The Laisvall sandstone-hosted Pb-Zn deposit along the erosional front of the Scandinavian Caledonides: A 50 Ma history of Cambrian–Ordovician hydrocarbon reservoir cementation

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Stratabound, non-stratiform, epigenetic galena-sphalerite mineralization in Ediacaran–Cambrian sandstone, including the previously mined deposit at Laisvall, occurs along the eastern erosional front of the Caledonian orogen in Sweden and Norway. The sandstone is part of a transgressive, siliciclastic, platformal sedimentary sequence that rests unconformably on top of Proterozoic crystalline basement beneath the Caledonian thrust nappes.

A detailed paragenetic sequence was established for the Laisvall deposit including several mineral phases that had not been described earlier. Stable isotope sulfur geochemistry was conducted on sulfide and sulfate phases. An age for the mineralizing event was determined by Rb-Sr geochronology on sphalerite.

Distinctive mineral associations corresponding to separate paleoenvironments define successive cementation phases in sandstone paleoaquifers from the later part of the Lower Cambrian to the Middle Ordovician. Following Ediacaran–Lower Cambrian platformal sedimentation and anatase precipitation in the oxic zone, close to the water-sediment interface, xenotime, apatite, Ba-K-feldspar and pyrite illustrate anoxic conditions and early burial diagenesis in sandstone beneath an oxygen minimum layer in the later part of the Lower Cambrian. Early diagenetic calcite concretions in the overlying Middle Cambrian–Lower Ordovician marine black shale were dated at 509.8±5.1 Ma (U-Pb) by others. The final stage of sediment compaction, protracted dewatering and diagenesis in black shale was dated at 478.2±4.9 Ma (Lower Ordovician) in a similar manner. It is suggested that the black shale subsequently entered the zone of catagenesis and started to generate petroleum.

Sulfur isotope data ($\delta^{34}S_{sulfides}$: +27 to +35 ‰) identified Thermogenic Sulfate Reduction (TSR) through hydrocarbon oxidation as the main source of reduced sulfur for the Pb-Zn mineralization. It is suggested that TSR occurred in a closed system to HSO_4^-, and reduction of sulfate was completed before the ore-forming fluids reached the site of deposition. Barite, calcite and fluorite cementation of the reservoir occurred during and after TSR, as indicated by bitumen inclusions in barite.

Rb-Sr geochronology on sphalerite yields an age of 467.2±5.4 Ma (MSWD=1.4). TSR-derived reduced sulfur was consumed at an early stage mainly in sphalerite, while subsequent starvation of the system in reduced sulfur caused mainly galena to precipitate at the expense of early biogenic and/or diagenetic pyrite. Cementation by sulfides was possible due to creation of secondary porosity by local quartz dissolution.

It is proposed that petroleum generation and migration that made TSR possible took place during the Lower–Middle Ordovician (478–467 Ma) in a foreland basin that developed on continental crust undergoing flexure. The basin was filled with siliciclastic material in response to uplift and erosion further outboard along the outermost part of the continental margin to Baltica, where the previously rifted margin to Baltica had been subducted around 490 Ma with the formation of high-P rocks including eclogite, and subsequently exhumed.

Pre-salt Lacustrine Sedimentation Patterns in the Kwanza Basin, offshore Angola

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Early Cretaceous (Barremian and Aptian) sedimentation in the Kwanza Basin of offshore Angola was dominated by lacustrine deposition. Barremian synrift sediments were deposited over faulted metamorphic and volcanic basement followed by deposition of Aptian "sag" deposits. Lacustrine systems included many different facies deposited in a variety of environments and lake types. Mollusk-rich sediments (including coquinas) were deposited in shallow water in Barremian, synrift lakes which had moderate to low salinities. The "sag" interval in the western part of the Kwanza Basin was dominated by saline lacustrine facies with microbial boundstones and spherulitic wackestones, packstones and grainstones deposited in shallow water while organic-rich dolomites were deposited in deeper lacustrine environments. Synrift and sag lithologies are dominated by limestone, dolomite and chert, all of which apparently precipitated out of lakes at different times. Some dolomitization and calcitization of dolomite occurred during shallow burial due to variations in lake chemistry while sediments were still in communication with lake waters. Hydrothermal waters feeding lakes were probably a key input for ions (Ca, Mg, Si) that were precipitated in those lakes, and variations of those ions are thought to be a major control on variations in precipitation of calcite, dolomite and chert during the Barremian and early Aptian.

Cold-seep carbonates as tracers for the evolution of the platform-basin system in the Miocene of the northern Apennines (Italy)

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The peculiar methane-derived carbonates enclosed in pelitic and marly deposits of the Miocene inner foredeep in the northern Apennines are useful tracers for an evaluation of tectonic and sedimentary processes in the Miocene shelf-slope-basin system in a compressive geodynamic context. The carbonate precipitation is related to emissions of hydrocarbon-rich fluids and it is controlled by: - tectonic events (tectonics constrains the plumbing system, with faults and fractures serving as conduits and channelling water and methane up to the seafloor); - climatic events (carbonate formation seems to correlate with cold periods and sea-level low-stand).

The correlation between methane-derived carbonates and climate during the Miocene in the northern Apennines has been suggested by recent results (Fontana et al,. 2013) of a sedimentological and biostratigraphic study of seep-carbonates and the enclosing hemipelagic Vicchio marls. The study suggests a correlation between the carbonate precipitation and the middle Miocene cooling event (Mi3b). The ascent and emission of methane-rich fluids may have been triggered by the pressure drop due to the eustatic fall. A detailed study of the $\delta^{18}O$ record of carbonates and $\delta^{13}C$ of total organic matter in enclosing marls has been performed in order to verify a correlative trend in correspondence of the climatic cooling event. A palaeocological study has allowed to check the influence of these stressed environmental conditions on benthic foraminifera assemblages. Therefore morphological, textural, biostratigraphic, geochemical studies could allow to characterize seep-carbonates related to climatic event. Results of this study could contribute to the reconstruction of transgressive-regressive events in the adjacent temperate-type carbonate platforms, as well as the definition of modes and rates of the demise of carbonate deposition and the onset of clastic sedimentation.

The identification of cold phases and lowering of sea level in slope-basinal deposits and their detailed timing, may be an useful and innovative tool for correlation with coeval shallow-water successions, and for the reconstruction of the evolution of the Miocene platform-basin system in the compressive setting of the northern Apennines.

Petrology, micro-XRF, XRD, SEM-EDS and stable isotope integrated study on carbonate core samples

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One of the challenges of the study of geological samples in the oil and gas industry is obtaining mineralogical properties of the rocks, from the thin section scale up to rock core. m-XRF (X-Ray Fluorescence) scan of thin sections can be used as a very quick compositional screening tool that facilitates the preliminary definition of the sedimentological facies and diagenetic textures and processes by different element/minerals distribution.

The integration of core observations and m-XRF multi-element overlay images has permitted a quick preliminary sedimentological facies definition and the recognition of several diagenetic processes as dolomitization and/or silica levels in carbonate samples. Further XRD and SEM-EDS and bulk rock stable isotope C and O analysis have confirmed those sedimentologic and diagenetic interpretations.

The core observation and the multi element overlay images generated by m-XRF allowed the identification of 2 main sedimentology facies in carbonate samples: (1) Crinoidal–bryozoan rich grainstone-packstone and (2) Dolo-mudstone-wackestone. Other features identified with the m-XRF images include calcite and silica cementation and replacement, dolomitization, stylolites, distribution of clay minerals, presence of evaporite minerals and sulphides.

Silicification is a significant process replacing bioclasts in grainstone-packstone facies and especially important in dolomudstone facies affected by silica nodules replacing the dolomitic matrix. Silicification was not complete in some areas with evaporite minerals and numerous remnants of anhydrite were encased in megaquartz crystals. Clay minerals are abundant in argillaceous dolomudstone facies normally related to stylolite structures. Veins of kaolin minerals (identified by XRD and SEM-EDS) are related to silicified areas and euhedral dolomite crystals in grainstone-packstone facies.

Two types of dolomites were recognized in petrographic studies and confirmed with the stable isotope (C&O) analyses: 1) early dolomite, replacing fine calcite matrix in dolomudstone facies, with $d^{18}O$ isotopic values between -4.8 and +0.9‰ and $d^{13}C$ isotopic values between +2.8 and -0.5‰; 2) later dolomite, occurring as single rhombs scattered throughout veins and filling porosity in grainstone-packstone facies with negative $d^{18}O$ and $d^{13}C$ isotopic values (from -15.1 to -7.7‰ and from -10.6 to -2.8‰ respectively). The O and C isotopic composition in early dolomites from dolomudstone facies retain the marine isotopic signal for carbonates rocks formed from chemically modified seawater. The isotopic ^{18}O depletion in later dolomites indicates higher temperatures during vein filling. This isotopic depletion of the dolomites and their relationship with veins of kaolin minerals and silicified areas suggest that fluids could be hydrothermal in nature.

Microbial carbonate precipitation under extreme acidic conditions

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Thermodynamic conditions fundamentally restrict carbonate precipitation to high pH environments (pH . 7), and, in terrestrial environments, the production of carbonates at pH, 4.5 does not occur either by abiotic or biotic mechanisms[1]. In spite of this general rule, iron-rich carbonate minerals (ankerite and siderite) have been recently recognized in the subsurface of Rio Tinto in mildly acidic to neutral pH (5–7) and somewhat reducing (Eh,0) conditions[2]. Rio Tinto is an acid-sulphate system considered as one of the potential analogues for life on early Earth and Mars[2]. The discovery of these iron-rich carbonates, in the extreme acidic environment of Rio Tinto, adds a new dimension to our understanding of carbonate formation.

In order to study the formation of carbonates under acidic conditions, culture experiments were designed with an iron-reducing bacterium isolated from Rio Tinto, *Acidiphilium* sp. PM. Acidiphilium species are very abundant in Rio Tinto[3], these alphaproteobacteria can grow on organic compounds under microaerobiosis and anaerobic conditions using ferric iron (Fe^{3+}) and/or oxygen as electron acceptors[4]. *Acidiphilium* sp. PM culture experiments were conducted under low pH (3.5), micro-aerobic and room temperature conditions. Using a combination of Raman, sensitive energy dispersive X-ray Spectroscopy (EDS), TEM, SEM and AFM analyses, we identified the mineral composition and investigated the involvement of *Acidiphilium* sp. PM in the nucleation of carbonate minerals. Our research demonstrates that bacteria can create chemical microenvironments in the region directly surrounding their cell walls, and, thus, can effectively produce spatially restricted supersaturated conditions in which otherwise unpredicted minerals can precipitate.

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Sedimentary processes and origin of thick depositional events in the Ionian Sea, based on new regional sedimentological data (CIRCEE data): megaturbidite and homogenite significance.

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The Ionian Sea is a deep and narrow basin in the Central Mediterranean Sea, bounded by two accretionary wedges formed by the Calabrian and the Hellenic subduction zones, respectively to the North West and to the East. The Ionian Sea and specifically the East Sicily Calabria region has been the site of strong historical earthquakes and tsunami.

Sedimentation in the deep Ionian basin consists of pelagic deposits alternating with thick depositional events, including typical gravity flow deposits as turbidites and very thick deposits named megaturbidite or homogenite (Cita *et al*, 2000). These thick deposits were described in seismic data, showing several thick transparent layers in the Ionian abyssal plain (Hieke *et al*, 2000). First cores sampling the most recent thick layer, named Augias event, led to the interpretation of the deposit as a megaturbidite related to a large tsunami. This event was inititally interpreted as being connected to the major Santorini volcanic eruption at 3.5 ka (Cita *et al*, 2000). However, more recently new dating has led some workers to re-interpret this deposit, which is now correlated to the AD 365 Crete earthquake (Polonia *et al*, 2013).

Thick depositional events can have several sources and origins. They are related to major submarine slope instabilities, potentially triggered by extreme events such as earthquakes, tsunamis, or volcanic eruptions. Triggering mechanisms, transport and deposition processes are not well constrained at the regional scale.

New data, including piston cores and CHIRP echosounder profiles, were collected during CIRCEE-HR cruise, with N/O Le Suroit in October 2013, in the western Ionian Sea, including the western part of Calabrian accretionary wedge and the base of the Malta escarpment. With a wide regional distribution of the cores, this new dataset will allow us to revisit the interpretation of these mega-events in terms of sedimentary processes and origin.

Sedimentological core descriptions and CHIRP data interpretation revealed that the Augias megaturbidite was completely sampled in 6 cores. An older megaturbidite, possibly corresponding to the Deeper Transparent Layer (DTL), is also sampled in 3 cores.
Geochemical signatures, thicknesses and grain sizes show a great variability for the same deposit between the cores. For example, the thickness of the Augias deposit varies between 70 cm and 605 cm, and the grain-size distribution of the base of the deposit is also highly variable, ranging from massive and laminated medium and to silty-clay grain size.
For these two megaturbidites described in the cores, first estimation stratigraphy is proposed thanks to correlation with data described by Polonia et al. (2013). Radiocarbon dating is currently in progress and will provide new age constraints to confirm this first hypothesis of chronostratigraphy.

In order to better understand the extreme events that led to such deposits in the Ionian abyssal plain and along the Sicily/ Malta slope, our study aims to correlate the megaturbidites observed in the slope (western part of basin) and in the Ionian basin thanks to sedimentary facies analysis and CHIRP echosounder profiles.
Furthermore, characterizing the megaturbidites, in terms of areal extent, thickness, chemical composition and grain size distribution will provide new constraints on their origin and the transport and depositional processes related to the megaturbidites in Ionian Sea.

Rock transport by wind-driven currents in playa lakes

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Altillo Chica is a 0.46 km × 0.42 km playa-lake in central Spain, at an elevation of 681 m, which is flooded in the wet season, occupying a Quaternary flat-bottomed depression. Over the winter the average water depth is lower than 5 cm. However, it has been observed that the advancing and retreating of lake waters due to wind stress will expose or cover many square metres of the playa in a short time. During the summer the surface desiccates completely.

Long tracks left by rocks (sailing stones) along the smooth floor of the playa drew our attention in December 2012. The tracks (drag marks) ranged from a few to 25 m. At the end of the tracks, cobble-sized stones (or some other tools), weighing up to 2 kg, were found. The rock tracks coexisted with smooth traces produced by wrinkled mat piles and massive sediment piles. Rounded depressions which we referred to as sitz marks were commonly found at the beginning of the tracks. The tracks corresponded in orientation with the direction of strong winds blowing above 7 m/s over the area. In addition, the traces were associated with ripple and microbial mat deformation structures consistent with wind induced-water currents.

Since then, two major generations of tracks were formed after windy storms, which further reinforced our previous interpretation of the above processes as the cause of the transport of rocks. In this work we describe the observed effects of two selected winter storms on sediment transportation, including the transportation of large objects. Our observations in the Altillo Chica and Altillo Grande playa lakes indicate that wind velocities higher than 8 m/s cause a great redistribution of the water mass and strong water currents in the playa lake. Wind-driven currents distribute fine-grained sediments and produce scour marks around the stones deposited on the bed. The results allowed us to reinterpret the sitz marks typically found at the beginning of the rock tracks as scour marks. Furthermore, our observations provide evidence for the transport of large object by wind-driven currents in shallow and very low gradient systems.

Similar drag marks decorate some playa floors in the SW part of the USA, as well as parts of Tunisia and South Africa. Thus, hydrodynamics of flooded playa lakes appear to be dominated by wind-driven processes.

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Evaporite Deposition in a Dynamic Lacustrine Setting, Eocene Green River Formation, Piceance Basin, Colorado, USA – Implications for Climate Control

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The lacustrine Lower-Middle Eocene Green River Formation in the Piceance basin comprises a mixed carbonate/evaporite/clastic sedimentary system that was deposited during the Eocene climate optimum and displays changes from fresh to saline conditions during its history that are interpreted to have been controlled by slow tectonic subsidence and wet and dry climate cyclicity. Lake sequences commonly form thin, 10-30 m thick, upward-deepening cycles. Lake center evaporites and lean silty oil shale record low lake levels. Rising lake levels are characterized by fluvial, deltaic, or shoreline quartz sandstones that are overlain by carbonates. These include molluscan coquinas intraclast rudstones and oolitic grainstones. During high salinity lake periods 1-5 m thick coarse-agglutinated stromatolites or thrombolites were deposited and capped by fine-grained laminated stromatolites. Sublittoral to profundal oil shale occurs at high lake times. Absolute age dates suggest that these sequences are 400 Ky eccentricity cycles. Changes in $\delta^{13}C$ and $\delta^{18}O$ stable isotope values are consistent with lake cycles. Trends to heavier $\delta^{18}O$ reflect increased evaporation and higher salinity, and trends to lighter $\delta^{18}O$ indicate increased inflow and freshening of the lake. The $\delta^{13}C$ values are covariant and suggest a closed lake basin. Positive excursion of $\delta^{13}C$ values may have resulted from increased photosynthesis and high organic productivity during lake level falls. Respiration processes, and dissolved inorganic carbon replenishment result in negative excursions of $\delta^{13}C$ values correspond to lake-level rises.

The overall vertical succession of sedimentary deposits correlates with longer-term lake evolutionary stages. An initial Fresh to Mesosaline Lake Stage 1 is characterized by littoral coquina limestone and skeletal-oolitic lime grainstone deposits, deltaic and shoreline sandstones, and profundal illitic oil shale. An abrupt change to more restricted saline conditions occurs at the base of the Transitional Stage 2. Nahcolite and dawsonite were deposited in profundal areas. Mixed oolitic intraclast grainstones and rudstones and microbialite limestones were deposited along the lakeshore. Oil shale composition changes to siliceous feldspathic dolomudstone. The succeeding Highly Fluctuating Stage 3 phase is distinguished by the onset of nested high frequency depositional sequences of various scales. Hypersalinity occurred during low lake periods, and nahcolite and halite were deposited in the lake center. Deepening of the lake begins in the Rising Lake Stage 4, but the lake remains saline during low lake levels and nahcolite is common. This continues into High Lake Stage 5, and is accompanied by widespread oil shale deposition.

Evaporite precipitation occurs at the lake surface and within the sediment column. Precipitation of dawsonite, nahcolite, and halite requires high alkalinity and salinity, and oxidizing conditions. At least three potential precipitation centers are present and result in different evaporate textures. In a meromictic lake, at low lake levels, (1) surface evaporation causes precipitation of crystals that rain down to form thin beds; and (2) at the chemocline during moderate mixing, resulting in thin bottom layers. And (3) during times of low lake levels, when the lake shifts to monomictic or polymictic conditions, nodule and crystal growth occur at and below the sediment water interface under more oxidized conditions related to lake turnover, respiration, and an increase in dissolved CO2.

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Sedimentary facies and thickness distribution of sediment-gravity flow deposits generated by flood and slope-failure intercalated in lacustrine varve deposits: Middle Pleistocene Hiruzenbara Formation, southwest Japan

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Some hypothesis and limitations of application on marine turbidite successions are required to distinguish between slope-failure and flood-generated sediment-gravity deposits. In contrast, lacustrine deposits are well suited for examining depositional processes of gravity-driven sediment, and are ideal for the examination because they are formed in relatively small sedimentary basins affected by simple processes. Because of these advantages, it is easy to distinguish between paleoslope-failures and river inflows. In addition, if lacustrine deposits are composed of varve, we can measure quantities and locations of basal erosion, and can analyze how stratigraphic changes of sediment-gravity flow deposits are related to climatic changes. In this study, we analyzed sedimentary facies, spatial and stratigraphic variations, and thickness distributions of slope-failure and flood-generated sediment-gravity flow deposits intercalated in varves of the Middle Pleistocene Hiruzenbara Formation. Results indicate that sediment-gravity deposits have distinctive characteristics and stratigraphic record of climatic change.

Varved diatomite

Paleo-Hirzenbara Lake was dammed by volcanic materials that formed during the cooling period of MIS13 to 12 or MIS 15 to 14 in the Hirzenbara Highland, Okayama Prefecture, Japan. Deposits of the lake include varved diatomites consisting of mostly (95% or more) fossil diatoms. Laminae of varved diatomite have an average thickness of 1.5 mm and comprise sets of light-green and dark-green colored layers. Most of the light-green colored laminae are made from a planktonic diatom that blooms in the winter season, whereas the dark-green colored laminae are made of planktonic material with fine-grained carbonaceous and silt particles. Therefore, a couplet of light- and dark-colored layers suggests about 1 year of deposits.

The laminated diatomite consists of varve that was deposited over about 8,000 years. The varve shows upward thickening in stratigraphical, which is interpreted as representing a cooling period, with short-term (4–6, 8–12, and 20–25 years) and long-term (50–100 and 1,000 years) periodicity.

Facies of sediment gravity-flow deposits

Two kinds of sediment-gravity deposits are intercalated in the varved diatomite. Type SF consists of diatomaceous matrix with rip-up clasts of broken varved diatomites which are 3 to 20 mm thick, and type RF consists of carbonaceous silt, or silt to clay beds with thicknesses from 2 to 10 mm. We can easily distinguish them because type SF deposits are redeposits of varved dratomites, and type RF includes an assemblage of periphytic diatoms and consists of dark to light-gray silt or clay. In addition, most of type SF have irregularly eroded lower deposits except for a very thin layer, whereas type RF may have smooth-shaped concave lower erosional surfaces.

Sedimentary facies analyses indicate that type SF were deposited by paleoslope-failure of the paleo-Hirzenbara Lake and type RF were likely flood-generated deposits. In some cases, a type RF may have an eroded lower-contact, which indicates a deposit from a hyperpycnal flow, whereas a bed with no-basal erosion indicates a deposit from a homopycnal or hypopycnal flow.

Patch Reefs: A case study in Early Barreminan deposits from eastern part of Getic Nappe (Dâmbovicioara Couloir, Romania)

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The studied deposits are located in the easternmost part of the Getic Nappe (Southern Carpathians). The mixed carbonate-siliciclastic deposits of late Valanginian-Hauterivian-Aptian age from Dâmbovicioara Couloir follow unconformably the Kimmeridgian-Berrisian-?Lower Valanginian limestones of the Getic Carbonate Platform. The uppermost Valanginian-lowermost Hauterivian deposits are represented almost exclusively by limestones, including a rich glauconitic basal bed. The Hauterivian deposits are represented mainly by marls, with fine interlayers of lime-wackstone and peloidal lime-packstone, with fine terrigenous material, rarely with glauconite in some levels and with black, siliceous nodules in the middle part. They contain numerous foraminifers, cephalopods, rare gastropods, bivalves and rare brachiopods. The Barremian-Bedoulian deposits are also represented by marls rich in cephalopods, with slightly argillaceous limestones, but including thick, massive, light coloured, coarse lime-packstone and biolcastic rudstone, with rudists and occasionally with reef builders: ramified and lamelar corals, sometimes globulous, and sclerosponges. The late Barremian-Aptian marl succession includes, between levels containing Bedoulian ammonites, interlayers of limestones with foraminifers and calcareous algae.

The aim of this study is the detailed analysis of the Early Barremian limestones intercalated between the cephalopode-rich marls, a fortunate case which gives us a control over the age. According to Patrulius (1969), the Barremian deposits contain four levels with rudists and corals, and the marls surrounding these reefs contain a typical Early Barremian ammonite fauna.

The Barremian limestones are isolated and are easily distinguishable from the surrounding topographic features. The limestone patches are encased in marl deposits and are of meter to tens of meters in thickness and height. The numerous patches studied revealed the following depositional environments: distal shelf (offshore) and shallow external carbonate shelf. The distal shelf (offshore) facies are represented by marls and micritic limestone with sponge spicules, radiolarians and small foraminifera. They are located in the base and the top of the limestone succession. Shallow external carbonate shelf facies are represented by coral bioconstructions and bioclastic shoals. The limestones were accumulated on top of the micritic deposits in the base of the succession, while their transition is gradual. Two emersion surfaces have been identified in the top of these facies. The shallow water facies interlayered with the distal shelf (offshore) ones resulted as a consequence of a significant decrease of the relative sea level. This context favoured the formation of bioconstructions and of bioclastic shoals in the marginal areas of the carbonate shelf. The subaerial exposure of these limestone patches was due to the gradual reduction of the accommodation space which became negative as a result of the development and aggradation of the bioconstructions, or the progradation/migration of the bioclastic shoals.

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Climate versus Tectonics: The competing roles of Late Oligocene warming and Alpine orogenesis in constructing alluvial megafan sequences in the North Alpine foreland basin

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The Late Oligocene experienced a ca. 6°C warming as indicated by oxygen and carbon isotopic data collected from marine deposits. This warming occurred contemporaneously with the construction of the Napf alluvial megafan, located in the Molasse Basin to the north of the evolving European Alps. The age of the Napf deposits was established by magneto-polarity investigations, which yielded a chronology with a temporal resolution of 200 kyr. Because of the relatively small cross-sectional width of the basin (<50 km), a fluvial response time of c. 200-400 kyr should be short enough to record any perturbations related to changes in climatic and tectonic conditions, and to modifications in the granulometric composition of the supplied material. Here, we test whether the sedimentary archive can be uniquely understood as the result of: (i) a shift towards a warmer climate, (ii) a change in tectonic style in the adjacent Alpine mountain belt, or (iii) a modification in the granulometric composition of the supplied material.

The observed larger grain sizes and the change in fluvial style from wandering to braided could be explained by a shift to drier conditions with sparse vegetation, but would have resulted in less than 400 m of additional accommodation space during the 1 Ma duration of change. Therefore, a climate scenario alone is not compatible with rapid sediment accumulation rates of > 1000 m/Ma and total sediment accumulation of c. 1500 m recorded at Napf, or with a lack of any remarkable shifts in the Froude number, which would be expected if water discharge changed substantially. However, flexural downwarping in response to a tectonic pulse could account for: (i) the fast sediment accumulation, (ii) the increase in grain size and (iii) the change in fluvial style from wandering (more distal facies) to braided (proximal equivalent). In addition, a change in the granulometric composition of the supplied material is required to explain the contemporaneous backstepping of the distal gravel front and progradation of the proximal braided facies. We thus suggest a scenario where a tectonic pulse increased the orogenic load and steepened the erosional hinterland, resulting in a more widespread exposure of lithologies with higher erosional resistance, as inferred from an increasing contribution of crystalline constituents in the clast suites. Such a change would result in a larger D_{50} and a higher clast size variability of the supplied sediment, which in turn would contribute to the observed change from wandering to braided, the shifts in depositional systems and the rapid accumulation of sediment.

The archive in the mountainous Molasse contrasts to that recorded during the Palaeocene/Eocene Thermal Maximum in western Colorado where depocenter progradation was related primarily to global warming of a similar magnitude, which was associated with an increase in sediment supply. In the Molasse, the depositional systems stepped back during the first 1.5 Ma mainly because a fraction of the supplied material was retained at the Alpine margin, associated with megafan steepening. Accordingly, although warm epochs in Earth's history can be associated with sediment pulses, the stratigraphic archives at Napf are more compatible with a tectonic scenario. It is possible that the low flexural strength of the foreland plate results in high rates and/or gradients of tectonically driven subsidence, which might mask any response of a climate forcing in the here reported stratigraphic record.

Paleoshorelines of Megalake Chad (Holocene, Africa)

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Megalake Chad is a very large paleolake (water-surface : more than 350000km^2 ; maximum water-depths : ~150 m in the northern sub-basin, ~40 m in the southern sub-basin) that developed during the African Humid Period (AHP). This climatic optimum was marked by major paleoenvironmental changes, notably by the reactivation of ancient river networks and the development of lakes in the Sahara.

Considering the great extension of this lake system (from 10°N to 18°N, and from 12°E to 19°E), Megalake Chad is best understood from remote sensing which allows to identify both offshore deposits (widespread diatomites) and nearshore morphosedimentary features.

Satellite imagery (SRTM, ASTER-GDEM, Landsat, Pleiades) reveals conspicuous relict coastal landforms, coherently distributed all around the Chad basin. These features, unexpected in a continental desert, include isolated ridges, Azov-type spits, beach ridges, wave-ravinement surface, tombolos and wave-dominated deltas. The successive paleoshorelines of Megalake Chad can thus be firmly outlined and mapped, allowing to define its maximal size and also to follow its progressive demise, as a direct response to the climate (precipitation/evaporation budget, Intertropical Convergence Zone, West African Monsoon System). Since the particular shape and distribution of these shoreline features are mostly controlled by the alongshore drift, prevailing paleowinds could be estimated and resulting paleohydrodynamics were then simulated.

Paleoshorelines of Megalake Chad represent thus crucial archives of the climate and environment of the Sahara-Sahel region during the AHP. Paleoshorelines are to be considered as alternative/complementary archives of paleolakes. The spatial distribution and stratigraphic architecture of the coastal morphosedimentary features represent a record of the base/lake-level variations notably marked by a climate-driven forced regression (i.e., end of the AHP). Additionally, this study highlights the importance of wave related processes and deposits in lake systems.

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Mid- to late Holocene climate variability recorded in sediments from the shallow and deep Dead Sea basin

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Laminated lake sediments from the Dead Sea basin provide high-resolution records of climatic variability in the eastern Mediterranean region, which is considered, as is the entire Mediterranean region, being especially sensitive to changing climatic conditions. In the study presented here, we aim to reconstruct mid- to late Holocene palaeoclimatic changes and their relation to the frequency of flood/erosion and dust deposition events as archived in the Dead Sea basin. For this purpose, a ca 4 m thick, mostly annually laminated (varved) sediment section from the western margin of the Dead Sea (shallow-water DSEn-Ein Gedi profile) was selected as a test interval. The DSEn profile was correlated to the ICDP Dead Sea Deep Drilling Project core 5017-1 from the deep basin. To detect even single event layers, we applied a multi-proxy approach of high-resolution microscopic thin section analyses, µXRF element scanning and magnetic susceptibility measurements, supported by palynological analyses.

Radiocarbon dating revealed that the analysed section encompasses the mid- to late Holocene interval from ~4000 to 1900 years BP. At ca 3800-3300 yrs BP and 2800-2500 yrs BP two pronounced dry periods were detected that are characterized by a hiatus and enhanced frequency of coarse detrital layers, interpreted as erosion events, respectively, in the shallow-water DSEn core. In the 5017-1 deep basin core these dry periods are depicted by halite deposits. Following the later dry spell at 2800-2500 yrs BP, a 250-yrs period of increased dust deposition is observed. The dust deposits coincide with less arid climatic conditions, characterized by increased deposition of alternating aragonite and silty-detritus as well as enhanced percentages of trees and shrubs pollen.

Our results show that micro-facies analysis is a valuable tool to identify event deposits in the Dead Sea sediments. This opens new perspectives to identify flood/erosion and dust deposition events in the 450 m long 5017-1 sediment record from the deep Dead Sea basin, which comprises the last two-glacial-interglacial-cycles.

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Testing luminescence dating methods on Pleistocene carbonate intertidal deposits (bioherms), NW Sardinia (Italy); problems and perspectives

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Optically Stimulated Luminescence (OSL) dating is now routinely used to accurately date deposits in a variety of sedimentary environments; such as aeolian, fluvial and shallow marine settings. However, while this group of methods is increasingly used by many Quaternary scientists, it has mainly been applied to siliciclastic-rich deposits and seldom to carbonate rich sediments.

This paper explores the applicability of OSL for dating biologically constructed carbonate deposits (bioherms). These sedimentary bodies consist of mound-like biogenic rims built up by red and green encrusting calcareous algae (mostly *Lithophyllum byssoides*) and are widely colonized by intertidal invertebrate fauna (Barnacles and Serpulides). Dispersed abundant pebbles, granules, coarse sand and marine shells also occur. These deposits, interpreted as intertidal algal rims, are fundamentally important tools for reconstructing sea-level fluctuations during the Quaternary. Pleistocene algal rims crop out discontinuously along the NW Sardinia Island coast (Italy, Mediterranean Sea) and are often packed between a basal costal dunes and sandy beach deposits, dated respectively to MIS6 (150 ka) and MIS 5c (100 ka) using OSL. Based on their sedimentary features and stratigraphy, rim deposits were tentatively correlated to the MIS 5e highstand (113-125 ka). To test this, SAR OSL and post-IR IRSL at 290° C luminescence dating protocols has been performed on quartz and feldspar grains extracted from two samples of the bioherm. However, while quartz grains passed all the laboratory tests showing good luminescence characteristics, the first resultant OSL ages (177±16 ka and 138±12 ka) overestimated the expected burial age (115-130 ka). By contrast, feldspar post-IR ages agree with the expected ages (113±6 ka and 112±6 ka). Here, we consider the likely reasons for this discrepancy; including heterogeneity of radioisotopically driven dose rates, partial bleaching or post depositional mixing. For instance, a simple model applied to quartz ages for correcting the influence of dose rate heterogeneity yields ages more inline with those expected (113±9 ka and 90±7 ka). Although the causes of quartz age overestimation are under ongoing investigation, the feldspar ages suggest luminescence methods are promising tools in dating biologically constructed carbonate deposits.

The study of sediment accumulation rates in reservoirs and oxbow lakes; Moravia river catchment area, Czech Republic

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Reservoirs and abandoned meanders along regulated water courses represent ideal traps for suspended sediments. Those reservoirs often represent unique sedimentary archives for study of sediment accumulation rates, local climatic changes and rate of erosion in the watershed. The study area is located within Morava river catchment area in south-eastern part of the Czech Republic. Three reservoirs, Brno reservoir (filling in 1940), Plumlov reservoir (filling in 1933) and Nové Mlýny reservoir (filling gradually in 1978, 1981 and 1989) and four oxbow lakes were selected for high-resolution stratigraphic study of their bottom sediments. The obxow lakes are located especially in middle and lower part of Morava river along regulated and natural sections (Litovelské Pomoraví protected landscape).
Stratigraphy of bottom sediments was studied from short sedimentary cores. We determined the sedimentation rate and depth of reservoir and oxbow lakes sediments. On the basis of ^{137}Cs dating we can calculate sedimentation rate and create the age models. Magnetic susceptibility (MS), X-ray densitometry and spectral reflectance data were used to assess the stratigraphic framework of the cores.
The sedimentation in reservoirs reveals a distinct pattern. The sediments are fine-grained and consist from sandy silts, silts, clays and organic matter. The thickness of reservoir sediments depends on underwater current velocity, location within the reservoir and accommodation space. The thickness decreases considerably from the proximal parts of the reservoirs lakes to its distal parts. The sites with higher accumulation rates are more prone to silting. The ^{137}Cs peak was indicated in all cores and corresponds to the fallout from accident in the nuclear power plant in Chernobyl (1986). Older events (years 1952 and 1963) were detected in Brno reservoir; they should correspond with maximum in nuclear-weapon testing.
All studied oxbow lakes and meanders reveal similar trends in lithology and sediment infill. The sediments are composed mainly of silty fraction with variable content of sandy fraction. Rarely coarser laminae are evidence from flood events. Organic layers, composed of plant remains are common. The pronounced ^{137}Cs peak was observed in all studied cores from oxbow lakes. The observed maximum sedimentation rate is about 8 cm (Kurfurstovo rameno oxbow lake), 4.6 cm (Brno reservoir), 2.3 cm (Nové Mlýny reservoir) and 1.7 cm (Plumlov reservoir) per year. The high-frequency signal in MS coincides with the X-ray density and sediment colour and is interpreted as bed-scale grain-size variation. Positive MS peaks correspond often to fine-grained laminae and layers as indicated by the negative X-ray density and lower CIE L* values. Those proxies may serve as indicator of grain size. Multiproxy high-resolution stratigraphy proved as a useful tool in the identification of flood layers in the reservoirs lakes and the flooding history of river catchments on time scale. The database of the sediment accumulation rates can be used to predict short-term erosion rates in the watershed. Sedimentary record is more complete in reservoirs, but the sediment accumulation rates are lower in many cases due to higher accommodation space. Sediment supply is very irregular and is driven by floods in oxbow lakes. Accommodation space is much smaller according to reservoirs and this contributes to higher sedimentation rate. Sediment budget is strongly affected by human modification of fluvial environment of Morava river.

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High spatial imaging of the distribution and inter-element correlation of Fe, Zn, Cu, Ti and As in modern and ancient microbial mats from hypersaline environments

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Metals, widely used by all microorganisms and could act as indicators of past microbial activity in the rock record but only if we are able to distinguish specific enrichment by microorganisms from unspecific enrichment by abiotic processes such as passive concentration by biofilms or metal remobilization caused by diagenesis (± metamorphism).

Here we present the results of the investigations at different scale, from the cm- to the nm-scale, of metal and organic matter distribution and organization in 2.7 Ga-old stromatolites from the Tumbiana formation (Pilbara craton, Western Australia) and its modern analogue from the hypersaline lake of Big Pond (Bahamas) using a combination of Synchrotron Radiation X-ray Microfluorescence (SR-µXRF), Synchrotron Radiation X-ray Absorption Near-Edge Structure (SR-µXANES), Raman spectroscopy and Confocal Laser Scanning Microscopy (CLSM).

Results show that the distribution of metals is mainly governed by abiotic processes both in modern and in ancient stromatolite. In the dm-scale drill core of the Big Pond stromatolite, Fe, Zn, Cu and As distribution change from a homogeneous distribution at the top toward a heterogeneous distribution at the bottom. These are best attributed to a passive metal sorption by the biofilm matrix progressively affected by a pyritization linked to the early diagenesis that affects the bottom part of the stromatolite. As for Tumbiana stromatolites, they present a strong metal enrichment in the organic fraction (Fe >> Ti > As > Zn, Cu), that can be explained either by early diagenesis processes when metals are spatially distributed or by pervasive diagenesis when metals are concentrated within remobilized organic matter layers or randomly distributed through the structure.

In addition to these abiotically distributed metals, cell-like organic globules were identified, with significant enrichments in arsenic, with no, or only negligible contributions from other metals (specifically Fe) both in modern and ancient stromatolite. These As-bearing organic globules were interpreted as biological in origin. Although As-based metabolisms have been described in different environments and phylogenetic studies indicate that microbial arsenic metabolism is ancient and may have emerged prior to the Archaea/Bacteria split more than 3.4 billion years ago, it is the first time that a link between As-based metabolism and the primitive Earth is identified. These findings suggest that arsenate was available in the environment at least 2.7 Ga ago, thus providing niches for As(V)-respiring prokaryotes several hundred millions of years before oxygen became a permanent part of the atmosphere and shallow oceans.

Effect of igneous intrusions on the reservoir properties of Khyber limestone (Devonian), Peshawar Basin (NW Pakistan)

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Present studies revealed excellent exposures of Khyber carbonate succession (Devonian), comprising of limestone, dolomite and marble intruded by basic to intermediate igneous intrusions (dolerite dykes) in the Peshawar basin, NW Pakistan. These outcrops have NE-SW extension from Kali Shilman to Bara Fort respectively. Study area represents outcrop analogue for dolomitized carbonate reservoirs in relation to fracture-controlled igneous intrusions. Field relationship, petrographic studies and geochemical analyses helped in understanding the paragenetic history of the carbonate rocks and their relationship to igneous intrusions. Furthermore, effect of these intrusions on the reservoir properties of the Khyber limestone were also taken into consideration.

Field observations indicated numerous mafic intrusions of variable thicknesses in the host limestone. Due to these igneous intrusions, contact metamorphism resulted in coarse crystalline marble. Cross-cutting relationship showed that dolomitization occurred after the emplacement of igneous intrusion in the host limestone. Petrographic studies revealed alteration of host limestone, which resulted in diagenetic alteration (i.e., dolomite formation) and metamorphism (marble). Cataclastic deformation resulted in brecciation of host limestone as well. Fractures and faults provided pathways to the hydrothermal fluids, which resulted in above mentioned alteration. It is also observed that marble resulted from contact metamorphism acted as barrier for dolomitising fluids to alter host limestone. Stable isotope analyses showed depleted $\delta^{18}O$ values (-15.56 to -09.41‰ V-PDB), which shows high temperature fluids for dolomitisation (i.e., igneous origin).

Carbonate rocks affected by igneous intrusions showed mineralogical alteration which resulted in either enhancement in porosity/permeability (due to dolomite) or reduction in porosity/permeability (due to marble). Air porosity and klinkenberg permeability of dolomite showed considerably higher values (8 to 12% and 4 to 10mD respectively). Besides this, marble showed negligible porosity (1 to 3%) and permeability (>1mD) values. Fracture porosity mostly contributed in the porosity enhancement of these carbonate successions (8 to 15%). Besides this, cataclastic deformation due to dolerite intrusions resulted in brecciation. This phenomenon also resulted in porosity enhancement (5 to 12%). Late stage calcite precipitation resulted in occludation of porosity and permeability.

In conclusion, igneous intrusions showed positive impact on the reservoir behavior of the carbonate succession by increasing its porosity/permeability due to mineralogical substitution (i.e., dolomite formation) and cataclastic deformation. Besides this, lesser negative effect on reservoir properties due to marble formation is also evident.

Keywords: Igneous intrusions, Dolomite, Marble, Flow paths, Alteration, Reservoir properties-

Organic matter enrichment in typical faulted lake basin: A case study of the fifth organic-rich shale bed of the third Member of Hetaoyuan Formation in the Biyang Depression

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The Biyang Depression is taken as one of the more productive depression with a small area and high hydrocarbon production in China. 6 organic-rich shale beds in the third Member of Hetaoyuan Formation are the main exploration targets for shale oil. Of them, the fifth organic-rich shale bed is believed to be the best one in this depression. In this study, a plentiful core description, well-logging, lithologic data, and 80 samples in BYHF1 Well for trace elements and REEs are used to expound the forming mechanism of organic matter enrichment in a faulted lake basin.

The sample analysis results show that the content of B varies from 44 ppm to 464 ppm with an average of 189 ppm, 71% of which are higher than average value of continental saline lake (135 ppm) and the content of "equivalent boron" is between 272.14 ppm to 968.98 ppm, demonstrating brackish to salt water environment. The value of V/(V+Ni) is between 0.71 and 0.84, and all of the values of Ce_{anom} are higher than -0.1, indicating reducing environment. The differentiation of ΣLREE and ΣHREE is obvious, displaying low REE enrichments and high REE loss, the ratio of (La/Yb)n is obviously higher than 1, and the value of δCe range from 0.93 to 1.17 with an average of 0.99, which have vague or positive Ce anomaly. The value of (La/Yb)n and δCe reflect the relatively low depositional rate of sediments. The fact can be concluded that the fifth organic-rich shale bed was formed in semi-deep to deep lake environments in arid-semiarid paleoclimate. The increase of salinity, medium-high productivity and reducing environment are believed to be the origin of organic matter enrichment.

Diapirs and their impact on the Central Canyon System in Eastern Qiongdongnan Basin, South China Sea

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Diapirs and deepwater canyon system are characteristics during the post-rift stage in the Qiongdongnan Basin (QDNB), northern margins of South China Sea. 10 diapirs near the Central Canyon System (CCS) are identified along the Central Depression of the basin on the basis of high-resolusion 2D/3D seismic data. They distributed on both sides and bottom of the CCS in Songnan Low-Uplift, Songnan-Baodao Depression and Changchang Depression. On top of the diapirs accompanied with synchronous normal fault, the strata with a decrease of thickness were uplifted and bent. In addition, at each side of diapirs, strata became inclined. Considering the geological background and morphology of diapirs, it is suggested that they are most likely magmatic diapirs. According to stratigraphic contact relationship and the synchronous fault effected youngest stratum, as well as other detailed characteristics in seismic profiles, duration of those diapirs are inferred to be classified into 5 episodes, at T60(21Ma), T50(15.5Ma), T29(4.2Ma), T28(3.8Ma) and T20（1.64Ma）respectively. And associated diapirs have been named as T60-1, T60-2, T60-3, T50-1, T29-1, T29-2, T29-3, T29-4, T28-1 and T20-1 respectively.

Since the diapirs are very close to the CCS, they have a profound impact on formation and evolution of the CCS. The CCS begins to be formed since 10.5Ma (corrisponsing to the boundary of T40). Some diapirs formed earlier than the CCS, such as T60-1/2/3 located at Changchang Depression, are constrained the role of canyon wall directly. Some diapirs formed in the canyon filling stage, such as T29-2, were developed at southern CCS on Songnan Low-Uplift, where the canyon wall is characterized by asymmetry with steeper in South and gentler in north originally. In addition, diapirism led to the uplift of the southern wall of the canyon, and resulted in delay of the filling up time of the canyon. The seismic profiles revealed that those diapirs are developed along the main pre-existing faults, and the strike of each diapir is basically parallel to the CCS. They only distributed in the middle and eastern QDNB. Toward east, some diapirs formed at same time are present in the Xisha Trough. It is inferred that intense magma diapirs even during the post-rift stage are occurred along the almost E-W direction from the Northwest Subbasin, the Xisha Trough to the Central depression of the QDNB. Those diapirs also have significant effects on deepwater deposition.

Latest Permian coals in southern China: their petrology, mineralogy and isotope geochemistry

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Non-marine terrestrial coal measures of the Late Permian are developed in the Xuanwei area of Yunan Province (SW China). The C1 Coal, which contains the B1, B2, B3 sub-coal seams in descending order, lies in the uppermost portion of the Xuanwei Formation (Lopingian). The proximal nature of the C1 coal to the PTB (Permian and Triassic Boundary) has been established by a combination of biostratigraphic, geochemical and lithological evidences. For instance, above C1 no coal seam was found, and like elsewhere in the world, it indicates the beginning of the "coal gap" in the early Triassic. For these latest Permian coals, especially the B2 and B3 coal seams, we have investigated the coal petrology, mineralogy, organic carbon isotopes, organic sulfur isotopes, as well as heavy metal compositions.

Coal petrology studies have revealed the upward increasing trend of the inertinite abundance in the latest Permian coals and this could imply that the Late Permian peatland was suffered from frequent wildfires. Since ignition and burning depend on sufficient oxygen, a model-based calculation suggests that the O_2 levels at the latest Permian near the PTB could reach 28%. This indicates that the oxygen deficiency was not present at the end Permian.

Different sulfur fractions of low sulfur (average 0.11%) coals from the latest Permian coal in Xuanwei area were analyzed isotopically at a high vertical resolution. S_{org} (organic sulfur) accounts for 87% of the total sulfur content on average, while S_{py} (pyritic sulfur) is very low (13%) and relatively constant throughout the profile except for some insignificant additions in clay-rich layers. The $\delta_{34}S_{org}$ values have a relatively narrow range, from +1.5‰ to +7.6 ‰, and the stratigraphically lower coal (B3) has $\delta_{34}S_{org}$ values around +4 ‰ while the stratigraphically higher coal (B2), which is closer to the Permian–Triassic boundary, has clearly higher $\delta_{34}S_{org}$ values, ranging from +5.3 to +7.6 ‰. This change is most likely due to increased marine sulfate aerosol inputs into the coal-forming peatland caused by coastline retreat during Late Permian transgression.

The organic carbon isotopes of these latest Permian coals were analyzed, and the results showed that the carbon isotope profile depicts an upward lightening trend throughout the whole Late Permian (Lopingian), and in the uppermost few seams, a negative excursion with magnitude of about -1.1‰ is evident. These phenomena are consistent with the observations from other reported marine and terrestrial PTB sections.

It has been generally accepted that the PTB event was a protracted event with various causes including volcanic eruption, release of methane, baking or burning the coal measures in the major coal basins. However, coal is the product of the peatland, which is the direct evidence of the terrestrial ecosystem. Coal persisted after the onset of the negative excursion, suggesting the causes of the carbon cycle perturbation did not wipe out the terrestrial productivity immediately. Comparatively, the major marine fauna extinction started at the beginning of the carbon isotopic excursion near the PTB in marine sections. It is thus suggested that terrestrial ecosystem was more resilient towards the carbon cycle perturbation.

Volgian (Upper Jurassic) and Aptian (OAE-1a?) accumulation of high-carbonaceous sediment in the Central Russia: distinctive characteristics and paleoenvironmental models

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The study of the Upper Jurassic–Lower Cretaceous strata in the Central Russia has revealed two levels of OM-enrichment – Middle-Volgian (Panderi Zone) and Lower Aptian (Volgensis Zone). Both could be assumed as regional manifestation of specific conditions, were spread on the global scale. The Late Jurassic Period was characterized by the accumulation of high-carbonaceous sediments in many regions of the Northern Hemisphere (Western Europe, Barents Sea, Western Siberia). The Aptian episode is reffered to Volgensis Zone (= Forbesi ammonite Zone Casey, 1961) that provides a good correlation with OAE-1a.
The Rock-Eval and palinofacies data indicate the prevalence of aquatic OM in the carbonaceous shales (Volgian - kerogen of type II, TOC up to 20-35%, Aptian - kerogen of type II-III, TOC up to 4-9,6 %). Both kerogens are dominated by the amorphous OM (up to 98–99%). Carbonaceous shales of both intervals are enriched with a range of chemical elements which could be divided into groups with regard to their concentrations: Mo, S, Se exceeds average shale in 10 times or more; V, Ag, Cu, P, Ni, Co, and Zn exceed in 2-5 time. The Volgian and Aptian OM-rich shale sequences were formed in paleobasins with the different types of sedimentation. During Middle-Late Jurassic (from Callovian to Volgian) the mixed carbonate-siliciclastic marine sedimentation took place, while in the mid Cretaceous time (from the Late Hauterivian to the Aptian) it was replaced by exclusively siliciclastic one.
The structures of Volgian and Aptian OM-rich shale sequences are different. In the Volgian basin organic carbon accumulation was impulsive, resulting in a shale-bearing sequence with a well-defined cyclic structure. Elementary cycles (up to 1 m thickness) demonstrate contrast distribution of C_{org} and $CaCO_3$. In the Aptian basin OM was accumulated more regularly and that resulted in the formation of relatively monotonous “bituminous” horizon.
Based on the complex of sedimentological, biotical and geochemical parameters it is assumed that: a) a stable anoxia existed in the central part of the Early Aptian basin when OM-rich sediments were accumulated; b) anoxic environments existed in numerous extensive depressions of Middle Volgian basin, where carbonaceous sediments were accumulated, but anoxia were unstable and often interrupted by short- and long-term periods (to first tens of thousands of years), when normally aerated conditions prevailed.

Both OM-rich shale sequences were accumulated in shallow epicontinental seaways (no more than 100-200 m in deep), in the course of frequent sea level fluctuations. The high OM concentration in both cases was caused by a sharp increase of the organic-walled plankton productivity. These, in turn, led to the increased influx of nutrients from the onshore landscapes into basins during rapid and powerful transgressions, preceded by a brief regressive episode. It is supposed that such regressions were accompanied by rapid formation of lacustrine–boggy onshore landscapes on released from seawater territories These specific short-living (“ephemeral”) landscapes were favorable for the accumulation of both dissolved OM and compounds of biophile elements, such as P, N and Fe. Correspondingly, sea level fluctuations (in particular, rises) even of low-amplitude resulted in the flooding of spacious lowlands, covered by such landscapes and, as consequence, to the rapid increase of bioproductivity and accumulation of OM-rich sediments. The accumulation proceeded in humid, but different climates. Palygorskite presence in the Volgian sediment presumed more arid conditions for Volgian time interval.

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Sedimentary characteristics of the 9th member of Yanchang Formation, in Jiyuan area, Ordos basin, China

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In this paper, the lithology, texture, sedimentary structure and electrofacies of delta plain are described, and Triassic paleogeography of Ordos Basin is also introduced. The 9th member of Yanchang formation (Chang 9) is composed of light grey or grey siltstone, fine-grained sandstone, medium-grained sandstone, dark grey silty mudstone, and black mudstone. The reservoir lithology is chiefly medium to fine grained, grain-supported sandstone with medium to good sorting, poor sphericity, cementing contact and low textural maturity. A series of sedimentary structures developed in Chang 9, including scouring structure, deformation structure, nodular structure, water-escape structure, biogenic structure and a variety of bedding structures, such as trough cross-stratification, blocky stratification, parallel stratification, and so on. Five main types of elecrofacies were identified based on gamma ray curve and self-potential curve: (toothlike) bell-shaped, (toothlike) box-shaped, smooth shaped, tooth shaped and low-to-moderate amplitude finger-shaped. On the background of a gentle terrain, braided delta plain was developed in Jiyuan area, Ordos basin, during Chang 9 was deposited. It mainly included 3 sedimentary microfacies: distributary braided channel, levee and interdistributary bay. The lithology of distributary braided channel is chiefly medium-fine grained sandstones and some siltstones, with various cross-bedding developed, such as trough cross-stratification, tabular cross- stratification, and so on. Its gamma ray curve is generally low-amplitude bell-shaped or box-shaped. At the bottom of the distributary braided channel, scouring structure is developed, and there are often mud pebbles or plant debris distributed here and there, or distributed along bedding surface, sometimes with pyrite nodules developed. Levee is generally located on the sides of distributary braided channel horizontally and above distributary braided channel vertically. It is mainly made up of thin dark grey muddy siltstones and silty mudstones, with veined cross-bedding, wavy bedding, linsen bedding and horizontal bedding developed. Its gamma ray curve is often finger-shaped with low-to-moderate amplitude. Interdistributary bay is located in lowland area between distributary braided channels, with weak hydrodynamic condition. Its lithology is mainly black or dark grey mudstone and silty mudstones with horizontal bedding and intense bioturbation developed. Its gamma ray curve is usually smooth or tooth shaped. The vertical composition of distributary braided channel, levee and interdistributary bay make up of a fining upwards cycle. During Chang 9 was deposited, braided channels migrated frequently in horizon like bands in a north-south direction.

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Reservoir Characteristics and Influential Factors of Fuyu Reservoirs in Daan Area, Songliao Basin, China

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Daan area is located in a secondary structure zone named Daan-Honggang terrace, between the Central Depression and Western Slope District of Songliao Basin. Fuyu Reservoirs, about 120m thickness, are composed of silt-fine sandstones interbedded with unequal thick mudstones, medium and bottom parts of which are mainly made up of purple-red mudstones, grey fine sandstones and grey siltstones, and the top of which mainly contains dark mudstones, grayish-brown siltstones and grayish-brown argillaceous siltstones. The diagenesis and porosity evolution of Fuyu Reservoirs in Daan area were analyzed using thin-sections, casting thin-sections, X-ray diffractometry, scanning electron micrograph observations, and other data. The sandstones consist mainly of lithic arkoses and feldspatic litharenites, with with silt and fine sand. Pores consist of primary pores and inter-granular dissolved and intra-granular dissolved pores and a bit of microfractures, with disadvantageous pore configuration and poor property, belonging to low porosity (6%～14% mainly, 10.58% on average) and low permeability ($0.01\times10^{-3}\mu m^2$～$1\times10^{-3}\mu m^2$ mainly, $0.42\times10^{-3}\mu m^2$ on average). The sediments experienced compaction, cementation, metasomatic replacement, dissolution and other diagenetic features, including precipitation in pore space of clay minerals, carbonate and siliceous cements, feldspar and pyrite. Sandstone reservoirs are currently at the medium A period. Reservoir characteristics are mainly controlled by deposition and diagenesis. Sedimentation dominates the distribution of favorable reservoirs named underwater distributary channel sand bodies and the original porosity. Reservoir properties and deposition parameters (such as median grain diameter, sorting coefficient, and content of matrix) correlated significantly. Taking 13 sandstone samples of well H75-1 as an example, the initial porosity of sandstones ranges from 30.30% to 34.79% (32.45% on average). After compaction, porosity of the sandstones is reduced to 12.80%～22% (18.75% on average), which means 28%～58% (42% on average) initial porosity is reduced by compaction. Hence, undergoing cementation, porosity of the sandstones is reduced to 7.37%～13.34%(10.95% on average), which means 10%～39% (24% on average) initial porosity is reduced by compaction. Experienced dissolution which increases 0～0.72%(0.27% on average) initial porosity, the porosity of sandstones became vary from 8.10% to 13.78%(11.23% on average), approximating to porosity analysed (8.10%～14.10%,11.56% on average). Overall, compaction is the main factor influencing the reservoir properties in the study area, and cementation the third. Cements on the one hand resist the effects of partial compaction as framework support particles, on the other hand clog he pores of reservoir. Dissolution not only improves the porosity reservoir at a certain extent, but also connects part of the pores and increases hydrocarbon migration path.

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Characteristics of anastomosed river delta and its origin mechanism in Zhenjing Area, Ordos Basin

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The Ordos Basin is the second biggest basin in China, covering an area of about 250000 km^2. It is famous for the river-delta deposition system in the Triassic Formation characterized by the shallow lacustrine facies and the Cratonic background with low gradient. Zhenjing oil field locates in the southeast of Ordos Basin. The Chang 8 group in the Yanchang Formation belong to Triassic Formation is the primary oil reservoir in the study area. 3D seismic data covers the whole area, and there drilled hundreds of wells in Zhenjing area. Some scholars have proved that there deposited the large-scale delta system in the Chang8 group. However, the distributional characteristics of distributary channel of the delta and it's control factors remain unknown.

In the Zhenjing area, the interval velocities of sandstone and mudstone are similar, so this indicates that the sandstone in the Chang8 group can't be reliably identified using seismic attributes including the amplitude attributes, acoustic impedance. However, the distributary channels of the delta in the study area can be clearly identified by the seismic facies characterized by the trough fill with constraint by wells data (including well logs, cores and test data). The interpreting channels based on the seismic facies have a very good agreement with the channels identified by the wells data. This indicates that the distributary channels of the delta can be interpreted by the seismic data with constraint by the wells data. The shape of the distributary channels almost indicates the distribution characteristics of the delta, so we can understand the delta characteristics by the distribution characteristics of the distributary channels.

The interpretation results show that the distributary channels appear a pattern of anastomosing channels. This indicates that the delta should be an anastomosed river delta more than the braided delta called before. The distribution characteristics of anastomosing channels are very similar with the present Lena river delta reported in the paper. The distributary channels is about 800–1200m wide, and stacked vertically each other. The distributary channels can be further identified bars and channels based on the seismic facies, and were filled with coarse-fine grain sandstone. The mudstone in the Chang 8 group characterized by the dark or gray thick mudstone indicates the underwater sedimentary environment.

The anastomosed river delta was seldom reported before, so the origin mechanism is interesting. we analyzed the control factors on the anastomosed river delta based on the geological and geophysical data as follows. ① The anastomosed river delta deposited in a background with low gradient of 0.1^o-1^o and the shallow water environment. ② The climate during Triassic in the Ordos basin was humid that the river construction was dominated. ③ The provenance was rich in the chang8 group period, the distance between provenance area and the study area is about 136-150Km, the water depth in the study area is about 20-25m, which can hinder the normal sediments transport in the channels and made it branching and forming new channels.

Keywords: Distributary channels, Anastomosed river delta, mechanism, Ordos Basin

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An Overview on the Sedimentology, Geochemistry and Biostratigraphy of Non-marine Permian–Triassic Transition at Dalongkou Section, Xinjiang, Northwest China

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The well-cropped out Permian–Triassic non-marine transitional sequences are consisted of Wutonggou, Guodikeng and Jiucaiyuan Formations at Dalongkou, Xinjiang Province, Northwest China. An detailed investigation on sedimentology, geochemistry and biostratigraphy were undertaken in the north limb of Dalongkou anticline. The 121 m thick Wutonggou Formation at Dalongkou including 12 sandstone units represents cyclical coarse terrigenous input to the lake basin during the Late Permian. The rhythmically-bedded, mudstone-dominated Guodikeng Formation is 197 m thick representing the lake expansion. The 220 m thick Jiucaiyuan Formation is dominated by reddish purple mudstone and siltstone, represent floodplain and lakeplain deposits in arid climate condition.

Based on abundant palynological data, four palynofloral assemblages are established in the middle part of Guodikeng Formation. Some key taxa are discovered, confirm the palynostratigrahic placement of the Permian–Triassic boundary. Lycopsid *Annalepis* were discovered in Bed 24 in Guodikeng Formation. The "FAD"of genus *Annalepis* represents a terrestrial marker for the basal-most Triassic in China. New palynological data and fossil plants indicate the Permian–Triassic boundary may be placed approximately 83.4 m above the bottom of this formation at Dalongkou.

Characterization of Karstification Lower Paleozoic carbonates in Nanpu Depression, Bohai Bay Basin

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With the domination of the reservoir quality, a better understanding of the origin of karstification has become important. This paper investigates the characterization of the karst reservoirs of lower Paleozoic formation in Nanbu depression, Bohai Bay Basin using outcrops observations, core analysis, wireline logs, and geochemical data.

Characteristic and origin variations permit the Nanpu depression to be divided into supergene and burial karstification. The supergene karstification is associated with two major erosional unconformities which formed during Caledonian and Yanshanian tectogenesis. The dip slope is in favor of the formation of karstification than that of reverse slope. Supergene karst belt is influenced by meteoric water, and up to 50 meters beneath the unconformity. High-angle fracture, brecciation, vuggy can be observed from this belt. Compared with host rock, most of corroded limestone is low with respect to $\delta^{13}C_{PDB}$ and negative with respect to $\delta^{18}O_{PDB}$.

Burial karstification formed in the semi-enclosed to closed environment, and is associated with the hydrocarbon fluids which formed during the early stages of the late diagenetic phase. These fluids mixed with formation water and dissolved (leached) carbonate rock as it flowed through permeable strata. This leaching further enhanced preexisting vug, fracture porosity and late cements. This type of porosity is always partially filled by the asphaltenes. Both $\delta^{13}C_{PDB}$ and $\delta^{18}O_{PDB}$ values of corroded carbonate are less than that of host rock, the dissolved fluids come from the overlying source rocks, which can be approved by same value of trace element and REE with the corroded carbonate.

This integrated study has helped in understanding the hydrocarbon potential of the lower Paleozoic formation in Nanbu depression, Bohai Bay Basin.

Gamma-ray burst triggered the end-Permian mass extinction: indirect evidences and possible processes

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The pattern that giant asteroid impacts act as the trigger for Earth's catastrophes is widely used to explain the K/T biotic crisis and the extinction of the dinosaurs, while it being the cause of the end-Permian mass extinction was questioned intensely. However, another reasonable astronomical explanation (e.g. a cosmic event) for the cause of this most significant biotic extinction event in the Phanerozoic Eon should not be ignored. It is hypothesized by us that a violent Gamma-ray burst (GRB) happened near the solar system. Such a firework pageant in space caused a large number of high-energy rays reaching the earth, caused turbulence of earth system and brought about the mass extinction.

Though there has been no direct proof for this astronomical interpretation, a series of indirect evidences and reasonable inferences are proposed. (i) The extinction event happened within a very short time period. (ii) The metazoans living in the euphotic zone (e.g. aeshnidaes, calcareous sponges, some corals, etc.) were (nearly) completely extinct due to the P-T event. While during the recovery of residual species in the Early Triassic, the most obvious ones are the benthos (e.g. bivalves, brachiopods, snails). (iii) Scientists still haven't found the (dubious igneous rock) source of the PTB tuffaceous (if it is) claystone, widely distributed in China. Perhaps there isn't one at all. What is more, during the Phanerozoic (especially in the Mesozoic), massive volcanic activities happened frequently, whereas the biological extinction happened only a few times. (iv) The large-scale regression in the Latest Permian and in turn the exposure and erosion of the carbonate platform have not be interpreted reasonably.

The cosmographic hypothesis we put forward includes the following scenarios: (i) During the latest Permian, the biggest stars newly generated from the galactic collision came into the end of its life. An intensive GRB from the explosion of a supermassive star affected the earth and mass extinction occurred inevitably. (ii) The gamma-rays converted some nitrogen and oxygen in the atmosphere into nitrogen dioxide which would filter out sunlight, turning the skies dark. (iii) The cooling effect triggered a transitory ice age and large-scale regression, thus the Late Permian carbonate platforms were exposed. (iv) Nitrogen oxides also caused acid rain that aggravated the land weathering and caused more input of clay materials into the ocean in turn, which was similar to that Melott *et al*. (2004) reported for the late Ordovician event.

Key words: end-Permian mass extinction, Gamma-ray bursts, regression, cosmic event

Lithofacies and distribution of oil sand reservoir in the Lower Cretaceous McMurray Formation, BlackGold Lease, northern Alberta

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The Lower Cretaceous McMurray Formation is a prolific producer of crude bitumen in Athabasca Oil Sands of northern Alberta. Bitumen reservoirs of the formation have been recognized in tide-dominated successions consisting primarily of point-bar deposits. The point-bar deposits typically comprise alternating interbeds of sandstone and mudstone deposited on a large-scale inclined surface, classified as Inclined Heterolithic Stratification (IHS). The IHS deposit is considered to be a major portion of the bitumen reservoirs in the McMurray Formation. Delineating the geometry and extent of the IHS deposit is crucial in predicting reservoir behavior in flow simulation and optimizing well pair placement and production. This study focuses on lithofacies interpretation based on cores and wire-line logs in BlackGold Lease area and delineation of the geometry and distribution of bitumen-saturated reservoirs. Lithofacies analysis using conventional cores from about 90 wells established six lithofacies: cross-stratified sandstone and mudstone-clast breccia (Lf1), sandstone-dominated IHS (Lf2), mudstone-dominated IHS (Lf3), thinly interbedded sandstone and mudstone (Lf4), laminated mudstone (Lf5), and clean sandstone with interbedded mudstone (Lf6). The lithofacies characteristics and their lateral and vertical relationships suggest three depositional stages for the McMurray Formation: early stage represents fluvial channels with minor tidal influence, middle stage represents tidally-influenced estuary with meandering channels, and late stage represents a drowning of tidally-influenced estuary. The potential bitumen reservoirs are fluvial channel sandstones in the early stage and lower point-bar deposits in the middle stage. The fluvial channel sandstones are well stacked and correlatable between wells, forming sheet-like sandstone bodies that align in a SW–NE direction parallel to the inferred orientation of major channel systems. The lower point-bar deposits consist mainly of base-of-channel and sandstone-dominated IHS deposits. The direction of point-bar migration, which is crucial in horizontal well design for bitumen production, is inferred from lithofacies slice maps. The lateral changes in lithofacies from base-of-channel to abandoned channel-fills through IHS deposits probably indicate that the point bar once migrated toward abandoned channel-fills. Based on this lateral lithofacies trend, the dip direction of some point-bar deposits are approximately estimated to be southwestward or northwestward, which is oblique or perpendicular to the major channel orientation. This study shows that lithofacies slice maps at a certain stratigraphic interval are useful for capturing mosaic images of the distribution of IHS deposits and provide a possible direction of individual point-bar migration at a certain time increment. The inferred migration direction from lithofacies slice maps should be confirmed by dipmeter log analysis and 3-D seismic images.

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Mass accumulation rate of hemipelagic environment during the 20th century around the central Japan: A possibility of influence of dam reservoir deposition

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Introduction - It is well known that dams construction on river caused decrease in sediment supply and serious coastal erosion. Taking into account similarity of grain size, deposition in dam reservoir may influence not only to coastal environments, but also to deep marine hemipelagic environment. To investigate influence of dam deposition to hemipelagic environment, mass accumulation rate (MAR) of surface muddy sediments around the central Japan during the last ca. 50–100 years were estimated with Pb-210 radioactivity concentration.

Methods - Core samples were obtained from the Kumano region on the Pacific side and the Niigata region on the Sea of Japan side, the central Japan. Because it is difficult to estimate MAR of core samples intercalating turbidite layer due to erosion and rapid deposition, muddy cores were selected for this study.
Kumano region is located on southeastern side of the Kii Peninsula where IODP NanTroSEIZE has been ongoing. Two core samples in this study were obtained from bottom of the western Kumano Trough, forearc basin with ca. 2000 m water depth on 2007 spring and 2008 autumn. Coring sites are ca. 60 km apart from the Kumano river mouth, the largest river in the Kumano region. In the watershed of Kumano River, a vast landslides and flood disaster occurred at the end of the 19th century. Huge dams were constructed 1960's and coastal erosion was reported since 1970's.
Niigata core samples investigated for this study were obtained from slope and bottom of the Mogami Trough (ca. 400–600 m water depth) on 2010 spring. Coring sites are ca. 50–60 km apart from the Agano river mouth, one of major rivers in the Niigata region. Although river mouth of the other major river, Shinano River is located nearby the Agano river mouth, it does not supply large amount of sediments since opening of the diversion channel which discharge flood flow ca. 40 km southwest from the original river mouth on early 20th century. Huge dam in upstream of the Agano River was constructed 1960's. Analysis of a core sample has been finished and analyses of the other core samples are ongoing.
Subsamples sliced with 1 cm thick were dried, crushed and measured by an ORTEC High Purity Ge gamma spectrometer housed in the Department of Geography, Tokyo Metropolitan University with a 48 hour counting. MAR was estimated from excess Pb-210 radioactivity concentration and dry bulk density of other subsamples measured with the Shimadzu Accupyc 1330 gas pycnometer housed in Atmosphere and Ocean Research Institute, the University of Tokyo.

Results - Although estimation of MAR and depositional age of the core samples in the western Kumano Trough has considerable error due to low MAR, decrease in MAR from ca. 0.05 to 0.02 g/cm2/y was estimated around 1940–1960. Whereas MAR of the Niigata core sample on the slope to the Mogami Trough showed decrease in MAR around 1970–1975 from 0.14 to 0.10 g/cm2/y.

Conclusions - It is remarkable that decrease in MAR was estimated from both the studied regions. Contemporaneity of dams' construction and decrease in MAR and the grain size similarity suggest that it is possible enough to deposition in dam reservoir causes decrease in sediment supply to deep marine hemipelagic environment. As a next step, it is necessary to seek evidences directly showing influence of dam reservoir deposition from hemipelagic sediments.

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Origin of Spectacular Submarine Bedform-like Morphologies Surrounding Volcanic Islands – Slope Failure or Eruption-Fed Bedforms?

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Submarine and subaerial volcanic island eruptions have the capability of producing extremely large quantities of material, most of which is transported into and deposited within the marine realm. The small Pacific islands of Macauley and Raoul are no exception, with the majority of the island's mass located below sea level. The submarine flanks of these islands are covered with bedform-like seafloor features of various morphologies. The distinction between whether these seafloor features are bedforms or the result of slope failures, and if similar features also occur in the subaerial environment is the focus of this discussion. High-resolution multibeam echosounder and multi-channel seismic data allow visualisation of seafloor and sub-seafloor volcano morphology. Geomorphological mapping of seafloor features has identified two end-member waveform morphologies, which represent eruption-fed bedforms and slope failures. Eruption-fed bedform morphologies are characterised by a series of asymmetrically shaped sediment waves that spread out from the submarine Macauley caldera for 20 km. The sediment waves have waveheights of 10 m to 140 m and wavelengths of 250 m to 2000 m. In planview they produce neat convex, bifurcating seafloor undulations, which noticeably decrease in size and wavelength downslope, away from the caldera. Slope failures are associated with concave to linear, asymmetrical and symmetrical waveforms, which do not show any regular downslope change in geometry. Waveheights are between 10 m and 50 m with wavelengths ranging between 500 m and 1300 m. Slope failure waveforms are associated with an arcuate headwall scar, well-defined lateral margins, and occasionally tension cracks above the headwall. Interpretation of the seismic data shows that the upslope limb of each eruption-fed bedform is characterised by a thicker well-bedded sedimentary package compared to the downslope limb. In comparison, the seismic data for the slope failure waveforms show chaotic and discontinuous sub-parallel reflectors, which overlie a basal truncation surface.

We interpret the eruption-fed bedforms to have been sourced from the last voluminous caldera-forming volcanic eruption on Macauley Island, as Macauley Island is too small to support any fluvial systems and the features are inconsistent with being formed by ocean currents, slope failure or volcano deformation. The morphology and internal architecture of the eruption-fed sediment waves are interpreted to represent bedforms deposited from supercritical density currents. Unlike the eruption-fed bedforms, slope failure waveforms are sourced from the shelf break rather than directly from material ejected during a volcanic eruption. Identification of volcanic eruption-fed bedforms and slope failure waveforms of this size, spatial extent and morphology is unique to the marine realm, and such large-scale features do not have subaerial analogues.

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Caves in caves: evolution of post-depositional macroholes in stalagmites

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We have examined twenty-six stalagmites from a variety of settings and shown that almost all have a variety of microscopic to macroscopic pores. X-ray computed tomography (CT) confirms that these holes are true spelean features, rather than artifacts of sectioning or of preparation of thin sections. These individual holes can be divided according to their position into two important categories: axial holes and off-axis holes. *Axial holes* form along and parallel to the stalagmite axis; they are usually elongated, ranging in length from 0.5 to 4 cm and their width may reach 1 cm. A significant feature of the axial holes is the downward bending of the surrounding growth layers towards the holes; *Off axis* holes (OAHs) are developed away from the stalagmite axis. They cut discordantly through growth layers, and rarely terminate at a current growth surface. OAHs are usually more rounded and smaller than the axial holes, ranging from 1 mm up to 2 cm; their axis vary from parallel to the stalagmite axis to parallel to the crystal growth axis.

The stalagmites can be divided into six categories according to the spatial distribution of their macroscopic holes: intact stalagmites (having no holes at all), stalagmites with random sparse distribution of holes, stalagmites dominated by axial holes, stalagmites with abundant random holes, stalagmites with layer-confined holes, and stalagmites with a combination or mixture of holes. Holes can also be categorized by internal surface features, i.e by eroded walls, or in contrary, by new ingrown crystals along the walls.

Possible origins of OAHs in stalagmites include (1) corrosion of micro gours at surface, enhanced by further dissolution beneath the stalagmite surface whilst calcite precipitation during stalagmite growth has subsequently sealed these cavities off from the outside environment under new calcite layers; (2) a post-depositional shift in the chemical equilibrium to $\Omega ct < 0$ at specific loci inside the stalagmite, i.e. water penetrating through micro fissure dissolves the calcite forming diagenetic porosity. The process could be enhanced or even triggered by the action of bacteria living inside the stalagmites. Bacteria seem to be capable of creating the lowered pH conditions necessary for corrosion of the host calcite. The known permeability of stalagmites would permit entry of the bacterial spores and continued supply of nutrient in the form of dissolved organic species derived either from the soil or from excretions of resident spelean fauna (principally bats). We have shown bacteria inside off axis macroholes, and on the surface of an active growing stalagmite from a cave in Israel.

Macroholes in stalagmites and the search for lost water

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Fluid microinclusions in stalagmites have provided samples of paleowaters present during the growth of the stalagmite, but only in microliter amounts. In attempt to identify fluid-filled macroholes, we visualized their interior structures, using two medical imaging methods: X-ray computed tomographic scans (CT) and magnetic resonance imaging (MRI).

We searched for such macroinclusions in 21 stalagmites from diverse localities in North and Central America and the Caribbean. We show that most stalagmites contained numerous mm to cm-sized internal cavities (*macroholes*). These do not penetrate the outer surfaces which in most cases are deceptively unblemished. Some stalagmites have up to 10% average internal porosity.

Two types of macroholes are distinguishable: *axial holes* formed during growth due to slower calcite accumulation at the axial drip site; *off-axis holes* formed penecontemporaneously with growth in discrete layers; these cut previous growth laminae showing that they are post-depositional. Analysis of the form and distribution of the macroholes shows that axial holes are formed during growth of the stalagmite, whereas off-axis holes are clearly post-depositional. Since the off-axis holes were presumably formed by dissolution of their host speleothems and are entirely enclosed inside them, it seems likely that they were initially full of water. This water was subsequently lost by leakage along an interconnected system of crystal boundaries, or through micro fissures or other defects. We note that the axial holes which surely must also have initially contained water, are also found to be empty. Therefore, loss of water from macroholes in seemingly intact, uncut speleothems is a widespread phenomenon which is itself worthy of future study.

Using MRI on uncut, apparently sealed specimens, we found water but only in one of the 21 stalagmites investigated, and only in small amounts, although they were clearly formed while the stalagmite was being continuously bathed by drip water. Presumably, the water has escaped post-depositionally, through micro fissures, extensive connected hole system, crystal boundaries or other defects.

CT imaging is well suited to detect mm to cm sized cavities inside a stalagmite but is less well suited to visualizing any water that may be contained in the cavity. As opposed to CT, MRI is very sensitive to water, but unable to detect the solid calcium carbonate structure. Combining the two imaging modalities offers the potential to do complete non-destructive mapping of the stalagmite.

Timing and duration of the Holocene distal mud formation on continental shelves associated with large rivers: mechanisms and implications

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Sediment materials discharged into the sea by large rivers may have different fates. Some are trapped by the estuary, forming estuarine and deltaic deposits, or transported across the continental shelf by oceanic circulations and/or sediment gravity flows and eventually deposited in the forms of turbidites, contourites or deep-ocean muds. The remainder may be transported by shelf currents along the shoreline, to form distal mud deposits. The shelf muds represent a high resolution sedimentary record, which is valuable in climate change and environment evolution studies. However, in order to make appropriate uses of the record, the timing and temporal coverage of the deposit muse be known, In the present study, the distal mud on the northern South China Sea shelf, associated with the Pearl River, is analyzed. Based on sediment mapping, shallow geophysical survey and 210Pb dating, the mud deposit in consideration occupies an area of around 8000 km^2, but the thickness is modest and the age <100 years. Shallow seismic survey indicates that the deposit is related to the Pearl River, with the thickness increasing from the distal mud area towards the river mouth. In contrast, the distal muds associated with the Yellow River, in the northern Yellow Sea, and the Changjiang River, on the inner shelf of the East China Sea, have highly different the timing and duration. They started to develop at the time the sea level reached the present elevation at about 6500 yr B.P., and 2000 yr B.P., respectively. The mechanism responsible for the difference is associated with the estuarine processes of these large rivers. The Yellow River did not have a large estuary; hence, sediment was escaping from the river mouth from the beginning of the high sea level period (from 6500 yr B.P. to present). In the case of the Changjiang, because its estuarine area was large at 6500 yr B.P., sediment escape did not take place until 2000 years ago when the estuary was filled with sediment and the Changjiang delta was formed. The Pearl River estuary is the largest of the three systems, but its annual sediment discharge is the lowest. As a result, it took a long time to complete the sediment infilling. Only very recently has the fine-grained sediment discharge intensified. Such a difference is important for environmental change studies. For example, the Pearl River distal mud does not contain much information on the catchment changes during the Holocene.

Key words: Distal mud deposits, continental shelf sedimentation, sedimentary record, process-product relationships, Holocene, Pearl River

Geochemistry and chronology of detrital zircons of the Late Paleozoic detrital rocks of the north margin of the Dabie orogenic belt: constraints to the stratigraphy ages, provenance and tectonic settings

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In the north margin of the Dabie orogenic belt situated across eastern China, there is a suit of detrital and carbonate rocks of about above 3000 meters thick, including Huayuanqiang (HYQ), Yangshan (YS), Daorenchong (DRC), Huyoufang (HYF), Yangxiaozhuang (YXZ) and Shuangshitou (SST) Fms from the bottom up, which are conventionally considered to be Carboniferous. According to the fossils found, the YS Fm. is the visean stage of Early Carboniferous, the DRC and HUF Fms are the early stage of Late Carboniferous, and the HYQ Fm. is Late Devonian. However, the geological ages of the YXZ and SST Fms are short of constraint of fossils, although at present they are placed in later stage of Carboniferous covering on the Huyoufang Fm. Based on our research, the youngest ages of detrital zircons from the strata indicate that HYF Fm. has a maximum deposition age of 401±10 Ma (YSG), and the SST Fm. has a maximum deposition age of 638±16 Ma (YSG). So, the HYQ Fm. should be middle-late Devonian, and the SST and YXZ Fms belong to Neoproterozoic Ediacaran.

The Devonian and Carboniferous strata have Th and U contents of 2.8-23.8 ppm and 0.7-6.7 ppm respectively, ratios of La/Sc, La/Y, Th/U and Th/Sc of 1.28-3.84, 1.23-3.16, 1.95-6.33 and 0.54-1.76 respectively. These data indicate that their source rocks formed mostly under continental island arc and active continental margin settings.

Age populations of detrital zircons in sandstones shows that HYQ Fm. has wealthy Early Paleozoic ages (ca. 425-525 Ma) occupying 62.5% of the age populations, 11.25% of the Neoproterozoic Tonian ages (897-991 Ma), 12.50% Mesoproterozoic ages (1035-1544 Ma), and 10% Paleoproterozoic ages (1661-2456 Ma) ; Early Carboniferous YS Fm. has age populations of detrital zircons similar to the HYQ Fm, no more than, it has younger Middle Paleozoic ages (401-429 Ma) of 17.5 %; In addition to above chronofacies, Late Carboniferous HYF Fm has 12.1-13.3% Neoproterozoic Cryogenian ages (689-849 Ma) and 10% Devonian –Carboniferous ages (309-392 Ma). As is well-known, Early Paleozoic, especially Ordovician ages has affinity with the north Qinling island arc, and Neoproterozoic Cryogenian ages have affinity with the Yangtze Craton. Owing to the bottom conglomerates of the YS Fm. containing gravels which are made up limestones with Silurian coral fossils which are affinity with the Yangtze Craton, so, the source rocks of the Early Carboniferous strata were partly derived from the Yangtze Craton.

Source rocks of the Middle-Late Devonian HYQ Fm. are mostly derived from the terrain similar to Early Paleozoic north Qinling island arc, next late stage of Neoproterozoic and Meso-Paleo Proterozoic terrain similar to the cap rocks and the basement of the south margin of North China Block. Early Carboniferous, the Yangtze Craton became part of the source rocks of the north margin of the Dabie orogenic Belt, and continued to Late Carboniferous, while the crap rocks and basement as the source rocks almost disappeared. These may indicate that the converge between the Yangtze Craton and North China happened in Late Devonian, and the Paleo-Tethys Ocean began to formation in Late Carboniferous, which has been attested by the finding of Late Carboniferous deep water carbonate slope sediments in the north side of the Guishi-Feizhong fault（Li et al., 2014）. The neonatal ocean blocked the material from the North China Block as provenance afflux into the south margin of the Late Carboniferous basin.

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Paleovalley sediment infilled pattern along a sediment-starved continental shelf: combining high-resolution sequence stratigraphy and sedimentological analysis

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Continental shelves are highly complex depositional systems and their sedimentary records are the result of the combinationed action of hydrodynamics, antecedent morphology, sea level changes and sediment supply. Analysing shelf sedimentary records allow us to reconstruct the paleoenvironmental evolution and understand the influence of past climate and oceanographic conditions. Neogene lithostratigraphic units, named Barreiras Formation, form a continuous deposit along the eastern and northern-northeastern Brazilian coast. These deposits are related to the presence of soft cliffs along the coastline, representing a sediment starved coast. Major areas of high sediment supply form delta plains, giving a prograding characteristics for the coast, so along a sediment-starved coast there are sections of coastal progradation, for example the Doce, Jequitinhonha and São Francisco River Deltas. During the last glacial maximum, the Brazilian continental shelf was carved by incised valleys. During the last post-glacial transgression, these valleys were not totally infilled due to low sediment input. Therefore, modern continental shelf morphology is marked by exposed and semi-filled paleochannels. Aiming to identify the controlling factors of Neogene deposits upon the formation and sedimentation of paleochannels along an accommodation shelf, high resolution seismic data (Boomer – 300 J) and piston cores were acquired along the central- north Espirito Santo shelf. Herein, only one 3.37 m long piston core data will be presented. This was collected between two paleochannels, at 45 m depth. Sediment samples were analyzed for grain size, calcium carbonate and organic matter content. The seismic interpretation revealed three stratigraphic surfaces: subaerial unconformity, maximum regressive surface and maximum flooding surface across the continental shelf. The mapped subaerial unconformity represents the fluvial incision that occurred during the last glacial period (Later Pleistocene) and it occurs from 10 to 35 m below seabed and seems to be the boundary between Neogene and Quaternary deposits. Besides, lowstand and transgressive deposits fill the paleochannels. The description of the 3.37 m long core revealed two main sedimentary facies: fluvial (from the base to 3 m depth) and marine carbonate (from 3 m to the top). The fluvial facies is composed of muddy sands and low carbonate content (< 15 %). Morphoscopic analysis revealed that quartz grains are dirty, frosted and subrounded to rounded. On the other hand, marine carbonate facies is composed of muddy gravel and high carbonate content (> 50 %). Calcareous algae and shell fragments represent the gravelly sediment. From top to base, carbonate content ranges from 98 % to 6 %. This variation indicates the transition between marine and continental environments. In turn, organic matter content ranges from 2 % to 12 % and its distribution in the sediment is not uniform. There is a tendency of increasing organic matter content from the top to 2 m depth and a tendency of decreasing content below 2 m. Finally, seismic data and sedimentary data suggest the formation of incised valleys during sea-level drop and their occurrence and morphology are controlled by the Barreiras Formation, as it is observed today along the coast, where estuarine coastal morphology is controlled by the same deposit. Sediment analysis indicates a terrigenous source at the base of the core. During deglaciation, the absence of a major sediment input from the continent, these valleys were filled by transgressive carbonate sediments.

Comparing tsunami and storm sedimentary signatures in Salgados (Portugal)

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Many questions remain regarding differentiation of storm and tsunami deposits and locations preserving both types of sediment make the ideal setting to support that distinction.

This is the case of Salgados coastal lagoon (south Portugal), where the AD1755 tsunami deposit has been described within the Late Holocene lagoonal infill. The tsunami deposit occurs intercalated in lagoonal muds and is fan-shaped, massive, with maximum thickness of 80cm and consists of bioclastic medium sand with rip-up clasts; it rests at ca. 1.30m a.s.l. (40cm below surface) and presents an erosive basal contact. The deposit fines and thins inland until ca. 850m from the coastline. On the same stratigraphic sequence, at app. 0.20m below surface a very thin (up to 8cm close to the shoreline) muddy sand *laminae* was found, separated from the tsunami sand by lagoonal mud. This layer is spatially restricted to the southernmost area of the lagoon and vicinity of the inlet; it also thins and fines inland and wedges out at app. 380m from the coastline. Extrapolation of sedimentation rates obtained from ^{210}Pb and ^{137}Cs profiles constrains its emplacement to the late 19th or early 20th century, thus suggesting relation with a storm event.

The aim of this study is to characterize the storm deposit, discuss likely sources and compare it with the underlying tsunami unit. Samples retrieved from trenches, cores and present-day analogues (dune, beach and nearshore) were analyzed for texture, microtexture and heavy mineral (HM) assemblages. Area and volume of both units were calculated in a GIS environment.

The storm and tsunami sandy *laminae* are similar in texture (Mz = 1.3 Φ and σI=0.5 Φ) and microtextural imprints of quartz grains, but markedly contrast with nearshore sediment in these attributes. In all samples the HM assemblage was dominated by tourmaline, andalusite and staurolite, but the storm and tsunami sediments differ in the higher percentage of staurolite – the densest transparent mineral of the assemblage – shown by the former (24%) whereas tsunami sand yielded 13 -19%. Overall, the storm sand shares more similarities with beach sand, thus suggesting this environment as its most likely source, whereas tsunami sand also retains microtextural signatures of dune sands.

The volume of the storm deposit is ca. 500m^3 and the gradual fading of thickness inland indicates preservation of the original shape. In contrast, the tsunami deposit retains over 10000m^3 with its maximum thickness also found close to the inlet. This suggests erosion of the beach and eventually foredune at the lowest point in the barrier (the inlet) during both events, the tsunami apparently incorporating a larger contribution of the dune. The smaller extent, volume and thickness of the storm *laminae* compared to the tsunami deposit results from contrast in energy associated with the forcing mechanisms responsible for the deposition of these exotic sedimentary units. In addition to differences in microtextures and composition, the essential criteria allowing distinction between sand layers emplaced onshore by tsunami and storm are related with spatial attributes of the sedimentary units.

Presenting the *Sedfate* Project – Sediment fate in a changing watershed during the Anthropocene

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Mountain ranges in Alpine environments are sculpted by erosion and sediment transport processes that are driven by climate. Sediment availability in these systems is also dependent on long-term exhumation and short-term seismic processes. The glacial inheritance of the Alpine region also plays a part in the sediment availability, hydrological and geomorphic response that drives sediment transfer. The topographic response to these forcing factors is complex and scale-dependent.
Additionally, in the last ca. 200 years, anthropogenic activities also significantly impacted the sediment balance in the watershed. In the Alpine basins these impacts are hydrological and geomorphic, and include flow abstraction, land usage changes, dam construction, sediment flushing, river channelization and gravel extraction.
The main goal of the *Sedfate* project is to quantify the impact of anthropogenic activities in the last ca.100 years on the erosion and sediment transfer in the Rhône River catchment down to Lake Geneva. In order to achieve this, the direct effects of human activities on this system need to be differentiated from the effects of climate variability (which can also have an indirect effect of human activities) and from long term 'background' erosion rates.
To address this question the project is designed based on four closely related sub-projects:
Sub-project A focuses on the quantification of the pattern of sediment flux to Lake Geneva in the last ca. 100 years. Detailed bathymetric surveys, seismic data, and sediment dating will be analyzed and sediment sources will be traced upstream and identified in the Rhône River basin.
Sub-project B will characterize the sediments coming from selected sub-basins of the Rhône River and relates these to changes in sedimentation rates and sediments present in the sedimentary record found in Lake Geneva. Physical and geochemical fluxes will be characterized and sediments sources will be determined from XRF, REE and heavy mineral assemblages.
Sub-project C will focus on the Val d'Hérens basin, which hosts one of the largest dams in the Alps – La Grande Dixence – which retains 30% of the total water abstraction in the Rhône River. The impact of water abstraction, sluicing and flushing on the sediment sorting and redistribution downstream will be assessed. This will be achieved by the analysis of representative water intakes, remote sensing, in-stream measurements and sediment transport modeling.
In sub-project D, a physically-based basin-scale model will be built to upscale the results from sub-project C to the entire Rhône River basin. The simulation of sediment production and transfer and their uncertainties will be the main focus of this project. Hydroclimatic and streamflow data for the Rhône basin in the last ca. 100 years will be analyzed to detect variations and trends and assess the impact of flow regime's changes on potential sediment transport.
With this interdisciplinary approach, *Sedfate* aims to be one of the few collaborative projects in a major alpine river basin with the objective of quantifying changes in sediment transfer rates due to the impact of anthropogenic activities superimposed to climate change effects.

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Eustatism vs tectonics in the Jaca basin: a microfacies approach to the Lutetian-Bartonian boundary

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Detailed sedimentological analysis of the Lutetian-Bartonian transition at the Osqueta section (Jaca basin, External Sierras, Pyrenees, N Spain) has allowed the characterization of a regional drowning unconformity. Its surface is related with a major sedimentation turn over between shallow marine carbonate platform facies extensively developed during the early Paleogene and prograding riverine to deltaic sedimentary successions. This unconformity marks the onset of the so-called "Biarritzian" (=Bartonian, middle Eocene) transgression, defined in the Jaca Basin. However, the origin of this event has remained controversial since its definition; some authors interpreted this transgression as a tectonically driven sequence boundary, whereas others pointed to a eustatic origin. This controversy was most likely caused by poor exposure of the unconformity surface.

In most of the External Sierras the unconformity is generally associated to a sharp lithological change between the shallow marine limestones of the Guara Fm and the prodelta marls of the Arguis Fm. In some shallower domains of the western External Sierras, such as the studied Osqueta area, the unconformity is well exposed and overlain by marly limestones (Santo Domingo Mb), thus offering the rare opportunity to reach a more complete and accurate sedimentological characterization of the drowning unconformity. Our data come from a detailed bed by bed, 75m-thick, sedimentary log comprising both the Guara Fm and the Santo Domingo Mb. Age calibration is based on magnetostratigraphic and biostratigraphic data (larger benthic foraminifera). At Osqueta, the Guara Fm is mainly composed of very well sorted cross-laminated bioclastic-peloidal grainstones, bearing porcelanaceous foraminifera such as *Alveolina* and *Idalina*. At the uppermost part of the unit, this facies shows a reddish coloration and a cm-thick irregular hardground including mm- to cm-sized borings filled by the overlying sediments of the lowermost Santo Domingo Mb. These correspond to a condensed level with abundant bivalves, echinoids, serpulids, corals, and flat ortophagminids, with large amounts of glauconite in a micritic matrix. Above this level, flat *Discocyclina* specimens become abundant and the siliciclastic content increases. The relative sea level rise represented by the drowning surface could have been of about 50 meters, from the very shallow subtidal facies of the Guara formation to the outer ramp *Discocyclina* facies of the Santo Domingo Mb.

In conclusion, our results show an abrupt relative sea level rise close to the Lutetian-Bartonian boundary in the Jaca Basin, which is at odds with a purely tectonic subsidence trigger. Despite middle Eocene greenhouse conditions, some authors have proved the occurrence of ice sheets in Antarctica and glacioeustatic sea level changes during this period. Thus, the studied drowning unconformity may be related to a glacioeustatic sea level rise, coupled to an increased tectonic subsidence in the Lutetian-Bartonian transition.

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Changes in Eocene-Miocene shallow marine carbonate factories along the tropical SE Circum-Caribbean responded to major regional and global environmental and tectonic events

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Changes in the factory of Cenozoic tropical marine carbonates have been attributed to major variations on climatic and environmental conditions. Although changes on the factories of Cenozoic Caribbean carbonates seem to have followed global climatic and environmental changes, the regional impact of such changes on the shallow marine carbonate factories along the Caribbean is not well established. Moreover, the influence of transpressional tectonics on the occurrence, distribution and stratigraphy of shallow marine carbonate factories along this area is far from being well understood.

Here we report detailed stratigraphic, petrographic and Sr-isotope chemostratigraphic information of several Eocene-Miocene carbonate successions deposited along the equatorial/tropical SE Circum-Caribbean from which we further assess the influence of changing environmental conditions, transtentional tectonics and sea level change on the development of the shallow marine carbonate factories.

Our results suggest that during the Eocene-middle Oligocene interval, a period of predominant high atmospheric pCO_2, coralline algae were the principal carbonate builders of shallow marine carbonate factories along the SE Circum-Caribbean. The carbonate factories were characterized by the development of laterally continuous red algae build-ups and reefs along rimmed carbonate platforms. The predominance of coralline red algae over corals was likely related to high sea surface temperatures and high turbidity. The occurrence of build-ups and reefs was controlled by changes in basin topography, i.e. the occurrence of basement highs and lows, resulting from local transpressional tectonics.

Calcareous algae persisted as the main constituents of the shallow marine carbonate factories until the middle Oligocene; a period when atmospheric pCO_2 dropped significantly, allowing the onset of global icehouse conditions and the decrease in sea surface temperatures along the Caribbean. This drop ultimately allowed the appearance of corals as the main constituents of the shallow marine carbonate factories. Low diversity patchy coralline reefs dominated the late Oligocene carbonate factories. The patchy coral reefs usually developed along rimmed mixed silicilastic/carbonate platform. Their development was also controlled by transtentional tectonics and seems to have been influenced by a relative decrease in sea level. The early-middle Miocene interval is characterized by widespread development of rimmed carbonate platforms, along which high diversity fringing coral reefs developed. The occurrence of these high diversity coralline carbonate factories was favored by a decrease in the siliciclastic input from the continents and a further decrease in sea surface temperatures. Regional transtentional tectonics would have also controlled the occurrence and stratigraphic development of these coral dominated factories.

Coral reefs would have dominated the shallow marine carbonate factories until the middle Miocene, when a new period of calcareous algae reefs occurred along the Caribbean. This new change was likely the result of major changes in the Caribbean environmental conditions, which were driven by increased continental sediment runoff resulting from the exhumation of the northern Andes.

The usage of gamma-ray spectrometry as an indicator of provenance changes in siliciclastic sediments

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The sedimentary rocks of foreland basins adjacent to young orogenic belts usually reveal low mineralogical maturity, which cause low composition contrast of different sedimentary facies. This fact limits common usage of gamma-ray spectrometry as a sensitive facies indicator, because facies can produce "false" responses in spectral gamma-ray logs due to variable distribution of K-, U- and Th-bearing detrital minerals. On the other hand, these depositional systems usually reflect composition of source rocks very well, because they represent the final target of material eroded from continents and the steep transport gradient eliminates effects of weathering and selective sorting of clastic material. The main aim of this work was to explore the relationship between changes in detrital composition of sediments and changes in their spectral gamma-ray signal. The research was focused on outcrops of the Lower Carboniferous (the Nízký Jeseník culm basin) and the Upper Cretaceous (the Silesian basin) flysch sediments of the Variscan, respective the Western Carpathians orogens in Czech Republic. The direct observation of facies in outcrops allows effectively filter out facies effect and intensify detrital signal in gamma-ray spectra.

Natural radioactivity and concentrations of K, U and Th were measured using portable spectrometer RS-230 with BGO detector. Simultaneously with gamma-ray spectrometry, the detail lithological description of outcrops was carried out. The field measurement was supplied by laboratory gamma-ray spectrometry. Obtained spectral gamma-ray data were confronted with results of complex petrographical and geochemical study of sediments (optical and cathodoluminescence microscopy, analyses of transparent heavy mineral assemblages, electron microprobe and X-ray powder diffraction).

Sediments of the variscan foreland basin are characterized by moderately high outcrop radioactivity (174 API on average), whereas synorogenic sediments of the Western Carpathians have rather low values (116 API on average). In both cases, low composition contrast causes, that mudstones have only slightly higher K, U and Th concentrations than sandstones and in several stratigraphic levels of the Nízký Jeseník culm basin, sandstones are even more radioactive than mudstones. Hence, the reliable facies identification from spectral gamma-ray records is possible only in combination with other methods of petrographical and geochemical study of sediments. K is present in detrital grains of all grain sizes (feldspars, micas, clay minerals), whereas U and Th are predominantly coupled with silt-to-mud fraction of sediments (some heavy minerals, clay minerals). Modal analyses of sandstones and heavy mineral assemblages reveal decrease input of material from sedimentary sources and increase of material from plutonic and high metamorphic sources during the sedimentation. These provenance changes can be explained by progressive deep erosion of source area, which is also consistent with provenance ternary diagrams, where the most of samples plot within the recycled orogen field. The main trends of changes of K, U and Th concentrations bear out initial erosion of low radioactive sedimentary and meta-sedimentary cover, followed by gradual increase of material input from more radioactive deep-crustal crystalline rocks (gneisses, durbachites).

The gamma-ray spectrometry in combination with other methods of sedimentary study is sensitive indicator of provenance changes and can be used as a supplementary method for field lithostratigraphic orientation and identification of sedimentary bodies, which composition can reflect specific processes in the source area.

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An unusual thick succession of a paleoproterozoic eolian sand sheet (bandeirinha formation, south-eastern Brazil)

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Present-day eolian sand sheets are flattened areas where the main bedforms are wind ripples, slipfaceless dunes (zibars and nabkhas) and more rarely slipfaced dunes. Zibars and nabkhas are constituted by climbing wind ripples and, in general, do not own slipface. These dunes are related to different stabilizing factors (precocious cementation, rising of the water table, predominant coarse-grained sands, vegetation cover), which reduce the availability of clastic materials for wind transport and consequent slipfaced dunes creation. Low input of clastic material constitutes an important control factor that inhibits the formation of thick succession of eolian sand sheet, which overall are less than 20 m thick.

This work tries to explain the anomalous large thickness of eolian sand sheet deposits of the Paleoproterozoic Bandeirinha Formation (SE Brazil). This unit is 250 m thick and is composed of fine- to coarse-grained sandstone, organized in superposed sets of translatent strata that form packages more than 50 m thick. The sandstone deposits are interbedded with three sandstone conglomerate beds, 7-18 m thick, composed by intraclasts of laminated sandstone. The sandstone deposits are interpreted as a dry eolian sand sheet paleoenvironment dominated by zibar dunes, whereas the conglomerate was deposited by high-concentrated subaqueous flows within ephemeral river channels. The sandstone intraclasts were originated by cannibalization of the eolian sand sheet surface. Differently of many eolian sand sheets, this system received a large bulk of sediments to eolian construction, as testified by the large thickness of the laminated sandstone deposits. Moreover, the significant absence of gravel or very coarse-grained sandstone lag deposits suggests high input of sediment into the basin. However, the sandy material did not remain available for long time on the topographic surface in order to form greater dunes with slipface, but only the sufficient time to form embryonic dunes, the zibars. What was the main controlling factor that caused the low availability of sand, although a great quantity of sediment was introduced into the basin? The abundance within the channel deposits of angular intraclasts, derived by the erosion of the eolian sand sheet, testifies early cementation of the sand. This cementation, probably linked to evaporite minerals, should have been the main cause of low availability of sand material and consequently of the unusual large thickness of this eolian sand sheet succession.

Scale dependent deformation of Himalayan catchments with an example from the Indus catchment of Ladakh, NW Himalaya

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Global sediment fluxes are dominated by high erosion and sediment transport rates from mountain ranges. By far the greatest sediment flux is generated by the rivers of the Himalaya which form large catchments, many of which drain high topography behind the main peaks, and which are anomalously elongate parallel to the range. This unusual catchment geometry drives major along-strike variations in topographic dissection of the mountain range, and concomitant sediment delivery to the Gangetic Plains. We demonstrate that range-parallel elongation is scale dependent in both the front and lee of the Himalaya. We interpret the dependence of catchment form on size as a result of long-term (>10^5 yrs) distributed crustal strain across the range which is variably recovered by the efficacy of bedrock rivers to transmit tectonic signals of displacement to drainage divides; this process having response times that are dependent on a range of parameters, but dominated by upstream area. Hence, range-parallel elongation of river catchments is a characteristic of high relief mountain ranges where horizontal rates of crustal shortening are able to counter the erosional capacity to recover the imposed strain. We further test the ability of rivers to recover imposed strain by analysing Holocene shortening rates versus erosion rates from cosmogenic nuclides in the Indus catchment of Ladakh, NW Himalaya. Shortening rates across the Indus catchment have been >0.25mm/yr based on displaced terraces, whereas erosion rates are ~0.002mm/yr indicating that erosion is not able to counter the rates of shortening in the lee of the high Himalaya.

A three-dimensional reconstruction of cyclic steps in the Pleistocene carbonate ramp deposits of Favignana Island (Sicily, Italy)

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Bedforms are key in the recognition and reconstruction of palaeo-environments. They are typically divided into those formed under Froude subcritical flows (e.g. ripple, dune, lower and upper plane bed) and those generated by Froude supercritical flows (e.g. antidune, chute-and-pool, cyclic step). Over the past few years, supercritical-flow bedforms are increasingly invoked to explain sedimentary structures observed in a multitude of depositional environments, including deep-marine, proglacial, fluvial and volcanic. Most of our present-day knowledge on supercritical-flow bedforms has resulted from physical and numerical modelling. These experiments often showed upstream migrating hydraulic jumps associated to series of downslope asymmetrical cyclic steps. Although these modelling results have greatly contributed to the process-based understanding of cyclic step bedforms, the question remains: How representative is a two-dimensional model in a three-dimensional world?

Here, we explore supercritical-flow bedforms by analysing the three-dimensionally exposed sedimentary structures observed in the ramp deposits of the Pleistocene Favignana Calcarenite (Sicily, Italy). The calcarenites are composed of sediment gravity flow deposits built almost exclusively by supercritical-flow structures. Low cementation rates made this rock a target for excavation and a vast network of three-dimensional exposures was preserved: the so-called Cave di Tufo. The outcrops in an area of 200 x 500 metres were analysed, within which an area of 60 x 60 metres was selected to study in high detail. We used orthogonal photography and seismic exploration software (Schlumberger Petrel) to trace individual strata throughout the exposures. This method allows for an attempt to reconstruct cyclic step morphodynamics in the three-dimensional world.

Preliminary results in palaeoflow-parallel outcrops show a train of scours with circa 20-30 metres spacing, two of which fall into the high-detail study area. The studied unit was deposited on top of a 1 metre high dune, which was present at the sea floor during initiation of the flow. The first strata to be deposited comprise backsets on the upstream face of a downstream asymmetrical antidune, inferred to result from massive suspension fall-out directly downstream of a hydraulic jump associated to flow acceleration down the dune lee side. Upstream, such strata terminate into decimetre-scale concave-up scours on the dune top, successively generating metre-scale truncations of strata deposited moments earlier through the same process. By upstream migration of the hydraulic jump the antidune became progressively more asymmetrical, until its downstream face was sufficiently steep for the flow to accelerate again to supercritical conditions. By this time, backsets were circa 20 metres long and contained superimposed symmetrical antidunes. This pattern is repeated many times in downstream direction and true cyclic steps were thus generated. By correlation to outcrops perpendicular to palaeoflow directions the three-dimensional aspect was added. Hydraulic jump-related scours appear to be spoon-shaped with downstream-narrowing crests separating them.

The outcrops allow us for the first time to study the distribution of sedimentary facies over cyclic steps. This link between bedform and facies is key for their recognition in outcrops with a more limited exposure and especially in cores. The results of this study may have profound implications for future palaeo-environment interpretations.

Catastrophic events on a cool-water carbonate ramp: the Pleistocene Favignana Calcarenite (Sicily, Italy)

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Here, we present the extraordinary cliff and quarry exposures of the Pleistocene calcarenite wedge of Favignana Island (Sicily, Italy). Deposition occurred on a prograding carbonate ramp on which three zones are identified: inner-mid ramp (shoreface), ramp slope, and outer ramp (offshore). The ramp slope and outer ramp are comprised by a succession of heavily bioturbated cross-beds containing second order cross-stratification interpreted as resulting from the migration of low-energy dunes, intercalated with event beds characterised by supercritical-flow (i.e. high-energy) structures. Grain sizes range from coarse sand to granule, with large fossil fragments up to 15 cm constituting the gravel size clasts.

Biological assemblages are composed of fragmented red algae, bryozoans, echinoids and (mainly benthic) foraminifera with, in places, rhodoliths and/or well preserved mollusc shells. The deposits are devoid of hermatypic (reef-building) corals, calcified green algae and non-skeletal grains. Microfacies are of heterozoan origin indicating relatively cool-water conditions. This is confirmed by the presence of so-called Boreal Guests (e.g. *Arctica islandica*).

The combined observations reflect bi-modal deposition on a cool-water carbonate ramp characterised by either low-energy currents or supercritical currents. The carbonate factory is inferred to have been located on a submarine high in between Favignana and another island, situated four kilometres northward. The particular palaeoceanographic setting of the Aegadian Archipelago, with two islands located on the shelf separated by a shallow passage where skeletal debris is produced, had a funnelling effect on approaching currents.

Background sedimentation of subaqueous dune facies resulted from strong northwesterly winds, such as those dominantly observed today, creating a set-up of the water level on the windward side of the passage which generated currents in accord with the observed palaeotransport directions of low-energy bedforms, which were intensely bioturbated during following calm times.

Episodic catastrophic events, such as megastorms, hurricanes or, possibly, tsunami waves, are thought of to have had a devastating effect on the carbonate factory. Such high-energy events swept the shallow passage, delivering vast amounts of material to the slope edge, which, upon gravitational acceleration, transformed into supercritical sediment-gravity flows resulting in the generation of high-energy bedforms. Between such events there was sufficient time for the factory to recover.

Standing waves and hydraulic jumps! Cyclic-step sedimentary structures in Pleistocene clastic carbonates (Favignana Calcarenite, Sicily, Italy)

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Antidune, chute-and-pool and cyclic step sedimentary structures in the Pleistocene calcarenite wedge of Favignana Island were formed on a prograding carbonate ramp. Three zones are identified: inner-mid ramp (shoreface), ramp slope, and outer ramp (offshore). The ramp slope dips 3° to 10° to the S-SE and drops 30-40 m over 400-600 m. The ramp slope and outer ramp show a succession of heavily bioturbated low-energy dune cross beds with intercalated event beds containing supercritical-flow structures. Grain sizes range from coarse sand to granules, with large rhodoliths (algal balls) and shells as gravel-sized clasts.

During background conditions low-energy currents generated submarine dunes migrating across the sea floor. During exceptional high-energy events (megastorms, tsunamis), large amounts of skeletal debris from the carbonate factory were transported towards the top of the ramp slope, where gravity acceleration generated a sustained supercritical sediment gravity flow.

At slope breaks, e.g. directly downstream of dunes on the distal ramp, the above conditions were no longer met and the flow became subcritical. This led to the formation of an initial hydraulic jump with thickening and deceleration of the flow. The rapid decrease of flow velocity caused massive suspension fall-out directly downstream of the hydraulic jump, and backsets developed on the upstream face of an asymmetrical antidune thus generated. Progressive deposition of backsets forced the hydraulic jump to migrate upstream with minor erosion of underlying deposits. By the upstream migration of the hydraulic jump the antidune became progressively more asymmetrical, until its downstream face was sufficiently steep for the flow to accelerate again to supercritical conditions. This process could repeat many times. The end situation is a series of bedforms, with a wavelength of 20-30 metres, with gentle stoss sides with super-imposed antidunes, a convex-up crest, and a steep lee side, accompanied by hydraulic jumps in the intervening troughs.

The structures in the succession are thus interpreted as the sedimentary record of cyclic steps generated during extreme high-energy events on the platform. To our knowledge they represent the first example of such sedimentary features in the literature on carbonate ramp settings.

Type and origin of microporosities in tight carbonate reservoirs

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Extensive studies have been undertaken on microporosity in fine-grained rocks (mudrocks) in recent years but there are few investigations of fine-grained carbonates with a view to understanding these systems which are often hosts to migrated or in-situ generated hydrocarbons and bitumen. In our project we are using as an example an Upper Permian Z2C (Main Dolomite and its equivalents) carbonate petroleum system operating in the Southern Permian Basin of Europe to investigate the geochemical characteristics of organic matter, but also the type and origin of microporosities. It has long been thought that hydrocarbons were generated from within this Z2C formation and trapped in porous toe-of-slope and/or shelf-margin ooid-shoal facies, or they migrated through fractures of tectonic origin. Even though it has been suggested that basinal facies of the Z2C could have a shale-gas or shale-oil potential, this is unlikely in view of the inconsistent and low total organic carbon (TOC) values, low thickness of potential source rocks, common over-mature and degraded character of organic matter in basinal facies, and low total porosity volume in these tight carbonates. However, based on SEM-EDS analyses, but also analyses of biomarkers, we report oil droplets in laminated/biolaminated tight (porosity <2.6 %, permeability <0.2 mD) lime- and dolo- mudstones from slope and basin-rise lithofacies. The droplets are trapped within sub-planar inter-crystalline microcavities (tens of microns long and <1 µm thick), microvugs (<5 µm), and polygonal to oval-shaped pores, probably after dissolution of diagenetic minerals: mainly halite, enclosed within carbonate crystals during their growth, and also pyrite, possibly degraded by bacterial activity. Biomarker analyses reveal a positive correlation between crude oil, extracted organic matter and extracted oil (the trapped oil droplets) in tight lime-mudstone facies, confirming the same source. The origin of nanopores can be related to the maturation of organic matter during deep burial and the decarboxylation of kerogen (kerogen type IIS or mixed II/III), which produces carboxylic and phenolic acids or gases such as CO_2 and H_2S and/or early diagenetic transformation of kerogen type IIS (which may account for the low values of TOC) and subsequent expulsion of liquid hydrocarbons. This approach and an understanding of porosity, diagenesis, the nature of organic matter and the hydrocarbon generation history may lead to the recognition of additional oil reserves in similar tight carbonate systems, and hence new exploration perspectives and challenges.

Biogeochemistry of Holocene intertidal microbial mats of Qatar: implications for petroleum source rock formation in carbonate-evaporite systems

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Organic-rich mesohaline microbial mats occur in the intertidal zone of a lagoonal area developed to the lee of a coastal spit in Mesaieed, eastern Qatar. The mats grow on a substrate of seagrass-rich dolomitic lime mud with cerithid and monachid gastropods and other small bioclasts, reaching a thickness >20 cm. The mats are well laminated with different microbial communities, from cyanobacteria to sulphur bacteria, reflected in the distinct colour changes from green to pink to brown. The lipids reflect the biomass of the principal mat-building phototrophic and heterotrophic microorganisms. A variety of hydrocarbons, including *n*-alkanes, diploptene, and isoprenoids such as phytane, phytene, phytadiene and squalene were detected, in varying concentrations within the various mat layers. In particular, *n*-heptadecane, likely derived from cyanobacteria, dominated the *n*-alkane distribution at a depth of 0-0.1 cm. The concentration and abundance of *n*-alkanes increase with depth through the mat, likely representing the early diagenetic initiation of hydrocarbon generation.

The most representative compounds of sterols and stanols are 5α-cholestan-3β-ol or cholest-5-en-3β-ol but hopanol distribution with trimethyl-5α-cholest-22E-en-3β-ol (dinosterol) is predominant of all neutral fraction compounds. The significant contribution of dinoflagellates to the total biomass is also confirmed by the presence of spheroidal (2-10 µm in diameter) dinocysts. Abundance of C_{27-29} sterols and stanols decreases with depth whereas concentration of dinosterol (0.4-13 µg g^{-1}TOC) is similar at all depths within the mat. It is very likely that marine organisms (algal phytoplankton) are the major contributor of sterols and stanols to the mats. High concentrations of dinosterol can be related to periodically increased productivity of marine algae during red tides which are common in the Arabian Gulf. Hopanoids are represented in the apolar fraction solely by diploptene and in the polar fraction by hopanols (C_{30-32}) and C_{27} hopanoid ketone which is most abundant of all compounds eluting in the polar fraction. Hopanols have similar concentrations at almost all depths within the mat. As the C_{27} ketone is most abundant in dark layers of the mat it is very plausible that it is associated with anoxic conditions. Fatty acids are dominated by saturated, unsaturated and branched fatty acids and are most abundant in the top surface layer of the mat. The distribution of fatty acids provides evidence for the presence of different bacteria including sulphate-reducing bacteria. 'Phospholipid' and 'glycolipid' fractions reveal the presence of glycerol dialkyl glycerol tetraethers (GDGTs). They are solely dominated by methyl branched (Ia, IIa, IIIa) GDGTs (total 442 µg g^{-1}TOC) and are most abundant in the middle part of the mat (0.9 cm depth). Isoprenoid GDGTs are mostly represented by archaeol and crenarchaeol whose concentrations increase with depth; this is consistent with dark anoxic layers of the mat.

In summary, unravelling the early diagenetic alteration of organic matter and its preservation in marine carbonate-evaporite systems, as well as other associated processes such as $CaCO_3$ and dolomite precipitation, could improve our understanding of the hydrocarbon potential of such systems. This will help considerably in the prediction of hydrocarbon occurrence in frontier, as well as mature, petroleum carbonate-evaporite basins.

Constraining silica diagenesis in methane-seep deposits

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Silicified fossils and silicified early diagenetic carbonate minerals, as well as authigenic silica phases, are common in ancient seep limestones. Silicification of calcareous fossils facilitates the preservation of even fine details and is therefore of great interest to paleontologists, permitting reliable taxonomic identification of the chemosynthesis-based taxa that lived at ancient hydrocarbon seeps. Four methane-seep limestones of Paleozoic, Mesozoic, and Cenozoic age with abundant silica phases are compared in this study; one, an Eocene seep deposit on the north shore of the Columbia River at Knappton, western Washington State, USA, is described for the first time. Its lithology and fabrics, negative $\delta^{13}C_{carbonate}$ values as low as −27.6‰, and ^{13}C-depleted biomarkers of Archaea involved in the anaerobic oxidation of methane (AOM) reveal that the carbonate rock formed at a methane seep. The background sediments of the studied Phanerozoic seep limestones contain abundant siliceous microfossils, radiolarian tests in the cases of the Late Carboniferous Dwyka Group deposits from Namibia and the Late Triassic Graylock Butte deposits from eastern Oregon (USA), diatom frustules in the case of the Eocene Knappton limestone and an Oligocene seep deposit from the Lincoln Creek Formation (western Washington State, USA). These microfossils are regarded as the sources of dissolved silica, responsible for silicification and silica precipitation. All seep limestones used in this study are characterized by very similar paragenetic sequences. Silicified fossils include brachiopods and worm tubes; silica cements include microquartz, fibrous microcrystalline silica, and megaquartz. The silica cements formed after the AOM-derived cements ceased to precipitate but before equant calcite spar formed. Numerical experiments using the computer code PHREEQC were conducted to test the hypothesis that (1) AOM increases the pH of pore waters and that (2) this pH increase subsequently mobilizes biogenic silica, (3) followed by the re-precipitation of the dissolved silica in the periphery of the AOM hotspot. The experiments revealed that degassing of carbon dioxide, resulting from AOM-driven carbonate precipitation, is a key factor that has the potential to significantly increase the local pH of pore waters. The results indicate that carbon dioxide degassing exerts an even stronger control on the local pH and silica dissolution than the rate of AOM alone. Numerical experiments demonstrate that AOM in combination with degassing of carbon dioxide is an effective trigger for silica dissolution, allowing for silica re-precipitation at some distance from the AOM hotspot. Our experiments provide a conceptual model for the mechanics of silicification and silica precipitation at seeps.

Evolution of spit system in Lake Mossoe, Denmark

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A complex spit system at the eastern end of Lake Mossoe, Denmark, has been investigated in order to record past lake levels and wind regimes. The lake formed after the last glaciation in an east-west elongated depression created by ice. Present lake is 9 km long (aspect ratio 5:1), mean depth is 9 m and max depth is 22 m. Prominently westerly winds in Denmark have promoted spits to evolve in the eastern part during the Holocene.

A Digital Elevation Model (LiDAR), boreholes and excavations were used to observe the morphology of the spit system. A chronology of spit formations were established by OSL datings.

Present eastern shoreline of Lake Mossoe is formed by a connection of two spits, which has cut off an eastern basin. One spit prograded from the northern shoreline towards SE and was active by 4.2 ka. The other and youngest spit prograded from the southern shoreline towards NNW and reached the proximity of the first spit by 1.94 ka. Subsequently, further supply of sediment has build-up the present barrier shoreline. Lake-bottom erosion, observed from seismic profiles, constitutes a part of the sediment source to the northern spit. The main sediment source of the southern spit is an erosional cliff situated 500m westward on the southern shoreline.

The isolated basin east of the barrier shoreline is subsequently filled with sediments and is now a drained meadow. Two remnant spits are observed by LiDAR in the meadow, which both are formed around bluffs on the former southern shoreline. Both spits have their proximal part in the south and distal part in the north. The smallest and most eastern of the two spits is the oldest and stopped prograding shortly after 10.2 ka. The younger remnant spit is c. 400 m long and is situated parallel and close to the spit forming the present eastern shoreline. The tip of the remnant spit is dated to 2.08 ka. Thus, the spit has probably been active in the distal part, while the youngest spit was prograding on the western side of its more proximal part.

Activation of each spit in the system is thought to be controlled by wind and lake level changes. Storms induced erosion on bluffs and generated alongshore wave-induced currents transporting sediment towards the location. Refraction of waves curved the shoreline and transported the sediment towards the distal part of the spits. Lowering of the lake level during the Holocene is an explanation for the shifting of spit formation in a westward direction.

Evolving shelf-margin to inner-shelf deltaic sedimentation, Silurian succession, Saudi Arabia

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A thick Silurian succession, up to 5000 feet, fills a sag basin in eastern Saudi Arabia. It consists of deep-water turbidite, shallow-marine deltaic and fluvial deposits. The deltaic deposits are informally called the Mid-Qusaiba Sand and the Sharawra Member. This study investigates such deposits in subsurface cores to gain insights into the development of the Silurian deltas.

Core logging allowed the recognition of mass-transport, hyperpycnite, tempestite, mouth bar and terminal channel facies associations. Mass-transport deposits include distal debrite and proximal slump facies. Hyperpycnites vary spatially in scale and stratification. Distal hyperpynites are thin- to medium-bedded, centimeter- to decimeter-scale, and display well-developed inverse to normal grading. Medial hyperpycnites can be very thick-bedded, meter-scale, and exhibit alternating structureless and laminated/rippled divisions. Proximal hyperpycnites have internal erosional surfaces and may lack the lower inverse graded division. They are commonly hosted in erosional channels, where they intercalate with trough cross-stratified sandstones, indicating alternating suspension fallout; sediment bypass; traction current reworking and bedload transport. Tempestites include coquina beds, graded, laminated to wave-rippled and hummocky cross-stratified sandstones. Mouth bar sandstones can be graded, current-rippled, laminated, moderately burrowed and may have cyclic mud drapes suggesting buoyancy-dominated and tidally influenced river mouth processes. Alternatively, they may be associated with erosional terminal channels and dominated by trough cross-stratification reflecting frictional shallow-water processes.

The architecture and the stacking of the facies associations vary stratigraphically. The Mid-Qusaiba Sand wedges-out towards the basin margin and is partitioned, into lower and upper intervals, by a laterally extensive erosional surface dipping towards the basin center. The lower interval comprises down-stepping parasequences dominated by mass-transport deposits and hyperpycnites. These reflect a falling-stage detached delta front sedimentation in an unstable shelf-margin setting. The upper interval is capped by a transgressive boundary demarcated by *Glossifungites* Ichnofacies. It consists of hyperpycnites passing upwards into buoyancy-dominated mouth bars stacked in a progradational to aggradational pattern. These facies mark the advance of lowstand shelf-margin deltas. They are overlain by retrogradational parasequences comprised mainly of tempestites and wave-modified hyperpycnites reflecting back-stepping of the deltas and the development of a storm-dominated shelf. These transgressive deposits change gradually upsection into hyperpycnites, cross-stratified mouth bar and terminal channel sandstones. These are stacked into aggradational to progradational parasequences and represent regressive highstand inner-shelf deltas of the Sharawra Member. The stratigraphic architecture and the evolution from flood-controlled shelf-margin deltas to frictional inner-shelf deltas reflect sedimentation in progressively shallower water conditions and declining rates of sea-level rise and/or basin subsidence.

Multiple diagenetic environments and evolvement model in the Upper Paleozoic tight sandstone reservoir in Ordos Basin, China

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The abundant unconventional natural gas resources, if exploited reasonably and efficiently, will provide stable energy supply for the sustainable development of Chinese economy. In China, the prospective reserves of tight sandstone gas resources is estimated to be more than $12\times10^{12}m^3$, which take more than 20 percent of the total resource extent of the natural gas. Until recently, Ordos basin and Sichuan basin, as the biggest gas-bearing basin in china, have achieved the large-scale exploitation of tight sandstone gas. By thin-section analysis, scan electricity microscope observation, inclusion analysis, raman spectroscopic quantificational analysis, *R*o test and reservoir physical parameters analysis, combining histories of tectonic development and organic maturation, the diagenetic environment and diagenetic evolvement model of tight sandstone reservoir of the Upper Paleozoic in Ordos basin were studied. It was recognized that the tight sandstone reservoir in the Upper Paleozoic might have multiple diagenetic environments, such as acidic environment, alkali environment and alternating one of acidic and alkali environments. The forepart carbonate and feldspar dissolved but kaolinite and autogenic quartz developing in the same time were symbols of the acidic diagenetic environment The alkali diagenetic environment was indicated by quartz grain and secondary quartz outgrowth cement dissolved, secondary feldspar outgrowth cement and carbonate deposited in the same time. The diagenetic environments of tight sandstone of the Upper Paleozoic in Ordos basin underwent a process from fast compact in the early stage - alternating of acidic and alkali(obvious alkali locally) in the middle stage – intense cement in the last stage. After a series of diagenesis modification, the reservoir space of tight sandstone in the Upper Paleozoic mainly consist of quartz dissolution pores and microcracks. To sum up, the diagenetic evolvement and reservoir reconstruct model in the Upper Paleozoic tight sandstone reservoir in Ordos Basin were established.

Keyword: Ordos basin in China; Upper Paleozoic; tight sandstone reservoir; large gas field; diagenetic environment evolvement

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Paleogene tectonic evolution and controls on the sequence stratigraphic patterns in the central deepwater areas of the Qiongdongnan Basin, northern South China Sea

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In active rift basins, tectonism is extremely important for controlling sequence stratigraphic geometries, affecting both the sequence architecture and internal makeup. The sequence stratigraphic framework of a Paleogene rift succession in Qiongdongnan Basin, northern South China Sea, was built using seismic profiles, complemented by well logs and cores. One first-order and three second-order sequences were identified on the basis of basin-scale unconformities. Seven third-order sequences are also defined by unconformities along the basin margins, which pass into correlative conformities within the central parts of the basin. Through an unconformity analysis and sediment backstripping, the Paleogene syn-rift tectonic evolution of the deep water area of Qiongdongnan Basin was proved to be episodic and can be divided into rifting stage-I, rifting stage-II and rifting stage-III. Episodic rifting resulted in the formation of various types of structural slope break belts, which controlled different architectures and the internal makeup of sequences. This study enhances our understanding of the influence of tectonic evolution on sequence stratigraphic patterns in this basin. It also establishes relevant depositional patterns in a typical rift basin, and helps to model the location of favorable sandstone reservoirs in different sequence stratigraphic patterns, which will be helpful for subtle hydrocarbon pool exploration in deep water petroliferous basins.

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Dust in the Late Paleozoic Earth System: An Archive and Agent of Icehouse Climate and Climate Change

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Loess and dust deposits are well recognized and studied as both an archive and agent of climate and climate change for Earth's late Cenozoic record. Cenozoic deposits demonstrate that loess/dust are extra-tropical, generated by 1) physical (glacial) weathering in high-mid latitude regions, or 2) deflation of ephemeral lacustrine/fluvial systems, or eolian abrasion in low-mid latitude (desert) regions. Loess and dust remain less known prior to the Cenozoic, but evidence in continental and marginal marine strata indicate widespread deposition of loess and dust in western tropical Pangaea during the Late Carboniferous-Permian. These indicators of tropical atmospheric dustiness are highly unusual compared to the extra-tropical loess and dust of the Cenozoic. Here, we report on the growing recognition of voluminous dust deposits preserved in the Late Carboniferous-Permian record of the western-central U.S. (western tropical Pangaea), the timing and sources of the loess, and implications for tropical paleoclimate.

Many paleo-loess and dust deposits consist of red mud/siltstone in commonly structureless units, locally overprinted by pedogenic or sub-aqueous (e.g., lacustrine and marginal marine) processes, and also occur as silt trapped in epeiric carbonate systems formed isolated from fluvial input. The internally massive and laterally continuous character and fine grain size signal wind transport. They occur in the western-midcontinent US (western tropical Pangaea), as well as regions farther afield (e.g. Japan; low-latitude Panthalassa).The thickest unit documented to date reaches nearly 1 km, the thickest loess deposit documented anywhere on Earth, of any geologic age. Moreover, sedimentologic, sequence stratigraphic, and geochronologic data indicate that loess deposition pulsed on a glacial-interglacial, Milankovitch timescale, recording a link between dust formation/deposition, and glacial expansion/contraction. Provenance data for Permo-Carboniferous paleo-loess in the western-midcontinent US indicate sourcing in the Central Pangaean Mountains (Ouachita-Appalachian) and Ancestral Rocky Mountains, including crystalline basement rocks.

The tropical setting of these units is remarkably unusual relative to the Cenozoic, and requires semi-arid to arid conditions in the source regions, and a glacial-interglacial modulation of the source processes. Climate modeling using the Community Climate System Model version 3 (CCSM3) suggests that cold tropical climate with upland glaciation represents one scenario capable of replicating the conditions necessary for dust generation and mobilization from the Central Pangaean Mountains.

The Late Paleozoic icehouse has long been cast as climatically analogous to the Late Cenozoic, with glaciation limited to high-latitude regions of (primarily) Gondwanaland. If the hypothesis of more widespread (upland) glaciation is valid, then these vast deposits archive unusual climatic conditions, but moreover likely acted as major *agents* of climate change. Atmospheric dust affects radiative forcing directly, and indirectly-- through feedbacks that influence cloud and storm formation, as well as biogeochemical effects of seeding continental and marine ecosystems with highly chemically reactive material. Dust rocks in the late Paleozoic are vast, and house fascinating insight into the Earth System of our most recent pre-Cenozoic icehouse.

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Persistent non-solar forcing of Holocene storm dynamics in coastal sedimentary archives

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Considerable climatic variability on decadal to millennial timescales has been documented for the past 11,500 years of interglacial climate. This variability has been particularly pronounced at a frequency of about 1,500 years, with repeated cold intervals in the NorthAtlantic. However, there is growing evidence that these oscillations originate from a cluster of different spectral signatures, ranging from a 2,500-year cycle throughout the period to a 1,000-year cycle during the earliest millennia. Herewe present a reappraisal of high-energy estuarine and coastal sedimentary records from the southern coast of the English Channel, and report evidence for five distinct periods during the Holocene when storminess was enhanced during the past 6,500 years.We find that high storm activity occurred periodically with a frequency of about 1,500 years, closely related to cold and windy periods diagnosed earlier. We show that millennial-scale storm extremes in northern Europe are phase-locked with the period of internal ocean variability in the North Atlantic of about 1,500 years. However, no consistent correlation emerges between spectral maxima in records of storminess and solar irradiation. We conclude that solar activity changes are unlikely to be a primary forcing mechanism of millennial-scale variability in storminess.

Hydrological changes in western Central Asia (Kyrgyzstan) during the Holocene: Results of a paleolimnological study from Lake Son Kul

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From a 168-cm long composite core retrieved in lake Son Kul (a Kyrgyz alpine lake basin), we constructed an age-depth model covering approximately 8400 to 2000 cal yr BP on the basis of 9 AMS ^{14}C dates as well as a sequence model. The limnological and hydrological changes were examined by lithological and geochemical proxies, such as TOC, carbonate, grain sizes, stable oxygen and carbon isotopes, at a resolution equivalent to ca. 40 years. As indicated by $\delta^{18}O$ record of bulk carbonates, mainly consisting of aragonite, the Holocene hydrological balance was negative during most of time, suggesting an excess of evaporation (E) over precipitation (P). However, the long-term negative anomaly of precipitation was impeded by several stages of marked increase of precipitation that lasted several decades to a few centuries. Moreover, the precipitation changes are also documented by short excursions of stable oxygen and carbon isotopes to more negative values and by increased contents of minerogenic detritus and TOC. We propose that seasonal pattern of precipitation in western Central Asia varied transiently during the Holocene. When the annual water balance is less critical (E>=P), the excess of precipitation mostly was due to increased precipitation during cold season when oxygen isotopes of carbonates became more negative. However, similar to today most of the time moisture was delivered during warm season when the annual water balance was negative (E>>P). The increases of precipitation during cold season in the Tien Shan mountain ranges coincide with the North Atlantic ice rafted detrital (IRD) events from 5 to 2. This indicates that the Artic and adjacent Seas played an important role in transporting moisture to western Central Asia during these periods. On the contrary, when the Holocene hydrological balance was negative, moisture was mainly delivered during summer from the extended Caspian-Aral Basin. However, a minor amount of precipitation forming during cold season was originated mainly from the eastern Mediterranean and occasionally from the Arctic.

Gravity-flows processes and depositional architecture on the Gulf of Genoa submarine fan system

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The behavior of gravity-flows processes in relation to morpho-bathymetric trends as well as the evolution of architecture and sedimentary facies in submarine canyons are crucial points in the understanding of turbidite systems. Furthermore, the potential connection/disconnection between the canyon area on continental slopes and the distal deposits in deep basins has a strong impact on the longitudinal connectivity of sand-prone bodies and could thus impact reservoir models.
In this contribution, we focused on the recent activity and the detailed analysis of sedimentary structures/architectures of two canyons located in the Gulf of Genova (Ligurian basin, north western Mediterranean). Since the Pliocene, this margin segment has undergone a tectonic inversion leading to the reactivation of inherited transverse structures and development of new fault systems. Such tectonic activity is responsible for the enhancing of gravity-driven processes on the continental slope. The aim of this work is to better constrain the effect of the morpho-bathymetric trends, linked to the uplift of the margin, on the architecture and depositional patterns along the canyons and at the canyon-basin transition. The results of this study are based on the integration and interpretation of multibeam bathymetry, seismic profiles (Chirp, High-resolution 24 and 72-channels data, deep-towed "Sysif" data) and cores collected during the MALISAR (2006, 2007) and PRISME cruises (2013).
In the Gulf of Genova, the two Polcevera and Bisagno canyons coalesce at about 2100m water depth to form the Genova valley that fed Ligurian basin. Currently, these canyons are disconnected from river mouths on land but canyon heads exhibit evidences for the recent triggering of abundant submarine landslides, representing a total eroded volume of 14.1km3. The main sediment processes active during the present-day sealevel hightstand are thought to be large ignitive turbidity currents resulting from the transformation of landslides. Within the canyon thalwegs, side-scan sonar (SAR) images combined with Chirp data allow discriminating three planform patterns: (1) Deposition of coarse/fine particles on scroll-bar-like features and downstream from knickpoints, on slope angle of 3-4°; (2) Erosion above previously deposited cohesive-flow material freezing in areas of slope angle 1-2° in the main canyon body; (3) Bypass over bedrock in areas of increasing slope angle to 4-5° along the last 30 km of the canyon mouth. This bypass zone is responsible for the disconnection between the canyon deposits and the distal basin accumulation.
The distal accumulation built at the mouth of the Genova valley. Here, it does not consist of a channel-levee system but of the stacking of lenticular bodies migrating by lateral compensation and retrograding within the canyon mouth in response of the margin deformation. The whole accumulation is about 640km2. The development of the accumulation is controlled by the growth of faults at the transition between the continental slope and the basin. From the core data, the youngest deposits consist of sandy to gravelly turbidites and debrites, about 30cm thick.

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Facies and benthic foraminiferal fauna from cold-water coral mounds and reefs: Tools for paleoceanographic reconstructions

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Cold-water coral (CWC) ecosystems are especially developed along the European margins, where they have been extensively studied. Their investigation and documentation present a challenge to understand their development, preservation and possible importance in the geologic record.

The scleractinian *Lophelia pertusa* is the main frame-building coral in these ecosystems together with *Madrepora oculata*. It settles and colonizes hard substrates, in environments characterized by elevated currents and high food availability. Along the European margin these CWC mounds and reefs characterized indifferent times with different morphologies: they colonized elevated hard substrata along the upper slope of the Norwegian shelf, and large carbonate mounds along the Irish margin (Rockall and Porcupine Bank, Porcupine Seabight) and in the Gulf of Cadiz.

The CWC reefs are "hot spots" of biodiversity as their warm-water counterparts. We present here the last 12 years of our studies on foraminiferal assemblages associated with CWC ecosystems along the European margin and in the Mediterranean Sea. Selected species of 373 benthic foraminifera including those poorly reported in the literature are documented in a comprehensive Atlas and ecological conditions are described for the different regions.

Recent and sub-recent benthic foraminiferal assemblages in these ecosystems are strictly related to environmental parameters and to the distribution of sedimentary facies. They show strong similarities among different regions and different latitudes, e.g., Norwegian margin, Porcupine/Rockall Bank and Mediterranean Sea and are different from those characterizing off-reef/-mound settings.

Benthic assemblages from reefs or mounds are dominated by epifauna, e.g., *Discanomalina coronata*, *Cibicides refulgens*, and *Lobatula lobatula* but also infaunal species e.g., *Angulogerina angulosa*, *Globocassidulina* spp., *Epistominella* spp., *Cassidulina* spp. are highly abundant. This faunal composition represents the typical benthic fauna occurring in high-energy and oxygenated settings and high organic matter supply, requiring similar ecological conditions as CWC. Therefore, benthic foraminifera are the ideal faunal tool to investigate CWCs as they have the potential to be preserved in the fossil record and can provide valuable information on the fossil record.

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Sedimentological evidence for tsunamis and storms at Anegada, British Virgin Islands

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Anegada, a small Antilles island, offers uncommon opportunities to parse geologic evidence for extreme waves in the northeast Caribbean. The island's depositional and erosional features may record tsunamis of nearby and distant origin as well as tropical cyclones.

Anegada is a low lying island (max. 8 m asl) situated ca. 125 km south of the Puerto Rico trench. The coast consists of sandy beaches with several generations of beach ridges in their back. Hypersaline ponds in which microbial mats are growing, dominate the western part of the island, whereas the eastern part is mainly represented by karstified Pleistocene limestone pavements. A coral reef several hundreds of meters offshore fringes the island on its N/NE side.

Anegada´s position on the outer rim of the Caribbean island arc makes it vulnerable to the impacts of hurricanes crossing the Caribbean Sea, and tsunamis of regional origin, as well as trans-Atlantic tsunamis. Historical reports and recent observations prove that Anegada experienced several hurricane impacts (e.g., 1713, 1819, 1960, 1989, 1995, 2008, 2010) and large tsunamigenic earthquakes (e.g., 1690, 1785, 1787, 1867, 1918) within the last centuries. These reports do not mention any tsunami effects on Anegada. This is surprising on the first glance because neighbouring islands, such as St. Maarten, Hispaniola, etc. were hit by historical tsunamis. If these events may have affected Anegada, discontinuous settlement of people on Anegada hampered their documentation.

The nearshore environments on Anegada produce sufficient carbonate sediment to provide calcareous material for onshore transport during high-energy wave events. The variety of sedimentary archives on Anegada (salt ponds, beach ridges, coastal platforms) offers the possibility to search for sedimentary and erosional evidence of such inundation events and to correlate the preserved features in different depositional environments.

Sedimentological evidence on Anegada is present as graded units of carbonate mud and shell hash in salt ponds, fields of coral boulders (max. boulder diameter ca. 2 m) that reach up to 1.5 km inland, and coast parallel coral rubble ridges. Erosional features include breaches in beach ridges as high as 3 m asl.

Initial results point out that Anegada was at least twice hit by severe inundation events, most possibly tsunamis in AD 1200-1450 and 1650-1800. The AD 1200-1450 event seems to be the most devastating one to have hit Anegada, possibly representing a regional tsunami caused by an earthquake, e.g. on the outer rise of the Puerto Rico trench or along a olique-slip-thrust fault at the nominal plate boundary. The younger event may be related to the 1755 Lisbon tsunami, but more age data is needed to underline this. In contrast, the effects of recent hurricane surges (up to category 4) are much smaller.

Transient but pertinent: constraining the sedimentary architecture of intraslope submarine lobes using exhumed examples from the Karoo Basin, South Africa

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Commonly, submarine slopes have an uneven seabed bathymetry that influences sediment dispersal patterns. Intraslope lobes develop in areas of transient accommodation, and have been identified from reflection seismic datasets on many continental margins (e.g. the Gulf of Mexico, Niger Delta). However, intraslope lobes are seldom identified at outcrop due to insufficient continuity of exposure to confirm their context. Therefore studies of their depositional architecture are rare. Extensive exposures of discrete sand prone packages in Unit E, Fort Brown Formation, Karoo Basin, South Africa, permit analysis of the sedimentology and stacking patterns of two intraslope lobes in the Geelbeck and Zoutkloof areas. Bed-by bed sections were logged along oblique dip sections, and physically correlated.

At Geelbeck, subunit E2 is divided into 3 packages along an 8 km outcrop. The basal subunit (E2.A) is characterised by deposits from turbidity currents with opposing flow directions and distinct erosional surfaces which, when combined with horizontal datums, indicate a highly confined setting. Subunit E2.B has a highly erosive base cutting out E2.A up-dip, and is dominated by thick bedded structureless sandstones. Subunit E2.C is the most extensive of the subunits, shares close facies affinities with terminal lobes, and indicates a final relatively unconfined phase of deposition. However, the lobe off-axis environment is characterised by medium to thick bedded climbing ripple laminated sandstones, while common facies transitions occur over 10s of metres.

Zoutkloof offers the possibility of 3D reconstruction of an intraslope lobe in Subunit E1 as outcrops can be found along three adjacent ridges. Channel-fills of subunits E1, E2 and E3, incise through the intraslope lobe deposits indicate the transient state of the accommodation before the system healed the bathymetry and propagated basinward. The deposits of the intraslope lobe fringe environment are dominated by climbing ripple laminated and sigmoidal bedforms that indicate rapid deposition, which supports the presence of bathymetry.

These sub-seismic scale field observations on intraslope lobes can be used to improve the understanding of depositional architecture and facies composition of these deposits, and thus the stratigraphic evolution of submarine slope systems.

Frequency and initiation mechanisms of submarine slides inferred from levee deposits on the Fraser Delta front, British Columbia, Canada

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The Fraser Delta hosts a population of over 500,000 including the municipalities of Richmond and Delta and the Vancouver International Airport. The main arm of the Fraser River has been fixed in place by construction of a jetty focusing sediment deposition at the mouth of the main distributary channel. There is a history of submarine slide events at the delta crest which pose substantial risk to coastal infrastructure near the delta front. At least one past slide event was large enough to be tsunamigenic, although no surface expression was observed. A submarine channel, characterized by prominent levee deposits, extends seaward from the main distributary channel.

Sand beds in levee deposits indicate turbidity currents which were large enough to overspill the channel walls and are used as a proxy for slide events from the delta crest. Sediment cores collected from levee deposits were analyzed to infer a chronology of slide events. Ages of sand beds were resolved by establishing a sediment accumulation rate using excess ^{210}Pb activity from mud intervals inferred to represent constant deposition from the Fraser River. Sedimentation on the levee is characterized by sandy mud, interpreted to be deposited continuously by river plume suspension fall-out, and two distinct kinds of sand beds which represent two genetically different processes. The first type of sand bed (Facies 6) is thick, sharp based and clean, often showing classic Bouma turbidite elements including a massive sand base followed by planar laminations, fining up to a mud top and is interpreted as the deposit from slides involving large volumes of material at the upper reaches of the tributary channels. The second type of sand bed (Facies 5) is characterized by more poorly sorted muddy sand, has gradational contacts, and is interpreted as a deposit from river generated turbidity currents.

Facies 6 sand beds often occur in sets of 2 to 4 beds and individual bed sets correlate in age to known large-scale slide events with a return interval of 10 to 15 years during the past 40 years. Deposits of smaller events, including Facies 5 beds, occur on average every four to five years. Event ages are compared to large spring floods from the Fraser River and seismic activity to determine any causal relationship. The return period of event beds corresponds to that of above average river flood years, but the largest sand beds do not correspond directly to the largest flood years or to seismic activity. It is concluded that there are likely a combination of other factors which determine the volume of slope failure including cumulative over-steepening and increased pore pressure.

Faunal assemblages and geochemical signatures from cold-water coral ecosystems reveal paleoceanographic variations in the western Mediterranean Sea

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The Melilla Mounds Field located on the southeastern margin of the Alboran Sea is a cluster of biogenic deep-water carbonate buildups. They form elongated and dome shaped mounds in 230 to 500 m water depths, are up to 100 m high and partially buried under fine grained sediments. Radiocarbon dating suggests that these mounds started to develop during the Bølling–Allerød interstadial. Benthic and planktonic foraminifera were investigated in cores MS–396G (355 cm core length), MS–399G (340 cm) and MS–401G (560 cm) recovered during TTR17 cruise at water depths of 300 m, 258 m and 251 m, respectively. Benthic foraminifera species were identified, at least 200 specimens per fractions (63–125 µm, 125–250 µm and >250 µm) were counted. Analyses of total organic carbon (Rock-Eval pyrolysis), stable $\delta^{13}C$ and $\delta^{18}O$ isotopes of planktonic and epibenthic foraminifera, stable $\delta^{13}C$ and $\delta^{15}N$ isotopes of the organic fraction were carried out. The bioclastic fraction (>250 µm) was qualitatively and quantitatively analyzed and consists of scleractinians, bivalves, echinoderms, bryozoans, serpulids and occasionally verrucids.

The three cores are correlated based on six AMS ^{14}C dates and on a major turnover of the planktonic foraminifera fauna from an interval dominated by *Neogloboquadrina incompta* to an interval dominated by *Globorotalia inflata*, dated at ca. 8 kyr BP in the Alboran Sea. All cores contain abundant cold-water coral fragments, dominated by *Madrepora oculata* in the upper 60 to 100 cm and *Lophelia pertusa* in the lower part, and are characterized by a relatively high benthic foraminifera diversity (up to 180 species). Detailed cluster analysis on the benthic foraminiferal compositional data highlights the occurrence of three major assemblages in the cores consisting of BFA1 dominated by *Bolivina dilatata* and *Nonionella turgida*, BFA2 characterized by epibenthic species (*Discanomalina coronata*, *Cibicides* spp., *Cibicidoides pachyderma*) and BAF3 (*Bolivina* spp., *Bulimina* spp., *Hoeglundina helegans* and *Uvigerina mediterranea*) representative of the upper part of the cores coinciding with the replacement of *N. incompta* by *G. inflata*. These three benthic foraminifera assemblages suggest the evolution of a relatively cold, nutrient-rich and poor oxygenated environment (BFA1) to a cold, nutrient-rich, well oxygenated and high energy environment (BFA2), followed in turn by an environment characterized by (strongly) oxygen-depleted bottom waters and high productive surface waters (BFA3).

Benthic foraminifera assemblages BFA1–BFA3 respond to the source and preservation of the organic carbon exported to the sea-floor as suggested by the Rock-Eval data and the isotopic signature of the organic matter. Moreover, variations in benthic foraminifera assemblages can be correlated to changes in composition, abundance and/or size of other faunistic groups. Foraminifera assemblages, and the principal macrofaunal components show evidence for paleoceanographic variations in the western Mediterranean Sea since the late Pleistocene and indicate that *M. oculata* may thrive in a more stressed environment compared to *L. pertusa*.

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Specific palaeoenvironmental conditions during the OAE 1a at the stratotype section of Cassis-La Bédoule (Provencal basin, southeast France)

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The well-dated section of Cassis-La Bédoule in the South Provencal Basin (southern France) allows for a detailed reconstruction of palaeoenvironmental change during the latest Barremian and Early Aptian.

For this study, phosphorus (P) and clay-mineral contents, stable-isotope ratios on carbonate ($d13C_{carb}$) and organic matter ($d13C_{org}$), and redox-sensitive trace elements (RSTE: V, U, As, Co, and Mo) have been measured.

The base of the section consists of rudist limestone, which is attributed to the Urgonian platform. The low P and RSTE contents, associated to up to 30% of kaolinite in the clay mineral assemblages indicate deposition under oligotrophic and oxic conditions, and the presence of warm, humid climatic conditions on the adjacent continent. The top of the Urgonian succession is marked by a hardground with encrusted brachiopods and bivalves, which is interpreted as a drowning surface. The section continues with a succession of limestone and marl containing planktonic foraminifera. This interval includes several laminated, organic-rich layers recording RSTE enrichments and high C_{org}/P_{tot} ratios. This suggests the deposition of these organic-rich layers under oxygen-depleted conditions. During this interval, a negative peak in the $d13C_{carb}$ record is observed, which dates as latest Barremian. In this interval, an increase in P content, owing to reworking of nearshore sediments during the transgression, is coupled with a decrease in kaolinite content, which tends to be deposited in more proximal areas. The overlying hemipelagic sediments belong to the Early Aptian (*Deshayesites oglanlensis* and *D. weissi* zones). This interval is marked by rather stable palaeoenvironmental conditions with low P content and stable d13C values. A change towards marl-dominated beds occurs close to the top of the *D. weissi* zone. These beds display a long-term decreasing trend in $d13C_{carb}$ and $d13C_{org}$ until the end of the *Deshayesites deshayesi* subzone (corresponding to isotope stage C3). The following positive shift in d13C during the *Roloboceras hambrovi* and *Deshayesites grandis* subzones corresponding to oceanic anoxic event (OAE) 1a interval, is coeval with two increases in the P content. The marly interval equivalent to OAE 1a lacks organic-rich deposits and RSTE enrichments indicating that oxic conditions prevailed in this particular part of the Tethys Ocean. The clay mineralogy is dominated by smectite, which is interpreted as reflecting the trapping of kaolinite on the surrounding platforms rather than indicating a drier climate

The Cassis-La Bédoule section recorded important palaeoenvironmental changes around the Barremian-Aptian boundary leading to several anoxic phases. On the contrary, strong anoxic conditions during OAE 1a were not observed. This specificity within the Tethys Ocean is probably linked to the particular palaeogeographic position of the La Bédoule section remote from centers of important marine palaeoproductivity and organic-matter preservation.

Multi-technique single-grain and whole rock analysis of dust source variation to the Chinese Loess Plateau

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The Chinese Loess Plateau records past atmospheric dust dynamics over potentially 10s of millions of years. Debate over the origin of this material limits interpretation of sedimentary climate proxies and understanding of the causes of past dust generation. Recent work using heavy mineral analysis and detrital zircon U-Pb age has suggested that at least during the Quaternary dust sources seem to have been related to the northeast of the Tibetan plateau, perhaps transported via the Yellow River and stored in local desert systems. However, some authors also emphasise the role of the Gobi Altai and there is little consensus on whether loess sources vary through time or across the Plateau. Here we analyse Quaternary-Pliocene loess and red clay from the Chinese Loess Plateau, as well as modern river samples from the upper reaches of the Yellow River for bulk geochemistry, heavy minerals, single-grain zircon U-Pb age and quartz luminescence characteristics. We analyse multiple sites and track source changes through the Quaternary. We also make comparisons to Pliocene red clay sediments to examine the nature of the transition between Pliocene to Quaternary climate regimes. Generally, Yellow River samples from Qinghai and Gansu provinces yield signatures that are almost identical to those from the Chinese Loess Plateau. This suggests that dust on the Loess Plateau shares a source with modern fluvial sediment from the upper reaches of the Yellow RiverWhile Quaternary provenance signatures strongly suggest a northeastern Tibetan Plateau origin, Pliocene dust may have come from more distal northwestern Tibetan plateau sources, although vary through time. There is also clear evidence of Quaternary dust source variation across the Loess Plateau, implying spatial complexity in sources. Abrupt changes in source appear in late Quaternary loess but consistent differences between glacial and interglacial periods are less apparent.

Insights from Lake Van (Turkey) into decadal to orbital-scale drought intensities in the Eastern Mediterranean during the past 360 ka

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Decadally-resolved lacustrine paleoclimate records from deep closed lakes can provide new insights into the mechanisms of past environmental changes in the continental interior. We retrieved a 220-m long sedimentary sequence from Lake Van (Turkey) that records over 600,000 yrs decadal to orbital-scale climate variability.

Using a suite of proxies in this record we reconstruct variations in run-off, lake level, water mixing, chemistry and shoreline distance. Dansgaard Oeschger (DO)-related hydroclimate variability can be traced over several glacials. Sedimentary color data (B*) capture the details of DO variability and rainfall seasonality in an unprecedented manner, allowing for a detailed study of global climate linkages on centennial to millennial timescales. The reconstructed DO teleconnections and regional hydroclimate changes in Turkey are consistent with a transient 50-30 ka B.P climate model simulation which was forced by estimates of iceberg calving in the Nordic Seas. Our detailed paleo data/model comparison supports the notion that centennial-to millennial scale iceberg instabilities, originating from the Northern Hemisphere ice-sheets, caused major disruptions of the Atlantic Meridional Overturning circulation, which in turn shifted global hydroclimate patterns.

The Lake Van record further documents the presence of pervasive glacial DO continuum variability extending back to at least 360 ka B.P. The statistics of this variability as well as the orbital scale hydroclimate changes in the Eastern Mediterranean are clearly modulated by glacial ice-volume changes. This result is further supported by another 408-0 ka-transient climate model simulation, which provides a means of quantifying the direct orbital effects on Mediterranean seasonal rainfall changes, as well as the ice-sheet induced changes of the large-scale atmospheric circulation and hydroclimate.

Global to continental-scale glaciations and their sedimentary record on the Precambrian Earth

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Earth's climate during the Precambrian was marked by major glacial events with evidence for large continental ice sheets on many cratons, and with sedimentological data indicating that glaciers had extended to sea-level. This study emphasizes the sedimentological and sequence stratigraphic responses to glaciations to evaluate the major driving forces of glaciations during the Precambrian. First- and second-order sequences are recognized related to continental-scale fragmentation and formation of marine rift basins wherein sedimentary rocks indicate glacial influences and pronounced tectonic climatic linkages. These glacial deposits seem always to be associated with extensional tectonic setting, although not necessarily always having very intimate relationships to the Earth's supercontinent cycles.

During the Precambrian, however, it is suggested that long-lived marine terminated glaciers also situated at low paleolatitudes, were related to an extensional tectonic setting and possible global extent. In such settings, glacial deposits associated with sedimentary sequences of distinctively different origin, e.g. carbonate and chemically mature siliciclastic sequences, can well be used to detect the prominent sequence boundaries to verify depositional systems tracts. Internal sediment stacking patterns in sequences are indicative of dynamic processes along glaciated continental margins and without always having the need for global synchroneity. In glacially influenced rift basins and continental margins it is important to recognize the sequence boundaries of significant subaerial unconformities and their correlative conformities. A sequence boundary is a chronostratigraphically significant surface always produced as a consequence of a change in relative sea-level. These can then be well related to initiation and decay of glaciations.

There is a need to continue detailed sedimentological studies of pre-glacial and post-glacial deposits as well as to interpret syn-glacial lithofacies for their inferred transportation and depositional processes. Pre-glacial deposits, especially, should provide a new target to help us understand the processes that initiated these Precambrian glaciations. For better comprehension of the environmental settings of these glaciations there is a need to detect at least the first- and second-order global cycles possibly formed due to glacioeustacy in different cratons including the Amazon, Congo, Kaapvaal, Karelian, Pilbara, Rae-Hearne, São Francisco, Singhbhum, Superior and Yilgarn cratons. The sequence stratigraphic approach with understanding of the stacking pattern of depositional systems could prevent oversimplification and use of just single events to explain the complexity of evolution of glacially influenced Precambrian continental margin sediments.

Palaeogeography of a shallow carbonate platform: the case of the Oxfordian in the Swiss Jura Mountains

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According to the Oxford Dictionaries, palaeogeography is "the study of geographical features at periods in the geological past". Commonly, palaeogeographic maps are based on plate-tectonic reconstructions and cover large areas. Coastlines and facies distributions are presented time-averaged over million-year long time intervals. In the case of shallow carbonate platforms where facies patterns change rapidly through time as well as through space, it is useful to search for a more detailed picture of palaeogeography.

The Late Jurassic (Oxfordian, Kimmeridgian, and Tithonian) carbonate-dominated platform outcropping in the Swiss Jura Mountains offers a good biostratigraphic, sequence-stratigraphic, and cyclostratigraphic framework to reconstruct changes in facies distribution at a time-resolution of at least 100 kyr and thus allows interpreting the dynamic palaeogeographical evolution in detail. As examples, two Oxfordian time slices are presented: one around sequence boundary Ox6 (Grossuvrei-Hypselum ammonite subzones), and one between sequence boundaries Ox7 and Ox8 (Bimammatum-Hauffianum subzones). The studies are based on 15 sections logged at cm-scale. The interpreted depositional environments include marginal-marine emerged lands, freshwater ponds, tidal flats, shallow lagoons, ooid and bioclastic shoals, and coral reefs. Although carbonates dominate, marly intervals occur sporadically.

Major facies shifts are related to m-scale sea-level changes linked to the orbital short eccentricity cycle (100 kyr). The 20-kyr precession cycle caused minor facies changes in sensitive (i.e. very shallow) environments but cannot be resolved in all sections. Synsedimentary tectonics induced additional accommodation changes, by creating shallow basins where clays accumulated or highs on which islands formed. Climate changes intervened to control terrestrial run-off and, consequently, siliciclastic and nutrient input. Coral reefs reacted to such input by becoming dominated by microbialites and eventually by being smothered. Concomitant occurrence of siliciclastics and dolomite in certain intervals further suggests that, at times, it was arid in the palaeo-study area but there was rainfall in more northern latitudes, eroding the Hercynian substrate.

These examples from the Swiss Jura demonstrate the highly dynamic and (geologically speaking) rapid evolution of sedimentary systems, in which tectonically controlled basin morphology, orbitally induced climate and sea-level changes, and the ecology of the carbonate-producing organisms interacted to form the observed stratigraphic record.

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Sequence stratigraphy and cyclostratigaphy – nothing new yet full of promise

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Repetitive facies changes in the sedimentary record have always fascinated geologists. Already in 1864, Croll attributed them to climatic cycles. Gilbert (1895) related the limestone-marl alternations in the Late Cretaceous Niobrara Formation to the cycle of the precession of the equinoxes. Heim (1909) rather saw them as a result of "organo-chemical" processes. Milankovitch (1941) linked the Quaternary glaciations to climate changes induced by orbital cycles and calculated the parameters, and his name now is used (or misused) for all kinds of sedimentary cycles. In the following, many authors discussed – sometimes controversially - the origins of sedimentary cycles (climatic vs eustatic vs tectonic vs diagenetic; allocyclic vs autocyclic). As this congress is held in Geneva, Augustin Lombard (1905-1997), professor at the University of Geneva, must be mentioned. As an excellent stratigrapher and pioneering sedimentologist, he discussed all types of stratification, including limestone-marl couplets (e.g., Lombard 1965, Davaud and Lombard 1975).

The term "Cyclostratigraphy" was introduced at the meeting of the Global Sedimentary Geology Program in Perugia (Italy) and Digne (France) (Fischer et al. 1988). Hilgen et al. (2004) give the following definition: "The subdiscipline of stratigraphy that deals with the identification, characterisation, correlation, and interpretation of cyclic (periodic or nearly periodic) variations in the stratigraphic record and, in particular, with their application to geochronology by improving the accuracy and resolution of time-stratigraphic frameworks". Cyclostratigraphy is now becoming an important dating tool. Astronomical target curves are available down to the Miocene (the 405-kyr long eccentricity cycle down to the Late Cretaceous), and intercalibration with radiometrically obtained ages improves the geological time-scale (e.g., EARTHTIME project).

Sequence stratigraphy evolved differently and was first based on the interpretation of seismic lines for the purpose of hydrocarbon exploration. Sloss et al. (1949) introduced the concept of sequences. Mitchum (1977) and Vail et al. (1977) then developed the well-known "Exxon" model, which was constantly refined in the following years and also applied to outcrops and downhole logs. Based on sequence-stratigraphic patterns around the world, Haq et al. (1987) proposed a "Chronology of fluctuating sea levels since the Triassic". The "Exxon" model as well as the "global" eustatic sea-level curves provoked abundant controversy that, however, stimulated fruitful new research. Today, the sequence-stratigraphic concepts are being continuously refined and adapted to the studied sediments and basins, and the sequence-stratigraphic nomenclature is being standardized (Catuneanu et al. 2009).

For the use of both sequence stratigraphy and cyclostratigraphy, there are conditions: the sedimentary record must be as complete as possible and well dated, and the functioning of the sedimentary system must be fully understood. As such, these disciplines are strongly dependent on sedimentology as well as on bio-, chemo-, and chronostratigraphy, and the geodynamic and oceanographic context must be known. While sequence stratigraphy and cyclostratigraphy have evolved mostly as separate disciplines so far, there is a great potential in combining the two approaches. Orbitally controlled insolation changes create sea-level changes that may leave a signature in the sedimentary record. The resulting sequences can then be analysed and interpreted with the sequence-stratigraphic tools, revealing the dynamics of the sedimentary system. Ultimately, this will improve our understanding of sedimentary, oceanographic, climatic, and biological processes with a (geologically speaking) very high time resolution.

Submarine landslides and turbidites from the St. Lawrence Estuary and Saguenay Fjord regions, Eastern Canada: a Holocene paleoseismological record

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The St. Lawrence Estuary and the Saguenay Fjord regions are located within the Charlevoix-Kamouraska/Lower St. Lawrence Estuary seismic zone (CK/LSLE), the most active intraplate seismic zone in Canada, where at least five earthquakes of magnitude 6 or stronger occurred during the last 350 years. In addition, due to very high sedimentation rates (as high as 30 m/ka in the St. Lawrence Estuary during deglaciation), the deposition of marine clays during deglaciation, and the influence of postglacial rebound, the thick Quaternary sedimentary sequence is prone to remobilisation following strong earthquakes. Here, using sedimentological, paleomagnetic, geochronological and geophysical data, we will overview some of the large Holocene submarine landslides and turbidites recorded in the St. Lawrence Estuary and Saguenay Fjord and discuss their characteristics and implications as paleoseismological archives. Finally, although sediments can record seismic events they cannot directly inform on the magnitude of a given seismic event. Using the dated distribution of these signatures in lakes, an approach similar to the one proposed by Keefer (1984; GSA Bulletin 95, 406-421) using the areal distribution of such signatures will be introduced as a way of estimating the magnitude of these earthquakes.

Morpho-sedimentary features of the slope-confined submarine canyons in the Shenhu Area, northern continental slope of the South China Sea: the sediment routing system from north to south

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The eighteen slope-confined submarine canyons at the water depth of 500-1600 m were the most distinctive features from the bathymetric map in the Shenhu Area, northern continental slope of the South China Sea, showing the NNW-SSE orientations with relatively short (30-50 km), straight, and narrow (1-8 km in width) courses. Using bathymetric and seismic data covering areas ranging from upper slope to lower slope and basin floor, this study describes the morpho-sedimentary features of the eighteen submarine canyons, divides the segments from north to south, and reveals the sediment routing system sub-perpendicular to the continental slope.

According to the morphological features of the seafloor and internal architectures of the canyons, in this area, five segments could be divided from north to south, the head area, the upper, middle and lower reaches, and the mouth of the canyons to basin floor. At the head area, due to the abrupt changes of the seafloor topography adjacent to canyons (about 3.2º to 4.8º), the sediments would be dragged downwards to the canyons with truncations of the seismic reflectors, which could be interpreted as the detachment faults. Hence, on the plane, creeps with short linear structures could be observed in the north near the canyons, with the NEE trending. In the upper reach, the bases of the canyons equated to the seafloor and no infillings could be observed. Because of the relatively steep flanks (about 2.5º to 9.3º), sediment failures were developed on the flanks. The bases of the canyons in the middle to lower reaches were interpreted as the paleo-erosional basements. The infillings were constituted of two parts, chaotic, moderate to high amplitude reflectors with several discordances at the bottom, and continuous, moderate-amplitude reflectors with some convex morphological features at the top, which might be suggested as the axial deposits along the talwegs and the sediments collapsed from the ridges, respectively. Unlike the sediment failures at the flanks in the middle reach, in the lower reach, the characteristics of the overbanks could be observed, such as the levees. The increasing thickness of the infillings from upper reach to lower reach indicated that these slope-confined canyons were suggested as the main conduits for the sediments transportation. In the mouth of the canyons to basinfloor, sediments transported through the canyons could be accumulated as the layer-cake stratigraphy with continuous reflectors, turbidites with high-amplitude reflectors, and mass transport complex (MTC) with chaotic reflectors. The sediments could be re-transported along the Pearl River Mouth Canyon from north to south, and parts of them might be deposited in the Southwest Sub-basin. On the basis of these five segments, these eighteen slope-confined submarine canyons were preferred to be initiated as the sediment failures associated with sediment supplies from the north and the seafloor topographic changes. Therefore, these canyons are represented as the sediment routing system sub-perpendicular to the continental slope, linking the terrigenous deposits transported through shelves and upper slopes in the north and the sediment accumulations in the Pearl River Mouth Canyon and the Southwest Sub-basin in the south.

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Digital Outcrop Models and Distribution of Facies of Pleistocene Carbonates in Bonaire, Southern Caribbean

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Bonaire is an isolated carbonate platform in the southern Caribbean part of the Netherland Antilles, (ABC islands) with Aruba and Curacao. Bonaire is located in the South Caribbean Plate Boundary Zone (SCPBZ), which separates the Caribbean and South American plates. Its development is related to subduction of the Caribbean plate creating volcanism that occurred during the Late Cretaceous. The ABC islands are located on the Bonaire Block, which is underthrusted by the Caribbean Plate to the north, and forms a dextral strike-slip fault with the Maracaibo Block to the south, which is part of the South American Plate. The underthrusting of the Caribbean Plate is estimated to be between 150-250 km, and has led to deformation in the SCPBZ, producing uplift and exposing the ABC islands. The Cretaceous volcanic rocks form the basement of the carbonate island, being comprised of basalts, dacite, and andesite. Carbonate production began in the Miocene, and continues to this day. Through the Plio-Pleistocene, Bonaire has been influenced by uplift and sea level fluctuation, so that seven terraces are recognized, ranging from 5 to 90 m above present sea level.

The objective of this study is to understand the facies distribution of the Pleistocene carbonates and their evolution through time. The importance is due to the lack of studies on the facies distribution, as well as Pleistocene dolomites not being previously described. Cores and hand samples have been taken throughout the island, and with thin sections a facies scheme has been developed. Seismic transects have also been acquired across the center of the island, with the objective of creating a 3D visualization. DEMs using LiDAR and digital outcrop modellings have been created to define the morphology of the deposits.

The facies present are commonly boundstone with corals (*Diploria sp.* and *Acropora sp.*) as the main component, as well as bioclastic grainstones. A massive dolomite is present in a terrace that can be correlated across the northeast side of the island. The carbonate deposits overlaying the volcanic basement show a trend from north to south of progressively younger carbonate rocks, with Miocene outcrops at Goto Meer, and Holocene carbonate sediments at Lac Bay and Pekelmeer. Pleistocene outcrops are most abundant, and span most of the carbonate portion of the island.

Upper Cretaceous Hinterland Basin of the Lhasa Block, with Implications for Early Topography Uplift of the Southern Tibetan Plateau

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The tectonic evolution of the Lhasa block (southern Tibetan plateau) plays a fundamental role on the formation of the Tibetan plateau, however, many uncertainties remain concerning the tectonic and paleogeographic evolution of the Lhasa block prior to the India-Asia collision. To determine the early tectonic processes that controlled the topographic evolution of the Lhasa block, we analyze the Upper Cretaceous strata exposed in the Cuoqin basin (northern Lhasa block), which comprises the Penbo and Daxiong formations. The Penbo Formation unconformably overlies the Lower Cretaceous Zelong Group volcanic rocks and consists of ~80 m orbitolina-bearing limestone, which was deposited in a low energy, shallow marine environment. Micropaleontological analysis indicates that the Penbo Formation was deposited from latest Aptian to Early Cenomanian times (~113-96 Ma). The overlying Daxiong Formation (~1700 m thick) consists of conglomerate, coarse sandstone, and siltstone with interbedded mudstone, recording deposition of alluvial fans and braided rivers. The Daxiong Formation was deposited after Early Cenomanian time (~96 Ma) and accumulated until at least ~92 Ma, indicating relatively rapid accumulation rates of more than 0.4 km Myr^{-1}. By combining paleocurrent data, sandstone petrology, detrital zircon U-Pb ages and Hf isotopes analysis, we demonstrate that the Daxiong Formation was mostly sourced from the northern Lhasa block. During the Late Cretaceous time, two thrust systems with opposite vergencies were responsible for transforming the northern Lhasa block into an elevated terrain, resulting in the environmental evolution from shallow marine (Penbo Formation) into a terrestrial depositional environment (Daxiong Formation). Given the regional paleogeographic context, we propose that the Daxiong Formation was deposited in a hinterland basin influenced by regional upper crustal deformation. The development of this basin is analogous to the Altiplano basin in the central Andes during the Late Oligocene time. We conclude that the Daxiong Formation in Cuoqin basin represents isolated accumulation in a hinterland region of the northern Lhasa block, implying early topographic growth of the northern Lhasa block in the Tibetan plateau prior to the India-Asia collision.

Keywords: Upper Cretaceous; Daxiong Formation; Hinterland basin; Lhasa block; Detrital zircon provenance; Uplifting of the Tibetan Plateau.

Sandbody distribution and sedimentary model in shallow lacustrine fluvial-dominated delta front

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In recent years, a special kind of delta was found in the ancient Songliao Basin and modern Poyang Lake and other large lacustrine depressions in China. It is a shallow lacustrine fluvial-dominated delta. It is quite different from the skeleton sandbody types, vertical sedimentary sequence and facies of a fluvial-dominated delta. Especially, the characteristics of a sandbody in a delta front is its thinness, small scale and diversification, which is quite different when compared to the sedimentary model of a fluvial-dominated delta that is large scale and has a thick debouch bar in the delta front. In this context, sandbody distribution and sedimentary model in shallow lacustrine fluvial-dominated delta front, deserves further study.

Through analysis of outcrop, modern sediments and cores, logging and seismic data, it is realized that underwater distributary channel sandbody as the framework of shallow lacustrine fluvial-dominated delta front is abundant, closely spaced and narrow. It is continuous and extends far under water, until disappearing into a thin debouch bar and sheet sand. The debouch bar is not well preserved and is fluvial-dominated; it is located mainly in the underwater distributary channel on both sides and at the front. It is consistent with the source direction, and has narrow banded morphology. Characteristics of the debouch bar are more similar to thin sand under water. In each of the underwater distributary channels is formed in the center of the sequence of sedimentary microfacies. This sequence is: underwater distributary channel→ main part of thin sand→ thin sand→ edge of thin sand→underwater distributary bay from the center to the edge. The study also found that the distribution of a sandbody is controlled by the position of the sedimentary facies in the delta front. It can be divided into a transition zone between high and low level, nearshore shallow water zone, medium depth zone of the shore, and deepwater zone of the offshore. The sedimentary model of the nearshore is formed in the transition zone between high and low level. Its sedimentary features show that continuous and narrow fluvial-dominated banded deposition is the main, with restrictive and straight distributary channel sandbody as the center. And small scale discontinuous thin sand underwater is more. The sedimentary model of fluvial-dominated banded deposition is formed in the shallow water zone of the nearshore. Its sedimentary features show that the sequence of sedimentary microfacies is formed with its less restrictive and dendritic underwater distributary channel sandbody as the center. This sequence is: underwater distributary channel→ thin sand under water (residual debouch bar) → underwater distributary bay from the center to the edge. The sedimentary model of terminal distributary channel and fluvial-dominated sheet sand is formed in the medium depth zone of the shore. Its sedimentary features show that distribution of a sheet sand is over a large area, and is fluvial-dominated. The sequence of sedimentary microfacies is formed with terminal underwater distributary channel sandbody as the center. This sequence is: terminal underwater distributary channel→ sheet sand → the edge of sheet sand→ underwater distributary bay from the center to the edge. The sedimentary model of wave-dominated sheet sand is formed in the deepwater zone of the offshore. Its sedimentary features show that the distribution of single sheet sand is perpendicular to the source direction, and a plurality of sheet sand are arranged parallel to each other. A strip and annulus distribution in the inner sheet sand is formed. The sequence of sedimentary microfacies is sheet sand →the edge of sheet sand→ underwater distributary bay from the center to the edge.

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Triassic Petroleum System as the Alternative Exploration Concept in Offshore Western Timor, Indonesia

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Offshore Western Timor has unique exploration concept. No Jurassic Plover interval in study area due to massive erosional event known as Valanginian event. The Jurassic Plover sandstone is the proven reservoir and source rock in Abadi Gas Field, one of giant gas field situated in the offshore Timor region. Therefore deeper and older intervals have to be assessed to reveal alternative concept in study area. 2D seismic and exploration well data available in the area and surroundings are utilized for conducting this study.

Triassic Mount Goodwin interval could be considered as primary gas-prone source rock with mainly kerogen type II/III; TOC is up to 2.09%; and HI could reach to 569 mg/g. Based on pseudo-well conducted in this study, Mount Goodwin interval has reached gas expulsion in Eocene. Alternative reservoir can be obtained by Triassic Challis and Triassic Pollard interval. Triassic Challis interval is typically shallow marine shelf sands interbedded with shales and some carbonates. Petrophysical and petrography studies in this interval suggest good reservoir properties, such as effective porosity which has in range of 18-20%. Triassic Pollard interval has poorer properties (effective porosity in range of 6-10%) and mainly consists of shelf carbonates with sandstone intercalation. Challis intra-formational shales are proven to have good seal capacity (threshold pressure. 5986.2 psia, porosity 7.1% and permeability 0.016 mD) that can hold 561 meter of gas column.

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Influence of growing salt structures on Late Cretaceous chalk contourite deposition in the Danish Basin

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Study of reflection seismic profiles have led to a complete revision of the paradigm for chalk deposition as a gentle rain of coccolith debris down through the water column. Instead chalk deposition was strongly influenced by long-living bottom currents which sculpted the sea floor into drifts, moats and channels on a variety of scales, reaching reliefs up to 100 m and widths of many kilometres.The position and axes of the main current systems in the Danish Basin were controlled by major faults. Data from northern Denmark show that growing salt structures and anticlines split the currents into two strands running on each side of the structure, causing chalk drifts to climb both flanks of the structures. These drifts are part of what is probably the World's largest ancient contourite complex reaching a width of, and minimum length of 300 km, and a volume of the order of $2x10^4$ km^3. The currents appear to have controlled sorting chalk particles in zones trending parallel to the structures and thus influencing porosity and permeability and thereby reservoir properties.

A Preliminary Evaluation of the Global and Temporal Changes in Accommodation of the Lower Palaeozoic

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A preliminary evaluation of deposition processes and un-decompacted, time-averaged rates of accumulation can be facilitated by the application of a biostratigraphically calibrated, 3rd-order sequence stratigraphic model to Lower Palaeozoic successions. This comparison was made globally across a wide range of sedimentary environments and tectonic settings and resulted in the creation of a database that provides the ability to compare sediment accommodation and characterise typical rates of accumulation.

The initial results of this comparison are insightful and illuminate major temporal changes in the average global creation of accommodation for different sequences throughout the Lower Palaeozoic. At the outset, it must be recognised that the absolute generation of accommodation in any one locality is naturally affected by the amount of eustatic change. However, at a global scale it can be recognised that the observed temporal changes in the average amount of accommodation do not appear to be influenced by changes in the absolute magnitude of eustatic change. This may point to a wider geodymanic influence on sedimentation over a period of several 10s of million years. The nature of the processes influencing the timing of these changes in accommodation is uncertain.

As mentioned above, this evaluation is preliminary and reflects only an interpretation of un-decompacted data but it does have the ability to provide an interpretation of a minimum estimate of the range in magnitudes of sedimentation rates for the Lower Palaeozoic. It is suggested here that the interpreted range in magnitudes sits well within that predicted for rock units deposited within a timeframe of 10^5-10^6 Ma. However, what is also evident from these data is that the shorter-duration systems tracts (<2Ma) appear to have been deposited at higher, and more variable, sedimentation rates when compared to their longer duration counter parts (>2Ma). These observations are tentatively interpreted to support the interpretation that globally averaged systems-tract thicknesses do not seem to be sediment-limited and that systems tracts can accumulate rapidly until they reach the state of balance. This may also support the commonly held view that the stratigraphic record is dominated more by gaps that by rock.

Temporal and spatial distribution of radiolarites in Japan

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In Japan continuous radiolarite sequences are widely distributed, which are mostly contained in ancient accretionary complexes. Except one locality of Upper Devonian radiolarite from the Hayachine Belt (Hamano et al. 2002), radiolarite successions start from the Upper Carboniferous (Ishiga 1982). Upper Palaeozoic radiolarite successions are included in, e.g. the Tamba and Chichibu Terranes, in which 14 radiolarian zones from the Upper Carboniferous to Upper Permian are distinguished (Ishiga 1986, Kuwahara et al. 1998). Triassic radiolarite sequences occur in the Chichibu, Tamba, Mino and Ashio Terranes. Among them the Mino Terrane yields entirely continuous sequences from the lowest Middle to uppermost Triassic including the Triassic/Jurassic boundary on the bank of River Kiso. Sugiyama (1997) proposed 18 radiolarian zones for the Triassic in the area of River Kiso. Lower and Middle Jurassic radiolarite sequences are also included commonly in the Chichibu, Tamba, Mino and Ashio Terranes. Upper Jurassic radiolarites are mostly missing except for some occurrences of Oxfordian radiolarite, because pelagic radiolarite facies are changed into hemipelagic to terrigenous facies (claystone to siltstone) in Late Jurassic time. Possible occurrence of Upper Jurassic radiolarite is referred to the Nikoro Group of east Hokkaido (Sakakibara et al. 1993). 10 radiolarian zones are recognised for Jurassic radiolarites of Japan (Hori 1990, Matsuoka 1995). Although Lower Cretaceous and lower Upper Cretaceous (Cenomanian) radiolarite sequences occur continuously in the Shimanto Terrane of Shikoku Island (Okamura 1992), occurrences of Upper Cretaceous radiolarites are discontinuous sporadically. Youngest radiolarite of Cretaceous was reported from the Akimaru Melange of Shikoku Island, indicating a Campanian age (Ishida & Hashimoto 1998). In principle Cenozoic radiolarite is missing in Japanese Islands.

Consequently, the development of radiolarite sequences in Japan is dependent on plate tectonic setting. Continuous radiolarian ooze sequences were deposited on large abyssal plain in pelagic realm, which were later accreted along continental margin of eastern Asia and were transformed into radiolarian chert. One exception is a radiolarite deficiency horizon situated around the Permian-Triassic boundary, which was caused by the biggest mass-extinction event. Around the Permian-Triassic boundary, claystones were deposited instead of radiolarites. This lithologic feature indicates that no or few radiolarian tests were deposited during the extinction event.

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Thickest tsunamiite by the 2011 Tohoku Earthquake Tsunami

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We have investigated sediments transported by the tsunami, which attacked the Pacific coast of Northeast Japan on the 11th March 2011. Tsunami deposits have been sought on the muddy substratum like rice fields, rim of lagoon etc., because psammitic tsunami deposits can be distinguished from previous substratum. In the first expedition from the end of June to the beginning of July 2011, we could identify tsunami deposits in three areas: the mouth of River Kitakami (Miyagi Prefecture), Torinoumi lagoon (Watari Town, Miyagi Prefecture) and Matsukawaura sand bar (Soma City, Fukushima Prefecture). Among the areas the thickest sand deposits were found on the previous rice fields of the area around the mouth of River Kitakami: 115 cm thick sandy tsunami deposits were dug up by using of excavator. However, the wall of excavated trench was readily collapsed due to wet and loose nature of deposits.
The next expedition in the area around the mouth of River Kitakami was done in October 2012 in cooperation with Fukken Co., Ltd., who kindly lent us a set of the handy geoslicer. The handy geoslicer is a powerful tool to get a loose sediment column without disturbance (Takada et al. 2002). We could survey tsunami deposits on previous rice fields in the area around the mouth of River Kitakami by using of the handy geoslicer, because the new embankment has been constructed and the inundated area has emerged. We have got columnar sections at 5 points in the field.
In each sediment column obtained by the handy geoslicer, a 10 cm thick clayey soil layer of previous rice fields is observed at the depth of 64.5 to 97 cm from the present surface. On the clayey soil layer a thick sandy layer of the thickness 64.5 to 97 cm was identified, which is the tsunamiite transported by the tsunami current on the 11th March 2011. The thickness of these tsunamiites is comparable with that of the first expedition measurement (115 cm). Consequently, about 1 m thick sandy tsunami sediments were deposited on rice fields in the area around the mouth of River Kitakami. Goto et al. (2011) have summarised the thickness and the distribution of tsunamiite deposited by the 2011 Tohoku earthquake tsunami. According to them the maximum thickness of tsunami deposits amounts to 30 cm in the coastal forest. Our measurement of the tsunamiite thickness of the mouth of River Kitakami is much thicker than previous results. We should recognise that the 1 m thick tsunamiite can be deposited by one earthquake tsunami event.
The sediment columns obtained by the handy geoslicer show roughly four stratigraphic divisions: 1) basal coarse-sand division with mud patches, 2) middle medium-sand division including wood chips, 3) upper medium- to fine-sand division with parallel lamination, and 4) bioturbated division by living benthos (bivalves and worms). Grain size distribution of each division was analysed. As a result, it is concluded that basal coarse-sand division (1) shows a bimodal grain size distribution, and middle and upper divisions (2 & 3) show a unimodal distribution. This result of grain size distribution is almost same as that of tsunami deposits from Torinoumi lagoon and Matsukawaura sand bar reported by Suzuki et al. (2012).

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The Role of Diagenesis and Source in Controlling the Correlation between the Carbon Isotopic Composition of Inorganic and Organic Components

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While many large negative $\delta^{13}C$ excursions in the carbonate and organic carbon records during the Neoproterozoic and Paleozoic have been interpreted as records of global carbon cycling, we explore the possibility that records in some instances record changes in the source of carbonate and organic material as well as diagenesis. One of the key pieces of evidence which has been used to support the original nature of the carbonate $\delta^{13}C$ record is the covariance of $\delta^{13}C$ values in the carbonate and organic carbon in the same deposit.

Recently, a study of carbonates deposited over the past 5 Myrs adjacent to Great Bahama Bank revealed that varying correlations (between ~ +1 and 0) between the $\delta^{13}C$ of organic and inorganic carbon can result of different degrees of mixing of materials derived from different sources. In fact the strongest correlations arise in situations where there is mixing between two sources each with distinctive C isotopic compositions in the inorganic and organic components. In other locations, which are dominated by one source of carbonate and organic carbon, correlations between the $\delta^{13}C$ of organic and inorganic carbon are absent. Such situations include other carbonate platforms and pelagic sediments.

A second assumption is that covariance always indicates a global control on the $\delta^{13}C$ values, and that there are no post-depositional processes that can alter carbonate and organic $\delta^{13}C$ records in the same direction at the same rate. In order to investigate the effects of post-depositional alteration on the relationship between carbonate and organic $\delta^{13}C$ records, we analyzed carbonate and organic $\delta^{13}C$ records from a core taken through Holocene to Miocene aged sediments that has been unequivocally altered. During the late-Pleistocene multiple sea level oscillations allowed the upper 120 m to be influenced by meteoric processes and ten subaerial exposure surfaces have been identified in the top 100 m of the core, and each is proposed to be related to a Pleistocene glacial period. These periods of subaerial exposure have resulted in diagenetic alteration within the meteoric realm, including the development of caliche crusts, blocky spar cements, large scale dissolution, and soil development. These processes not only cause the $\delta^{13}C$ of the limestone to become isotopically negative, but post-depositional additions of terrestrial organic material, which is more negative than marine organic matter, occur during the subaerial exposure of the platform top. As a consequence paired $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ analyses have produced records that are strongly covariant particularly in the Plio-Pleistocene section of the record.

Our studies illustrate how artifacts in the $\delta^{13}C_{carb}$ record can lead to conclusions regarding the global carbon cycles which are incorrect. Such evidence necessitates the reappraisal of the globally synchronous negative $\delta^{13}C$ anomalies with strong correlations between carbonate and organic values associated with biogeochemical events throughout Earth history.

Scientific drilling in the Lake Chad Basin: Paleoclimate and paleoenvironment archives of continental Africa since the Miocene

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Lake Chad is a permanent, large but shallow, freshwater body located at the Sahara-Sahel transition. This terminal lake is mainly fed from its southern watershed (Chari-Logone river system) and fringes the southern edge of the Sahara desert. The sedimentary archives from Lake Chad are a very sensitive recorder of past climate change (e.g., West African monsoon system) and environment evolution. This is very well illustrated by its dramatic lake level decrease (1960's: ~25000 km^2; 2000's: ~2500 km^2) as well as by its remarkable past extension (i.e. middle-Holocene Mega-Lake Chad: water surface >350000 km^2, Schuster et al., 2005). Much earlier (down to Late Miocene) climate-induced changes are also recorded in the Chad basin as it is denoted from geological outcrops that reveal successive wet-dry lake/desert alternations (Schuster et al., 2006 and 2009). This intracratonic basin has thus accumulated about 500 m of Neogene and Quaternary sediments (Burke, 1976).

Considering the remarkable geological conditions of this lacustrine system, the Chad basin appears as an ideal target to conduct a comprehensive study of past monsoon-induced changes in environments and ecosystems in central continental Africa, both for the so-called African Humid Period as well as for earlier and complete wet/dry cycles. However, reconstructing past continuous climate oscillations solely on outcrops is not straightforward, as these are discontinuous. Recent studies in Lake Chad (Sylvestre et al., this congress) as well as available geological data (Moussa, 2010) strongly suggest that over than 300 m (~6 My) of almost continuous lake deposits are available in the Lake Chad basin.

We thus propose to conduct a drilling and continuous coring campaign of Lake Chad and its surrounding, which will bring a long continuous record of past climates and environments for which continental central African archives are rather rare, fragmentary and widely scattered. Moreover, results from this study will shed light into the paleoenvironmental conditions during one of the less known and understood chapters of human evolution: the Toumaï (*Sahelanthropus tchadensis*).

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Coherent monsoonal changes in the northern tropics during the African Humid Period revealed by Lake Chad sedimentary archives

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In northern African tropics, it is now well established that the Last Glacial Maximum (LGM) was dryer followed by a wetter middle Holocene. The numerous Holocene paleolake records document a fairly consistent pattern of a moister early-Holocene resulting in a green Sahara followed by a general aridification ca. 4000 years ago. These paleoenvironmental conditions are deciphered from several continental records distributed over the sub-saharan areas, including diverse environments. However pronounced differences in the apparent timing and amplitude of these moisture changes inferred from sedimentary records point to both regional climatic variability change and site-specific influences of local topographic-hydrogeological factors which biased the evolution of water balance reconstructed from individual paleoenvironmental archives.

This is particularly true when looking at the end of the humid period during the middle Holocene. Marine records evidenced that this termination was abrupt, occurring within decades to centuries at ~5.5 ka. However the abruptness of this termination is still a matter of debate since a lacustrine record, e.g. Lake Yoa from northern Chad, evidenced that the drying of a regional ecosystem was rather progressive from 5.6 to 4.3 ka with desert conditions established only at ~2.7 ka.

Here, we investigate sedimentary records from Lake Chad, considered as a good integrator of hydrological changes of the summer monsoon.

Seismic data coupled with sedimentary archives evidenced that during the LGM, a dune field recovered Lake Chad, suggesting that Sahara desert reached, at least, the current southern lake shore. Based on ^{14}C ages and subsequent sedimentary rates from three lacustrine cores, our data show that wetter conditions occurred at around 12.5-12 ka, followed by a lacustrine transgression, reaching a maximum extension at ca 10.5 ka. The regression started as early as 6 ka and water inputs in the lake dramatically reduced between 5.1 and 4.9 ka. Concomitant changes recorded in the closest oceanic basins, e.g. tropical Atlantic and Indian, confirm that the African humid period ended at the same time.

Our data suggest an abrupt decrease of water inputs from the rivers supplied by monsoon precipitation, whereas surrounding terrestrial environments remains moister in response to geomorphological and hydrogeological effects. These original data provide new insights on the response of a large lacustrine ecosystem in a context of both external and internal forcing the climatic changes.