The Late Triassic succession of the Tamar Valley (northern Julian Alps, Slovenia): remarks and implications for the eastern Southern Alps paleogeography

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Late Triassic paleogeography of the eastern Southern Alps (easternmost Italy, western Slovenia) is poorly resolved. In present reconstructions, the majority of the Julian Alps belongs to the Julian Carbonate Platform, marked by a thick Upper Triassic sequence of peritidal Dachstein Limestone. The platform was bordered to the south by the Slovenian Basin, and the Bled Basin was likely located at its eastern margin. Numerous short-lived basinal successions are known besides, testifying for a much more complicated morphology of the platform.

The succession outcropping in the Tamar Valley (NW Slovenia) has been revisited. In the lower part it consists of the Julian peritidal Conzen Dolomite, followed by marlstone and marly limestone alternations of the Julian-lowermost Tuvalian Tor Fm. Facies association can be related to a shallow terrigenous-carbonate ramp environment, grading later in the shallow water, loose carbonate grain dominated system of the Portella Dolomite. At the top, a deepening-upwards trend is marked by bedded dolomites attributable to the Carnitza Fm., followed by bedded cherty dolomites, sometimes with slump breccia layers, of the Bača Dolomite. Conodont sampling and biostratigraphical analysis point to an Upper Tuvalian age for the lower basinal unit, and to an Upper Tuvalian to lowermost Rhaetian time span for the upper unit. The series ends with thin-bedded bituminous limestones and marlstones of the Frauenkogel Formation.

Based on correlation with known sections from western Julian Alps and Southern Karavanke (Klek/Hahnkogel structural unit), the Tamar Valley succession represents part of the Tarvisio Basin, likely extending as far as to Santo Stefano di Cadore (northeastern Dolomites), 90 km to the west. The basin was bordered to the south by the Dolomia Principale/Dachstein Limestone carbonate platform since the late Tuvalian, and experienced its progradation from the latemost Tuvalian onwards. However, the regressive trend stopped at some point in Norian, and deep-water conditions persisted in the neighbour Tamar Valley at least until the mid-Rhaetian. Even in the most distal part of the Tarvisio Basin, preserved in Southern Karavanke, pelagic sedimentation continued at least until the Lower Jurassic.

Similarly to the Tarvisio Basin, also eastern Julian Alps record a deepening in the Upper Tuvalian followed by a closing prograding stage during early Norian (Martuljek Mountain Group), and somewhat later in more distal areas (Vrata Valley). A connection of this region with the aforementioned basin cannot be excluded, and the whole northern marine domain could be related to a western inlet of the Hallstatt/Meliata pelagic realm.

Controls on non-marine microbialite deposition; Tectonic setting, Facies models and Palaeoenvironments. The lower Purbeck Formation (Late-Jurassic to Early Cretaceous), Dorset, Southern England

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The discovery of Lower Cretaceous, non-marine carbonate hydrocarbon reservoirs in the South Atlantic, has triggered the interest of understanding such complex deposits. Sedimentary facies and basin architecture are controlled by a range of environmental parameters (*i.e.* climate, hydrology and tectonic setting) but facies models are few and limited in their predictive value. This study is developing new depositional models for non-marine microbialite in a semi-arid climate setting in an extensional basin; the Purbeck Formation (Upper Jurassic – Lower Cretaceous) exposed in Dorset (Southern England).

Seismic data imaging the Lower-Upper Jurassic in south Dorset shows east-west syndepositional extensional faults separated by relay ramps in the southern Wessex Basin. This study presents evidence of syndepositional movement of the two main southerly dipping faults during Late Jurassic time; the Ridgeway fault in the eastern part and the Purbeck fault in the western part. These are linked via a relay ramp and new palaeogeographical maps indicate this relates to the "Mid Dorset Swell" of previous workers with accumulation of strata occurred in half-graben sub-basins controlled by these east-west extensional faults.

The lower Purbeck limestones are characterised by the accumulation of in-situ microbialite mounds that occur within bedded inter-mound packstones-grainstones. The microbialite mounds are located in three stratigraphic units ("Skull", "Hard" and "Soft Caps") separated by three palaeosols ("Basal", "Lower" and "Great Dirt Beds") respectively within three shallowing-upward lacustrine sequences. These microbialite mounds change in thickness from about 0.5 to 4m, are developed around tree trunks and branches which are preserved as moulds (or silicified wood) and comprise three sub-facies (Stromatolites, Thrombolites and Burrowed Collar). Horizontal stratification onlapping and interfingering with the mounds suggest that the deposition occurred with the development of the mounds. Interpretation of high resolution ground-based LiDAR data collected from seven quarries in the Isle of Portland enables a quantitative description of the morphology of the mounds and their relationship with the inter-mound facies.

The overall goal of this ongoing study is to predict the controls on the siting, the shape and the size of microbialite mounds and to constrain the facies models and palaeogeographies of the lower Purbeck within the Wessex Basin. Initial work suggests (1) that the two main extensional faults were active during Purbeck times; (2) development of microbialite mounds seems to be tectonically controlled as indicated by their relationship with the relay ramp; (3) mound occurrence is controlled by palaeotopography generated on sub-aerial exposure surfaces, palaesols and early conifer trees and (4) mounds are developed mainly on the shallowest area of the lake as indicated by their relationship with the inter-mound packstone-grainstone facies and the palaeosols. The new depositional models developed in this study integrate sedimentological facies models with the syn-rift setting of the Wessex Basin to explain the distribution of the microbialite mounds.

Travertine: distinctive depositional features of the thermal-spring systems

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Travertine limestone is a continental deposit commonly found associated with hydrothermal alkaline/Ca-rich spring systems, in extensional, tectonically active/volcanic regions of the earth. It shows specific lithologic features and facies associations that cannot be interpreted with the depositional models applied to the other subaerial terrestrial or marine carbonate deposits.
Depending-on multiple and interconnected parameters (from tectonic regime to climate), travertine bodies may develop with a wide variety of depositional fabrics and structures.
Morphology, elevation and architecture are controlled by the physicochemical proprieties of the hypersaturated hot waters rising from spring vents and by the leading tectonic regime. The compared analysis of travertine facies and thermal field products suggests that their depositional features are inherent to the hydrothermal system and results in limestone bodies characterized by specific architectures.
The auto-building capacity of the upwelling waters results from the joint effect of the water physicochemical proprieties, the rate of accumulation of calcium carbonate, the mechanics of flux (turbulent or laminar), the quantity, velocity and continuity/duration of supply and the morphology of the flowing surfaces. Fabric and structures of the carbonate buildups reflect the relative distance from the spring mouth, the energy/velocity of the flux and the morphology of the pathway of the running waters.
Precipitation of Ca-carbonate in the vent zone, driven by the swift drop in temperature, intense degassing of the hypersaturated hot waters coupled with local structural/rheological parameters, produces punctiform vent mounds (sub-circular to pinnacle or shield-like) or composite fissure ridges with dominant macro-crystalline fabrics (crystalline travertine). Vertical banded sheets of palisade crystals represent the hypogean roots of open linear fractures.
The discharge apron zone corresponds to the flowing surface departing from the vent. Here water velocity (slope gradient and thickness of water sheets) control the carbonate deposition). The slope locally becomes terraced (laminar flow and stagnant to very shallow sheet) and/or may evolve in waterfall (turbulent flow). The terraces, ephemeral pans bounded by half-moon crystalline (feather-like/dendritic) dams, are mainly filled with microbial and lime mud laminae (bedded travertine) while the waterfall front consist of subvertical sheets of botryoidal fan/ray crystals.
The depression flats or wetland zone, the more distal part of the thermal depositional system, may occur close or far from the vent according to the morphology/inclination of the apron, the volume and continuity of the flux. The decrease of the flux energy, of the Ca concentration and water temperature joined to the likely input of meteoric (rain or karst-derived water) inhibit/reduce the growth of crusts and the autobuilding while promote the instauration of an intermittent paludal-to-"wetland" setting, where tufts of pioneer macrophytes (reeds) and calcretic soils can develop. The carbonate deposits produced in such a contaminated setting can be regarded as a hybrid travertine.
The deposits of the different zones may coexist and juxtapose/superpose on each other without any regularity and consequently their architecture is represented by the casual succession of facies and superposition/distribution of lenticular units. Some of the discontinuities can be related to depositional (climatic/tectonic) interruptions of activity, but others may be only the result of diversion of the water-flow due to the unpredictable presence of self-built obstacles on the pathway.

Sedimentary Succession and Facies Model of Ephemeral Streams in Arid Climate

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Great breakthrough has been achieved for oil and gas exploration in widely-distributed thick-bedded sandstone in Jurassic of the Junggar Basin and Jurassic - Lower Cretaceous in Kuqa Depression of the Tarim Basin in western China, which indicates that study of reservoir sedimentary facies for widely-distributed thick-bedded Mesozoic sandstone in western basins is very important. As for lower Cretaceous Baxigai Formation - Bashijiqike Formation thick sandstone on Kuqa River outcrop of Kuqa Depression and thick conglomerate of the southern margin of Junggar basin Haojiagou – Toutunhe River outcrop and Manas River outcrop of Upper Jurassic, predecessors carried out a lot of sedimentary facies studies. It is believed that widely-distributed thick sandstone and conglomerate are mainly braided delta sedimentary facies. By study of lithology, clastic grain structure and sandbody sedimentary structure of lower Cretaceous red formation sandstone on Kuqa River outcrop, Baxigai Formation-Bashijiqike Formation were developed as aeolian sandstone sedimentation. Therefore, it can be seen that difference exists in the studies of widely-distributed Mesozoic thick sandstone and sedimentary facies of conglomerate in western basins.
Nowadays, semiarid - arid climate presents in western China, and Cretaceous Period had the same climate, moreover, atmospheric circulation strength was similar with today's status. Currently, in western China's Xinjiang and Inner Mongolia etc., several ephemeral streams depositions are developed under arid climatic conditions. Ephemeral streams refer to a river that is dry and anhydrous in one of seasons or for a long time in one year. Generally, rivers in arid areas are ephemeral streams, large rivers in semiarid areas can be regular rivers but small rivers are generally ephemeral streams.Ephemeral streams sedimentation is the main sedimentation type in current south and north of Tianshan Mountain in Xinjiang Province, where fluvial facies sandstone and mudstone were deposited widely and thickly, creating broad alluvial plain sedimentations. By our survey on sedimentation outcrops of lower Cretaceous Baxigai Formation - Bashijiqike Formation on Kuqa River outcrop of Kuqa Depression, upper Toutunhe Formation in middle Jurassic-Qigu Formation and Kalazha Formation in upper Jurassic on Haojiagou – Toutun River outcrop and Manas River outcrop in the southern margin of Junggar basin, lithofacies combination features, rock colors, sandstone sedimentation structure and genetic mechanism, conglomerate features as well as ancient sedimentary environment are analyzed respectively, combined with ephemeral streams sedimentary features in modern south and north of Tianshan Mountain, it is believed that ephemeral streams in dry climates background and seasonal river delta sedimentation are the important sedimentary types in south and north of Tianshan Mountain during middle and late Jurassic – Cretaceous. Ancient ephemeral streams and modern seasonal rivers widely developed in north and south of Tianshan Mountain have very similar sedimentation characteristics, not only with typical fluvial rhythm sand body and wide deposition, detrital clay gravel at channel bottom and large thick massive cross-bedded sandstone well developed, but also showing high-energy fine-grained sandstone and siltstone deposition, with basic characteristics of low compositional maturity and high structure maturity. By above analysis of sedimentary facies marks and sedimentary succession, ephemeral streams sedimentary facies models of arid climatic background are established.

Acknowledgements: This study was financially supported by National Science and Technology Major Project: Midwest foreland basin structural geology, reservoir characteristics and favorable area evaluation (2011ZX05003-002) and PetroChina Science and Technology Project: Midwest foreland basin sedimentary formation characteristics and favorable reservoir geology evaluation (2011B-0402).

Magnesium carbonates in hydrothermal spring build-ups, Betic Range, SE Spain

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The hydrothermal spring deposits studied are located in the village of Baños de Mula at 38º02'16,37''N, 1º25'34,69''W (Murcia province, SE Spain). Water of spring is used in several local spas. The hot spring of Baños de Mula is related with hydrothermal circulation along the Mula-Archena active fault in a Neogene-Quaternary post-tectonic basin, placed in the geological area of Eastern Betic Range. In the XVIII century, this spring is moved to the current location by the reactivation of the fault system (Eastern Betic Shear Zone), which has induced seismicity in the area.

The mineralogy was studied by X-Ray diffraction of powered samples. Samples were embedded in resin in order to make thin sections, and these were observed with an Axioscop Zeiss TLM. Surfaces were observed with a Hitachi S3000N VPSEM and a Zeiss SUPRA40VP (FESEM). Uncoated polished sections were studied with VPSEM-bse and an EDS Bruker XFlash 3001 model to examine the composition. Point by point analysis and mapping were carried out.

Spring waters were analysed during 2013 and 2014 and results reveal that water temperature, electrical conductivity and pH range from 39 – 40 ºC, 2.7 - 4.8 µS/m, 6.5 - 7.3, respectively. Anions and major cations were determined by ion chromatography and trace composition was performed by ICP-MS. The saturation index of different minerals (SI) was calculated using the PHREEQC program. Water is oversaturated with respect to calcite (0.61), aragonite (0.47), ordered dolomite (1.26), disordered dolomite (0.77) and undersaturated in gypsum (-0.46), magnesite (-0.92) and hydromagnesite (-10.54).

The current hydrothermal spring emerges in a small outdoor fountain built with Red Mula travertine (a Pleistocene travertine extracted in a near quarry). Two types of carbonate build-ups were observed in the fountain: (i) thin laminated crusts, travertine crusts, in contact with the water flow and (ii) soft spongy moss tufa on the splash zone. Growth of the laminated build-ups adjacent to the outflow is mediated by thin microbial mats, dominated by cyanobacteria that colonize the surface. Accordingly this type of build-ups may be considered stromatolites, although many crystalline laminae lack clear evidence for biogenicity. The crystalline laminae as well as the tufa build-ups are composed mainly of calcite crystals, with size ranges from 20 to 50 µm. Gypsum and detrital quartz are present.

VPSEM and EDS analyses indicate the presence of Mg-bearing carbonates, dolomite and magnesite, and celestite together with calcite in the laminated build-ups. Dolomite, magnesite and sometimes calcite crystal aggregates show globular shapes, which are associated with EPS and show three specific sizes: 2 µm, 10 µm or 20 µm. The surface of the globules consists of microcrystals that exhibit a wide variety of morphologies and degrees of isomorphism.

The different sizes of the spherical aggregates suggest that their genesis may be related to the physiological activity of the different components of microbial mat communities, cyanobacteria, diatoms and bacteria.

Primary dolomite was also found in spring deposits from this region (Alicún, Almería province, SE Spain). Its presence in these build-ups confirms that primary dolomite, and magnesite formed in springs are more common minerals than previously thought.

This research was financed by the Spanish Ministry of Economy and Competitivity (Projects CGL2011-25162 and CGL2011-26781).

First identification of MIS 3 sediments in shallow marine environments from the Ría de Vigo (NW Iberia)

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Introduction. Ría de Vigo is the southernmost of the Galician Rías Baixas. It is a large submerged incised valley, orientated SW-NE, with a distinctive funnel shaped physiography and an area extend of 176 km^2. The underlying geology of the Galician coastal area is characterized by Palaeozoic sedimentary rocks, metamorphosed during the Hercynian orogeny. The geological framework, the relative sea level variations and the climatic and oceanographic conditions, constitute the main factors controlling the stratigraphic evolution and sedimentary facies distribution inside the ría.

Methodology. More than 940 km of high-resolution seismic profiles have been recorded in several surveys carried out in the Ría de Vigo since 2003 to 2011. The seismic lines data were acquired using a "modified Boomer". Two vibro-cores were retrieved in the ría, one located in the middle-inner part of the ría (B-5) and the other situated in the outer part (MRV-3). The sedimentological (grain size), geochemical (total organic carbon) and palynological characteristics of the core were analyzed. Some shells and vegetal remains were used to radiocarbon dating.

Results. The combination of high-resolution seismic profiles together with new sedimentological, palynological and radiocarbon data lead us to make a new reinterpretation of the sedimentary record of the Ría de Vigo.
Four main seismic sequences composing the stratigraphic infill of the ría have been identified in the seismic records. The lower sequence (Sq_1) is characterised by irregular and in some case chaotic reflectors. The next sequence (Sq_2) is constituted by parallel reflectors that are slightly folded; the upper facies of this Sq_2 were recovered in both vibro-cores and correspond to mainly fine sand (B-5) and silt (MRV-3). The radiocarbon data confirm an age of 45380 cal. yr BP in the top of this sequence. The Sq_3 shows quite irregular internal reflectors with a very irregular and erosive basal surface. The facies corresponding to Sq_3 are not registered in the vibro-cores. The youngest sequence (Sq_4) identified in the ría is constituted by a fining upward sequence (from sand to mud), whose bottom facies have been dated in 10800 cal. yr BP in core B-5. These changes in the facies are also accompanied with changes in the TOC content.

Conclusions. Until now, the sedimentary infill of the ría has been attributed to the last 20 kyr with a tentatively undetermined Upper-Pleistocene age for Sq_1. However, the new data have evidenced for the first time that MIS 3 sediment remains into the stratigraphic record of the ría. Therefore, now the two oldest seismic sequences are interpreted to be deposited during, at least, the last 60 kyr BP. This new interpretation is also supported by the existence of several radiocarbon dates as well as the pollen assemblages, including the presence of *Carpinus betulus* L. at the top of Sq_2. During the last glacial period (aprox. 18 kyr BP) the sea level fell provoking the partial erosion of Sq_1 and Sq_2 within the ría and the sedimentation shifted to the shelf.
After LGM, the sea level started to rise again until 11 kyr BP, when a new stabilization and/or slight drop took place during the Younger Dryas cold event. After this period, the sea level continued rising up to the present position.

Acknowledgments: This work was supported by projects CTM2009-13926-C02-01 and CTM2009-08158-E (MCIIN) as well as by the project CGL2012-33584 (MINECO) co-supported by FEDER funds. N. Martínez Carreño is funded by the FPI- MCIIN research program (BES-2010-037268) and I. García-Moreiras by a PhD fellowship from the Xunta de Galicia (PRE/2013/404). We thank IHS who provided free the Kingdom Suite software.

Archaeal populations in the water column above gassy sediments in the Ría de Arousa (NW of Spain)

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Introduction. The Ría de Arousa, is located in Atlantic Margin of Galicia (NW of Iberia). It is a drowned valley controlled by N-S, NE-SW, NNW-SSE Hercynian fault lineations reactivated during Tertiary. It has an area of 230 km^2 with depths ranging from 5-10 m in the inner part to 50-60 m at its mouth. The Ulla and Umia rivers are the two main freshwater inputs influencing the circulation in the ria that behaves as a partially mixed estuary in the inner part. The middle and outer parts are dominated by the exchange of water with the Atlantic Ocean, causing a circulation in two layers.
The Ría de Arousa is affected by upwelling events from May to October, which bring up nutrient-rich cold water resulting in a high primary production system. Gas fields in the ria for a total area of 48 km^2 have been mapped.

Methodology. CECOMER-2013 survey was carried out in the area in order to investigate the gas system. Two locations, A1 within the largest gas field, and A2 in the outer area free of gas accumulations, were selected for both gravity coring and water column sampling. Methane, sulphate, TOC, etc were measured from cores and water. Temperature and salinity data were acquired with a CTD system. The Sample Filtration and Archival (SaFA) instrument, developed at the University of Wisconsin Madison, allowed the collection, filtration and stabilisation of 12 time-stamped water samples of 500 mL of volume at A1 and A2 locations. Filters were obtained at 1 hour intervals over two 12 hour tidal periods. DNA from the microorganisms was extracted from filters and 16S rRNA gene was partially amplified by PCR employing Archaea-specific and Methanobacteria-specific primer pairs. Clone libraries were prepared and sequenced. The identity of the microorganisms was inferred by means of taxonomical analysis performed using the ARB-SILVA software.

Results. Analysis performed in core samples confirms the existence of methane as the mayor component of the gas. Methane concentration ranges from a maximum of 1.6 mM in core A1 to 0.0042 mM in A2. Dissolved methane concentration in water column ranges between a maximum of 327 nM (A1) and a minimum of 45 nM (A2). Mean salinity and temperature were 34.95 PSU and 13.13 ºC at A1 and 35.44 PSU and 13.20 ºC at A2.
PCR analysis allowed the detection of 16S bands of Archaea at locations A1 and A2. Methanobacteria were detected mainly at location A1 and, to a lesser extent at location A2. Taxonomical analyses lead to the detection of a variety of Archaea belonging to Crenarchaeota, Thaumarchaeota and Euryarchaeota phyla. Among the latter, phylotypes related to Methanomicrobiales and Methanosarcinales were also present in different amount depending on the location. QPCR analysis allowed the quantification of genomes present in the samples.

Conclusions. The SaFA was a valuable instrument as allowed the in situ collection, filtration and stabilization of marine water samples during a whole marine tidal cycle. Gassy sediments and cold seeps are widely identified and mapped in the ria. Different environmental metagenomes related to the methane cycling were detected in the water column located above gassy and non-gassy marine sediments from the Ría de Arousa.

Acknowledgments: This work was supported by the projects CGL2012-33584 (MINECO) co-supported by FEDER and CN2012/301 (Xunta de Galicia). V. Cartelle-Álvarez was funded by the FPI- MINECO research program (BES-2013-066901). N. Martínez Carreño was funded by the FPI- MCIIN research program (BES-2010-037268).

The Early Toarcian Event in the Caucasus Basin

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1. The display of Lias anoxic events are revealed in many areas of the World (Jenkyns, 1988). Among them, the early Toarcian anoxic event is the best known. The sediments related to this event are commonly presented by clayey shales rich in organic matter (OM). However, the sediments of different types accumulated in some areas.

2. In the European part of Russia, the most complete Toarcian successions are located in central Caucasus. The sediments formed in different paleo-shelf environments, from near- to offshore, are presented in the most central part of this area. The Toarcian sediments are characterized by cyclic structure: clayey sediments deposited at the base of each cycle change into siltstones and sandstones upward. The lower Toarcian shales show specific geochemical zonality. The abnormal amount of siderite-bearing beds (up to 8-10 per one meter) are observed in the sediments accumulated in nearshore area; they are characterized by low OM (<0.5%) and Fe (~ 1.5-2.5%) concentrations. Basinward, the amount of siderite-bearing beds gradually decreases while TOC and Fe contents increase (>1% and up to 5.5%, respectively). Thus, the lowest OM and Fe concentrations are featured for sediments with highest amount of siderite concretions.
Inversed relationship between siderite enrichment and concentrations of OM and Fe in the siltstones led to conclusion that initial OM and Fe contents in the clayey sediments were significantly higher, but became reduced due to active diagenetic processes caused the formation of Fe^{++} compounds, their redistribution and contraction into concretions. Estimations suggest the initial OM content up to 4-5 %, i.e. the sediments can be highly enriched in OM.

3. Lower Toarcian clayey sediments accumulated during rapid eustatic transgression preceded by regression at the Pliensbachian/Toarcian boundary. Advancing sea water actively interacted with coastal humid landscape with many lakes and marshes (wetlands) that resulted in wide input of chemically reactive OM and many elements (P, Fe, a.o.) into the basin. Fe could partially migrate in form of metal-organic compounds. Entering into the basin OM and Fe accumulated mainly in the nearshore areas, where diagenetic processes were the most intensive and wide siderite amount was formed. In the nearshore areas, terrestrial OM dominated, while the portion of basinal OM increased in the central part of the basin.

4. Lithological and geochemical characteristics of sediments do not suggest occurrence of anoxic environment in Caucasian basin during early Toarcian. At the same time, it should be kept in mind that: 1) input of great amount of solid and dissolved terrestrial OM caused the formation of the products of its oxygenation (CO_2, a.o.) in the sea water and 2) exceptionally active diagenetic processes were accompanied by massive evacuation of CO_2 into the sea water. These caused occurrence of carbon-dioxide contamination and acidification of the water at least in some parts of the basin that oppressed calcareous organisms.

5. Early Toarcian transgression in the Caucasian basin was the result of additive effect of global (eustatic sea-level rise) and regional (pulsed downwarping of the basin) factors.
The formation of upper Pliensbachian sedimentary cycle in the central part of the Caucasian basin generally followed similar scenario.

This research was supported by RFBR (Project no. 12-05-01138).

The Late Cenomanian Paleoecological Event (OAE 2) in the Eastern Caucasus Basin: sedimentology, geochemistry, and biota

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The late Cenomanian Oceanic Anoxic Event (OAE 2) is readily recognizable in the sedimentary record of the eastern Caucasus basin, which represented a constituent of the northeastern Peri-Tethys. Sediments of the transitional Cenomanian/Turonian interval were investigated in seven sections. Based on the stratigraphic completeness, the sections are divided into three types: (1) sections with complete OAE 2 interval; (2) sections containing only the OM-rich sediments overlain by the middle Turonian limestones; and (3) sections marked by the complete erosion of OAE 2 sediments during the early Turonian transgression. The OAE 2 sediments are characterized by a distinct cyclic structure. The SB comprises 11 or 12 cyclites each up to 15–17 cm thick. The cyclites consist of alternating black marlstones (at the base) and gray clayey limestones. Together with the under and overlying sequences, the sediments rich in OM form a single sedimentary cycle. OM-rich sediments differ from their embedding rocks lithologically, geochemically, and paleontologically: they demonstrate positive $\delta^{13}C$ and negative $\delta^{18}O$ anomalies, elevated concentrations of many minor elements, substantial reorganizations in nannofossil assemblages, disappearance of benthic organisms, a.o. Since some changes are observable already in the underlying layer and extend up to the top of overlying layer, the interval of the OAE 2 seems to be larger than the layer rich in OM.

Variations in the composition of nannofossil assemblages indicate environmental perturbations at the Cenomanian/Turonian transition. The increased relative abundance of cool-water species suggests relative cooling during OAE 2. At the same time, negative oxygen isotope excursion indicates relative warming or desalination of the basin. Widest occurrence of opportunistic *Watznaueria* spp., which are tolerant to changes in temperature, trophication and salinity, might suggest decreased salinity during this event.

The formation of elementary cyclites evidently correlates with the Milankovitch precession cycles (~21 ka). The number of cyclites suggests that the duration of periods corresponding to the accumulation of OM-rich sediments was 230–250 ka, whereas the entire OAE 2 sequence in the most complete section accumulated during ~370–410 ka. Thus, the formation of the whole sedimentary cycle embracing all OAE 2 sediments likely corresponds to a single ~400 ka long eccentricity cycle or a complex of precessional cycles.

The lithological and geochemical characteristics of OM-rich sediments imply the intermittent anoxic environment in the basin that involved insignificant part of the water column (mostly, bottom water layers). The role of anoxia in the accumulation of organic matter was not dramatic. OM-rich sediments were deposited during a rapid eustatic transgression, when basin waters became highly enriched with biophile elements transported from flooded coastal landscapes that stimulated the rapid growth of phyto- and bacterioplankton productivity and caused the accumulation of OM-rich sediments. The nonlinear development of the transgression resulted in the irregular influx of biophile elements to the basin affected the formation of cyclic sequences.

Acknowledgements: Supported by RFBR (project no. 12-05-01138) and the Program of Presidium RAS (project no. 27).

Triassic-Jurassic radiolarite events in the western Neotethyan realm

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Radiolarites occur widespread in the different orogenic belts around the Mediterranean. Their deposition is related to two oceanic realms, the Tethyan and the Atlantic oceanic systems. We focus on the Triassic-Jurassic radiolarite events in the eastern Mediterranean mountain ranges (Eastern and Southern Alps, West Carpathians, Pannonian units, Dinarides, Albanides, Hellenides). Rifting in the Neotethys Ocean started in the Permian, the oceanic break-up followed in the Middle Triassic (Late Anisian) and closure started in the late Early Jurassic accompanied by ophiolite obduction and formation of an orogen during Middle-Late Jurassic times. Rifting in the Alpine Atlantic (= Magura/Vah, Penninic, Piemont, Ligurian oceans) started around the Triassic/Jurassic-boundary, the oceanic break-up followed in the late Early Jurassic and closure started in the Late Cretaceous. The Triassic sedimentation in the eastern Mediterranean mountain ranges was triggered by the Neotethyan opening, and in the Jurassic by its closure. Whereas the more southern orogenic belts (Dinarides, Albanides, Hellenides) were practically not affected by the Atlantic related rifting in Jurassic times, the Eastern and Southern Alps, the West Carpathians and some units in the Pannonian were affected by both events: closure of the Neotethys and opening of the Alpine Atlantic.

The oldest radiolarites were deposited in Late Anisian to Early Ladinian times, in both the Neotethyan ocean and in the (distal) passive margin setting, where the water depth did not exceed a few hundred metres. The peak event is in the Late Anisian (Illyrian), a period characterized by intense volcanism and restricted carbonate production and a relative high sea-level. In the southern orogenic belts pure radiolarites were deposited and in the northern orogenic belts siliceous radiolarian-rich limestones. The second more short-lasting radiolarite event followed the demise of the Ladinian - Early Carnian shallow-water platform cycle in the Middle Carnian (Julian), but was restricted to the remaining intra-platform basins before they become filled by siliciclastics. In the distal margin setting radiolarites are missing. Mid-Carnian radiolarites or radiolarian-rich cherty limestones occur therefore more rarely, but also in all mountain ranges. The peak of radiolarite event predates the Mid Carnian Pluvial Event and can be related to a sea-level lowstand. The Late Carnian to Norian is characterized by carbonate platform formation. Only in the Rhaetian in some areas of the distal margin radiolarian-rich sediments were deposited; this is related to the partial drowning of the Late Triassic platform due to the increase of siliciclastics with the formation of deep lagoonal areas. The final drowning of the Late Triassic platform around the Triassic/Jurassic boundary is widespread followed by radiolarite deposition in the earliest Jurassic; in the distal passive margin setting and in the former deep lagoon areas (sea-level lowstand to sea-level rise). In the deep lagoon grey cherty limestones, rich in radiolarians and spicula, were deposited. The Toarcian black shale event, with deposition of radiolarian-rich sediments is contemporaneous with the break-up of the Alpine Atlantic und the onset of intra-oceanic subduction in the Neotethys Ocean and therefore overall to recognize (sea-level highstand). Strong Middle Jurassic rifting in the Alpine Atlantic and onset of ophiolite obduction in the Neotethys resulted in the Bathonian-Oxfordian radiolarite event with the peak in the Callovian-Oxfordian. On the Neotethys-side new trench-like basins started to be filled with argillaceous-radiolaritic carbonate-clastic flysch from Bathonian times onwards. These radiolarites were deposited in a relative deep-water setting.

Paleothermal Effects on an Organic Carbon Records of Paleozoic Carbonate Rocks of Peninsular Malaysia, Southeast Asia

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Peninsular Malaysia is in the southernmost part of the Southeast Asia mainland. It is divided into three stratigraphic belts based on major geological and geophysical differences: Western, Central, and Eastern. Within this tripartite division the Kinta Limestone is the most volumetrically important Paleozoic sequence, representing approximately 95% of Silurian through Permian time in rocks of the Kinta Valley region. Many of these rocks have been significantly diagenetially altered or metamorphosed and are sparsely fossiliferous as compared to northwestern equivalents. These alterations, and surface weathering, have increased the difficulty of geologically characterizing this formation.

We described stratigraphic sections from outcrops in the Sungai Siput area at the northern margin of the Kinta Valley region. Core description, geophysical logging, petrographic thin-section description, trace and major element data, organic carbon data, micropaleotological data, and mineralogic analyses have allowed interpretation of depositional environment, age, and degree of thermal alteration of these rocks. Porosity and permeability measurements using the mercury injection method and carbon content determined by direct thermal digestion at 1200^{o}C was conducted on a few representative samples.

The Sungai Siput limestone section is characterized by fine-grained, light-to-dark gray, thinly laminated carbonate mudstone interbedded with black shale and siltstone. Sedimentary structures include syndepositional slumps. The section is dated as Upper Devonian to Lower Carboniferous based on identification of *Polygnathus longiposticus?* and *Bispathodus sp.?* conodonts. Conodont alteration index values range from 4 to 5. The permeabilities are very low, generally 22.7 x 10^{-6} to 870 x 10^{-6} mm^2. The Mg/Ca is 0.026; the Mn/Sr is 2.21. One hundred twenty six meters of core from two boreholes are dominantly dark-gray carbonate mudstone with average total organic carbon (TOC) of 1.05 wt.%. The interbedded black shale has 4.93 wt.% TOC, and the siltstone has lower TOC. TOC distribution decreases with increasing grain size.

Petrography and trace element data indicate marginal-marine and freshwater diagenesis. Well logs and porosimeter measurements indicate very low permeabilities. These low permeabilities might have contributed to preservation of sedimentary features because of hindered fluid flow, which would have also facilitated heat transfer through convection. The relationship of TOC and grain size suggests that organic matter content is associated with depositional environments. Conodont color alteration indices and preservation of high TOC suggest that the Sungai Siput limestone section was not actually metamorphosed. Indeed, the degree of thermal alteration of these rocks is lower than those at other localities and lower than what has been reported in the literature. TOC values indicate that these rocks might have once contained more organic matter. These data suggest an anoxic depositional environment and higher primary productivity. The higher carbon content also affects conodont color alteration indices because of surface staining, which exaggerates maximum time/temperature estimates.

Acknowledgments: We are grateful to the IAS and South East Asia Carbonate Research Laboratory for financial and logistic support.

Syn-tectonic Late Devonian platform evolution, Canning Basin, northwestern Australia

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Well-exposed Late Devonian carbonate platforms of the northern Canning Basin (Lennard Shelf) developed on syn-rift fault blocks associated with oblique extension of the Fitzroy Sub-basin. A number of studies over the last 20 years have contributed to increased understanding of the tectonic history of the Fitzroy Sub-basin and the importance of both tectonism and eustasy in controlling platform evolution and architecture. We have integrated field- and core-based sedimentology and biostratigraphy, within a sequence-stratigraphic framework, to revise and refine the 2nd and 3rd-order relative sea-level history for the Lennard Shelf platforms. They are important outcrop analogues for the buried shelves on the southwestern margin of the Fitzroy Trough, coeval platforms of the neighboring Bonaparte Basin, and rift-related carbonate platforms and hydrocarbon reservoirs elsewhere.

Backstepping Pillara (Late Givetian–Frasnian) and prograding Nullara (Famennian) platform geometry has long been recognised with backstepping typically associated with extension. This change in platform geometry occurred in the Late Frasnian (base conodont Zone 12/within lower rhenana Zone) and is associated with major platform collapse, siliciclastic influx, and a pronounced biotic change from stromatoporoid-microbial to microbial reef builders. Tectonic control is also interpreted for two major flooding events that resulted in marked backstepping along the Lennard Shelf. The Middle Frasnian event occurred at/near the base of conodont Zone 9 (~base Upper hassi) and resulted in major deepening with development of platforms on Precambrian basement along the northwestern Lennard Shelf. The Late Famennian event (late trachytera–postera conodont Zones) also caused major deepening and is associated with a significant change in biota and platform morphology. This Late Famennian platform phase appears to have been transitional to major carbonate ramps (Fairfield Group) that subsequently developed over the Lennard Shelf.

Tectonic controls on 3rd-order platform development include rotation of fault blocks and subaerial exposure and karstification of fault block footwalls. At least seven Late Givetian–Late Frasnian platform phases of <2 myr duration are recognised and are typically bounded by prominent flooding surfaces. Biostratigraphic dating, mainly using conodonts, indicates synchronous flooding events within the resolution of the conodont zonal scheme, highlighting fault linkage across the Lennard Shelf during the Frasnian. Major subaerial unconformities are much less common although some flooding surfaces locally feature evidence for karstifcation prior to flooding. Progradational geometry is rare and one prominent phase was terminated by major platform margin collapse and coarse siliciclastic influx. Progradational reef complexes (latest Frasnian to mid Famennian) are characterised by fewer platform phases of longer duration (~3-4 myr) with common subaerial exposure features and siliciclastic lowstand wedges. Falling stage/lowstand carbonate facies are also recognised. In summary, tectonism exerted fundamental controls on 2nd-order platform history, morphology and biotic composition, with 3rd-order platform phases showing evidence for significant tectonic influence especially in the Frasnian.

Acknowledgements: We thank colleagues for discussions over many years, funding from the Australian Research Council, Natural Sciences and Engineering Research Council of Canada, University of Manitoba and University of Western Australia, and permission from landowners, companies and Department of Mines & Petroleum to access outcrops and core.

Downstream-migrating fluvial point bars and their recognition in ancient stratigraphic record

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Textbook models traditionally portray point bars as evolving by channel-bend expansion, with an increasing bend radius and the bend apex migrating transversely away from the channel-belt axis. This mode of meander evolution is thus widely used as a guide in studies of ancient point bars for reconstructing their bedding architecture and sedimentary facies distribution. However, many modern meandering rivers in reality show bend translation with a down-valley migration of the bend apex and with little or no change in meander radius and wavelength. The resulting depositional architecture differs considerably from that predicted by the classical model.

Downstream-migrating point bars (DMPBs) are little known from ancient fluvial channel belts, as their distinction from simple expanding bars requires outcrops revealing full 3D architecture. The present study reviews outcrop evidence of DMPBs from four different fluvial successions: the Jurassic Scalby Fm. of Yorkshire, UK; the Cretaceous McMurray Fm. of Alberta, Canada; the Eocene Cemalettin Fm. of Turkey; and the Pleistocene Aalat Fm. of Eritrea. These ancient point bars vary in grain size from coarse sand to mud, consist of laterally-accreted bed packages 5 to 40 m thick, and show evidence of down-valley migration by 250 m to several kilometres. The non-tilted Scalby Fm. is exposed along a modern tidal platform and adjoining cliffs, where both the palaeochannel-belt planform and 3D bedding architecture are recognizable. The McMurray Fm. is tectonically tilted, but affords good 3D outcrops. Only the McMurray fluvial system was tidally influenced. The outcrops of Cemalettin Fm. are extensive cliffs roughly parallel to the palaeochannel-belt axis. The 3D outcrop of Aalat Fm. reveals spatial evolution of a large, km-scale point bar. The main results of these four case studies can be summarized as follow:

(1) DMPBs are common features of valley-confined meander belts (Aalat and Scalby fms.) or where the river cut-banks are poorly erodible (McMurray and Scalby fms.). Even though subordinate, the occurrence of DMPBs also in rivers with erodible banks (Scalby Fm.) suggests however that other factors may contribute to their development.

(2) The development of DMPBs is not necessarily accompanied by the formation of counter-point bars or eddy-accretion deposits (Aalat and Scalby fms.), as these features seem rather to be a function of the impingement angle of thalweg flow against the cut-bank. Counter-point bars form when the angle is <70°, whereas eddy-accretion deposits tend to form when the angle is >70° and – contrary to earlier suggestions – are not necessarily coarser-grained than the adjacent point bars (Scalby Fm.).

(3) When lacking three-dimensional exposure, the bedding of DMPBs in outcrop sections parallel to channel-belt axis may resemble that of classical expanding point bars (Scalby and Cemalettin fms.) and lead to misinterpretation of the channel-belt actual direction.

(4) The DMPBs can form under channel-belt aggradation, as shown by the rising trajectory of the associated inter-bar thalweg in outcrop sections parallel to the belt axis (Cemalettin Fm.).

(5) Overbank floodwater may re-enter the river channel at the DMPB's downstream side and enhance development of secondary circulation cells, with deposition of meander scrolls on the downstream side (Aalat and Scalby fms.).

The Aalat succession (Dandiero Basin): an archive for the Pliestocene environmental dynamics of the Eritrean Rift

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The geology of East Africa has been deeply studied under the focus of numerous Earth Science disciplines. Environmental changes which affected East Africa since the Pliocene still represents a hot topic in Earth Sciences, mainly in the frame of the linkage between climate and human evolution. The detailed deep marine sedimentary record from the Red and Arabian Seas has been widely investigated to unravel these Pliocene - Pleistocene climate dynamics. Marine proxies were correlated with the coeval continental records from the sedimentary successions of Ethiopian and Kenyan basins, aiming at defining the time and mode of the main biotic and abiotic events. Notwithstanding, most of the continental sedimentary successions of East Africa are usually not sufficiently expanded to provide proxies with a resolution comparable with that obtained from the marine realm.

This study focuses on Pleistocene deposits of the Dandiero Basin, located along the Eritrean rift margin, an area relatively poorly explored if compared with other areas of the main Ethiopian rift. The Early to Middle Pleistocene Dandiero Basin is located 110 km south of Massawa, and is filled by about 500-600 m thick fluvio-lacustrine deposits bearing *Homo erectus* remains. The aim of this study is to provide palaeoenvironmental and chronological constrains for a 285 m thick stratigraphic interval exposed in the Aalat section, in the northern part of the Dandiero Basin. The Aalat section includes six formations, from bottom up: Bukra Fm. (fluvial), Alat Fm. (fluvio-lacustrine), Wara Fm. (fluvial), Goreya Fm. (lacustrine), Aro Fm. (fluvio-deltaic) and Addai Fm. (alluvial fan). The upper part of the Alat Formation contains the largest preserved remains of vertebrates, and two main fossiliferous horizons have been identified therein. These intervals yielded a very rich vertebrate assemblage, which is currently investigated, comprising fishes, reptiles, birds and mammals, including a human skull and a few other human remains.

The Aalat section displays three polarity chrons: a 70 m lower normal one (N1), a 165 m reverse one (R) and 50 m upper normal one (N2). The quality of paleomagnetic data, and its crossing with absolute dating (tephra layer at the base of the Aalat Fm.) and vertebrate paleontology, provide a robust correlation of the recorded magnetostratigraphy and allow the following correlations: N1 is C1r.1n (Jaramillo), R is C1r.1r and N2 is C1n (Brunhes).

These results highlight that the studied succession was deposited under extremely high accumulation rates (also confirmed by the overall poor soil development of the sediments), which allowed an aggradation of about 160 m during C1r.1r (i.e. 210 kyrs). This expanded section can be correlated with other continental successions of East Africa (e.g. Turkana Basin) or deep sea records of the Red Sea – Gulf of Aden area (e.g. DSDP site 231) providing discussion on climate variations in the Lower-Middle Pleistocene transition in East Africa.

Putting rockslide events into an environmental context: The search for the dust layer of the Flims rockslide, Graubünden, Switzerland

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Rockslides are the result of gravitational collapses of mountain flanks posing a major natural hazard in the alpine realm. Therefore, it is crucial to know the temporal occurrence of this natural hazard in order to understand the trigger mechanism. In the last decade, there was a great effort in dating numerous rockslides using different techniques. The two most common approaches are radiocarbon dating of organic material found below, within or atop of the rockslide deposit and surface exposure dating of rockslide bolder or the sliding surface.

In case of the Flims rockslide, which was the largest one in the Alps, several newer dating approaches were conducted. Poschinger and Haas (1997, Bull. Angew. Geol., 2, 35–46) used tree trunks found within the rockslide deposit for dating, Deplazes et al. (2007, Terra Nova, 19, 252–258) dated the oldest sediments in lakes on top of the rockslide and Ivy-Ochs et al. (2009, Geomorphology, 103(1), 104-112) did exposure dating. All of them revealed an early Holocene age of 9.4 ka revising the classical view that the age of the Flims rockslide is Late Glacial.

However, dating rockslides is one thing, but understanding the environmental conditions leading to the rockslide occurrence is another important issue, which is often neglected. It would be extremely interesting to investigate paleoenvironmental archives like lakes or peat bogs in the close vicinity of rockslides, where the rockslide event can be directly linked to the environmental record by the occurrence of its dust layer. Only in this way it would be possible to link unequivocal the rockslide event with a environmental record und understand the preconditions for the occurrence of a slope instability.

For the Flims rockslide, there were attempts to find its dust layer in small lakes (e.g. Augenstein, 2007, Jber. Natf. Ges. Graubünden, 114, 43-57). Augenstein claimed to have identified remnants of the dust layer in Lake Dachli/Obersaxen, although the sedimentological evidence is not conclusive. Now, several peat bogs and ponds in the close vicinity of rockslide area of Flims were cored in order to find clear evidence for the presence of a dust layer. Currently, several layers have been identified as potential dust layers, which will be closer investigated to confirm an atmospheric origin of these sedimentary features. Combined with radiocarbon dating below and above the dust layer, an unequivocal link to the rockslide event should be possible.

Paleoclimate similar to modern Mediterranean one as early as late Oligocene in Western Europe? Inputs of original climofunctions for alluvial Calcisols

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Paleosols that are frequent in continental successions open the possibility of high-resolution reconstitutions. These are classically based on the study of paleontological remains, preserved in scarce lacustrine or swampy facies in alluvial succession. Specific-Calcisols climofunctions have been developed to estimate the paleoclimatic parameters of the Upper Oligocene-Lower Miocene in Western Europe.

Published climofunctions based on physical description of paleosols are very useful when the entire profile is preserved and give info on Mean annual precipitations (MAP) and their seasonality. Other based on the geochemical composition giving MAP and MAT (temperatures) are unfortunately not adapted to alluvial Calcisols. The two original equations have been developed based on geochemical analyses of 28 modern Calcisols from NE Spain. Because they are forming on a heterogeneous alluvial substratum, we propose to include ratios of a geochemical index calculated for the superficial alteration horizon (B or Bt) on the same one for the parent material in order to allow comparisons between profiles.

$MAT\ (°C) = 1{,}255 \times [(CaO+K_2O)/Al_2O_3]_{B/C} + 13{,}26 \qquad r^2 = 0{,}69$
$MAP\ (mm/yr) = 1126 \exp [-0{,}639 \times (Al_2O_3/SiO_2)_{Bt/C}] \qquad r^2 = 0{,}84$

Their application to the pedogenic profiles from the Digne-Valensole (SE France) and Loranca (central Spain) basins suggests mean MAT around 15,4 °C ± 1 and mean MAT of 550 mm/yr ± 184 for both areas, which does not show any climatic gradient. In one hand, MAT are in agreement with those obtained from the study of paleoflora or the isotopic composition of rodent teeth, and some variations of temperatures appeared to be linked to global events recorded by the isotopic study of benthic foraminifera. In another hand, MAP quantified with paleosols are twice lower than those estimated by paleobotanical studies, which indicate a difference in the recording of the conditions of humidity, organic remains being preferentially preserved in humid zones and pedogenesis of Calcisols requiring a dry period. Indeed, the formation of these Calcisols is dependent of a strong seasonality in terms of precipitations/evaporation, and the seasonality calculated using the Bk horizon thickness is comprised between 20 and 152 mm ± 22.

These results indicate a paleoclimate similar to modern Mediterranean semi-arid climate at least since the end of Oligocene, for which a tropical or subtropical humid and warm climate was proposed up to there. Moreover, it highlights the need to cross paleopedological and paleontological studies in paleoclimatic reconstitutions.

Where did the ancient ice-sheet fronts stop?

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Ice-marginal subglacial to proglacial depositional environments are systems dominated by glacial meltwater processes and glacier-related tectonics. Their recognition in the sedimentary record, and that of related ice-sheet fronts, is crucial to the mapping of ancient ice-sheet extents or to the understanding of ice-recessional scenarios including time-transgressive ice-front still stands. While preserved glacial landsystems may help for the characterization of Quaternary ice fronts, the identification of ice-marginal systems from the pre-Pleistocene glacial record (e.g. Cryogenian, Late Ordovician, Carboniferous-Permian) is not straightforward, especially those related to recessional continental ice fronts. This study aims at characterizing ice-front related stratigraphic architectures and structures. A well-preserved ice-marginal domain and related succession have been recently identified in the Upper Ordovician (Hirnantian) glacial record of the western Murzuq Basin (SW Libya). The study area (40x20 km) offers opportunities for a seismic-scale analysis of glacigenics due to continuous outcrop belts available along walls of two deep wadis. Two main geological profiles have been reconstructed based on the combination of forty sedimentary logs, panoramic views and satellite images. They basically show a 90-150 m thick, sandstone-dominated depositional wedge corresponding to the last glacial sequence extended regionally where three superimposed depositional units have been delineated. The wedge comprises from base to top, a lower proglacial delta unit, a middle ice-marginal unit and an upper transgressive unit. The present study specifically deals with the middle, ice-marginal unit. It includes a range of glaciotectonic deformations and depositional settings, which has strong similarities with both present-day and Pleistocene ice-marginal systems. We first present an inventory of macro-scale ice-marginal features, organized on the basis of four categories of structures, differentiating: (i) Deformation structures from flowing glacier ice that include proglacial fold-and-thrust belt and subglacial shear zone dealing with intraformational glacial striae, S-C structures, sheath folds and normal microfaults, (ii) Structures from overpressured subglacial (meltwater) flows including clastic dykes and tunnel valleys, (iii) Subaerial depositional sedimentary structures from proglacial meltwater flows where sandstone intraclasts, large-scale bedforms, climbing-dune cross-stratification and kettle holes are documented, and (iv) Deformation structures from non-glacier ice comprising deformation from free-floating ice and ice crystal marks analysis. The understanding of this corpus of deformational and depositional features in the frame of a relative chronology based on cross-cutting stratigraphic relationships permits to reconstruct an ice-front evolution and to depict the development through time of the resulting ice-marginal sedimentary system. Results allow the identification of ice-front advance and retreat phases, which include coeval glacial basin development and formation of a glaciotectonic fold-and-thrust belt. Continental proglacial outwash sedimentation dominates at ice-sheet margin during ice-front fluctuations. Such fluctuations are related to short-lived advance and retreat phases during glacial stillstand occurring throughout the global ice-sheet recession over the platform. Our results are relevant to the delineation of other Upper Ordovician ice-marginal sedimentary and to any other situation where an ice-front evolution left behind a record associated with large scale, e.g. seismic scale, stratigraphic architectures.

The influence of sea level, antecedent topography, and subsidence on reef development in Bora Bora, Darwin's type barrier reef (Society Islands, Pacific): first results

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This project focusses on the Holocene development of the barrier reef system around Bora Bora, Society Islands, French Polynesia. Bora Bora is significant as it is one of the few oceanic barrier reefs. Charles Darwin selected Bora Bora as his type barrier reef to put forward his universally known subsidence theory, which genetically connects fringing, barrier, and atoll reefs based on subsidence and vertical reef accretion around volcanic islands. However, no subsurface data from Bora Bora exists. Rotary drilling in barrier, fringing and patch reefs, vibracoring in the lagoon, and shallow reflection seismics will be used to detail the late Quaternary history of this unique reef location. While the subsidence theory can be used to explain the formation of isolated barrier reefs and atolls in the open ocean over longer time periods, it does not sufficiently elucidate the formation of continentally-attached reef systems and Quaternary reefs in general because the influence of sea level variation and antecedent topography was neglected.

The project focusses on elaborating five key questions, including (1) the influence of sea level, antecedent topography, and subsidence on barrier reef development, (2) the impact of the same factors on the formation of lagoonal fringing reefs, (3) the occurrence of microbialites in Holocene coralgal reefs, (4) patterns of lagoonal sedimentation including the role of siliciclastics, and (5) the nature of non-skeletal carbonate grain sedimentation. The occurrence of the latter opposes the widely-held concept of the virtual lack of these grain types in the Indo-Pacific as compared to Atlantic reef and carbonate platform systems. Bora Bora is well-suited for this type of study as it represents a small natural laboratory with the common occurrence of different types of reefs and lagoons in very close proximity.

From a wider perspective, this project will contribute to a number of fundamental questions in carbonate sedimentology and coral reef geoscience. Apart from pure scientific interests, the study of environmental factors such as, e.g., sea level on reef and reef island development is also of socio-economic interest. More than 50 million people of the small island developing states live very close to sea level, many of them on reef islands, which are threatened by acute drowning. It will be crucial to understand the recent past of reefs and adjacent islands in order to be able to make predictions for the near-future, which will presumably be characterized by a rapid rise in sea level.

First results of an expedition to Bora Bora in May 2014, which is being funded by the Deutsche Forschungsgemeinschaft, will be presented at the ISC in Geneva.

Study of Sediment Dynamic on the Doce River Inner Continental Shelf using the bulk density

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Bulk density of the surface *sediments* gives an indication as to how susceptible the material may be to *resuspension* events caused by wind-driven waves. So this sediment characteristic can be a suitable tool to infer sediment transport conditions and events.

The aim of this study is to correlate bottom sediment bulk density to hydrological events and atmospheric conditions to infer the sediment dynamic pattern in a portion of a continental shelf. The study area located along the continental shelf adjacent to the Doce river, northern Espirito Santo state, eastern Brazilian coast. This area is covered by mud sediment supplied by the Doce river.

As general knowledgement the shelf and coastal dynamics are controlled by physical processes (wind, waves and currents) and sediment supply. The wind plays an important role in the coastal region that includes mix, extent, direction and movement of river plume. At the study area trade winds are dominant during summer (October to March), and the waves generate longshore current southward. By contrast, during S/SE/SW cold front incursions mainly during winter months (April to September), generate a longshore currents flowing northward. The Doce river presents higher and lower discharges in summer (rainy) and winter periods (dry), respectively. The tidal range is microtidal with weak currents in the shelf.

Surficial sediment sampling at 31 stations were collected during January, May, July and October, 2013 and January, 2014, using a Van Veen grab. Wind and river discharge data were obtained from database of the government agencies.

Results showed that the bottom sediment bulk density varies during the year. The shallow shelf (<30m depth) is dominated by mud sediment that varies under different meteorological events. Lowers bulk densities were observed during January 2013 and January 2014. These results were expected, once during this period the river presented higher discharge values (5 m above the mean level) and the wind trades (NE winds) dominance. January 2014, due 5 m above the mean discharge presented a different deposition pattern, with two depocenters.

May, July and October 2013 showed different scenarios. May 2013 presented higher bulk densities values (1700 kg/m^3). In this case the wind pattern didn't showed great direction variations from January 2013 (from N/NE to S/SE), so the bulk densities values probably were related to consolidation process. From May to July 2013 the meteorological forcing showed more cold fronts incursions that changed wind direction. It appears be indicated by the bottom fluidization process. October 2013 the weather conditions remained similar to period before. The results suggested that resuspension processes occurred since the sand bottom were exposed near to the river mouth. Besides that the depositional process occurred southward.

This study showed that the Doce River shelf during periods of trade winds and higher rivers discharges presented a mud bottom with lower bulk density.

Furthermore the bulk density of the mud bottom increased as result of consolidation processes. During the period of cold fronts dominance the dynamic increased as expected and was observed a sand bed exposition that were covered by mud previously, which suggested a sediment transport.

Third Generation Paleoseismology: Convolving Sedimentology with Site Analysis, Slope Stability and the Earthquake Source in Sub-aqueous Settings

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Third generation sub-aqueous paleoseismology is moving beyond event identification and dating, and to some extent beyond simply establishing long recurrence statistics. Long and detailed paleoseismic records afford uncommon opportunities to examine recurrence models, clustering, segmentation, interaction with other faults, long term strain history and paleo slip characteristics. Submarine paleoseismology is a multidiscipline endeavour, both requiring and benefitting from broad consideration of slope stability, drainages, source pathways, physiography and sedimentology to both test and develop an earthquake record from a sampling strategy that is commonly sparse. An important tool commonly unavailable in land paleoseismology is litho-stratigraphic correlation. Correlation of deposits over broad areas (relative to the size of the earthquake) is one key element (of many) in testing the stratigraphic record for earthquake origin. Detailed sedimentology alone is rarely enough to accomplish this task. Fortunately, well log correlation, a well-developed method, can be adapted to correlation of core samples. Many geophysical proxies such as CT and gamma density, and magnetic susceptibility can provide not only "wiggle" traces for comparison, but good grain size proxies that sometimes reveal very detailed structural similarities with deposits and deposit sequences over large as well as short distances. Although turbidite structure is commonly assumed to be controlled by hydrodynamics, we show that correlation across multiple environments can demonstrate that at least in the case of very large earthquakes, these effects can be overprinted with other factors, including earthquake source effects. Cores may be correlated between sites with continuous stratigraphy, and even between sites with no physical connection in some cases. In Cascadia, inter-site correlation has now been accomplished between deep marine sites in several settings, as well as both fjords and (tentatively) with onshore lakes with no physical connection to the deep water sites. Chirp seismic reflection profiles can be used to test for earthquake origin within lakes, and offshore between slope basins and by correlation of beds over very large distances. Other tests can be applied to test for synchronous origin, such as at channel confluences where provenance, flow direction and turbidite sequence and structure can be used to test for synchronous passage and deposition from turbidity currents far beyond the abilities of dating methods. As with all geologic methods, site selection is critical. Channelized turbidity currents may travel hundreds to thousands of km, but unconfined turbidity currents and their deposits may wane rapidly away from the source. Slope stability analyses typically show that relatively small earthquakes will generate slope failures. However, other factors such as the slip model of the earthquake, directivity, local physiography, and the "Q" distribution in the region of interest also likely factor into the distribution of interpretable deposits from earthquakes.

Acknowledgements: We thank the U.S. National Science Foundation, and the U.S. Geological Survey for support of this work.

Investigation of (authigenic) clay minerals and their distribution in limestones and hydrothermal dolomites of the Ramales platform, Cantabrian Mountains, Spain

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Structurally controlled hydrothermal dolomite reservoirs (HTD) have been considered in several petroleum fields worldwide, consequently there exists an increased interest in their importance with regards to reservoir characteristics. In this respect, in several studies, for instance Keith et al. (2002), Davies (2004), Shah (2011), authigenic clay minerals have been reported in HTDs, which is always a fascinating subject from sedimentological/diagenetical and petrophysical point of view. The precipitation of authigenic clay minerals even in small volumes in the pore space can remarkably influence reservoir properties of these carbonates.

The Ramales carbonate platform in Northern Spain is one of the best examples of the development of authigenic clay minerals in hydrothermal dolomites. Host limestone (Aptian-Albian) are affected by hydrothermal dolomitization fluid circulation along the Pozalagua fault. In the current study carbonates from Pozalagua quarry in the Basque – Cantabrian Basin were examined in order to understand the origin of these clay minerals and to unravel the processes involved in their formation. Classical polarizing, cathodoluminescence and scanning electron microscopy and micro-CT were used to unravel the sedimentological, mineralogical and textural characteristics of these rock bodies. Optical microscope and electron probe micro-analyzer cathodoluminescence (OM-CL and EPMA-CL) are employed to reconstruct a paragenesis history. Quantitative XRD analysis on bulk sample and also on the clay fraction together with FEG-EPMA analysis are applied to investigate the mineralogy and chemical composition of the samples.

Regarding on these investigations some changes in mineralogy, crystal size, fabric and spatial distribution of the different clay minerals and dolomite lithotypes has been revealed. Almost in all of the samples the carbonate part was >95%, however, clay minerals were less than 2%. Authigenic clay minerals in the Ramales platform carbonates are dominated by chlorite and kaolinite. Illite and several mixed layer clay minerals (corrensite, chlorite-smectite and smectite-illite) occur in small quantities. Iron (hydr) oxides as well as organic matter and some non-carbonate constituents present in the samples. Despite of small differences in distinct clays portions, the clay mineralogy of the samples were more or less the same even in the limestone host rock. Conversely, based on textural properties and crystallinity of clay minerals we assume a detrital origin for the clays presented in the limestones and stylolites, whereas, an authigenic origin is very likely for the clays present in intercrystalline pore spaces within the hydrothermal dolomites. Consequently, clay minerals point to an in-situ source of the constituents. Based on the current examinations, clay rich dolomites in Ramales platform are formed in different paragenetic phases of dolomitization from clay- lime cave filling precursors.

Dolomitization simulation and investigation of its effect on reservoir properties of Sarvak formation in Hendijan oil field

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The Hendijan oil field is an offshore field which is located in the north-west section of the Persian Gulf, 10km north-east of Bahregansar platform. The Sarvak Formation (Cenomanian to Turonian) is one of the main reservoirs in that region. Understanding the sedimentary characteristics, diagenetic processes and petrophysical properties of the Sarvak Formation as reservoir is critical for hydrocarbon exploration, production and management.

A detail petrological and petrophysical study is carried out on Sarvak carbonates using thin sections, cores and XRD results of one single well and well log data from nine wells. Light microscopy and secondary electron microscopy (SEM) are employed to evaluate the porosity types. In addition, different well logs, i.e. RHOB, NPHI, PHIE, GR, DT are used to investigate log-facies to reconstruct a 3D facies distribution model of the reservoir by PETREL software. In order to model these facies, a sequential indicator simulation (SIS) geostatistical method was applied. Besides, the hydraulic flow units were calculated from measured porosity and permeability values to classify reservoir rock types.

As a result of these studies, sedimentological analysis allowed to differentiate seven microfacies based on application of the Dunhum classification and dolomites textural parameters on first well. The later includes dolomite concentration, size, packing, nucleation centers, distribution, edges sharpness, and sorting. In addition, due to lack of cores from other wells, log-facies were codified using hierarchical cluster analyses of well logs by MATLAB software in the analyzed wells. Regarding on these data the Sarvak Formation was divided into seven hydraulic flow units based on flow zone indicator (FZI) variations.

These studies show Sarvak Formation in Hendijan oilfield consists of limestones, dolomitic limestone and some anhydrite layers occurring at the top of the formation. Geophysical studies conform presence of a disconformity which diminish the thickness of the Sarvak Formation from the east toward the west of the study area. The depositional environment corresponds to a carbonate ramp. Additionally, dolomitization is the major diagenetic event which controls reservoir properties. Except a few overdolomitzed locations, dolomitization enhanced reservoir properties.

Determined log-facieces are compared with hydraulic flow units. The match between calculated and measured data demonstrates that this relation can be used to predict permeability from well logs by zoning the data from training wells into hydraulic units. Both approaches show satisfactory results in reservoir geology of the Sarvak. Based on this study seven log facieses were constructed leading to several stochastic models. Finally, by making a comparison between log-facies established from well logs and those predicted from stochastic models, an optimal model among them was chosen with regard to the studied reservoir.

Microfacies analysis and paleoenviornmental interpretation of the Pennsylvanian coral reef in Guangxi

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The early Late Carboniferous is a particular time interval of the Earth in terms of paleoclimate and paleoenvironment. The diversity of reef-building organisms is low. A Late Carboniferous coral reef developed in Longjiangdong village, Tianlin County, Guangxi Province. This reef located in the isolated carbonate platform margin of the Yunnan-Guizhou-Guangxi basin during the Bashkirian to Pennsylvanian. The key bed level belongs to the Huanglong Formation.

The Longjiagndong reef is mainly distributed in the nearly EW direction, and the thickness of the outcrop about 31m in thickness and 15m in width. Three stages are distinguished, with a thickness of 3.8m, 2.5m and 9m respectively. The base of the reef is crinoid clastic bank. The mainly reef-building organisms is rugose corals of the genus *Diphyphyllum* sp., subordinate organisms are crinoids, brachiopods, foraminifera, calcisphere, bryozoans, bivalves, gastropods, solitary corals, ostracods, microbes and algae.

The Longjiangdong reef is inferred to growth on the carbonate platform margin, and be divided into four facies:

Shelf facies at the base of each stage in the reef. The main fabric is mudstone with high diversity bioclasts, which indicates that sedimentation took place in an open-marine environment below the fair-weather wave base, with low-energy conditions.

Coral reefal facies, consisting of three reefal stages. A reef-framestone characterized by in-situ growth of phacelloid rugose coral. Inter-framework filled by mud and bioclasts including crinoid, brachiopods, gastropods, and foraminifers. This facies was deposited above the fair-weather wave base on an open-marine environment with shallow, clean, agitated and well-circulated water.

Shoals facies: appeared at the end of the first stage. The overall lack of oolitic banks instead of bioclastic with low diversity and a spot of micrite matrix. It indicates that the strong current was lasting for a short period. And a lenticular brachiopod bank may be the result of a time interval of high-energy conditions. The facies suggests a normal marine environment above the fair-weather wave base with medium to high hydrodynamic energy environment.

Restricted platform facies: It was posterior to the first and third stages, and common in intra-framework with restricted-low water energy conditions. This facies consists of fine-grained microcrystalline limestone and algae/microbe. This is poor in skeletal fragments and non-skeletal grains, only dominated by crinoid fragments. A high percentage of carbonate mud and the rare faunal elements suggest that deposition occurred in a shallow-low energy water environment.

According to the changes of facies, the Longjiangdong reefs consist of three growth stages. Each stage may indicate the sedimentary environment with falling sea level, shallow water, enhanced water energy. The growth stage of the Longjiangdong reef occurred at a in an environment of relatively weak water energy. In terms of lithology, a high percentage of mudstone, wackstone and packstone, and the rare grainstone and oolite also suggest a low energy water environment. On the basis of the evolution of facies models, all of the three stages grow on the shelf facies. But the reasons that three stages stop growing have slight differences. The first stage was influenced by fluctuating conditions in the environment of deposition, while the second and third stages may be controlled by nutrition and the deposition rate of carbonate mud.

Acknowledgements: This research was supported by Specialized Research Fund for the Doctoral Program of Higher Education of China (No 20120042110027); National Natural Science Foundation of China (No 41202018).

Sedimentation controls diagenesis and reservoir properties in unconventional tight sandstones: a case from Yanchang Formation of Upper Triassic in Jiyuan Area of Ordos Basin

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During the research on Chang 6 oil group of Yanchang formation at Jiyuan Area, Ordos Basin, differences of oil-bearing between different part of sedimentary units from macro-scale to micro-scale were identified. Contrary to general understanding, oil occurs easily in the part of the sedimentary units which have worse initial porosity and permeability (such as upper part of subaqueous distributary channel, upper part of oblique bedding), while the other part of sedimentary units which have better original physical properties have serious carbonate cementation and low oil-bearing grade.

Different oil-bearing grades from oil immersion sample to heterogeneous oil containing sample to no-oil sample were chosen to find the sedimentation controls on diagenesis and final reservoir properties of tight sandstones in the background of impact on the original properties, by analysis techniques of thin section, casting sections and scanning electron microscope(SEM).

Oil immersion samples have low percentage of carbonate cement in pack-pore cementation type around 3%-5%. The surface of grain growth chlorite rim, and the pores are filled with chlorite cements and carbonate cements that attach to chlorite cements. Dissolution develops in framework grain which have chlorite rim, even remaining chlorite rim only.

No oil samples have high percentage of carbonate cement in basal cementation type around 15%-23%.The surface of grains have no chlorite cements and the pores are fully filled with carbonate cement which attach to grains directly

Heterogeneous oil containing samples have middle percentage of carbonate cements in basal to pack-pore cementation type around 8%-13%. The surface of grains are covered by carbonate cements or by chlorite rim wearing carbonate cements

Through the analysis of different samples, four diagenesis evolution stages of Chang 6 tight sandstones were established according to basic tectonic evolution.

First, original sedimentation compaction stage: Grains deposit under principle of mechanical sedimentary differentiation forming sedimentary heterogeneity from genesis unit scale to micro-scale, sediments are compacted initially under alkaline environment, and microcrystalline calcite cements developed.

Second, early acidulous water injection stage: Indo-china movement uplift Ordos Basin, Calcium-rich groundwater have the priority impregnating into well porosity and permeability reservoir, and carbonate cementation occurred with the reduce of pore water CO_2 partial pressure. Meanwhile, sandstones which were not disturbed by acid pore water for the lower porosity and permeability developed chlorite for the favorable temperature (28℃with 3℃/100m geothermal gradient and 25℃ LST), chemical environment and material conditions.

Third, carbonate cementation obstruction stage: reservoir with better original physical properties was maximum filled with carbonate cements, chlorite cements existing in pores of worse original properties sandstones inhibited carbonate cements precipitating after the calcite-rich groundwater injection.

Fourth, organic acid and hydrocarbon injections stage: Organic matter into the mature stage, it release Organic acids, which chould inject into the pore in chlorite cement, and dissolving grains with chlorite rim, which conversely have no channel to coming into reservoir badly carbonate cemented.

The results above show that the sedimentary environment determines the original sediments properties, and controlling the diagenetic process, affecting the final reservoir properties in chang 6 unconventional tight sandstones.

Antecedent Topography and Sea Level Controls to Holocene Coral Reefs of Maydolong, Eastern Samar, Philippines

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Holocene coral reefs are well developed along the coasts of Eastern Samar, Philippines, a cyclone-prone area, yet little is known about their history or internal structure. To investigate the controls over reef growth in the area, three cores of 12.4 to 19.6 m in length, were recovered from Holocene coral reef at Maydolong, Eastern Samar with two located at reef margin and one in the backreef zone. Lithofacies and ^{230}Th ages of 15 fossil corals and 3 travertine samples from the cores show that the reef development was controlled by degalcial sea-level rise, and antecedent landform of the Pleistocene karst underlying the Holocene coral reef. The reef margin is dated to start from 8,296±19 yr BP (before 1950 AD) at 7.1 m below mean sea level (MSL) and ended about 5,710±13 yr BP when reached the paleosea level. Only 120 m landward, the backreef deposition occurred during 8,181±20 to 6,664±18 yr BP, comparable to the reef margin but start from a much lower depth, 17.7 m below MSL. Travertine occurs in the limestone underlying the Holocene reef and is dated to range from 35 to 55 kyr BP. The evidences suggest that antecedent karst topography decided the locations of reef framework. The backreef deposition started in a pre-existing depression but was able to catch up the sea-level rise at a sedimentation rate of 9.6 m/kyr before the paleosea level slowed down in the middle Holocene.

Keywords: Holocene Coral Reef, U-Th dating, Antecedent topography, Sea level, Philippines

Paleoenvironmental interpretations of the Cretaceous-Tertiary sequences and paleoecological approaches to larger benthics from the Nallıhan-Çayırhan area (western Ankara, Turkey)

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The Nallıhan-Çayırhan area including various Palaeozoic, Mesozoic and Tertiary sequences is located in the northwest of the Anatolid plate. In this study, paleoenvironmental interpretations of Cretaceous-Tertiary (C-T) sediments, particularly Campanian-Maastrichtian ones, their boundary relations and paleoecological approaches based on larger benthics are presented. For that purpose, revisions on the geological map using Google Earth satellite views and field works' data, and several measured sections from the Maastrichtian sediments were realised. The widely exposed Campanian to Maastrichtian sequences has the importance for reconstruction of the geological history in the area. In the Nallıhan-Çayırhan and its surrounding area, Palaeozoic metamorphic rocks form the basement of the sequences. Jurassic to lower Cretaceous sequences namely Soğukçam limestone and its constituent Tokmaklı Member, unconformably overlie the basement. The Campanian to Maastrichtian sediments are represented by (from bottom to top): Haremiköy conglomerates, Nardin Formation including Çegiköy Member and Taraklı Formation. The paleoenvironmental reconstructions utilize stratigraphical, taxonomic and paleoecological information to show that there was a transgressive to regressive succession during the late Campanian to late Maastrichtian in the area. From bottom to top, the following main facies were defined: alluvial, reefal, open marine and shallow marine facies. From these, reefal and open marine facies further subfacies can be divided. Siliciclastic sediments of Taraklı Formation from the Nallıhan region, are middle to upper Maastrichtian in age. They include rich larger benthic foraminifers, bivalves, gastropods, echinoids, corals, and macro-traces and microboring activity are also seen abundantly within some levels of *Orbitoides apiculatus* Schlumberger abundance biozone. *Curvichnus semorbis* Nielsen and other microborings were identified. They were interpreted as an endobiontic parasitic and hermit-type life modes. As a result, different kinds of microboring activities and their paleoecological approaches to clastic and carbonate environments were taken into consideration. In addition to these paleoenvironmental interpretations of the unconformably overlying Tertiary sequences on the Cretaceous sequences, namely Kızılçay Group, Palaeogene-aged red bed clastics, and other terrestrial Miocene-aged clastics and carbonates were also briefly studied. In conclusion, during the late Campanian to late Maastrichtian, a transgressive to regressive succession mainly according to foraminiferal data and overturned sediments based on rudist fauna and field observations were supported. Mass killings of larger benthics identified as *Orbitoides apiculatus* related to environmental changes in the C/T boundary and microboring activity in their tests show that the Nallıhan region is one of the significant catastrophic event locations in Turkey.

Acknowledgements: The authors would like to thank the Research Foundation of the Ankara University (BAP) for financial support of the project related to Nallıhan region.

Permian climate change recorded in Gondwanan coal and black shale deposits: a South African perspective

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Permian organic-rich sediments of the South African Karoo Basin play a crucial role in the study and interpretation of Gondwana's climate history and biodiversity in this time of major global changes in terrestrial and marine ecosystems. The palynological record of coal deposits reflects changes in land plant communities and vegetational patterns related to climate change and thus provide significant data for high-resolution palaeoclimate reconstructions in deep time. Marine black shale deposits contain sedimentary organic matter and palynomorphs that document both marine and terrestrial signatures and thus also allow for nonmarine-marine correlations.

In the present study palynological data are presented from the Main Karoo Basin, documenting major changes in palaeoclimate. The spore/pollen ratios are used as a proxy for humidity changes. Stratal variations in the composition of the pollen group (monosaccate/bisaccate taeniate/bisaccate non-taeniate pollen grains) indicate warming and cooling phases. Variations in the amount and in the type, size and shape of phytoclasts reflect short-term changes in transport and weathering. The detected palaeoclimate signals are used for high-resolution correlation on basin-wide, intercontinental and intra-Gondwanic scales. Palynostratigraphic schemes for coal seam identification and correlation are refined and applied to correlate coal deposits of the NE Main Karoo Basin with marine black shale deposits of the N and S Karoo Basin. Major climate shifts are identified by the palynomorph record and are used for cross-basin correlations on high time resolution.

Acknowledgements: This work is based on the research supported by the National Research Foundation of South Africa (Grant No. 85354).

Old valleys of Mars (3.5 Gy) were they subglacial tunnel valleys?

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Large quantities of observables indicate that early Mars (3.5 Gy) was an hydrological active planet (old valley, mineralogy). But the true climatic conditions of Early Mars are still debated. Two end-members are in opposition: an earth-like model with rain or snow precipitation in ultra arid context or always icy Mars with ice melting. We study old martian valleys (3.5 Gyrs old) in the low to mid latitudes of Mars and measure their long profiles, slopes, depths and widths with MOLA PEDR data. We find “anomalous” valleys with an approximately constant width downstream and an undulating long profile with a lack of tributaries. Altogether, these geometric characteristics are similar to those of terrestrial tunnel valleys formed by meltwater drainage beneath ice covers. The undulating nature of terrestrial tunnel valleys profiles is due to erosion driven by water flowing under the pressure of the overlying ice. Observation of such undulating long profiles on Mars could indicate a subglacial origin for these “anomalous” valleys. Such an origin for those martian valley networks is consistent with an early mars cover by widespread patches of ice, with water circulation at the base of the glaciers.

Facies, sedimentary environments and depositional history of Holocene tufa in Slovak Karst

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Tufa is an important palaeoenvironmental archive recording climate, vegetation type, hydrological conditions, tectonic and the activity of the prehistoric humans. Several tufa complexes are known in the Slovak Karst. This area is built of Mesozoic carbonates, mainly Triassic in age. It is a typical karst area of a temperate climate. Carbonate plateaus are drained by karst systems which lead water to resurgences located in the valleys which are up to 300 m deep. Below the resurgences there are Holocene fossil tufa deposits that exceed 12 m in thickness.

Three different inactive tufa successions – Haj, Hrhov and Gombasek – were selected for this study. Sixteen tufa sections were analyzed bed-by-bed. The facies were distinguished on their macroscopic and microscopic – including SEM – characteristics. The study was supplemented by geochemical analyses (content of Si, Al., Fe, Na, K by ICP-emission spectrometry and calcium carbonate contents by calcimeter) and by powder X-ray diffractometry. Radiocarbon dating of charcoal and terrestrial snail shell samples was carried out. The radiocarbon dates obtained were calibrated using the OxCal program and IntCal09 calibration data. Age-depth models were constructed using MOD-AGE software.

The tufas include stromatolite, moss, phytoclastic, oncoidal, and intraclastic facies. Two depositional systems were recognized within the tufas studied. The tufas at Hrhov and Gombasek represent a perched springline transverse system whereas the tufas in the Haj Valley correspond to a longitudinal fluvial depositional system. It comprises tufa forming barrages and filling inter-barrage areas. The former are composed of moss, stromatolitic and phytoclastic tufa facies, whereas the latter comprise chiefly oncoidal and intraclastic tufa facies. Fluvial tufas were laid down in narrow, steep-sided valleys, down which a confined stream flowed with limited lateral migration. Barrages were formed in constrictions of a valley or associated with irregularities in the pre-existing valley bottom. Wood debris jams enabled inception and growth of barrages. In the inter-barrage areas, active stream channels existed, where oncoidal and intraclastic tufa were laid down. Perched springline tufas were deposited below resurgences located on the plateau slopes. Steep slopes prevented the creation of barrages and extensive dammed areas. This resulted in the formation of a lobe-shaped tufa body. Such tufas comprise moss, stromatolitic and phytoclastic tufa facies.

The tufas studied were formed in the Mid-Holocene, namely in Atlantic and Sub-Boreal times. Subsequently, they experienced substantial erosion and were incised down to their Mesozoic basement. Erosion is hypothesized to have been stimulated by deforestation caused by prehistoric humans. Following erosion, this deposition of tufa was renewed. At present tufa grows at all the sites studied. Thus, the Slovak Karst represents an example of an area where after a late Holocene decline, which was a European-wide phenomenon, tufa deposition was reactivated.

The study was financed by the National Science Centre grant N N307 151538.

Bizarre freshwater carbonates associated with Permian hydrothermal karst; Kraków region, Poland

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Facies architecture and conditions influencing the origins of freshwater carbonates have received increasing interest in recent years. This is stimulated by the discovery of oil and gas in the South Atlantic region within such kinds of carbonates.

Bizarre freshwater carbonates have been found in the Kraków region, southern Poland. They occur mainly as fillings of extensive karst hosted by Middle Devonian to Mississippian age carbonates which form the Dębnik Anticline. In this region, activity of the major transcontinental strike-slip Hamburg-Kraków-Dobruja fault zone induced a series of minor, en echelon, extensional faults. This tectonic deformation was succeeded by Permian (ca. 300 Ma) post-Variscan volcanism which slightly predates the karstification.

Presently visible fossil karst forms are up to a few metres in lateral extent. However, very large (up to around 100 m across) forms were recognized in the early 1980s, but have since been completely quarried out. The filling of the karst forms comprises: i) massive, subaqueous, coarse crystalline calcite spar; ii) crystalloclastic bedded limestone; iii) jasper lenses, and iv) kaolinitised tuff. The sediments are characterized by red colouration caused by iron compounds.

Coarsely crystalline calcite spar composes beds up to several dozen centimetres in thickness. They are laminated and comprise frutexites type structures. The calcites are interbedded with pinkish-red crystalloclastic limestones, which are formed by detritic calcite crystals from silt-size to a few millimetres across. Some of the crystals are of skeletal type. Crystalloclastic limestones are normally graded. They are hypothesized to have been derived from fine carbonate structures growing in non-equilibrium conditions which were crushed, presumably during eruption of gases. Kaolinitised tuffs with jasper lenses underlie the carbonates and fill the lower parts of karst forms. The deposits underwent synsedimentary deformation, which resulted in brecciation.

The karst forms are parts of an extensive circulation system. This was fed by waters of elevated temperature, rich in endogenic CO_2, which is demonstrated by fluid inclusion and stable isotope analyses. The origin of this system and its filling were associated with volcanic activity. The roots of the system are represented by fissures filled with coarse crystalline, red and white vein calcites of onyx type, which are common in the Dębnik Anticline. Water issuing from this system onto the surface caused precipitation of red travertines that are only preserved as clasts in the Lower Permian conglomerates deposited in local tectonic depressions. The more distal facies is presumably represented by calcareous tufa, known as Karniowice tufa.

The study was financed by Ministry of Science and Higher Education project N307 022.

The contribution of calcareous green algae to the production of limestones

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Calcareous green algae (CGA) are an artificially united but highly heterogeneous group of large unicellular benthic algae with one character in common: all have the capability of secreting a calcareous coating on the outer side of the cytoplasmic envelope. The CaCO3 precipitated to form the coating is generally aragonite (the orthorhombic form). However, there are some exceptions during short periods of the geologic record where the calcite variant (the rhombohedric form) existed contemporaneously in few discrete species. Today, CGA remain a major contributor to carbonate sedimentation at all scales from clay-sized particles (aragonitic needles) to coarser grains (sand and gravel) and even to plurimetric sedimentary structures. Recent studies on *Halimeda* have shown that some of the Bryopsidales have the capability to calcify strongly in the lower portion of the euphotic zone (where respiration becomes more important than photosynthesis in the process of mineralization) and to produce positive sedimentary reliefs (bioherms) in situ below the fair-weather wave base. As a matter of facts there are fossil analogues to these features. Previous models of paleoenvironments considered the presence of Dasycladales or Bryopsidales to indicate shallow-water, that is the upper euphotic zone (from the sea surface down to -25 m), and predominantly low-energy, protected, lagoonal environments. When the algal remains were found in grain-supported facies, they were taken to have been subjected to dynamic transport and therefore indicative of high-energy environments of deposition. However, the finds of modern deeper-water self-supported *Halimeda* segments have changed interpretations of the environments ascribed fossil algae. A current conception is that ancestral inarticulated Bryopsidales could have grown at depths as great as -120 m (near the base of the lower euphotic zone). This preliminary review concludes with suggestions about fields for continuing investigations on CGA, both living and fossil.

Calcareous turbidites are the key to understand contemporary carbonate platforms of neighbouring areas: Example of the Vivarais Urgonian Platform and the Vocontian Basin

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The L'Estellon section is located some 20 km north of the locality of Nyons in the Drôme department, SE France, a few kilometres north to the Chaudebonne section (Moullade. 1966) and south of the Crupies section (Ferry, 1976). As in both of these sections, the succession, which consists mostly of basinal marls and associated vermicular limestones, includes a number of intercalations of conglomerates (debris-flows) and oobioclastic allodapic calcarenites (turbidites). These coarse-grained floatstone and oobioclastic wackestone facies contain numerous foraminifers and calcareous algae thought to be transported (freshly reworked) laterally from neighbouring carbonate shelves, most probably from the Vivarais Platform.

During this study the L'Estellon section was logged and a diverse ammonite fauna was collected from the argillaceous and muddy limestones. This fauna comprises Late Hauterivian and (Early and Late) Barremian forms. The co-occurrence of shallow- and deeper- water fossils allows us to use the ammonite biozones to reconfirm the calibration of the First Appearance Datum of these benthic foraminifers and algae. The L'Estellon section thus allows correlation of the distribution of allochthonous neritic (shallow-water) assemblages with time-equivalent sub-autochthonous pelagic (deeper-water) components in the fossil record.

We infer that the L'Estellon section can be regarded as a 'Rosetta Stone' for Urgonian biostratigraphy. A comparison of these updated microfossil appearances with their ranges shown on current orbitolinid charts provides contrasting results: for instance, these results call for the withdrawal of one chart (that denies Early Barremian, or even older, occurrences as documented herein) and leads us to question the conclusions of the several publications relying on such a biostratigraphic framework.

It has been proposed that there are no records of rudist-bearing, Urgonian-type oligotrophic limestones in Upper Hauterivian and Lower Barremian strata of Switzerland, France, Spain, Portugal, etc. Yet, the *Dasycladacean* algae at L'Estellon, here dated as Early Barremian, probably grew in the shallow-water environment of the Vivarais Platform. Their basinal occurrence demonstrates the possible existence of coeval platforms, that could have allowed the development of rudists and coral which, were either lacking (supposedly), eroded (eventually), or erroneously ascribed younger ages (most probably).

Sedimentary distribution and exchanges along a partially closed tide-dominated estuary (bay of Brest, Britanny, France)

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The bay of Brest (Western Britanny, France) constitutes an original megatidal system characterized by a large estuary that communicates to the open sea (Iroise Sea) by a narrow strait. Sediments are supplied to the bay both from two rivers (Aulne and Elorn) and from the ocean by tidal currents. Both areas are connected by paleovalleys that were incised in the Paleozoic basement during low sea levels and are still preserved in the present physiography. Using multibeam, side-scan sonar backscatter, archival (last century) and recent bathymetric data, a geomorphic and sedimentary study has been performed to apprehend the fluvial sediment dynamics and to highlight the sediment exchanges between the estuarine areas and the continental shelf. The reported features (dunes, mega-ripples, comet marks) seem to be a direct expresion of wave and tidal current activity. Particle size analyses (55 samples) allowed characterization of the sedimentary facies and linage of grain-size modes to river supply and/or marine deposits, thus defining the source of the sediments and the secular evolution of this sedimentary basin.

By comparing the bay of Brest and its approaches, results clearly show a strong contrast between an inner area characterized by mixed sediments composed of very-fine to coarse lithoclastic and bioclastic grains and an outer area open to the ocean mainly draped by a shelly sand cover in the north. Inside the bay, the sedimentary facies is controlled by reversing tidal currents confined by the morphology of coasts and bedrocks. The bank of the Cormorandière, at the entrance of the bay is characterized by tidal dunes and scours which are established by ebb current on one side and flood on the other. The sedimentary features at the outlet of the bay (e.g., rippled scour depressions) reveal a control of sedimentary distribution by the southwest prevailing oceanic swells modulated by megatidal reversing currents. Indeed, the long scours are covered by megaripples that are oriented according to the swell whereas the morphology of scour slopes and bases are remodeled by tidal currents. The partially closed bay of Brest acts as a progressive filter that attenuates wave activity and enhances tidal-generated processes. The transition of hydraulic regimes allows the development of a broad spectrum of sedimentary forms and it is thus an excellent environment to calibrate sediment and bedform types with measurements and models of hydrodynamic processes.

Detailed stratigraphic architecture and facies distribution of the Middle Cenomanian Sequence of the Natih Formation (Sequence II, Natih D and C members), from an outcrop study of the Jabal Shams area (SW Jabal Akhdar, Sultanate of Oman)

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The detailed study of approximately 5 km^2 of continuously-exposed outcrops in the Jabal Shams area (SW Jabal Akhdar, Sultanate of Oman) has allowed the constraint of the geometries and distribution of significant stratigraphic heterogeneities observed within the overall tabular ('layer cake') Middle Cenomanian Sequence II of the Natih Formation (Natih D and C members).

In the eastern Arabian Plate, the Middle Cenomanian corresponds to a very extensive inner carbonate platform system, which developed between the Arabian Shield in the southeast and the Tethys margin in the north. This platform records a regional third-order transgressive–regressive cycle, bounded by two regional exposure surfaces. In the studied area, this sequence is 60 m-thick and is isopachous. It comprises a flat-bedded, very-shallow mixed carbonate-clay system at the base, progressively grading up section to a more open carbonate-dominated system with abundant rudists above.

Analysis of the Jabal Shams outcrops comprised the precise mapping of more than 20 fifth-order sequences over the study area, allowing the physical correlations of about 100 field-sections, in which facies were calibrated by thin-section analysis. This resulted in a robust, high-resolution, almost 3D, sequence stratigraphic model which records the evolution of the depositional profile and facies distribution of the carbonate system through time. Its study allows us to define the main factors controlling this evolution, to quantify the geometries and understand the distribution of highly-permeable geobodies, which developed locally within the sequence.

The lower part of the Sequence (Natih D mb., 45 m-thick) corresponds to the homogenous, tabular aggradation of shallow-marine, muddy carbonate platform deposits during a period of overall increase in the rate of accommodation creation. The upper part of the sequence (Natih C mb., 15 m-thick) is characterised by much more complex stratigraphic geometries, displaying a wide range of dip angles (0° to 30°) and rather rapid lateral facies variations. This complexity is the result of the differential aggradation of shallow carbonate platform deposits during the period of maximum increase of accommodation rate, leading to the development of localized depressions (less than 10 m deep) on the platform top. The resulting low-angle dip of the depositional profile had a major influence on the hydrodynamic conditions of the system, as revealed by the progressive development of high-energy grainstone facies on the shallow 'highs'.

Improved marine conditions are inferred to have also been responsible for a palaeoecological change, as shown by the development of rudists and an increase in carbonate production at this time. This inversion of the ratio between accommodation and sedimentation rates resulted in the filling of the small depressions, characterized by a succession of prograding systems tracks of variable angles (5° to 15°) displaying rapid lateral facies changes (Gst grading to bioturbated mudstone along the foresets). Coarse, high-angle (up to 30°) rudist-rudstone sand-waves of high potential permeability developed locally and repeatedly within this regressive fill unit.

This work provides a well constrained field analogue for the time-equivalent Natih and Mishrif reservoirs in the Middle East.

Lithospheric convergence and drainage development: A case study from the Western Alps

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Understanding drainage network dynamics and development is crucial for deciphering the topographic response of mountain ranges to external forcing. Drainages classically display two main orientations: either transversal or longitudinal to the deformation front respectively. Transverse streams are dominant and stable toward the orogenic wedge participating actively to relief erosion, while longitudinal streams are commonly captured migrating toward the foreland during the propagation of the deformation. They preferably transport the detritus to the basin or partially constitute locus of deposition in the foreland.

The European Alps result from crustal thickening associated with ocean closure and Cenozoic uplift due to lithospheric collision. The present-day morphology of the Western Alps is characterised by a N–S-oriented asymmetrical topography with a smoother western side and a steeper eastern side that already existed in the Oligocene time. Previous investigations in the French southern Western Alps foreland basin highlighted longitudinal rivers active during the Oligocene–Miocene. They were partially filled by conglomerates and sandstones originated in the exhumed internal massifs and possibly drained by transverse-dominated streams. However, the initiation and evolution of the regional drainage pattern are still debated due to the complex tectonic history of the Western Alps.

New structural and sedimentological analysis, associated with published regional stress data, allow us to determine the impact of the structural heritage of the European margin basement on the initial geometry of the longitudinal drainage. The early N–S structuration of the foreland basin permitted maintaining the same location of the sedimentation during the transversal development of the drainage system in response to the rapid Oligocene exhumation of the southern Western Alps (1.5–2 km/Ma). We have reconstructed the geometrical evolution of this old drainage network (so called paleo-Durance) during the past by comparing with the modern Durance River system. Finally, we explain the extraordinary preservation of the initial longitudinal rivers on piggyback basins that characterise the modern foreland basin geometry. In that case, tectonics seems not only to induce reorganisation and river migration, but also drainage initiation and long-time preservation.

Acknowledgements**:** This study was supported by the *Agence Nationale de la Recherche*, Project no. ANR-08-BLAN-0303-01 “Erosion and Relief Development in the Western Alps”.

Stable isotope composition of quartz–calcite veins and their fluid inclusions: Implications for establishing regional fluid circulation pattern during mountain belt exhumation and sediment provenance

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Veins record deformation history at different levels of the earth's crust. They are often filled by one or more minerals precipitating from an aqueous fluid either of meteoric or metamorphic origin. These minerals sealing the veins can further contain fluid inclusions archiving the chemistry of the original fluids and their temperature of formation. Presently there are controversial views about the provenance of exogenous pebbles in the Cenozoic conglomerates of the French South Alpine Foreland Basin. Here we present geochemical results of several quartz and calcite veins and their fluid inclusions in pebbles of these conglomerates in attempt to discern whether they are coming from sediments of the Internal Alpine massifs or Mesozoic series from the foreland basin. Microthermometric results indicate P-T conditions of fluid entrapment for all lithological type ranging, between 500–675 bars and 170–215°C and thus corresponding to a crystallization of veins at an estimated burial depth of 2000 m. These estimations indicate that the source area of the studied samples have been the massifs that constituted part of the Internal Alps prior to their erosion. Well preserved two-phase fluid inclusions are aqueous with low salinity from 2.5 to 8.5 wt% eq. NaCl. The oxygen and carbon isotope composition of quartz/calcite veins (mean at +24.5‰ (VSMOW) and –1.15‰ to +2.05‰ (PDB) respectively) are close to the composition of host rocks (+17‰ to +24.3‰ (VSMOW) and –4‰ to +1.4‰ (VPDB) respectively) strongly suggesting water-rock interactions and a metamorphic water source. The $\delta^{18}O$ and $\delta^{13}C$ composition of the aqueous fluid in equilibrium with quartz and calcite were estimated at temperature between 150 and 200°C. They vary from +6.85‰ to +17.7‰ (VSMOW) and from –3.51‰ to +2.24‰ (VPDB) respectively confirming their development in a close system what implies a buffering of the fluid composition by host rocks during water transfer. These results are also confirmed by the subsequent development of microcracks and dissolution/recrystallizations structures commonly observed in the veins reflecting a complex fluid circulation during the exhumation of the Alpine massifs. Constraining the source area of pebbles of different lithologies provide crucial information about the location of the early exhumed and eroded massifs in the Western Alps.

Seasonal vs tidal control on fluvial to shallow-marine ancient deposits (Lajas Formation, Argentina)

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Heterolithic deposits are commonly interpreted as tidal in origin; however, they may also form in purely fluvial settings due to variations in river discharge on a seasonal or shorter time scale. Moreover, tidal and seasonal signals often coexist in the lower reaches of modern rivers and may be recorded in their deposits (e.g., Fraser River delta), making it difficult to distinguish between the two signals. The facies characterization of seasonal deposits is poorly constrained, leading to misinterpretation and overestimation of tidal processes with consequently less accurate facies and reservoir model reconstructions. We describe deposits from the Middle Jurassic Lajas Formation (Argentina) which formed in different fluvial to shallow-marine settings (fluvial, deltaic, estuarine? and shelf) during the back-arc, post-rift phase of the Neuquén Basin. The deposits of the Lajas Formation contain well-known tidal indicators, but also signs of seasonality which are described herein for the first time. Medial-distal parts of mouth-bars and crevasse mouth-bars show 0.10-0.40 m-scale interbedding of sandstones and siltstones or of coarser and finer grained sandstones. Couplets repeat regularly, but lack ordered rhythmicity. The coarser-grained dm-scale sandstone beds are usually slightly erosively based and/or show load structures. They are structureless or more rarely show cross-bedding and contain abundant mud clasts. Evidence of tidal action (e.g., drapes, rhythmicity and bidirectionality) or brackish salinity conditions (e.g., such as body or trace fossils) are commonly absent or greatly reduced in abundance relative to the intervening deposits. The deposits interbedded with these erosively based sandstones can consist of finer-grained sandstones or siltstones or a mixture of both (i.e. they can be heterolithic) and may show mud or carbonaceous/mica drapes forming mm-scale rhythmical couplets with bidirectional ripples and brackish-water trace fossils. The erosively based sandstone beds are interpreted as the deposits of river floods, whereas the intervening deposits with evidence of tidal processes and brackish salinity conditions are interpreted as interflood deposits formed during low river stage. Side-bar deposits of distributary channels and point-bar deposits of fluvial channels within valley-fills also show a similar pattern, which is commonly absent in other deposits such as shelf, the mud-rich part of the delta, channel thalwegs and the proximal parts of mouth-bars and crevasse mouth-bars. The seasonal signal is not preserved in shelf deposits and mud-rich deltaic deposits because of the lack or sporadic nature of the river input in these areas and also is rare in channel thalwegs and proximal mouth-bars and crevasse mouth-bars because the high energy during river floods results in removal of the interflood deposits and amalgamation of flood deposits. When conditions are ideal for preservation, seasonality is the main signal in the Lajas deposits as the interbedding is distinctive while tidal indicators are primarily restricted to the interflood deposits. A system dominated by tidal processes would profusely or completely overprint the seasonal signal showing tidal indicators through the whole deposit. Distinguishing seasonal and tidal signals and identifying which is the main control on deposition will improve our environmental reconstructions and reservoir models both at facies scale and in the prediction of larger-scale geometries. Moreover, the description of these deposits will help to recognize seasonality when other approaches (e.g., palaeobotanic, palaeontological) are not effective.

Interaction of tidal and fluvial processes in ancient deltaic deposits, Lajas Formation (Argentina): tide-dominated or tide-influenced?

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Modern deltas show a range of different morphologies, geometries, facies and grain size distributions. Although the interplay of several external factors may contribute to this variety, a significant role is played by the interaction of and balance between fluvial and marine processes. Constraining the relative importance of fluvial, tidal and wave effects in an ancient deltaic system, is crucial to improve prediction of 3D depositional architecture and reservoir connectivity over complete cycles of relative sea level change.

This study provides an example from Middle Jurassic deposits of the Lajas Formation that accumulated in different fluvial and shallow marine settings, during the back-arc phase of the Neuquén Basin, Argentina. Sedimentological logging, correlation panel construction, architectural element and facies studies were combined with statistical analysis of rhythmicity in stratal thicknesses, to evaluate the degree of tidal influence during deposition.

Lower parts of 5-12 m thickening/coarsening upward packages (medial/distal mouth bars) show ripple-scale bimodal palaeocurrents associated with brackish water trace fossils. Upper parts of these packages (proximal mouth bars) show unidirectional river-dominated paleocurrents and rhythmically distributed carbonaceous drapes to cross-beds, indicating modulation by tidal process. Fining-up sandstone packages 3-5 m thick lack trace and body fossils, bimodal paleocurrents, but have rare, rhythmically distributed carbonaceous drapes, and are interpreted as river-dominated distributary channel fills. Minor (0.5-2 m) thickening/coarsening upward packages are interpreted as crevasse subdelta systems which form in interdistributary, marine-influenced bays. Mud drapes, rhythmicity and rare bimodal palaeocurrents indicate tidal reworking during interflood periods.

The Lajas example shows a clear dissipation of tidal effects in the mouth bars/lower reach of distributary channels, with little or no evidence of tidal influence in the upstream sections of channel-fills, but minor influence in interdistributary deposits. The Lajas Fm. characteristics lack key features of tide-dominated deltas such as delta front scours, fluid muds and fining upward tidal bars separating mutually evasive parts of tidal distributary channel-fills. Moreover, the positions of tidal bidirectionality and modulated facies appear to be shifted seaward compared to modern and ancient examples of tide-dominated deltas and this is attributed to the prevalence of river processes over tides. The Lajas Fm. is interpreted as a tidally-influenced rather than a tidally-dominated delta, which has implications for (1) geometry of mouth bars, which might be less elongate and more interconnected than if tidally reworked; and (2) grain size distribution in distributary channels, which will contain fewer fluid muds and drapes, and can thus be considered as important additional reservoirs.

These results raise the possibility that the majority of ancient “tidal” deltas may be tide-influenced while ancient tide-dominated deltaic deposits, comparable to modern systems such as the Ganges-Brahmaputra or the Fly River deltas, have rarely been described and their facies model is still poorly constrained.

Autochthonous *versus* allochthonous micrite in an Anisian platform from the western Dolomites (Sasso Bianco area)

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The Triassic carbonate platforms of the Southern Alpine Dolomites offer a good opportunity to investigate the relationship between carbonate production and the depositional geometry. In the region, the Anisian low relief platforms were followed by late Anisian and early Ladinian steep-sided, high relief buildups. This evolution records the increasing importance of the autochthonous micrite production, the syndepositional cementation, and, subordinately, the skeletal metazoans growth in the bioconstruction. Only in a few key outcrops in the Dolomites, less affected by the late diagenetic modifications, it is possible to perform micromorphological, mineralogical and geochemical investigations. One example is represented by the Sasso Bianco area, where an. upper Anisian buildup belonging to the Contrìn Formation is well exposed and preserved. The succession is characterized by micritic layers, alternated to calcarenites and less common fine-grained calcirudites. To characterize the microfacies of the succession, and to correlate them to the depositional geometry, optical and electron microscopy analyses were applied. Microfabric, epifluorescence and siliciclastic elements distribution were utilized to discriminate between autochthonous and allochthonous micrite.

The lower part of the section is characterized by detrital calcareous facies, composed of bio-intraclastic packestones/wackestones. This facies is rich in bioclasts of echinoderms, gastropods, thick shelled pelecypods, brachiopods, sponges, etc., and benthic microforaminifers. Fragments of dasycladacean algae (*Teutloporella*) are sometimes abundant. Commonly the grains are engulfed into allochthonous micrite, rich in smaller bioclasts. Autochthonous micrite is rare in this lower portion, and, when present, it is subordinate to the detrital one. In the middle portion of the section the syndepositional cemented autochthonous micrite increases and alternates in dominance with the loose mud fraction. In the upper portion, the autochthonous micrite becomes dominant. The *in situ* deposition is testified by peloidal to clotted peloidal fabrics, engulfing *Tubiphytes*, encrusting foraminifers (e.g. *Tolypammina gregaria)* and sponges (e.g. *Olangocoelia otti)*. The dasycladacean remains are absent and crinoids clasts are here rare. Agglutinated tube worms are on the contrary common within the clotted peloidal fabrics. Their tube are composed by small peloids and they are very similar to the terebellids recently recorded, in symbiosis with sulfate reducing bacteria, in cryptic cave environments (Guido et al., 2014). The increasing activity of bacterial communities and their role in the stabilization of the carbonate geometries is testified by the gradual increase of clotted peloidal micrite.

The gradual change of the micrite type, from the loose detrital fraction, dominating the lower part of the section, to the syndepositional lithified fraction of the upper part, is associated with a gradual change in the depositional geometries of the carbonate body. A carbonate bank, initially developed in shallow water, evolved into an isolated platform with steep slopes, prograding onto a deeper water basin. We suggest that, during the sea level rise, suboxic/anoxic condition settled and permitted the proliferation of sulfate reducing bacteria. These communities probably developed on the available organic matter remains and induced micrite precipitation that cemented and stabilized the sediments. A clear correlation between the changing carbonate production and the evolution of the carbonate platform dynamics is therefore visible.

Clotted peloidal micrite associated with agglutinated tube worms: a new datum in microbialite research

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Pendant bioconstructions (biostalactites) occur within submerged caves in the Plemmirio Marine Protected Area, south of Syracuse (SE Sicily, Italy). The main framework builders are serpulids of the genus *Protula*, and subordinately *Semivermilia* and *Josephella*. These small biostalactites, made up of autochthonous peloidal to clotted-peloidal, and aphanitic micrite, are cemented by microbial carbonates and have downward growth directions from the walls and ceilings of the caves. The autochthonous micrite, deposited *via* sulfate-reducing bacterial activity, stabilizes the biostalactites. Agglutinated polychaetes, attributed to terebellids, are also present. These latter worms have micritic tube walls in association with microbial clotted micrite. This distinctive association has been reported in several ancient deposits, such as Oxfordian and Upper Jurassic reefs, and in Late Jurassic to Early Cretaceous platform margin facies.

The composition of the clotted peloidal micrite and agglutinated polychaete tubes suggests that calcification, promoted by bacterial sulfate reduction (BSR), is utilized by the terebellids to help develop their tubes. The bacteria obtain nutrients for growth from decaying metazoan organic matter, and the worms utilize the microbially induced peloids to form their skeletons. It is well-known that peloidal microbial carbonates are often associated with reef cavities and it is now recognized that these carbonates derive from BSR processes. Our case study of biostalactites in submerged caves from Sicily indicates an additional direct link between BSR and agglutinated polychaete growth. This appears to be the first report of such a mutualistic consortium in which invertebrates and sulfate-reducing bacteria combine to create carbonate skeletons.

Constrains of lithofacies of Red Beds on the Formation of Danxia Landform: a Case from Xinjiang Basin, Jiangxi Province, South China

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The Cretaceous red siliciclastic rocks are widespread in Xinjiang basin of Jiangxi province, China. The red beds are called Hekou Formation and Tangbian Formation, which are part of Guifeng Group. Hekou Fm is characterised by purplish- and brick-red conglomerates and sandstones, which is interpreted as sedimentary assemblage of the piedmont proluvial-alluvial fan facies. In the contrast, Tangbian Fm is mainly composed of brick-red fine sandstones, which is considered to be sedimentary association of meandering river and lacustrine facies. Analysis on lithofacies palaeogeography shows that Hekou Fm is distributed at the margin of the red basin, and Tangbian Fm lies in the center of the basin. We concluded that Hekou Fm and Tangbian Fm are the two different lithofacies of the same sedimentary period, and they are lateral overlapped.

At the northern piedmont of Wuyi Mountain, Hekou Fm is dominated by three proluvial fans at the southeastern margin of the basin, where three typical Danxia landforms of old age are distributed. The coarse grain sediments of the proluvial fans provide the material base for the Danxia landforms. On the contrary, because of low weathering-resistance of fine grain sandstones, Tangbian Fm in the center of the basin has been eroded and leveled into peneplain. Tangbian Fm does not have the lithologic condition for the development of Danxia cliffs, and did not go through development stages of Danxia landform. Therefore, Tangbian Fm is not representative of extinction period of Danxia evolution.

The result shows that the distribution of Danxia landform is obviously controlled by the lithofacies zones of the sedimentary basin. Because of great changes of the lithological features, the relief characteristics at the different part of the basin should not considered to be the different evolution stages of Danxia landform. The geomorphic evolution processes of the whole basin are different from each other, so which could not be explained by the same theory of Geomorphological Cycle (such as Davisian theory).

Key Words: Danxia Landform; Sedimentary Facies; Xinjiang Basin; Theory of Geomorphological Cycle

Acknowledgements: This work was financially supported by the Natural Science Foundation of China (41072077).

Biological activity and the Earth's surface evolution in early Mesoproterozoic: Insights from carbon and sulfur isotope records of the Jixian Group, North China

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The Mesoproterozoic (1.6-1.0 Ga) has used to be termed the "boring period in earth time" and received substantially little attention, because of the relative stability of the time frame in terms of tectonic activity and atmospheric oxygenation. However, as illuminated in recent lots of relevant researches, the Mesoproteorozic era possibly represents a critical period with respect to biological innovation and earth's surface system evolution. Further work is worthy to improve our knowledge for this time interval.

The biogeochemical cycles of carbon and sulfur are closely linked through biotic and abiotic processes at and near the Earth's surface and have been responsible in part for modulating oxygen concentrations in the oceans and atmosphere over geological time. The isotope compositions of carbon and sulfur thus can serve as key means to explore the biological activity and earth's surface evolution. Here we put our focus on the early Mesoproterozic, we present high-resolution carbon isotopes for carbonate and organic matter, and sulfur isotopes for carbonate associated sulfate (CAS) from the early Mesoproteorozoic Jixian Group (1.6-1.4 Ga), Yanshan Basin, North China, in order to investigate biological and environmental evolution during this time period. Probable alteration of primary isotopic values from post-depositional recrystalization and contamination from sulfate derived from anoxic oxidation of pyrite during CAS extraction can be extensively ruled out by examining petrographic preservation of sedimentary microfacies, and elemental and isotopic trends.

Carbonate carbon isotopes through the Jixian succession range from -2.6‰ to +1.8‰ and are arranged in a series of alternating positive and negative excursions with an average near 0‰, whereas $\delta^{13}C_{org}$ display facies-dependent differences with a depth-gradient from shallow to deeper water environments (below wave-base) approaching +4‰ on average. The spatial heterogeneity in $\delta^{13}C_{org}$ suggests dramatic differences in carbon cycling and microbial assembles between different depositional environments.

Contrast with $\delta^{13}C_{carb}$, stratigraphic variation in $\delta^{34}S_{CAS}$ is much more remarkable, $\delta^{34}S_{CAS}$ values range from +3.7‰ to +38.6‰ with more than two episodes of enrichments exceeding +35‰. The extremely positive $\delta^{34}S_{CAS}$ excursion occurred at deeper-water interval is found to coincide with $\delta^{13}C_{carb}$ negative excursion ($\delta^{13}C_{carb}$ go down to the minimum value of -2.6‰ within this succession), providing potential evidence for occurrence of sulfate reduction and associated organic carbon remineralization modulated by anaerobic heterotrophs. Anyway, the enhanced values and amplitude of variations in $\delta^{34}S_{CAS}$ reflect substantially low levels of sulfate in the early Mesoproterozoic oceans. All of these are most likely related to low oxygen conditions and dynamically maintained stratification of marine waters during this period.

Even so low oxygen contents, if we view the Jixian Group as a whole, the carbon and sulfur isotope compositions show an approximately parallel positive isotopic excursion (~1‰ for $\delta^{13}C_{carb}$ and ~15‰ for $\delta^{34}S_{CAS}$), which indicating a gradual increase in burial of organic matter and pyrite. The burial of reduced carbon and sulfur was expected to have likely induced a net increase in atmosphere pO_2 and paved a way for multicellular radiation since late Mesoproterozoic.

A global travertine GIS database - synthesis and implications for Pre-Salt reservoir targets

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Travertine deposits are widespread in tectonically active settings, especially in rift systems, and potentially form Pre-Salt reservoirs in the South Atlantic. Travertine has been studied for more than a century, and there are large amounts of published data on the facies, depositional processes and water chemistry of associated springs. However, the literature is widely scattered and frequently difficult to access. Geographic Information System (GIS) technology can be used to assemble all this information together by 1) cataloguing the spatial characteristics of (travertine morphology/facies and their associated springs) and 2) integrating observed images, analytical results and geological background elements into a single and standardized database.

This study has established an initial global travertine GIS database that contains 53 "provinces" located in 22 countries. The database can be used as a research tool to visualize and compare the spatial distribution of travertines and their geometric relationships. The database also enables users to assess the relationships between: 1) travertine deposition and spring chemistry; and 2) travertine deposits and geological background elements (such as faults, volcanoes, and limestones, with which travertines are typically associated). Ultimately, the database provides a valuable resource for synthesizing and generating conceptual models.

Based on the GIS database, we conclude the following:
1) travertine formation mainly occurs in rift systems, but also in strike-slip to transtensional systems;
2) travertines are formed in subaerial and sublacustrine environments;
3) travertine morphologies (megascale: 10s-100s m to km) can be characterized as flat top platforms, step-like mounds (large-scale terraces) and valley-filling belts in hillslope topographic settings and as fissure ridges, cones-mounds-mound complexes, and flats-pools in quasi-horizontal topographic settings.

We also propose the concept of Travertine Window as an approach to predicting travertine occurrence. Travertine can start to form at the beginning of rifting and continue more or less throughout the rifting phase. In these cases, in the absence of siliciclastics, travertine deposits can form most of the extensional basin fill, such as Itaboraí in Brazil. In other cases, such as in the Denizli Basin of Turkey and much of the central Italy, travertine deposits appear to have developed during the later stages of rifting. At these locations, travertine deposits are patchy and mostly scattered along basin margins. All travertines typically form in phases that were interrupted by intervals with little or no carbonate precipitation. This would suggest that travertine forms under potentially predictable conditions reflecting variations in tectonic and/or climate state.

These synthesized models have important implications for reservoir targeting and model-building strategies in Pre-Salt fields.

Stratigraphy, sedimentary environments and evolution of the Chinchiná-Palestina Basin (Colombia)

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In the western central region of Colombia, there are some neogene basins associated to the Romeral Faults System (sinistral, with hundreds of kilometers in length). One of them is the so called Chinchiná-Palestina Basin into which a stratigraphical study and a facial analysis were carried out in order to establish the sedimentary environments and their relationships with volcanism associated to a subduction zone. To get these aims, six stratigraphic sections at 1:100 to 1:50 scales were studied.

Within the basin, three formations were recognized.

The Irra - Tres Puertas Formation (Late Miocene-Early Pliocene?) can be subdivided in three members. The Lower Member is composed of conglomerates interbedded with sandstones and mudrocks, its thickness attains 9 m; the basal part seems to correspond to an intereruptive stage, due to the presence of permanent shallow gravel braided streams and polymictic conglomerates, suggesting a paleovolcanic source. After deposition of this part, there is an abrupt change, increasing the grain size; the lack of inclined stratification and of channel-shaped margins and existence of the sediment graviy flows associated to alluvial fans, over a distance greater than 50 km from their possible source, would indicate syneruptive conditions.

The Middle Member is constituted by mudrocks, lignites and volcanic conglomerates, is 2.5 m thick, the associated environments were gravel wandering and shallow gravel braided streams. It seems to correspond to intereruptive conditions, due to the coals have a limited lateral extent between the channels; moreover, the conglomerates are polymictic and show a channel shape geometry.

The Upper Member is composed of volcanic sandstones and its thickness is about 15 m, was originated from a transition from braided gravel streams to meandering sandy streams that would indicate a change from intereruptive conditions to syneruptive conditions

The Manizales Formation (Late Miocene –Early Miocene?) can be subdivided in two members. The Carminales Member interdigitates with Lower Member of the Irra- Tres Puertas Formation; is composed of mudrocks, conglomerates and lignites, its thicknes attains up to 20 m. It has features that toward the base of the lower part indicate intereruptive conditions, since the presence of swamps associated to meandering streams suggests periods where the volcanic activity decreases. Simultaneously, an allogenetic control related with seismicity was present producing soft-sediment deformation structures. In the top of the lower part of the Carminales Member a syneruptive aggradational period is suggested, due to predominance of gravity volcanic flows. The upper part of Carminales Member is corresponding to a syneruptive stage, as is indicated for the presence of gravity volcanic flows, unchanneled strata and high supply of pyroclasts.

The El Guayabo Member interdigitates with Upper Member of the Irra-Tres Puertas Formation and is composed by volcanic sandstones, mudrocks with vegetal remains and massive tuffs, its maximum thickness is 25 m; the origin was associated to middle alluvial fan and syneruptive conditions, based on abundance of pumaceous sandstones with trough cross bedding and provenance from undissected arcs. The existence of soft sediment deformation structures relatively abundant, indicate that seismic events also controlled the sedimentation.

Resting unconformably, is the Chinchiná Formation (Late Pliocene- Early Pleistocene?) composed of matrix-supported and clast-supported volcanic conglomerates, attains 8 m in thickness, was generated within the proximal part of alluvial fans with pyroclastic supply, developing type lahar flows and associated with syneruptive conditions.

The author thanks Colciencias and Caldas University for the financial support.

Dolomitization of Lower Triassic shallow-water, mixed siliciclastic-carbonate rocks from the Transdanubian Range, Hungary

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The Lower Triassic succession of the Transdanubian Range (TR) is made up of carbonates with various siliciclastic content. Limestone, dolomite, marl, sandstone and siltstone occur in which the main constituents are calcite/dolomite, clay minerals and quartz that are present in variable amounts. These rocks deposited in tidal flat, lagoon and ooid shoal environments on the marginal ramp of the western Neotethys. Seven cores were chosen for detailed petrographic and preliminary stable isotope study to reconstruct the paragenetic sequence with particular interest on the dolomitization.

Based on the microscopic investigations seven lithofacies types were differentiated: i) calcareous or dolomitic siltstone and sandstone, ii) silty and/or sandy limestone and dolomite, iii) fabric-retentive dolomite, iv) fabric-destructive dolomite, v) dolomitic limestone, vi) limestone.

Dolomite occur in-between the quartz grains in the first two lithofacies types either as fine crystals or poikilotopically enclosing the quartz grains. Both fabric-retentive and fabric-destructive dolomites are characterized by nonplanar-a texture. The crystals commonly show sweeping extinction. Most of the dolomites in the different lithofacies types are stained to turquoise, indicating iron content. EDX measurements confirmed the presence of carbonate minerals from dolomite through ferroan dolomite to magnesian ankerite. Black organic matter is present in the growth zones of the dolomite crystals and in the intercrystalline pores. Relatively uniform oxygen isotope values of the sandy dolomite suggest dolomitization by fluids of slightly elevated temperature (–8.4 to –6.6‰ for O-isotope and –0.2 to 1.9‰ for C-isotope).

Gypsum and anhydrite are relatively common in the NW part of the TR. Gypsum occurs as poikilotopic crystals in patches in sandstones, and also as fibrous crystals, filling fractures and anastomosing vugs. Furthermore it was found as nodules, enclosing 5 to 200 μm-sized anhydrite crystals or 50 to 200 μm-sized irregularly-shaped inclusions composed of dolomite crystals. Anhydrite is also present in various forms. It could completely fill the pore space in-between the quartz grains. It occurs in anastomosing vugs, enclosing 10 to 30 μm-sized dolomite crystals and crystal aggregates or quartz grains of similar size. Additionally, it was also found as needles in organic matter-rich dolomite. Siderite is present in fractures, vugs and along dolomite crystal boundaries. Traces of exotic minerals, such as barite, chalcopyrite, galenite and fahlores were found as filling of vugs and fractures in the dolomite-cemented sandstone.

Fabric of the partially dolomitized limestone suggests that organic matter-rich deposits may got in contact with brines transferred from the underlying, compacting evaporite series. This process resulted in the reduction of the dissolved sulfate to sulfide. The available iron was incorporated either in the dolomite or precipitated as ankerite, siderite and/or sulfides under reducing conditions. Transfer of metal ions (such as Sb, Cu, Zn, Hg) might have been possible in the form of Cl-complexes, most probably originated from the underlying Permian siliciclastic rocks.