**Similarities and differences in the dolomitization history of two coeval Middle Triassic carbonate platforms, Balaton Highland, Hungary**

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Dolomitization of platform carbonates is commonly the result of multiphase processes. Documentation of the complex dolomitization history is difficult if completely dolomitized sections are studied. Two coeval Middle Triassic sections, representing the internal part of two carbonate platforms in the area of the Transdanubian Range, were investigated to determine the mechanism and history of their complex dolomitization. Both sections are made up of metre-scale peritidal–lagoonal cycles with significant pedogenic overprint. One of the sections contains non-dolomitized, partially dolomitized, and completely dolomitized intervals, whereas the other is completely dolomitized.

From samples taken from cores and surface exposures detailed petrographic studies and stable isotope measurements were performed. In the partially dolomitized section, penecontemporaneous dolomite formation and/or very early post-depositional dolomitization were identified in various lithofacies types. In shallow subtidal facies porphyrotopic dolomite was found preferentially in microbial micritic fabrics. Microbially-induced dolomite precipitation and/or progressive replacement of carbonate sediments could be interpreted for stromatolites. Dolomite might also have been formed by pedogenic processes; dolomitic calcretes or dolocretes were developed in this way. Meteoric diagenesis during the recurrent subaerial exposure episodes may have locally resulted in partial dissolution and calcitization of the porphyrotopic dolomite. Fabric-destructive dolomite commonly found below these horizons was likely formed via reflux of evaporated sea-water.

As a result of the different palaeogeographic settings of the two platforms, their shallow-burial conditions were different. One of the studied sections was located at the basinward platform margin where pervasive fabric-retentive dolomitization took place in a shallow-burial setting, probably via thermal convection. In contrast, in the area of the other, smaller platform shallow-water carbonates were covered by basinal deposits, preventing fluid circulation and accordingly pervasive shallow-burial dolomitization. In the intermediate to deep burial zone recrystallisation of partially dolomitized limestone and occlusion of newly opened fractures and pores by coarsely crystalline dolomite took place.

By the Late Norian the Middle Triassic platform carbonates reached the deeper intermediate to deep burial zone. Recrystallisation of partially dolomitized limestone and occlusion of newly-opened fractures and pores by medium to coarsely crystalline dolomite can be attributed to this stage.

The genesis of dolomitic rocks is usually the result of complex sedimentary and diagenetic processes. In many cases it is initiated by synsedimentary dolomite formation and/or early diagenetic dolomitization in a near-surface setting, but the subsequent dolomitization stages commonly destroy the traces of the early dolomitization processes. In these cases the comparative study of contemporaneously deposited successions that are completely and partially dolomitized respectively, or the study of transitional intervals between the dolomitized and partially or non-dolomitized rock-bodies may provide a good opportunity for reconstruction of the mechanism and history of dolomitization. This study reveals that even neighbouring and coeval platform carbonates with similar sedimentary features may show remarkably different dolomitization patterns due to their different palaeogeographic setting and burial history.

**Evolution of the Sefidrud delta (South West Caspian Sea) during the last millennia**

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The Sefidrud River has developed a large delta in the south west of the Caspian Sea. This delta is characterized by very rapid sedimentation rates in a steep slope setting, which can be used as a model for oil-bearing reservoirs. The Caspian Sea Level (CSL) has undergone significant changes over time with major impacts on the surrounding coasts. During the last millennium, the CSL has experienced two major fluctuations, a low-stand during the Medieval Climate Anomaly (MCA: AD 950-1250) and a high-stand during the Little Ice Age (LIA: AD 1300-1850). This study aims 1) to explain the evolution of the Sefidrud delta in the last millennia and to propose a mechanism for delta building; and 2) to detect the impact of sea level changes on sedimentation by a multiproxy analysis in different wetlands and lagoons.

For this purpose, the Sefidrud Delta has been investigated using a large number of short cores (up to 3 m) and long cores (up to 13 m) taken onland and ofshore. Also, Ground Penetrating Radar (GPR) transects were obtained onland and seismic profiles offshore. The interpretation of the results from both methods were checked by cores taken on the geophysical profiles. The objectives of geophysical studies was to image the internal structure of sediments and consequently, to reconstruct the history of delta development. In addition lagoons and wetlands at various distances form the coast were cored.

This study confirms that the Caspian Sea experienced a high stand during LIA following a low-stand during MCA and CSL was 5 m above the present sea level. Although previous studies in the southern coast of the CS have detected a high-stand during the LIA period, it is the first time that this high-stand has been reconstructed so far in land in a sedimentary sequence and at such a high altitude.

Beside this, the internal sediment distribution patterns in the lagoons and along river distributaries were obtained using the correlation of cores and development of different lagoons and their evolutions under different situation were discussed. The highly dynamic sedimentation in the delta has been confirmed by radiocarbon and radionuclide dating.

**Diagenetic History of the Mid-Cretaceous Carbonates in Southwestern Iran and the Persian Gulf**

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The Mid- Cretaceous Sarvak Formation in southern Iran and the Persian Gulf represents a carbonate ramp that developed at the north eastern edge of the Arabian Plate. The carbonate platform which records the Anoxic Oceanic Event (OAE) was periodically subaerially exposed during Cenomanian-Turonian. Regional Turonian unconformity that marked the top of these carbonates greatly influenced the diagenesis of the underlying carbonates. In this study a detailed investigation of the Sarvak Formation diagenesis were carried out in surface and subsurface sections where the effects of the unconformities were documented. A combination of petrographic and geochemical analysis is utilized to unravel the diagenetic history of the Cenomanian-Turonian carbonates in the study area.

Over 300 thin sections were examined using transmitted light and over 100 representative samples studied using a Technosyn 8200 MKII model cold cathodoluminescence (CL) microscopy.

Rudist's shells, calcite matrix and different types of cements were micro-sampled. Powdered samples were analyzed for stable oxygen and carbon isotopes analysis using a Finnigan Mat Delta Plus mass spectrometer. All the results for oxygen and carbon isotope analysis are reported in per mil (‰) notation relative to the Vienna Pee Dee Belemnite (VPDB) standard. Precision for both isotopes was better than 0.05‰.

Trace elements data were obtained using an ICP-MS at Great lake Environmental Research institute, University of Windsor**.**

Based on field and petrographic investigations, the most important diagenetic processes which have influenced these strata could be summarized as; dissolution, compaction, dolomitization, pyrite formation and calcite cementation. The most abundant calcite cements observed include: Drusy mosaic, blocky, equant and syntaxial from which the drusy and blocky calcite cements were sampled for geochemical analysis.

The $\delta^{13}C$ and $\delta^{18}O$ values of the calcite matrix range from -6.4‰ to 4.1‰ and -9.4 to -0.9‰, and drusy mosaic calcite cements display values ranging from -5.8 ‰ to 3.6‰ and -9.3‰ to -0.6‰ respectively. In blocky calcite cements the $\delta^{13}C$ shows values between -2.4‰ to +3.6‰ and $\delta^{18}O$ from -12.3‰ to -2.8‰ VPDB.

Considering the petrographic and chemical analysis results, the Mid-Cretaceous carbonates in this area went through diagenesis in variety of environments ranging from marine to meteoric and burial. Although the results of the $\delta^{13}C$ analysis of most of the drusy mosaic and blocky calcite cements indicate the marine origin and even the OAE traces in these cements, depleted $\delta^{18}O$ values confirms their precipitation in mixed marine-meteoric environment. A likely mechanism that could cause $\delta^{13}C$ depletion in some of drusy mosaic cements (i.e.,-5.8 ‰) is meteoric diagenesis associated with oscillations in sea level (mainly the Cenomanian- Turonian and mid Turonian sea-level fall) that episodically exposed these shallow-water carbonates. Low concentrations of Sr (= 59 ppm) in these cements could also confirm the influence of meteoric waters on them. Higher depletion of $\delta^{18}O$ values (i.e. -12.3 ‰ VPDB) and two-phase fluid inclusions in some blocky calcite cements suggest their precipitation at higher temperatures in burial environment.

Acknowledgment: We would like to thank IOOC and NISOC for assistance in sampling and StatoilHydro Company and Natural Science and Engineering Research Council of Canada (NSERC) for financial support of this study.

**Sea-level changes in French Polynesia over the past 6,000 years**

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Since the Last Glacial Maximum (around 23 ka), relative sea-level changes have resulted mainly from the melting of land-based ice and the associated gravitational, rotational and isostatic effects, often termed glacial isostatic adjustment (GIA).
Studies of coral reef-based records from various regions (Barbados, Papua New Guinea and Tahiti [1]) have led to reconstructions of the last deglacial sea-level rise (19-6 ka). In contrast, sea-level changes during the Late Holocene (i.e., the past 6,000 years) in these regions are poorly constrained, thus hampering an accurate reconstruction of global ice volume changes spanning the deglacial and postglacial periods [2-4]. Extending the long time series records mentioned above into the Late Holocene is important in order to provide stronger constraints on GIA model parameters [5]. A primary aim of this work is to extend the Tahiti record using coral reefs from other islands in French Polynesia.
Coral reefs are valuable recorders of past sea-level, climatic/environmental changes, and are sensitive to subtle ecological changes affecting their environment. They provide unique archives for the tropical realm and allow an accurate reconstruction of Late Holocene relative sea-level changes and associated climatic and environmental changes, thus helping in the understanding and the modelling of regional geophysical processes.
This work aims to reconstruct relative sea-level changes during the Late Holocene in French Polynesia (South-Central Pacific) by examining coral reef records from five atolls from the Tuamotu Archipelago (Fakarava, Hao, Manihi, Rangiroa, Tikehau) and five high islands (Bora Bora, Mangareva, Maupiti, Moorea, Raivavae) from the Society, Gambier and Austral Archipelagos. These mid-ocean islands are ideal places for a sea-level study because: 1) they can be regarded as tectonically stable during the Late Holocene period, 2) they are located far from former ice sheets ('far-field'), 3) they are characterized by a low tidal amplitude, and 4) they cover a wide range of latitudes which produces significantly improved constraints on GIA model parameters.
Our reconstruction of sea-level changes relies on absolute U–Th dating of *in situ* coral colonies and their precise positioning via GPS measurements that are characterized by a vertical and horizontal precision of ± 2.5 cm and a few millimetres, respectively. Special attention has been given to coral microatolls which are sensitive low-tide recorders, as their vertical accretion is limited by the water level. Moreover, the occurrence of coral microatolls indicates periods of sea-level stillstands and allows the reconstruction of high-frequency sea-level fluctuations on centennial to decadal timescales during the Late Holocene.
A sea level rise of less than 1 m is documented between 6 and 3-3.5 ka, and is followed by a gradual fall in sea-level that persisted until the past few centuries. This reconstructed sea-level curve therefore extends the Tahiti sea-level curve [1], and is in good agreement with a geophysical model tuned to fit far-field deglacial records [6].

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**Late Holocene reef development in French Polynesia**

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Past records of reef responses to sea-level, climatic and environmental (temperature, salinity, nutrient concentration, etc.) changes may help in better understanding how coral reefs are likely to respond to current and future global changes. However, despite advances related to the outcomes of recent IODP expeditions #310 and #325, our knowledge regarding the impact of such changes on reef architecture and composition remains fragmentary.

The Late Holocene (i.e., the past 6,000 years) provides an opportunity to document sea-level changes of similar amplitude to those that are likely to occur before the end of the current century when mean sea level is expected to rise between 0.5 and 1.5 m, therefore affecting coastal ecosystems and water supplies, and flooding densely-populated coastal communities.

The analysis of the impact of sea-level change on reef accretion during the Late Holocene in French Polynesia (South-Central Pacific) is based on a multidisciplinary study of emerged reef platforms and features of five atolls from the Tuamotu Archipelago (Fakarava, Hao, Manihi, Rangiroa, Tikehau) and five high islands (Bora Bora, Mangareva, Maupiti, Moorea, Raivavae) from the Society, Gambier and Austral Archipelagos.

Our reconstruction of sea-level relies on absolute U–Th dating of *in-situ* coral colonies and their accurate positioning via GPS RTK (Real Time Kinematic) measurements (vertical and horizontal precision of ± 2.5 cm and a few millimetres, respectively).

The facies distribution and morphology of reef systems have been reconstructed both during a sea-level rise of less than 1 m, documented between 6 and 3-3.5 ka, and during a sea-level fall that occurred subsequent to the rise until the last few centuries. The composition of Late Holocene reefs is very similar to that of modern reefs, implying that the rate and amplitude of Late Holocene sea-level changes were too low to significantly affect their biological composition during this time frame. The facies distribution in Holocene and modern reefs is also similar and underwent a lateral shift ranging between a few metres to a few tens of metres during the studied period.

**3D visualization and characterisation of microbial dolomite through X-ray microtomography: results from an in-vitro lab experiment**

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The origin and formation of dolomite has been the topic of discussion for several decades. During the last years, many studies have revealed the potential influence of bacteria on the precipitation of dolomite and other Mg-carbonates. Different research groups were able to precipitate dolomite in a laboratory environment, either mediated or steered by bacteria. The presence of dolomite has been often confirmed by elemental point analyses during Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD) measurements, but the presence of ordered dolomite - typically recognised by its 015 peak in a XRD diffractogram - has not always been confirmed and is therefore still an important point of discussion.

During this study, 250 samples of microbial mediated Mg-carbonates precipitated in a monitored laboratory environment, were analysed. This large-scale experiment under aerobic conditions was set up to unravel the impact of the precipitation medium (agar plates, fluidum with *Bacillus sphaericus*), Ca/Mg ratio of the fluidum, urea ($CO(NH_2)_2$) concentrations (urease activity) and incubation temperatures (10°C – 25°C – 37°C) on the precipitation of Mg-carbonates. The impact of the drying temperature on the precipitates has been verified after cessation of the microbial activity through removal of the urea. The pH was measured at the start, after one day and at the end of the incubation period. A strain of *Bacillus sphaericus* was used because of its high urease activity, which increases the amount of Mg-carbonate precipitation in a short time period.

The precipitates were analysed and visualised with SEM, TEM, XRD and micro-Computed Tomography (µCT). The latter technique has, until now, not very often been applied in geomicrobiological research to determine the mineralogy and to visualize the morphology and the 3D distribution of the microbial precipitates. However through the combined approach of SEM, XRD analyses and micro-computed tomography, microbial-induced dolomite precipitates could be segmented and extracted from X-ray tomographic scans through applying dual thresholding techniques.

Most of the samples are dominantly composed of hydromagnesite, dypingite, dolomite, nesquehonite, bischofite and some minor quantities of calcite, aragonite and vaterite. Three standards of ordered dolomite were simultaneously scanned with the samples to determine the density threshold for the extraction of microbial-induced dolomite.

Additionally, 3D µCT reconstructions allowed the visualization of the microbial dolomite fractions and so the study of the spatial relationships between the presence of dolomite spheres and other Mg-carbonates.
The combination of XRD, SEM, TEM and µ-CT has the possibility to become a powerful tool to study microbial precipitates during laboratory experiments. However the authors are aware of the fact that good standards will be crucial to delineate and refine the density threshold for microbial dolomite in future investigations.

**The early diagenetic influence on the palaeo-environmental record of carbonate mounds unravelled by geochemical and mineralogical fingerprints**

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Along the European continental margin, from northern Norway down to Mauretania, cold water coral carbonate mounds are occurring at intermediate water depths in well-delineated mound provinces. The carbonate mounds provinces (CMP) in the Gulf of Cádiz along the Moroccan margin have been intensively studied during the last decades, and remarkably, no living Scleractinians have been found on top of those carbonate mounds. The focus of this study is to unravel the potential influence of early diagenetic processes within two carbonate mounds localized north of Meknes mud volcano along the Moroccan margin. The matrix sediments of two gravity cores, taken during expedition 64PE284 aboard of the RV Pelagia and localized on top of two neighbouring carbonate mounds, have been analysed to determine the influence of early diagenetic processes on the palaeo-environmental record registered in these mounds. Inductively Coupled Plasma Optical Emission Spectroscopy (ICP – OES), a Sequential Extraction method (SEDEX) for Phosphorus (P) analyses, X-Ray Diffraction (XRD) and petrographical microscopy have been used to investigate the geochemical, mineralogical and petrographical characteristics of the mound sediments  Dating of the cores has been performed with $^{14}C$ and U/Th methods. Based on the dating results, the two cores could be correlated allowing a detailed comparative diagenetic study.

Quantitative elemental analyses revealed the chemical composition of the mound facies. The main elements encountered are Ca, Si, Al, Ba, Fe, Mg, Mn, P and Sr. These results represent the occurrence of two major fractions; a carbonate-rich fraction and a siliciclastic-rich fraction, which can be directly linked to changing interglacial/glacial palaeo-environmental conditions. Mineralogical XRD analyses and statistical principal component analyses confirm the geochemical cyclic trends. Chemostratigraphy, based on the quantitative elemental compositions, could refine the correlation between the two core sections and confirmed the comparable palaeo-environmental framework of both mounds.

P-analyses through SEDEX combined with Ba-concentrations ($Ba_{excess}$) allowed distinguishing between early diagenetic processes changing the matrix sediments and changes related to palaeo-environmental processes. So through partial extraction procedures it was possible to unravel the different sources of P and Ba concentrations in the two cores. It should be emphasized that early diagenetic processes differ clearly between the two carbonate mounds evidencing that even at small local scale diagenesis can change the primary carbonate mound facies. Additionally, pyrite, secondary calcite and gypsum occurrences, together with coral aragonite dissolution show that sulphate reduction coupled to anaerobic oxidation of methane (AOM) are the main processes driving diagenesis in the studied core sections.

**Testing Sequence Stratigraphy on a Mega Scale: Lateral variation of key stratal surfaces from 3D seismic analysis of the Late Cenozoic Southern North Sea**

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'MegaSurvey' 3D seismic data and borehole data spanning the southern North Sea reveal an expanded sedimentary record for the Late Cenozoic, a period of intense climatic and eustatic changes leading to fully glacial conditions in high latitudes of the northern hemisphere.

The Late Cenozoic of the North Sea Basin was dominated by a large clastic depositional system, fed by the Baltic River System (BRS) and the proto-Rhine, -Elb and –Meuse rivers. Periodically, deltas reached the rapidly prograding shelf edge and shed sediment into the basin in the form of basin floor fans. During the Late Miocene-Pliocene (12.4-2.58Ma) the main sediment input into the basin was from the northeast. From the earliest Pleistocene (2.58Ma-1.8Ma), sediment supply from easterly and southerly directions dominated in the southern North Sea.

The lateral extent and character of sequence boundaries along strike within a sedimentary basin is a subject of debate in the literature. The spatially varying subsidence (regional and salt tectonic controls); variable sediment input (grade, volume and direction), changing climatic drivers and connection to the global ocean, in combination with extensive 3D seismic and borehole coverage, makes the Late Cenozoic North Sea a natural laboratory to test several sequence stratigraphic concepts. This includes the chronostratigraphic significance of seismic reflections, the lateral variability of sequence boundaries, and eustatic control on sequence development.

High resolution chronostratigraphy is available for several wells in the Netherlands North Sea. Within the framework key seismic reflections have been picked which represent a large change in the sedimentation in the basin, either a lateral change or basinwards shift in facies. A suite of software has been used: Schlumberger Petrel for interpretation and attribute analysis; Ellis Paleoscan for auto interpretation and FFA Geoteric spectral decomposition to image stratigraphic features.

The offshore seismic expression of this sediment input is in the form of largely low angle (<2°) clinoforms. They vary in style and height, from 50 m to 500 m, prograding and downlapping onto the Mid-Miocene Unconformity (MMU). Two main structural domains are identified within the basin: in the northeast the basin geometry is dominated by accelerated subsidence; and the southwest is dominated by Quaternary salt tectonic activity. Variation in coeval sequences across the basin suggests that although there is evidence for a strong influence of 40,000 year glacial/interglacial cycles between 2.58 and 1.8Ma, the creation and destruction of accommodation space by these two tectonic actions is shaping the resulting sequences.

Maximum flooding surfaces are typically associated with downlap surfaces observed in seismic images and condensed shale layers observed in gamma-ray logs. These are the most traceable key stratal surfaces across the basin, and can be more consistently tied to the global sea level curve than erosional/onlap surfaces.

**Controls of shelf evolution on a mega scale: 3D seismic analysis of the Late Cenozoic Southern North Sea**

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'MegaSurvey' 3D seismic data and borehole data spanning the Dutch, Danish and UK southern North Sea reveal an expanded sedimentary record for the Late Cenozoic, a period of intense climatic and eustatic changes leading to fully glacial conditions in high latitudes of the northern hemisphere.

The Late Cenozoic of the North Sea Basin was dominated by a large clastic depositional system, fed by the Baltic River System (BRS) and the proto-Rhine, -Elbe and –Meuse rivers. Periodically, deltas reached the rapidly prograding shelf edge and shed sediment into the basin in the form of basin floor fans. The purpose of this oral presentation is to describe the geomorphology of the basin throughout the Miocene to Early Pleistocene and to discuss the allogenic driving mechanisms behind clinoform geometry and seismic architecture variability seen within the study.

High resolution chronostratigraphy is available for several wells in the Netherlands North Sea. Within the framework key seismic reflections are interpreted which represent a large change in the sedimentation in the basin, either a lateral change or basinwards shift in facies. A suite of software has been used: Schlumberger Petrel for interpretation and attribute analysis; Ellis Paleoscan for auto interpretation and FFA Geoteric spectral decomposition to image stratigraphic features. Thickness maps of key units are integrated with maps from the Geopotenzial Deutsche Nordsee project to obtain a complete understanding of the offshore evolution of the shelf system.

The offshore seismic expression of this sediment input is in the form of largely low angle (<2°) clinoforms. They vary in style and height, from 50 m to 500 m, prograding and downlapping onto the Mid-Miocene Unconformity (MMU). During the Mid Miocene-Pliocene (12.4-2.58Ma) the main sediment input into the basin was from the northeast and the main depocentres were focused in the German and Danish sectors of the North Sea. From the earliest Pleistocene (2.58Ma-1.8Ma), sediment supply from easterly and southerly directions dominated in the southern North Sea with the depocentres firmly placed in the Netherlands North Sea. Several periods of increased sediment delivery into the basin during the Gelasian (2.58-1.8Ma) are identified and two main types of submarine fan system are recognised. The two types are: *a)* a coeval series of line source fans individually 2-5km in width and fed by individual slope channels and: *b)* individual incised canyon fed submarine fans, 20-30km in width. Both types of fan have been imaged using spectral decomposition techniques.

Shoreline trajectory analysis on representative seismic lines has been carried out from two main structural domains; in the northeast the basin geometry is dominated by accelerated subsidence; and the southwest is dominated by Quaternary salt tectonic activity. The resultant relative sea level curve is compared to the global sea level curve to understand the eustatic control on sequences in comparison to local structural controls.

**The evaluation of sand grain shape using elliptic Fourier and principal component analysis: implications for the discrimination of sedimentary environments**

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Investigations of the shape of clastic grains have long been pursued because shape possesses important information regarding transportation and deposition histories that individual grains underwent. Recently, Fourier analysis has been applied in order to quantitatively describe grain shapes. However, a full quantification of grain shapes using Fourier analysis has not yet been accomplished. This is because of the difficulties in handling the numerous descriptors that the Fourier analysis produces, which impedes to give a comprehensive interpretation. It is necessary to convert these numerous descriptors into simplified indices in order to give full description of grain forms. In this study, we developed quantitative indices for the evaluation of grain shapes by combining elliptic Fourier and principal component analysis (EF-PCA). The integrated EF-PCA method based on variance and correlation matrices enabled to quantify the overall form (macroscopic) and fine-scaled roughness (microscopic) features of the grains, respectively. These macro- and microscopic descriptors of grain shapes have been applied to medium sized quartz sands collected from glacial, foreshore, fluvial and aeolian environments. In total, 720 sand grain shapes from 8 different environmental sites were investigated. EF-PCA based on variance matrix produced macroscopic particle shape descriptors such as the elongation index (REF1) and two bump indices (REF2 and REF3). These indices indicate that sand grains exposed to subaqueous transportation (fluvial and foreshore) have forms that are more elongated than those exposed to subaerial transportation (aeolian dunes). Meanwhile, EF-PCA based on the correlation matrix is able to extract microscopic particle features, which can be interpreted as a surface roughness index (SEF). The SEF indicates that the surfaces of glacial grains are the most rugged, whereas those of aeolian grains are the smoothest because of greater abrasion. Consequently, these two approaches enable to separately measure both overall grain forms and grain surface roughness. On the SEF-REF1 diagram, samples from glacial, foreshore, fluvial, and aeolian sediments cluster in discrete regions, which allow sedimentary environments to be discriminated based on the shapes of the grains. The SEF-REF1 diagram indicates that sands morphologically mature in an order of transported by fluvial, foreshore and aeolian environments. Meanwhile, the SEF-REF1 diagram reveals that glacial grains are exposed to different morphological maturation pathways than are those from fluvial, foreshore and aeolian environments. These results indicate that sands transported in glacial environments mature differently from those exposed to fluid dynamic transport processes.

**Inversion Technique Based on Probabilistic Neural Network for Predicting Lithologic Reservoir in Delta Front - A Case Study of Melut Basin**

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Lithologic reservoirs in continental delta front laterally change fast and vertically superimpose, and this type of lithologic reservoir has the characteristics of small thickness and strong heterogeneity, which means that it is hard to be identified by conventional reservoir prediction techniques based on linear hypothesis. This paper takes lithologic reservoir in Melut Basin as an example. Aiming at the difficulties of small thickness and strong heterogeneity, the inversion technique based on probabilistic neural network algorithm is applied to predict lithologic reservoir in delta front of the main productive layer, Yabus Fm.

After well logging analysis and crossplotting, P-impedance is taken to be the most sensitive parameter to identify reservoir. Then, by extracting seismic traces around wells, the nonlinear relationship between P-impedance and multiple seismic attributes derived from seismic traces is predicted by probabilistic neural network algorithm; and by using the nonlinear relationship, P-impedance inversion is processed. The P-impedance cutoff of effective reservoir is obtained according to statistics from wells, and lithologic reservoirs of Yabus Fm. are identified and predicted in the study area. The comparison between well information and inverted results shows that it has a consistent rate of 70%. Finally, combined the structure characteristics and reservoir prediction results, a lithologic trap with 5.66km$^2$ is identified accurately in the study area. The exploratory well drilled in this lithologic trap has already completed, and got good oil and gas shows.

Study conclusions are as follows:

1. Reservoir inversion technique based on probabilistic neural network algorithm has a good application effect in the study of lithologic reservoir in delta front. It has obvious application advantages in predicting reservoir with strong heterogeneity.

2. Reservoir inversion technique based on probabilistic neural network algorithm avoids the influence of initial model and inversion wavelet of the conventional reservoir prediction methods. Taking reservoir heterogeneity into account, the prediction result is more consistent with the actual geological conditions.

3. The important basis of probabilistic neural network algorithm is to establish a nonlinear relationship between the logging curve reflecting reservoir and the seismic trace around wells, which is applied to the integrated seismic data in predicting the reservoir variation latterally and vertically.

Acknowledgements: The authors would like to thank NWGI for permission to show the data example. Thanks and appreciation goes to colleagues involved in this reseach.

**Sedimentary facies of Member 3 of Liushagang Formation in WZ10-3 Oilfield and surrounding areas, Beibuwan Basin, China**

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Beibuwan Basin is located between Guangdong-Guangxi Paleozoic fold belt and Hainan fold belt, which is a Cenozoic sedimentary basin in the northwestern part of the South China Sea continental shelf. The sequence of basin filling can be divided into 3 parts, and in ascending order they are: the Paleogene continental deposits including Changliu Formation, Liushagang Formation and Weizhou Formation, the Neogene marine sediments and the Quaternary greyish yellow sands and grey clays. Weixinan Sag is a third-order tectonic unit located in the north of the Northern Depression of Beibuwan Basin, in which oil and gas resources are abundant. With the improvement of exploration degree, lithologic traps of the Liushagang Formation in Weixinan Sag have become key targets for hydrocarbon exploration. Member 3 of the Liushagang Formation is the main reservoir in WZ10-3 Oilfield and surrounding areas. Guided by the theory of high-resolution sequence stratigraphy, making use of the core, logging and seismic data, the high-resolution sequence stratigraphy and sedimentary facies of the Member 3 of Liushagang Formation in WZ10-3 Oilfield and surrounding areas have been studied in detail. On the basis of identification of the different-level sequence interfaces and maximum flooding surface, Member 3 of Liushagang Formation was divided into 2 long-term base-level cycles, *i.e.* LCS1 and LCS2, and 8 mid-term base-level cycles, *i.e.* MCS1 to MCS8. According to the facies analysis of single well, well correlation and plane, combined with seismic spectral decomposition technology, the distribution of sand bodies and the sedimentary facies of the Member 3 of Liushagang Formation in the study area had been studied. The results show that the sand bodies were widely distributed in the study area with various types, and they were the production of traction currents and sediment gravity flows including sandy debris flows, muddy debris flows and turbidity currents. In addition, the distribution of the sand bodies was significantly affected by ancient earthquakes and paleontological activities. Three sedimentary facies comprising alluvial fan, fan delta and lacustrine were identified in Member 3 of the Liushagang Formation, which can be further divided into 7 sub-facies of inner fan, middle fan, outer fan, fan delta plain, fan delta front, pro-fan delta and shore-shallow lacustrine. The debris-flow deposits were divided into 2 types, *i.e.*, subaerial non-channelized and subaqueous non-channelized debris flows. On the basis of these, the sedimentary evolution of the sedimentary period of the MSC1 to MSC8 of Member 3 of the Liushagang Formation was discussed. During the sedimentary period of the MSC1 to MSC2, *i.e.*, the initial stage of lake expansion, an alluvial fan-flood plain sedimentary system was developed, and the alluvial fan was widely distributed in the north and south of the study area, while palustrine deposit was restricted to the middle part of the study area. During the sedimentary period of the MSC3 to MSC8, with the rise of base level, a fan delta-lake sedimentary system was well developed. And the distribution pattern of sedimentary facies of this period is similar to that of the MSC1 to MSC2, that is, fan delta widely developed in the north and south of the study area, with shore-shallow lacustrine deposits in the middle part. During the sedimentary period of the MSC3 to MSC8, the fan delta front was the favourable facies belt for oil and gas reservoir because that is where the sand bodies are most developed.

**The development of cold-water coral mounds along the Moroccan Atlantic and Mediterranean margins revealed by MeBo drillings**

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Cold-water corals (CWC) mostly occur in intermediate water depths between 200 m and 1000 m and are capable of forming substantial seafloor structures, so-called coral mounds. These mounds can reach heights from a few meters up to >300 m and are composed of a mixture of CWC (and other shell) fragments and hemipelagic sediments, that both individually serve as distinct paleo-archives. IODP Leg 307 drilled through Challenger Mound at the Irish margin and revealed for the first time the full life history of a coral mound. However, although CWC occur almost worldwide, the 155 m long Challenger Mound record was for many years the only record from a coral mound exceeding 10 m in length.

During expedition MSM36 with the German R/V MARIA S. MERIAN in spring 2014, several coral mounds along the Moroccan margin, both in the Atlantic Ocean and in the Mediterranean Sea, were drilled (actually: push-cored) by applying the Bremen Seafloor Drill Rig MeBo. The MeBo is a remotely controlled drilling system that is lowered from the vessel to the seafloor. Energy supply and video control are secured by an umbilical linking the MeBo to the vessel. The scientific foci of expedition MSM36 were to investigate (1) the long-term development of CWC mounds in both areas over the last several 100,000 years in relation to changes in the ambient environmental conditions in the respective intermediate waters, (2) the life time history of these mounds, and (3) the forcing factors for the initiation and decease of individual mounds.

In both working areas, a total amount of 11 sites were successfully drilled with MeBo. Eight drillings were conducted at CWC mounds (on-mound sites) and 3 drillings in the direct vicinity of the mounds (off-mound sites) in order to obtain continuous paleoceanographic records. Drilling depths ranged between 17 m and 71 m with the latter corresponding to the maximum drilling depth of MeBo. The core recoveries varied between the sites and ranged between 47% and 96%. The coral-bearing on-mound cores were frozen and opened (i.e., cut lengthwise) with a stone saw to avoid a destruction of the original sediment texture with the embedded coral fragments. After opening, it became obvious that the quality of the MeBo cores is excellent and that it will allow detailed post-cruise analyses at the MARUM laboratories in Bremen.

By obtaining on-mound records reaching lengths of >70 m (→ focus #1), supplemented by the full penetration of two coral mounds (→ foci #2 and #3) and by a >45-m-long double drilling at an off-mound site located between numerous fossil and buried mounds (allowing to put their full life history into a wider paleoceanographic context; → foci #1 to #3), the major technical goals of this MeBo expedition were fully accomplished.

The critical factor in applying MeBo is the sea state as during deployment and recovery dynamic loads on the umbilical might reach critical limits. Although during expedition MSM36 several MeBo deployments were done by wind speeds of 6 Bft, the sea state especially in the Mediterranean Sea allowed MeBo operations without any restrictions. On the Atlantic side, a high swell, which actually exceeded the operational limit given for secured MeBo operations, could be overcome by reducing the payload (i.e. reducing the maximum drill depth). Hence, the operational window could be widened allowing for almost continuous MeBo operations also in this area.

**The Vizcaíno "composite" Terrane – A potential Upper Triassic neighbour of the Mexican "Antimonio Terrane"**

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The North American Cordillera consists of several terranes that have a doubtful paleogeography, because the outcrop-situation for the time interval of the Upper Triassic is difficult. Taking into account todays reconstructions of the paleogeography and tectonic history of the Cordillera for this period, two potential terranes with shallow-water carbonates of Norian age were selected – the "Antimonio Terrane" (Sonora, Mexico) and the Vizcaíno 'composite' Terrane (Baja California Sur, Mexico). During two field trips, samples for the comparison of litho- and microfacies of the two localities were collected.

Our aims are:

- To prove a proximal relationship between the Antimonio and Vizcaíno areas, allowing us to reconstruct these two potential terranes as a single "joint terrane" environment;
- To compare these two localities with the previously-investigated Wallowa terrane in the Blue Mountain Province (Oregon, USA), also containing Upper Triassic shallow water carbonates.

The Upper Triassic succession of the Antimonio Terrane consists of shallow-marine sediments, whereas the deposits of the Vizcaíno 'composite' Terrane near the village of San Hipólito represent slope to deeper marine environments. In Sonora, we found limestones, calcareous siltstones, and fine grained sandstones. The first two lithologies contain shallow-water fossil assemblages that include chambered sponges and scleractinain corals. Near San Hipólito deepwater limestone, chert, a limestone breccia, and sandstone crop out. The Norian-dated clasts of the breccia contain shallow-water fossils. In particular the sponges and corals show strong affinities to the fossils observed in the Antimonio area.

Acknowledgements: This project has been funded by the Swiss National Science Foundation No. RM 200020-13766.

**The Pre-Salt lacustrine systems: Comparisons of non-classical carbonates from divergent and convergent settings.**

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Modern and ancient Pre-Salt lacustrine systems are characterized by worldwide distribution and a diversity of non-classical carbonates, such as microbialites, travertines and tufas. These systems are developed under a variety of conditions, such as fresh or saline, hot or cold waters, and convergent or divergent settings, and also continental to tropical climates.

In the light of such diversity, it is crucial to compare different lacustrine basins in order to decipher and explain the importance and the impacts of the controlling factors on the development of such continental carbonate systems.

Our study focused on two lacustrine systems from different regional settings, but containing similar carbonate facies.

The first system formed during South Atlantic Rift opening (Lower Cretaceous). The Pre-Salt Formation of this basin corresponds to a lacustrine rift system characterized by a metamorphic to volcanic basement, a complex deep fracture network, and late rift sedimentation largely controlled by climate and hydrothermal fluid circulation. Sequence and stratigraphic analysis of this basin indicates north to south segmentation linked to rift geometry and its associated physiography, and to clastic inputs.

The second system (Eocene, central U.S.A.) records lacustrine sedimentation of the late Laramide uplift phase in a foreland basin. The Green River Formation resulting from this lacustrine episode was associated with active volcanism, complex topography inherited from the Laramide orogeny, and climatic changes. These parameters led to the development of a lake network whose connections were controlled by climate and tectonic changes.

Even though the regional settings of these two lacustrine basins are quite different, they record very analogous depositional environments and carbonate facies; *i.e.* the margins of the two lacustrine systems are both characterized by travertine or tufa deposits during increasing lake level stages, whereas microbialite deposition occurred on lacustrine margins during the high lake level stages. However, even though their depositional environments and macrofacies are comparable, it appears that the sedimentation rates, geometries, microfacies and diagenesis of the Pre-Salt and Green River Formation do differ; e.g., the thickness of the Pre-Salt Formation is three times (and even more) less than that of the Green River Formation, even though they both represent a 5 to 10 My interval.

Hence, the comparison we propose aims to understand the impact and the importance of each controlling factor (tectonics, climate, physiography), and to describe the sedimentation rates, geometries, carbonate facies, depositional environments and, to a lesser extent, the diagenesis.

**Microbial carbonate build-ups in a Pre-Salt environment, the Afar Rift Lake System**

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The recent discovery of vast hydrocarbon reservoirs in Cretaceous marginal lacustrine deposits dominated by composite algal/microbial features in the South Atlantic has reopened the interest of the scientific community and oil companies in the study of recent and past continental carbonate systems.

Recent and past continental carbonate analogs which developed in a wide range of depositional settings, from subaerial to subaqueous environments, provide some key elements to depict the sedimentological and sequential patterns observed at core scale and to better understand the impact of climate change, fluid flow and water chemistry on the carbonate factories.

Quaternary carbonate systems from the Afar Rift area (Djibouti) are considered as a potential analog of the South Atlantic Cretaceous systems and are the subject of a multidisciplinary study.
The Afar area is located at the junction of three magmatically active rifts, the Main Ethiopian Rift, the Red Sea and the Gulf of Aden. This rift-in-rift system is responsible for the occurrence of a wide volcanic basement and a specific topography hosting several perched lakes. To the east, the Abhé Lake represents the topographically higher lake and is hydrologically linked to the western and lower part of the system, the Gulf of Ghoubbat al Kharad.

Changes in hydrological circulation are related to climatic conditions and therefore control the base level and the salinity of the lakes.
Carbonates, mainly comprised of coquinas and algal/microbial build-ups, developed during wet periods typified by lake level highstands, while evaporites were deposited in lake depocenters during periods characterized by drier conditions and lake level lowstands.

The interpretation of fossil systems will rely on the detailed reconstruction of stratigraphic relationships between carbonate build-ups, volcanic basement and salt deposits, the analysis of facies distribution and associated geometries, and the chemical characterization of the fluids which initiated and sustained the development of algal/microbial carbonate build-ups.
This multidisciplinary project will elucidate the relationships between volcanic activity and the development of carbonate systems, especially through the role of hydrothermalism in diagenetic processes in carbonate build-ups. The end-products of the project will also include a 3D geological map displaying the facies distribution, the geometrical characters of the potential reservoirs, and the structural pattern.

**Neogene climate evolution in Central Asia deciphered from terrestrial sequences in SE Kazakhstan**

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The Cenozoic climate evolution of Central Asia is dominated by a long-term cooling trend with short-lived interludes of warming lasting a few million years, most notably the Mid-Miocene Climatic Optimum. Since Central Asia experienced an extensive structural reorganization due to the collision with India in the Cenozoic, this collision event is thought to have had great impact on the climate evolution during that time. Changes in topography due to mountain uplift influenced the atmospheric moisture pattern, thereby contributing to global cooling and regional aridification. As aridification depends generally on a multitude of factors, any understanding of the aridification process of Central Asia critically hinges upon identifying the driving mechanisms involved and disentangling the interplay between them. We provide new sedimentological and stable-isotope data from the Cenozoic Ili-Basin in southeastern Kazakhstan spanning the time interval from the Oligocene to the Early to Middle Miocene. The about 350-m-thick sequence is characterized by an alternation of highly oxidized floodplain deposits and alluvial conglomerates with extensive pedogenesis in the lower part, indicating a semi-arid to arid climate. The succession yields a braided river facies in its middle part and finally grades into playa lake deposits. Pedogenic carbonate nodules as well as calcareous cements in alluvial to lacustrine sediments show a positive shift of nearly 4 permil in both oxygen isotopes and carbon isotopes, which is consistent with stable-isotope records from the adjacent Junggar and Tarim basins. This shift provides evidence for increased continentality. In addition, the facies transition from an alluvial to a lacustrine depositional environment likely reflects a regional base-level rise by the Tchokrakian Transgression of the Eastern Paratethys, possibly related to the Mid-Miocene Climatic Optimum. Hence, a connection to the Paratethys of an temporary open Ili-basin cannot be excluded. Therefore, besides the tectonically triggered aridification, the impacts of regional moisture sources have to be taken into account.

**Sedimentation styles in an intracratonic rift system; an example from southeast Australia**

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The Otway and Gippsland basins are two of a series of Late Jurassic- Cretaceous rift basins that formed along the southern margin of Australia as it separated from Antarctica during the breakup of Gondwana. Both basins have been successfully drilled for hydrocarbons, and understanding the sediments and their characteristics is vital to further exploration. In order to advance the understanding of sediment deposition, external controls, such as basin structures and climate, must also be understood. This research is focussed on the Barremian-Albian Upper Strzelecki Group of the Gippsland Basin and the Aptian-Albian Eumeralla Formation of the Otway Basin, both of which were likely sourced from a volcanic complex to the east of the Gippsland Basin and represent a dramatic change from the slightly older (Tithonian-Barremian) Crayfish Group sediments that were derived Palaeozoic basement rocks exposed along the rift margins. Particular attention is being paid to the manner in which the transitional structural regime may have affected the depositional styles in each basin: faulting had died out in the western Otway Basin, but continued in the east and also in the Gippsland Basin. In the past these basins and their sediments have been studied as two separate entities, but it serves to remember that they were contiguous at the time these sediments were deposited and thus, should be treated as a continuous corridor. The systems present in this region include channel sandstone, crevasse-splay sandstone, floodplain siltstones and mudstones, palaeosoil, coal seams and lacustrine shales. The aim of this research is to define the relationship between sedimentation and basin structures within the Otway and Gippsland basins and ultimately produce a regional model that explains the co-existence of trunk river deposits and extensive coal measures in a cold climate deposition system fed by a massive influx of volcaniclastic debris.

**Fault Seal Evaluation of Challis Reservoir, M Closure, Offshore Timor Sea, Indonesia**

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Since gas discovery in Abadi Gas Field, Offshore Timor Sea - Indonesia, many exploration works have been conducted in adjacent area, including M closure. However, so far no gas findings were reported in M closure. In order to determine post mortem analysis of M closure, evaluating fault seal is critical to understand trapping mechanism uncertainty. This evaluation is carried out at Triassic Challis sandstone reservoir, utilizing well data to obtain volume shale properties as well as 2D seismic data to map fault throw, orientation and juxtaposition. Shale Gouge Ratio (SGR) model will be calculated using Yielding algorithm.

M closure is a horst structure, bounded by two NNE-SSW trending vertical faults as part of extensional event in Early Jurassic Rifting. SGR model revealed that bounding faults in M closure has in range of 0.5 – 0.7. Utilizing reference from earlier studies, it indicates that those bounding faults are categorized as moderately - likely sealed faults. Rejuvenation of bounding faults by compressional event in Neogene (Banda-Australia Collision) will be possibly giving more sealing tendencies. Therefore trapping mechanism is not considered as main geological risk issue for the failure of M closure.

Acknowledgement**:** special thank to Directorate Oil and Gas Republic of Indonesia to allow the authors as scientific team members of joint study in the Offshore Timor, Indonesia.

**Spatial variations in geometries of polygonal faults due to stress perturbations & interplay with fluid venting features**

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3D seismic data from Offshore Angola is used to investigate how vertically migrating fluids were influenced by strata-bound arrays of compaction-related normal faults, here called polygonal faults (PFs), which deform Neogene-Quaternary hemipelagites. We discuss the sensitivity of fluid venting style to perturbations in the regional stress state due to salt tectonics, and locally due to salt diapirs and PFs. Regionally isotropic PFs become anisotropic around pockmarks, salt stocks and withdrawal basins. Aligned PF are attributed to local perturbations in a predominantly isotropic stress field. Four main patterns of aligned PFs are observed: ladder patterns composed of long (first-order) and short (second-order) faults which are orthogonal, radial patterns around salt stocks, concentric patterns around pockmarks and in salt withdrawal basins, and a hybrid form of radial and concentric fault pattern around pockmarks on diapir flanks. Fluid venting structures such as methane-derived carbonates and chimneys which are linear in plan view stem from PF intersections. Chimneys consistently have a linear planform and are interpreted to have formed by hydraulic fracturing. Hydraulic fractures propagated vertically and parallel to faults along the axis of PF grabens. We deduce from that observation that the geometry and location of linear venting conduits are controlled by the location of PF intersections. Most of the fluid venting structures with linear-to-elliptical planform geometries are controlled by the local state of stress around PFs. Our work highlights the sensitivity of polygonal fault systems to perturbations of local tectonic stresses caused by salt withdrawal and diapirism. Both PFs and the location stresses further control the location and geometry of fluid venting structures.

**Grain Size Control on Flow Efficiency within High-Density Gravity Flows: A Constant-Discharge Flume Experiment**

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Turbidity currents erode, transport and deposit sediments over the sea floor, thereby shaping the seascape. Experimental modelling has proven to be a powerful tool to increase our understanding of the basic flow characteristics of such turbidity currents. One of the key-learnings from previous experimental studies is that varying the grain-composition has a profound influence on the transport distance of a given sediment size in a fixed flow. These experiments showed that the addition of fine-sediment fraction can considerably increase the transport distances of the coarser sediment. This observation is often referred to as increased flow efficiency. The seminal work that established the flow efficiency concept included two lock-exchange studies. Unfortunately, these lock-exchange experiments are by their nature depletive experiments, meaning that the flow size continuously decreases with time. Such variations in flow size make these experiments unsuitable to single out grain-composition effects on the flow efficiency.

We here present experimental turbidity currents with constant flow-sizes with variable: slopes (4-11.3°), initial sediment concentrations (5.5-21v%) and grain compositions. The sediment composition was modified by adding different proportions of non-cohesive silt (D50=50mu) to a background fine sand (D50=144mu). The experiments focussed on finding the minimum slope angle necessary to transport all the sediment within the flow without leaving a deposit. This minimum slope angle is here defined as the bypass slope. The main aim of the experiments was to find the variation in by-pass slope as a function of sediment composition. Such relation could give us valuable insights into the coupling between sediment composition and system architecture in real-world systems, where often just one of these variables is known.

The results confirm previous observations showing that a proportion of 10v% silt-grade sediment in a sand-rich flow results in an increased flow efficiency and a reduction in the by-pass slope of 11-33%, depending on flow concentration. The efficiency increase, however, diminishes rapidly with increasing proportions of fine-grained materials, as the 50v% silt and 50v% sand runs show by-pass slopes very similar to those found in the 75v% sand - 25v% silt runs. Reduction in by-pass slope due to changes in grain size properties, is rather dependent on sediment concentrations as the reduction effect decreases with increased flow concentrations.

These changes in flow efficiency are thought to be related to the effect grain size can have on flow suspension heights and vertical velocity/concentration structures. Most importantly, this study shows that relatively small portions of fine-grained material are enough to have major effects on flow efficiency. This implies that natural flows with slightly wider grain-size distributions will be able to transport sediment much further into the basin, which may result in much larger lateral extensive submarine fan systems.

**Submarine lobe architecture at the base-of-slope: an integrated outcrop and core study**

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The depositional architecture of submarine lobes that form in base-of-slope settings remains relatively poorly understood. The well constrained palaeogeographic context of exhumed basin floor fan systems of the Karoo Basin, South Africa permits comparison of sedimentary facies and architecture in different subenvironments within proximal lobes in base-of-slope settings and distal lobes in basin floor settings. Here, the geometry and stacking patterns of depositional elements constrained from outcrop observations are integrated with detailed facies observations from research boreholes that intersect proximal lobes in Fan 3 and Unit 5. Proximal lobes have a higher aspect ratio, contain numerous scour surfaces, and are commonly only partially preserved due to incision by younger channels, compared to their terminal counterparts. Upward thinning profiles dominate proximal lobe successions, while a range of stacking patterns exist further downdip.

Distinctive sandstone facies in proximal lobes include individual sandstone beds with a high degree of internal variation in sedimentary structures including various ripple structures, planar lamination and long wavelength asymmetric wavy laminae. These internal structures suggest that flows were highly unstable, possibly related to local variations in seabed topography. These variations include changes from complex stratification structures to ripple lamination, which could both indicate rapid changes in flow direction and/or changes in flow regime. Banded sandstones are more readily identifiable in core than in outcrop. The banding is a function of alternating clean sand and dirty sand on a scale of 0.3-2 cm thick. The dirty sand is rich in mud and organic fragments with diffuse to sharp margins. The banded sandstones are interpreted as deposition from traction carpets with the alteration in character a function of the availability of mud and/or plant material, as well as variations in the nature of the flow.

The integrated core and outcrop datasets show differences in sedimentary facies, stacking patterns, and architecture between distal and proximal lobe deposits. This does not imply that there are two discrete lobe types; rather a continuum exists with a large portion of lobes (especially in mid-fan settings) that share characteristics of both end members. The recognition of distinctive facies characteristics of submarine lobes in base-of-slope settings can be applied to reconstruct submarine fan systems where the palaeogeographic context is poorly constrained.

**Early Cretaceous atmospheric carbon dioxide concentration estimated from pedogenic carbonates in the Gyeongsang Basin, Korea**

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Studying the role of atmospheric carbon dioxide concentration ($pCO_2$) regulating temperature during the Cretaceous is important not only to understand the evolution of the Cretaceous climate but also to predict the future global warming. The Gyeongsang Basin, the largest Cretaceous non-marine basin located in Southeast Korea, contains several pedogenic carbonate-bearing strata, ranging in age from the Aptian to the Early Campanian. Hong and Lee (2012) reconstructed long-term Cretaceous $pCO_2$ trend by combining the $pCO_2$ levels calculated from carbon isotope compositions of pedogenic carbonates in the Gyeongsang Basin with the recalculated $pCO_2$ levels obtained from the literature and suggested that the $pCO_2$ variation was associated with long-term Cretaceous climatic change. However, the existing $pCO_2$ estimates lack the resolution necessary to examine short-term climatic changes during the Cretaceous. Recently, a full cored borehole (total depth: 1200 m) was drilled in the Gyeongsang Basin. The cored sequence contains abundant pedogenic carbonate nodules in fluvial deposits (30-260 m) of the Albian age and thus provides an opportunity to report a more detailed Cretaceous atmospheric $pCO_2$ record. The carbon isotopic compositions of pedogenic carbonate in the borehole range from -2.5‰ to -6.5‰, with an average of -4.9‰. The $pCO_2$ estimates derived from pedogenic carbonates show a wide variation ranging from 780 ppmV to 2700 ppmV, with an average of 1400 ppmV. Although the average $pCO_2$ level is similar to those estimated from other carbon isotope studies of Cretaceous pedogenic carbonate, the detailed trend of the $pCO_2$ variations is different from the others. Our $pCO_2$ curve, more accurate than in the previous study, shows extreme fluctuations during the Albian. We expect that the high resolution $pCO_2$ curve can help to understand forcing mechanism of short-term climatic changes in the Cretaceous.

**Equatorial carbon cycling and the evolution of a carbonate factory across the Triassic-Jurassic boundary: evidence from the Musandam Peninsula, UAE**

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The Triassic-Jurassic boundary was marked by global changes, including carbon-cycle perturbations and the opening of the Atlantic Ocean. These changes were accompanied by one of the major extinction events of the Phanerozoic. The carbon-cycle perturbations have been recorded in carbon isotope curves from bulk carbonates, organic carbon and fossil wood in several Tethyan locations and have been used for chemostratigraphic purposes. Here we present data from shallow-marine carbonates deposited on a homoclinal Middle Eastern carbonate ramp (United Arab Emirates). Our site was located at the equator and on the southeastern margin of the Tethys throughout the Late Triassic and the Early Jurassic, and this study provides the first constraints of environmental changes at the low-latitudes for the Triassic-Jurassic boundary. The studied shallow-marine carbonate depositional system is extremely sensitive to palaeoenvironmental changes and its palaeogeographic location gives us a unique insight into a tropical carbonate factory at a time of major global change. Stable isotope measurements (carbon and oxygen) were carried out on micrite samples from three locations approximately 35 km apart. The stable isotope results on micrite show a prominent negative shift in carbon isotope values of approximately 2 ‰ just below the inferred position of the Triassic-Jurassic boundary. A similar isotopic trend is also observed across the Tethys but with a range of amplitudes (from ~2 ‰ to ~4 ‰). These results seem to indicate that the neritic carbonates from our studied section can be used for chemostratigraphic purposes, and the amplitudes of the carbon isotope shifts provide critical constraints on the magnitude of carbon-cycle perturbations at low latitudes across the Triassic-Jurassic boundary. In the proximal part of the ramp the Triassic benthic automicrite carbonate factory dominated by microbialites was replaced by an ooidal-bioclastic ramp during the Jurassic. In the more distal part, microbialites with abundant siliciclastic detritus are overlain by muddy carbonates with few oolites. The clastic component in the distal part is very abundant and being sourced most likely from the Arabian Craton. The change in the carbonate factory across the Triassic-Jurassic transition, especially evident in the proximal part of the studied carbonate ramp is the result of an important change in palaeoenvironmental conditions, potentially induced by the coeval injection of large amounts of isotopically light $CO_2$ into the atmosphere.

We gratefully acknowledge funding from Qatar Petroleum, Shell and Qatar Science & Technology Park.

**The record of Hirnantian (upper Ordovician) $\delta^{13}C$ excursion at Keping, NW Tarim, China**

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In the upper Ordovician, there are two major global $\delta^{13}C$ excursions, the oldest one is referred to as the Guttenberg isotopic carbon excursion (GICE), and the youngest one is known as the Hirnantian isotopic carbon excursion (HICE), and they both can be found in South America, Europe and South China. These two carbon isotope excursions provide time-varying signals which can be used for the upper-Ordovician stratigraphic correlation and division. Around 825Ma, since the breakup of Rodinia supercontinent, the Tarim plate is always regarded as one of the most important members of the Chinese continental tectonic research, but the GICE and the HICE are not found, so some researchers think the Hirnantian and Ordovician-Silurian Boundary (OSB) is missing because of the Caledonian movement. However, according to the latest research of lithofacies paleogeography, the southwestern Tarim region was always an environment of mixed continental shelf during the Ordovician, and the upper Ordovician is well-preserved in Dawangou section, so it can be helpful to the research of the upper Ordovician chemostratigraphy (Hirnantian). 82 micrite samples through the Kepintage Formation in Dawangou section show elevated $\delta^{13}C$ values of 2.8‰ to -3.1‰, and a positive excursion from -1‰ to1.2‰ in the base of middle Kepingtage Fm. (206-215.4m), and a negative shift from 0.71‰ to -0.637‰ in the top of middle Kepingtage Fm. (221.5-230.1m), after that, the $\delta^{13}C$ values rise to 0.733‰. These two $\delta^{13}C$ excursions are coincident with other sections globally, so the Hirnantian can be confined and divided in the middle Kepingtage Formation, and the OSB is suggested to lie around 234.3m, which is about the uppermost part of the middle Kepingtage Fm.

Key words: Hirnantian; NW. Tarim; $\delta^{13}C$ excursion; Ordovician-Silurian boundary; Kepingtage Fm.

**Pleistocene sea-level changes, their timing and amplitude: Results from IODP Expedition 317, offshore New Zealand**

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Introduction
IODP Expedition 317 targeted a shelf-slope system, well imaged by high-resolution seismic surveys, in the Canterbury Basin on the eastern margin of the South Island of New Zealand. We drilled three sites on the continental shelf (84-122 m water depth) and one site on the upper slope (344 m water depth) from November 2009 to January 2010 using the drilling vessel JOIDES Resolution. Core recovery of Pleistocene sediments from these sites was good and most Pleistocene sequence boundaries were sampled.

Methods
We analysed cores from slope Site U1352 and shelf Site U1354. Seven major core discontinuities correspond to Pleistocene sequence boundaries interpreted on the seismic profiles. A depth-age curve was generated based on isotopic analysis of benthic foraminifera coupled with biostratigraphy. Sea level amplitudes between glacial and interglacial stages were reconstructed by the analysis of fossil ostracode assemblage taking into consideration subsidence and sedimentation rates.

Results and conclusions
Seven Pleistocene sequence boundaries (PT1 to PT7 in ascending order) were identified. The oldest (PT1) is at 550 m core depth at slope Site U1352 and at 132 m core depth at shelf Site U1354. The absence of the section from 2.7 to 1.8 Ma at PT1 results in a hiatus of 0.9 m.y. In contrast, the remaining sequence boundaries (PT2 to PT7) have shorter hiatuses (less than 0.36 m.y.) and correlate with glacial stages MIS 54, 22, 16, 12, 8 and 6, respectively. They therefore formed at global sea-level lowstands. The intervals between these sequence boundaries range from ~0.1 to 0.7 m.y. indicating that they are 4th or 5th order sequences. However, although they form at MIS lowstands, their timing does not correspond in any simple way to Milankovitch frequencies: not every MIS lowstand resulted in a sequence boundary. In addition, no sequence boundaries were recognized within a long gap during the mid-Pleistocene transition (1.56 to 0.86 Ma). The sequence boundaries that follow the mid-Pleistocene transition (PT3 to PT7) correspond to the highest-amplitude oxygen isotope positive excursions that occur during this period (MIS 22, 16, 12, 8 and 6) and the corresponding sequence durations are ~0.2 m.y.. In contrast to the younger boundaries, which correlate with individual MIS glacial events, PT1 is a 3rd-order sequence boundary. It formed in response to a long-term falling eustatic trend and could have occurred at the falling inflection point, as suggested in the original sequence stratigraphic concept and in contrast to the lowstand formation of the higher-order sequences. We estimate that eustatic amplitudes were ~50 m from 1.8 to 1.26 Ma and exceed 100 m from 0.9 Ma to present. We could not estimate amplitudes between 1.26 and 0.9 Ma because of a hiatus at shelf Site U1354. The results therefore suggest that sea level amplitudes increased after the mid-Pleistocene transition.

**The Early Cretaceous volcanic event and palaeogeography in the northern Indian margin: constrained by detrital zircon geochronology**

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A major intra-plate volcanic event affecting the entire northern passive margin of India in the Early Cretaceous has long been documented by studies of volcanic and volcaniclastic rocks exposed in various regions of the Himalayan orogen, such as the Zanskar Range, Spiti, Kumaon, Nepal and southern Tibet. Geochemical analyses of basaltic grains and of detrital Cr-spinels from these sandstones point to the alkaline character of the volcanism, consistent with a "within-plate" tectonic setting. Lower Cretaceous volcanic rocks have never been reported so far in the western Himalaya, but are well known to occur in the Lesser Himalaya of Nepal (Aulis Volcanics) and in the Tethys Himalaya of southeastern Tibet (Sangxiu Formation).

This article provides new U-Pb ages and Hf isotopic compositions of detrital zircon grains from Lower Cretaceous volcaniclastic sandstones of the northern Tethyan Himalaya in southern Tibet, and a compilation of the available geochronological and isotopic data on detrital zircons from Cretaceous-Paleocene sandstones of the northern Indian margin, including the Lesser and Tethys Himalaya. Based on the abundant and precise radiometric ages available for detrital zircons ultimately produced during the Early Cretaceous magmatic event, the age range of volcanic activity will be accurately constrained. We will also discuss the paleogeographic significance of Early Cretaceous volcanism and the differences observed in the age distribution of detrital zircons in different regions and tectonic domains of the Himalayan belt.

**Himalayan detrital chromian spinels and timing of Indus-Yarlung ophiolite erosion**

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The geochemistry of detrital chromian spinels is commonly used to discriminate provenance from different tectonic settings of mafic and ultramafic igneous rocks. Detrital spinels in Cenozoic foreland-basin successions fed from the Himalaya Orogen were assertively interpreted as sourced from the ophiolitic rocks of the Indus-Yarlung suture zone. This study compares the geochemistry of detrital Cr-spinels from the Tethys Himalaya passive margin and Cretaceous Xigaze forearc successions with those from the Indus-Yarlung ophiolites. Cr-spinels in the Indus-Yarlung ophiolites have low $TiO_2$ (mostly < 0.2%) and high $Al_2O_3$ (10-48%). Detrital Cr-spinels from the Tethys Himalaya have instead high $TiO_2$ (mostly > 0.2%) and low $Al_2O_3$ (mainly 6-23%), indicating a rift-related basaltic origin. Detrital Cr-spinels from the Xigaze forearc basin have either low $TiO_2$ (mostly < 0.2%) and low $Al_2O_3$ (4-34%), suggesting provenance from a supra-subduction-zone peridotite, or high $TiO_2$ (> 1.0%), indicating intra-plate basaltic origin. Compositional fingerprints of detrital Cr-spinels from Lower Eocene foreland-basin strata in the central-eastern Himalaya indicate provenance from the Lhasa Block without input from the Indus-Yarlung ophiolites. Only Cr-spinels from the Lower Eocene foreland-basin strata in the north-western Himalaya and the Upper Eocene-Lower Miocene remnant-ocean turbidites of the Bengal basin are mostly ophiolite-derived. The Indus-Yarlung ophiolites were thus emplaced and exposed to erosion since the Early Eocene (> 50 Ma) in the NW Himalaya, but only subsequently (50-38 Ma) in the eastern Himalaya.

**Paleoceanographic transition from the Aptian oceanic anoxic event 1a (OAE1a) to the oceanic red bed 1 (ORB1) in the Gorgo a Cebara section (central Italy)**

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The Gorgo a Cerbara section is located 3 km west of the town of Piobbico (Marche, Italy) and was the subject for numerous paleoceanograpic studies related to the early Aptian oceanic anoxic event 1a (OAE1a) and the Barriacian-Aptian boundary. We performed a detailed study of the stratigraphic transition from the OAE1a to the oceanic red bed 1 (ORB1) from the classic Gorgo a Cebara section in Umbira region of central Italy. In this study, we focused on the study of a suite of 25 m-thick stratigraphic succession (totally 234 samples) by analysing TOC, CaCO3, magnetic susceptibility, diffuse reflectance spectrophotometry, stable carbon and oxygen isotopes of both bulk and organic matter, and cyclicity. In the Gorgo a Cebara section, the Selli-equivalent level of the OAE1a (approximately 2.3 m thick) consists of laminated to bioturbated olive-grey, greenish-grey and dark-grey to black mudstones and shales, with 20 thin (1 to 3 cm) greyish-yellow, olive-grey and medium- to dark-grey radiolarian silty/sandy layers. The carbon isotopic record shows several very negative excursion (C3 stage) at the bottom of the Selli-equivalent black shales. TOC contents of samples from the Selli Level from the Gorgo a Cerbara section is as high as 8%. A 2.5 m thick stratigraphic interval separates the Selli Level and ORB1. It is lithologically characterized by bioturbated greenish-grey cherty limestones, marly limestones with subordinate marls, in beds 1- to 30-cm thick. ORB1 is over 15 m thick at the Gorge a Cerbara section. It is dominated by bioturbated, dark red marlstone, red marly limestones and red calcareous shales with subordinate gray marlstones and marly limestones, in beds 1- to 30-cm-thick. The red beds are generally less calcareous than the gray beds. The contacts between red beds and gray beds are commonly sharp. Within the intercalated gray beds, the color becomes more reddish in zones a few mm-thick, both near the base and the top of the beds. With new data, the paleoceanographic changes from OAE1a to ORB1 is discussed, and age durations of the OAE1a, ORB1 and OAE1a-ORB1 transition are calculated. We also compare the data with the Yenicesihlar section, central Turkey for the paleoceanographic changes of the OAE1a-ORB1.

**The Sedimentary Characteristics of Post Rifting Stage Aradeiba Formation in Muglad Basin, Sudan**

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The mud-rich Aradeiba Formation in Muglad Basin was always considered as caprocks, but recent wells documented the thin sandbodies in Aradeiba Formation with great potential as exploration targets. However, absent systemic study of sedimentary setting impeded the hydrocarbon exploration significantly. The isopach maps and tectonic characteristics showed the strata belonged to post rifting with quiet structure movement. It was hard to understand the mud-rich sediments formed in post rifting phase with low accommodation space. To solve this problem, abundant data including well data, seismic data and thin section were collected and analyzed. The well cuttings showed the shale usually showed red, brown color which suggested the oxidation environment dominated. Fine to very fine grain size sand bodies in the Aradeiba Formation, usually were 5-15m thickness of each beds with upward fining. The sand/mud was in a range of 10 % to 22 % and high value zone showed ribbon-like distribution. The seismic attribute showed channel features in plan view. The paleo-topography was rebuilt based on seismic information. The eastern flank displayed low gradient contrasting to western flank. The channel in eastern flank revealed high sinuosity comparing to low sinuosity channel in the western. The paleontology information also provided the evidence of flood plain. Finally, flooding plain and meandering channel sedimentary setting were established in this period. The distribution and geometry of meandering channel were predicted based on seismic data and paleo-topography. As a result, the channel belt with abundant sand sediments was confirmed as the favorable exploration zone.

Key words: rift basin, flooding plain, paleo-topography

**Maturation of Neogene dolomite during shallow to deep burial: Xuande Atoll of Xisha archipelago, the South China Sea**

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Dolomitization is the most striking diagenetic process affecting the subsurface carbonate beds at Xuande Atoll of Xisha islands in the South China Sea. Petrographically, extensive dolomitization have developed at a minimum burial depth of 298 m in Pliocene strata of the ZK-1 well. But dolomite crystals initially occurs at the depth of ~180m in Holocene-Pleistocene carbonate with relatively small concentrations. At a scale of thin section, these dolomites can be divided into two types: matrix dolomite and cement dolomite. Matrix dolomites are generally dirty-looking due to abundance of inclusion. The fact that most matrix dolomites typically exhibit mimetic textures or “ghosts” textures of precursor substantiates their replacive origin. One dolomite and cement dolomite generally grew as either overgrowths around inclusion-rich cores (type 1 cement) or pores-fillings, some of which may line the walls of biomolds. Most dolomite have planar crystal boundaries but matrix dolomite crystals are typically smaller (<1-20 μm) than dolomite cement ones (10-100μm). Under cathodoluminescence, dolomite cements are mostly homogeneous dull to nonluminescent and unzoned whereas the replacive matrix exhibits greyish-red doluminescence. Spot analyses show that matrix dolomites are Ca enrichment (average of 62.6 mol%) and have a significantly higher amount of Mn (average of 271.6 ppm) than cement dolomites (average of 19.4 ppm).

The dolomite have experienced a progressive maturation process from shallow to deep depth was indicated by 1) an increase in crystal sizes with increased burial due to more volume of Limpid dolomite cements; 2) textural evolution from extensive fabric-retentive to predominantly mosaic texture; 3) alteration of metastable dolomite to stable dolomite during burial diagenesis involving the preferential dissolution of precursor, matrix crystal cores and subsequent reprecipitation process; 4)dolomite exhibits more well-ordered, stoichiometric downcore and 5) deeply-buried dolomite has relatively positive $\delta^{18}O$ values (2.49‰~5.07‰) than shallow ones (-2.16‰~2.91‰).

Positive $\delta^{18}O$ values of dolomite, comparing to calcite, suggest that dolomitization or dolomite precipitation solutions were dominated by hypersaline brine, whereas $\delta^{13}C$ values (1.76‰~3.49‰) indicate that diagenetic fluids were buffered by carbonate rocks. These geochemical and petrographic studies of Neogene dolomite from the Xuande Atoll have demonstrated that the early-formed metastable dolomite may occur in near-surface environments involving non-marine fluids but the seawater-derived fluids may respond for the maturation of dolomite in deeper burial diagenetic environments.

**Cenozoic Tertiary Sedimentary Facies and Reservoir Architecture Features of Block Junin-4**

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Block Junin-4 of Orinoco heavy oil zone is located in north of Orinoco River, southern margin of the East Venezuela Basin, where a fluvial-delta sedimentary system was developed under the transgression background in Cenozoic Tertiary period, and sediments were mainly sourced from the Guiana Shield to the south. It is revealed by this study that, Merecure Fm. (E), the primary target layer, is typical upper delta plain shallow water, near-source braided river deposit, developing braided channel fill, composite mid-channel bar and interchannel microfacies; the lower section (D~C) of Lower Oficina Member is upper delta plain meandering river deposit, developing meandering channel, flood plain, natural levee and crevasse-splay microfacies; and the upper section (B~A) of Lower Oficina Member is lower delta plain distributary channel deposit significantly affected by tide, developing distributary channel and interdistributary bay. The target layer of the study area is divided into thirteen lithofacies, i.e. lamellar shale, argillaceous siltstone, thick (shale lump-containing) sandstone, thick (shale lamina-containing) sandstone, moderately thick sand-shale, thin-bedded sand-shale, thin interbedded shale-siltstone, lenticular-convolute bedding sandstone, massive bedding sandstone, trough cross-bedding sandstone, horizontal bedding shale, boulder clay-granule-conglomerate and bioturbated sandstone, and then the typical lithofacies association for these sedimentary microfacies have been constructed. With the combination of modern depositional and outcrop studies, the division scheme of reservoir architecture for this block is proposed, and with this scheme eight types of architecture element unit under the control of the fourth-order interfaces within the basin have been divided, i.e. riverbed lag deposit, mid-channel sand bar, braided channel fill, interchannel deposit, meandering channel, flood deposit, natural levee and crevasse-splay, and the architecture model of fluvial delta system for the study area has been established.

**Forward stratigraphic modelling of sedimentary heterogeneities of shallow water deltas**

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For better predicting the spatial distribution of reservoir facies and permeability barriers, it is critical to understand the overall stratigraphic geometries and architecture of a basin fill. Stratigraphic forward modelling provides an intuitive tool to predict the deposition and evolution of sedimentary facies within a stratigraphic framework with given prior boundary conditions. The method mimics the depositional processes while taking into consideration a range of factors that affect sedimentation and basin evolution.

We used Sedsim, a three-dimensional stratigraphic forward modelling program, to simulate the development and evolution of the shallow-water deltaic sequence of the Chang 8 Member of the Yanchang Formation in the Odors Basin. The simulation takes into account a number of key processes and parameters affecting delta deposition including lake-level fluctuations, types and discharge rates of sediment, and the pre-existing topography/bathymetry. The sediment characteristics and depositional processes of the modern Poyang Lake deltas were used as a modern analogue. The primary objective is to predict the distribution of the favourable reservoir plays within the Chang 8 Member.

The results show that river-deltas from multiple sources migrate toward the subsiding basin centre resulting from the opening toward the southeast to the Odors Basin. The delta plain is dominated by distributary channel sand bodies, while the delta front is characterized by sheet sands. The sediment discharge from northeastern and southwestern sources accounts for 80% of the total sediment input, indicating that these are the two primary sources. In addition, the results indicate that sand bodies in the delta plain and delta front, with a porosity of 7%-13%, are potential future exploration targets.

Stratigraphic forward modelling tools can be used to rapidly test multiple working hypotheses about the relationship between depositional processes and sedimentary facies at various scales. Such a process-based modelling approach serves to predict rock properties away from wells and below seismic resolution with a given degree of confidence. Available data such as well, seismic and modern analogue data can be used to constrain the model predictions at appropriate resolution.

Acknowledgements: This research is sponsored by the “Element and process constraint petroleum system modeling” project (No. 2011A-0207) under the PetroChina Science Innovation programme from the Research Institute of Petroleum Exploration and Development, PetroChina.

**Measuring the Number of Turbidity Currents that Pass Through Submarine Channels**

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Seafloor surveys of submarine channels are continually captured at increased resolution, revealing critical insights into the sediment gravity flows that passed through them; however, the ability to directly monitor these flows remains largely elusive. In order to consider the dynamic history of channelized sediment transfer and deposition within slope channels, we examined the exceptionally preserved fill of submarine channels in outcrops of the Tres Pasos Formation (Cretaceous), Chile. This study reveals distinctive evidence for various processes, including turbidity current erosion, sediment bypass and deposition, all contained within channelform bodies 15-24 m thick and 200-400 m wide. This spectrum of processes results in distinctive fill patterns within channelforms, including: (1) an axial sandstone-dominated zone with steep and sharp composite erosion surfaces that define lateral contacts with (2) thin-bedded and finer grained channel margin units, the deposits of which drape or lap onto the composite edge of the channelform.

In strike-oriented cross-section, 70-80 % of the channelform bodies studied consist of sandstone-dominated (axis) strata; conversely, 20-30% of the cross-section consists of more mudstone-prone (margin) strata. A series of sections (0.1 cm resolution) through a single channelform, from the channel axis through margin transition, documents the number and spatial distribution of sedimentation units, or turbidity current event beds. Our analysis reveals that 525 individual, distinct sedimentation units are identified in a single channelform, yet <5% of the recorded sedimentation units are preserved in cross-sectionally dominant channel axis deposits. Therefore, unprecedented insight is preserved in the proportionally limited, and generally overlooked, channel margin strata. Collectively, these data are a measurement of the minimum number of turbidity currents that passed through the slope channel.

These results have the potential to inform numerous poorly constrained or unanswered questions about sediment transfer across channelized seascapes. For example, what can this more complete channel fill record, with insight into erosion and significant sediment bypass, shed about the formation and volume of linked depositional lobes in basinward positions? Additionally, ongoing research aims to deduce a detailed history of slope channel sedimentary processes, including the dynamic morphological expression of conduits, from inception to terminal filling. A simple, two-step cut and fill model, although widely considered, does not represent the true dynamic nature of slope channel systems.

**A history of ruptures of the North Anatolian Fault in front of Istanbul (Turkey) based on a submarine sedimentary records**

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Istanbul and its 12 million inhabitants borders the Marmara Sea, a submarine pull-apart basin related to the North Anatolian Fault (NAF), a major strike slip fault that ruptures in M>7 earthquakes. Constraining the recurrence rate of M>7 earthquakes that threaten the megacity is problematic because the active faults are submarine. An history of paleoearthquakes can be inferred only by using sediment cores. Here we focus on a main branch of the NAF just south of Istanbul, the Cinarcik Segment. To reconstruct the rupture history of this segment, we used a record of turbidites obtained in two cores. Core Klg04 (4 m long) was collected from a berm north of the fault and a second core (Klg03, 3.5 m long) was positioned in the Cinarcik Basin, 3 km south of the fault. Sedimentary sequences in the two cores were correlated using variations in Ca/Ti ratio, which reflect the local aquatic productivity compared with more terrigenous input. The turbidites between the two cores were then classified to distinguish the synchronous ones from the other ones. Radionuclide measurements suggest that the most recent turbidite recorded in both cores was triggered by the M=7.3 1894 earthquake. We identified the earthquake-generated turbidites based on: 1) their distinctive sedimentological and geochemical signatures, previously described and applied in the Marmara Sea; 2) on the correlation of turbidites between cores at berm and basin sites; 3) the match of the most recent turbidites with a 19th century historical earthquake; and 4) the elimination of others processes. Because of its specific geomorphological location, Klg04 core likely records only mass wasting events related to the rupture on the Cinarcik Segment. To date turbidites older than the 19$^{th}$ century, we used radiocarbon and paleomagnetic data to build an OxCal age model with a local reservoir correction of about 400yr. The Cinarcik Segment is found to have ruptured in AD1894, AD1509, sometime in the 14th century, AD989, AD740 and AD 480 and have a mean recurrence interval of rupture between 243 and 396 years. The obtained age model allows us to discuss past historical rupture scenario across the Marmara Sea. The fact that the 1766 earthquakes are not record is further discussed based on new macroseismic intensities and sedimentary records East of the Cinarcik Basin.

Keywords: North Anatolian Fault, Marmara Sea, paleoseismology, seismoturbidites, reservoir age, earthquakes

**Calcretes in volcanic islands. Their Ca sources and palaeoclimatic implications (Lanzarote and Fuerteventura, Spain)**

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Pedogenic calcretes are terrestrial carbonate materials whose formation, within a soil profile, results from the introduction of mostly vadose carbonate into soils, rocks or sediments. When calcretes develop on carbonates or carbonates are present in vadose or groundwaters the calcium sources are evident. On the contrary in Lanzarote and Fuerteventura (Canary Islands), where large areas of their impressive volcanic landscapes are covered by well-developed calcretes, several Calcium sources can be considered, 1) the basalt plagioclases, 2) the Sahara and Sahel wind-blown dust, 3) the marine sands exposed and transported during the last glacial, and 4) the marine spray. The different calcium sources have different palaeoclimatic implications in calcrete formation and different mechanisms of calcium carbonate accumulation. The sedimentological and petrological studies reveal that the calcretes are composed of various irregular carbonate lamina interbedded with fine clastic deposits partially or totally calcified. The geochemical study ($^{87}Sr/^{86}Sr$ ratios, $\delta^{13}C$, $\delta^{18}O$, major, trace and REE) of the canarian calcretes does confirm the important role of aeolian dust input in the formation of these calcretes. Calcrete $^{87}Sr/^{86}Sr$ ratios (0.706357 to 0.709208) show strong affinity with those obtained in aeolian carbonate dust and marine deposits, and are relatively different from those obtained in basalts. REE, major and trace element concentrations show that Ca-bearing minerals from volcanic hostrock contributed little to calcrete formation and most of the calcium was supplied by aeolian deposits such as the aeolian dust coming from the Sahara and Sahel or sand dunes.

The $\delta^{18}O$ (-2.70 to +2.22 ‰VPDB) and $\delta^{13}C$ (-8.21 to +0.24‰VPDB) values indicate that calcretes were formed by pedogenic processes. The $\delta^{13}C$ values originated from soils with different proportions and densities of C3, C4 and CAM plants, as occurs nowadays in the eastern Canary Islands. Comparison of calculated $\Delta^{18}O$ values for the Canary calcretes with continental mid-latitude calcrete values reflect the more homogeneous temperature regimes of calcrete formation in island (oceanic) settings.

These calcretes developed in several aggrading stages. Dust and/or alluvial deposition during arid periods alternated with carbonate leaching and precipitation during more humid stages where plants, insects and bacteria played a role in calcrete formation.

Acknowledgements: This research was funded by Project CGL-2011-27826-C02-01 from MINECO. We thank A. Meléndez and J. Genise for collaboration in previous field work studies.

**High molybdenum enrichments in the hypersaline region of Guerrero Negro, Baja California Sur, Mexico**

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Modern hypersaline regions can be used as giant laboratories where biogeochemical processes can be studied and results extrapolated to the geological past, when hypersaline regions were considerably more widespread. One modern analog is the hypersaline (S = 40 psu) Ojo de Liebre Lagoon (OLL), located in the middle of the Baja California Peninsula, close to the town of Guerrero Negro (GN), Mexico. In this saltern, OLL water is passed through a series of 13 evaporation ponds (combined area of ~300 $km^2$) with water depths between 1.0 and 1.5 m. Ponds are separated by dikes with openings through which the water flows from one pond to the other. Well developped benthic microbial mats (5-7 cm thick) are present in ponds 4, 5 and 6. Trace metal inputs to the ponds are negligible since the GN town (population: 30,000) is far (~28 km) from the ponds, there are no permanent rivers in the region and terrestrial vegetation and rain are scarce. Samples included one sediment core from each of the first six evaporation ponds (40-325 psu), 44 superficial samples from OLL and 20 samples from the surrounding soils. Total Mo ($Mo_T$) and Al ($Al_T$) were extracted using concentrated $HNO_3$, $HClO_4$ and HF. Two additional fractions operationally defined as HCl ($Mo_{HCl}$) and pyrite ($Mo_p$) were extracted with 1 N HCl and concentrated $HNO_3$, respectively. Metal concentrations were measured by flame or graphite atomic absorption. Precision and accuracy of the total concentrations were verified using the certified reference material MESS-3. Enrichment factors ($EF_{Mo}$) were calculated from the $Al_T$-normalized $Mo_T$ concentrations relative to Mo/Al ratios of Earth's crust sedimentary rock shales using the equation $EF_{Mo}=[(Mo_T/Al_T)_{sample}]/[(Mo/Al)_{crust}]$, where $EF_{Mo}$ values >1 and <1 indicate enrichment and impoverishment of Mo, respectively. Results indicate that average $EF_{Mo}$ values were 0.069±0.036 for OLL sediments, 0.055±0.031 for soils, and between 4.7±5.5 and (1.84±5.5)x$10^2$ for the six pond sediment cores. The high enrichments measured in the ponds are not a consequence of contributions from the surrounding soils and sediments since the average soil and OLL $EF_{Mo}$ values indicated Mo impoverishment, suggesting that Mo enrichments are produced by evapoconcentration and/or biogeochemical processes. Calculations made with $Mo_T$, salinities, evaporation rates, sediment densities and pond areas suggest that 7.0-19.5 ton of Mo have been evapoconcentrated since the salt company started extracting salt in 1953, explaining 45 to 513% of the Mo enrichment. Calculations made using reported Mo:C ratios for *Trichodesmium* and *Crocosphaera* (2.56±2.02 µmol $mol^{-1}$ and 0.08±0.04 µmol $mol^{-1}$, respectively) and organic C concentrations (7.9±2.2 mmol $g^{-1}$) for GN indicate that up to 80% of the Mo associated to the reactive fraction ($Mo_{HCl}$+$Mo_p$) can be explained by biochemical processes involving $N_2$ fixation by Mo-dependent enzymes used by cyanobacterias. Geochemical processes (e.g., pyrite formation) may contribute with ~50% of the enrichment through a so-called residual fraction ($Mo_R=Mo_T-Mo_{HCl}-Mo_p$) and another 50% through the $Mo_p$ fraction, except in the ponds with microbial mats where ~37% can be attributed to the $Mo_{HCl}$ fraction. Our results suggest that microbial mats from hypersaline regions may have been important for the Mo global cycle in the geologic past when these environments were more abundant. Used in combination with other trace metals (e.g., Fe, Cd), Mo could be used as a geochemical tracer of the presence of ancient hypersaline environments.

**Contrasting carbonate sediment facies in the Galápagos Islands – a result of oceanographic extremes**

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Since carbonate sediments are an expression of life-processes, we need to understand the limitations set by the environment, both on biological and sedimentological characteristics. This is particularly important when studying shallow-water carbonate-secreting organisms under a complex blend of contrasting trophic, temperature, and acidification conditions. The equatorial Galápagos carbonate systems are ideal for such a study as they feature areas of extremely high and low nutrient levels and well-defined gradients in temperature while being situated in a region of extremely low aragonite saturation levels and ocean pH. In fact, the equatorial Eastern Pacific has the lowest aragonite saturation levels of any tropical ocean. These natural sea-water properties are the consequence of upwelling, mixing $CO^2$-enriched deep waters into the surface layers along a shallow thermocline. This process results in an impoverished coral fauna, poor carbonate cementation, and may favour high bioerosion rates. Hence, the conditions in the Galápagos Islands are comparable to future scenarios for ongoing ocean acidification, where a lowering of ocean pH will result in declining aragonite saturation globally. The eastern Pacific is thus a natural laboratory for studying the effect of ocean acidification on carbonate-secreting organisms.

Here we calibrate shallow-water carbonate sediments collected across the geographical extent of the Galápagos Archipelago to remotely sensed nutrient and sea-surface temperature as well as carbonate saturation data. Biogenic composition was quantified on 187 sediment samples collected at depths ranging from 10 meters to 33 meters.

Results reveal that, though the Galápagos are situated within tropical latitudes, the archipelago contains a gradient of shallow-water carbonate environments; ranging from tropical phototroph-dominated facies in the warm, oligotrophic north, to heterotroph-dominated sediments in the cool, eutrophic, and low-aragonite, regions in the south and southwest. Between these two extremes exists a geographical zone of mesotrophic conditions, which exhibit carbonate facies types exhibiting transitional characteristics between the two end-member environments. The heterotroph-dominated facies is characterized by a low abundance of coral-derived sediments, absence of carbonate cements, and high abundance of non-aragonitic biogenic components. These characteristics mimic carbonate systems from non-tropical higher-latitude settings even though they are forming directly across the equator. Our results not only stress the importance of multiple oceanographic controls in determining the biogenic makeup of shallow-water carbonates, but also demonstrate that caution needs to be taken when interpreting palaeoclimates and palaeoceanography from fossil carbonate systems. Furthermore, tropical carbonate systems similar to those of the East Pacific Galápagos Islands may become more common globally with an ongoing increase in ocean acidification.

Funding is provided by the Natural Science and Engineering Research Council of Canada.

**The Miocene Mariño Formation (Central Argentinian foreland, Mendoza Region): a high-resolution integrated study of sedimentary and paleoenvironmental responses to tectonic and climatic forcing**

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Numerous studies relate foreland-basin infill to allogenic forcing, but to date only a few have been able to clearly disentangle the relative roles of tectonics and climate on long-term deposition. Here we present preliminary observations on the continental sedimentology and stratigraphy of the Central Argentinian Foreland near Mendoza. The basin comprises a thick (over 4 km), almost complete sedimentary infill recording local environmental change from the late Oligocene to the Quaternary, during active Andean orogeny.

The Mariño Formation comprises a large part of the Neogene sediments in the Central Argentinian Foreland, dating from ~15.7 to 12.0 Ma and extending over almost 1100 m in stratigraphy. It is extensively exposed as the surface expression of folds related to Plio-Pleistocene uplift of the Precordillera. The formation comprises a continuous stratigraphic record of aeolian and ephemeral fluvial systems developed during the uplift of the Principal Cordillera in an arid to semiarid climate context. The basal part is characterized by the frequent intercalation of aeolian and fluvial deposits, followed vertically by the stacking of fluvial deposits with highly differentiated facies associations and architectures. This stratigraphic picture suggests the interaction of different allogenic controls in the region, namely climate change and tectonics.

This project aims to provide a detailed reconstruction of paleoenvironmental dynamics and to unravel the relative roles of climate and tectonics through a high-resolution, integrated compositional and sedimentological analysis of the Mariño Formation. The main objectives are: to improve the current chronological framework by magnetostratigraphy; to obtain chemostratigraphic logs for sediment elemental composition (in order to detect geochemical signatures of allogenic controls); to track changes in sediment provenance and relative information on magmatism and exhumation in the uplifting Andes; and to recognize the effects of different allogenic drives on sedimentary processes and local environmental change.

Part of the research consists of a multidisciplinary compositional study of 400 m-thick succession which comprises significant environmental (aeolian to fluvial) transitions. Our approach consists of high-resolution petrography (based on conventional thin section, XRD and QEMScan technology), heavy-minerals analysis, geochemistry (major and trace elements by XRF and LA-ICP-MS), radiogenic isotope analysis (Sr, Nd, Pb by MC-ICP-MS), U-Pb dating of detrital zircon, magnetostratigraphy and palynology. A first field campaign provided a detailed stratigraphic and facies architectural framework; sampling was conducted along multiple transects (logged as continuous vertical sections).

The exceptional lateral exposure and the possibility to develop stratigraphic correlations calibrated with quantitative analytical approaches will constrain the relative role of different allogenic processes and offer insights for understanding similar sedimentary complexes in the subsurface.

**Record of sedimentation and tectonics in cretaceous to neogene paleokarsts of Southern France.**

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Paleokarsts constitute a record of base-level variation through time: they are formed during base-level drop and they trap internal sediment during base-level rise. Base-level movements are related to: 1) eustacy, 2) tectonics (subsidence and uplift) and 3) desiccation/flooding of endoreic basins. Dating and amplitude analyses of base-level variations in paleokarst may therefore provide a record of geodynamics.

Mesozoic carbonate massifs are well exposed in southern France. They underwent successive karstification events in relation with the well-constrained regional geodynamics of this area. Mapping shorelines, correlative continental sediments and karst systems provide downstream-upstream profiles for each paleokarst event.

- Comparison of successive profiles allows to determine the amplitude of base-level changes and the amount of differential vertical movements across fault zones or flexure. In particular, Late Miocene uplift reached 400m amplitude in the hinterland, in the footwall of a major regional fault, while the hangingwall was uplifted by only 250m.

- Occurrence of marine infill within paleokarst requires a base-level drop (karstification) followed by a rise (infill) of an amplitude at least equal to the vertical extend of the karst system. Early Paleocene foraminifera and nannofossils found in karst infill indicate up to three base-level variations ≥ 350m amplitude. Matching well-dated base-level changes with eustatic curves discriminates the mechanisms of base-level variation. The measured amplitude of Early Paleocene events exceeds eustacy-driven base-level changes, and the rate of change exceeds that of tectonic movements: this points to desiccation/flooding cycles of a silled endoreic basin.

For the last 100My, we correlate upstream-downstream profile modifications due to base-level changes with the known geodynamics of Southern France. Such approach could constitute a tool to decipher geodynamics within the karst record of other (frontiers) areas.

**Sedimentary record of paleokarsts : a patch on uncomplete continental stratigraphic records. Case study from Cretaceous to Neogene paleokarsts in Southern France**

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Continental erosion and weathering destroy parts of the stratigraphic record. Analyses of the sedimentary filling of paleokarsts help completing the geological record of regions that have been submitted to post-depositional, long-term, continental evolution.
Jurassic carbonate platform of Languedoc (South of France) has undergone several karstification phases from Cretaceous to Neogene. Later incision of canyons through the carbonate massifs allows to observe paleokarsts over 400m depth, within the massifs.
Paleokarsts are partly filled with sediments. Some have yielded marine bioclasts (echinoderms, radiolars), foraminifera and nannofossils; others are composed of polygenic detrital sediments, including sources from the upstream Paleozoic basement (Cevennes). The age of the filling of successive paleokarsts can be constrained by structural relationships and by biostratigraphy.
These findings suggests 1) the marine elements of the karstic filling relate to a Late Cretaceous to Early Paleocene interval, while 2) the Paleozoic basement-sourced-sediments were trapped in the karst during Miocene to Present.
Karstic sediment containing Early Paleocene foraminifera and nannofossils are found in paleokarsts cavities distributed across the entire thickness of the carbonate massif (≥350m). This requires base-level lowering and associated karstification, followed by base-level rise and karst filling of at least 350 m amplitude, respectively. The time interval corresponding to the occurrence of foraminifera and nannofossils in karsts covers 10 Myrs ; surprisingly, no equivalent marine sediments are preserved on the surface. In addition, analyses of the different forams species suggests several (up to 3) distinct karstification and marine filling cycles. Finally, sedimentological facies analysis of the karst filling reveals the following succession of processes: low energy settling of mudstone, high energy reworking, transport and deposition of silts and sandstones within the karst system.
Integration of geological, paleontological and sedimentological data, leads to a polyphase scenario in response to repeated base-level variations, more than 350m amplitude. Such an amplitude excludes eustacy, and the improbable repeated sequence of uplift and subsidence rules out tectonics, as driving forces for base-level change, respectively. We propose that the high-amplitude base-level changes results from a succession of desiccation-flooding events of an endorheic, silled, basin during Early Paleogene.
The later detrital assemblage sourced in the Cevennes occurs on perched paleosurfaces and in karst cavities across the whole 350m-deep canyon walls. When found on paleosurfaces, they correspond to the south-flowing Early Miocene fluvial drainage, and can be correlated downstream with the marine, well dated, Early Miocene, sediments. When found within the karst cavities, they correspond to successive base-level surfaces connected to the progressive incision of the canyon. This canyon incision is coeval with a Late Miocene uplift of the hinterland.

**Facies changes and heterogeneity along a tidally influenced paralic Late Triassic transect in central Svalbard**

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In Central Spitsbergen, 78 degrees north, at Deltaneset, a well exposed, 1 km long beach cliff in Late Triassic sandstones- mudstones makes the study of lateral changes of tidally influenced coastal facies possible. A succession of strata is continuously exposed from east to west due to a dip towards the southwest. The sediments are part of the Carnian Isfjorden Member of the De Geerdalen Formation and are equivalent to the Snadd formation in the Barents Sea. Regional studies have shown that the formation was deposited in a westward-prograding deltaic coastline in an epicontinental sea with the Urals as the main sediment source. Individual units resolved from seismic analysis exhibit lateral continuity on a scale of kilometers to tens of kilometers. Nevertheless, unit variation and heterogeneities below seismic resolution are seen on Svalbard, and are the focus of this study.

16 logs have been measured along the cliff, focusing in detail on two sand bodies. Two drill cores, each some kilometers southeast and southwest of the section constitute supporting data. The objectives were to become familiar with the small-scale lateral variation of the facies in this section combined with the km lateral variation when including the cores, because it can refine the understanding of the depositional setting and the environmental dynamics. With such an understanding, a likely three-dimensional architecture can be proposed. Additionally, the distributions of heterogeneities as a whole is aimed mapped, looking into the possible connections between facies and distribution of heterogeneities. The changes are interesting to reveal because a tidally influenced environment is subject to larger lateral variations than purely river-dominated and wave-dominated environments. Consequently, a tidally influenced coastal environment is prone to be complicated in terms of sedimentary heterogeneities. These data will serve as parameters in future studies, refining reservoir models of these kinds of deposits.

The compilation of data indicate that the sedimentary rocks were deposited in an environment that began as marginal marine, passed through a wide variety of coastal sub-environments and culminated in an alluvial setting with several palaeosols. During this transition paleosols and marine sandstones alternate both horizontally and vertically, registering gentle repetitive variation of submergence and sub-aerial exposure. Consideration on whether the alternating marine and continental deposits are the result of avulsions or gentle sea level fluctuations will be discussed. Paleosol characteristics such as calcretes and calcic nodules in colourful unconsolidated fine-grained substrate suggest a warm and arid climate. Characteristics such as abundant mud drapes, cyclic mudstone intervals in sandstones and current reversals indicate that the palaeoenvironment was tidally influenced. The architecture appears to be largely progradational with cyclic aggradational episodes, allowing paleosols with low preservation potential to become part of the rock record.

Studies are funded by the Climit Program of the Norwegian Research Council and Norwegian Government $CO_2$ storage Coordinator Gassnova and belong to Longyearbyen $CO_2$ lab project.