sedimentary environments, and discusses factors affecting reservoir capability.

The results are as follows: (1) In the study area, Shan 2 interval developed meandering river delta sedimentary system, and He 8 interval developed braided river delta sedimentary system, including meandering river delta plain, meandering river delta front, braided river delta plain and braided river delta front; (2) There are great differences in mineral components, pore-throat type and reservoir quality of sandbodies formed in different sedimentary environments. The main rock types of meandering river delta sedimentary system are lithic quartz sandstone and lithic sandstone, and the reservoir space are mainly dissolution pore, intergranular pore and residual intergranular pore. The rock type of braided river delta facies sedimentary system is mainly lithic quartz sandstone, and the main reservoir spaces are dissolution pores, intergranular pores and residual intergranular pores; (3) The reservoir quality is affected by both sedimentation and diagenesis. Sedimentation controls the scale and distribution of high-quality sandbodies macroscopically, and diagenesis controls the development characteristics of reservoir micro pore structure; (4) Calcite and illite filled the pores between grains and reduced the porosity, while the dissolution of feldspar and debris effectively improved the pore structure of the reservoir. Siliceous cement is conducive to retain primary pores or form secondary pores, thus forming a better reservoir property; (5) High quality reservoirs are mostly distributed in the multi-stage river channels, which are the key gas accumulation areas and can be developed as the sweet spots.

Online oral presentation with slides: Carbonates and evaporites, Tuesday PM

Tectonically driven climate instability during the Early Miocene, evidence from the shelf carbonates of Malta

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The early Miocene represents a unique period in the evolution of the cryosphere and associated climate regimes. The early Miocene is bound by the transient glaciation at the Oligocene-Miocene transition (23 Ma) and the warm interval that started in the latter stages of the Burdigalian (c.17 Ma). The Aquitanian-Burdigalian boundary, at 20.44 Ma, is essentially contemporaneous with the initiation of an episode of severe restriction of oceanic water flow from the Indian Ocean into the proto-Mediterranean via the Mesopotamian Seaway. This restriction was driven by the northward movement of the African and Arabian plates, and was likely intensified by expansion of the Antarctic ice-sheet and associated eustatic sea-level fall. The cooling was possibly also impacted by enhanced drawdown of CO2 via intensification of silicate weathering associated with the uplift of the Zargos Mountains during the collision. The tectonic event, together with the instability of the Antarctic ice sheet, would have resulted in rapid climatic perturbations at the time. The shelf sediments exposed at the 'il-Blata' section on the Island of Malta contain a depositional record that spans from the Oligocene to the Burdigalian. The late Oligocene and earliest Miocene deposits contain carbonate facies interspersed with phosphorite rich conglomerate beds indicative of deposition in oxic waters under varying energy regimes. A major hiatus in the record is coeval with the Aquitanian-Burdigalian transition, which is followed by the facies change to organic-rich carbonates and subsequently to chert-rich chalk facies. These facies changes, together with evidence from major element ratios, indicate that the hiatus is linked with a temporary arid perturbation over North Africa around the Aquitanian-Burdigalian boundary. In the aftermath of this hiatus, geochemical evidence points to a humid regime expanding over North Africa with fluvial systems depositing into the western part of the proto-Mediterranean. This humid period in the Burdigalian can be seen as evidence of a wetter, seasonal climate regime more similar to the present day systems of the Indian and Atlantic Oceans. We propose that the closure of the Tethys Gateway led to this regional change in hydrology, which was also accompanied by major changes in carbon cycling.

Online oral presentation with slides: Siliciclastic - shallow and marginal marine, Wednesday AM

Does it still make sense to apply classical, sequence-stratigraphical concepts to tide-dominated basins?

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Tidal dynamics in shoreline–shelf systems are principally a function of latitude and the physiography (geometry and bathymetry) of the depositional basin. By studying the influence of changing physiography on tides enables 1) better understating of historical sedimentary processes in shallow marine basins, and 2) potential changes in shoreline tidal dynamics in response to anthropogenically-driven changes in relative sea level. Here, we present an analysis of numerical modelling of tidal propagation in the Sundance and Curtis Seas during the Upper Jurassic, and show that: - Changes in palaeobathymetry control both the magnitude and the location of tidal amplification. Some palaeobathymetries resulted in a general increase in tidal amplitude across the basin (with various degrees of amplification), whereas other palaeobathymetries led to an overall dampening of the tidal amplitude. - The impact of change in palaeobathymetries on the flow speed and bottom shear stress is also significant. However, they are very sensitive to local variations, and their responses to palaeobathymetric changes are much more spatially heterogeneous than the response of the change in tidal amplitude. - Variations in initial tidal forcing and bottom drag coefficient impact the location of tidal amplification, as well as flow speed and bottom shear stress variations in the basin, but to a much lesser degree than changes in palaeobathymetry and with much more spatial variations. - Despite basin-wide trends associated with relative sea-level rise or fall, the spatial distribution of the tidal amplification across the basin is heterogeneous. This results in the resurgence of tidal amplification or dampening with different periods at different locations, with increasing spatial variations the deeper the basin is. Consequently, the stacking pattern of the various architectural elements would strongly vary from one side of the basin to the other, despite a similar relative sea-level (RSL) history. The interpretation of the RSL history across an entire basin therefore requires caution if tides are one of the major process active at the time of deposition, particularly when data points are sparse.

Online oral presentation with slides: Siliciclastic - deep marine, Tuesday AM

Controls on the variable nature of submarine channel evolution revealed from repeated seafloor mapping.

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Submarine channels play a globally important role in the deep sea transport of sediment and organic carbon and pose a hazard to seafloor infrastructure. The recent advent of repeated multibeam bathymetric surveys has provided the first direct observations of how such channels evolve. Based on new timelapse seafloor surveys, various studies made apparently contradictory conclusions about which mechanisms control channel evolution, including migration of: i) crescentic bedforms; ii) meander bends; and iii) decimetre-high knickpoints. Previous repeat surveys cover time windows of a few years, and generally do not cover the full source to sink extent of a submarine channel system; hence it is challenging to understand if and why certain mechanisms only dominate in some sections of the system. We present high resolution timelapse seafloor data spanning 13 years, from the full length of an active submarine channel in Knight Inlet, British Columbia, Canada. Channel evolution is dominated by both knickpoint and meander bend migration, but each mechanism dominates in different reaches. Surprisingly, erosion in the largest channel bend is dominated by upstream migration of knickpoints within the channel axis, rather than pronounced outer bend erosion. We use inflections in channel sinuosity to define the locations of channel bends, where we quantify radius of channel curvature, R. We identify a threshold above which knickpoints occur (R¿0.2 km) and below which they do not, and outer bend erosion dominates (R¡0.2 km). We posit that increased centrifugal acceleration in tighter bends causes enhanced superelevation of the flow, explaining why erosion is focused higher up on the outer bend. In straighter sections, centrifugal acceleration is negligible. Instead, flow remains focused within the channel axis, explaining the presence of knickpoints.

Where channel curvature is complex (e.g. large bend with tight incipient curves), knickpoints and outer bend erosion can be observed concurrently, illustrating how differing morphologic length scales affect flow behaviour. We finally show how the stratigraphic completeness of locations affected by meander bend migration is markedly higher than at knickpoints. Therefore, the influence of knickpoints may have been dramatically under-represented in models of channel evolution based on ancient depositional records.