Discovery of two major sediment sources for the Voirons Flysch (Gurnigel Nappe, Haute-Savoie, France)

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The Chablais Prealps (Haute-Savoie, France) are a stack of nappes thrusted in a northward direction during the build-up of the Alps in Early Tertiary times. The present study focuses on the Gurnigel Nappe, which is in this region solely comprised by the Voirons Flysch. It is subdivided into three units: the Voirons Sandstones (VS) representing distal channel to lobe deposits; the Vouan Conglomerates(VC), composed of proximal channel deposits; and the Saxel Marls (SM) represented by distal lobe deposits. Finally, according to other authors, the Allinges Sandstones (AS) to the northeast are considered as the lateral equivalent of the Voirons Sandstones and/or the Vouan Conglomerates.

Recent biostratigraphic results yielded a Late Eocene - Early Oligocene age for the Voirons Flysch, which was previously believed to have been deposited during the Middle Eocene. This younger age is in disagreement with most palaeogeographic models, which propose that subduction of the realm from which the Gurnigel Nappe is derived took place prior to the Middle Eocene. Additionally, there are only few sedimentological studies about the Voirons Flysch. Provenance interpretation is largely based on results from the other flysch deposits of the Gurnigel nappe. Hence, the aim of the present study is to determine sediment provenance of the Voirons Flysch deposits to resolve this palaeogeographic conundrum.

A total of 270 thin sections from the three members of the Voirons Flysch were prepared, from which we subsequently stained the feldspars and counted circa 300 grains following the Gazzi-Dickinson method.

Our results show that the Voirons Flysch was fed from two major sources, the most important of which supplied three of the four members and is similar to that of the other flysch deposits of the Gurnigel Nappe. It is characterized by a quartzose assemblage with sedimentary to granitic lithoclasts and a heavy mineral population dominated by the ZTR mineral group. These observations suggest a Continental Block to Clastic Wedge provenance of the Garzanti model as the dominant source for the VS, SM and AS.

In contrast, the Vouan Conglomerates are derived from a feldspathic source associated with metamorphic clasts and a heavy mineral population characterized by garnet. This implies a provenance related to the unroofing of the basement in the Axial Belt for VC.

Iron reactivity in sediments of Ría de Vigo (NW, Spain) with shallow gas

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The Ría de Vigo, in the northwest Iberian Peninsula, is a large submerged incised valley which is orientated SW-NE. In Ría de Vigo, the high biological productivity may lead to the deposition of organic-rich mud. The microbial degradation of this organic matter led to shallow gas accumulations of methane, currently distributed all along the ría. In this context, Fe minerals may be involved in redox reactions.

To evaluate the iron reactivity in the Ría de Vigo, two gravity cores were extracted. A corer located at the inner part of the ría inside a gas field (C8) and the other at the outer part, in an area without methane at the analyzed depth (control, C10). For each corer pH, Eh, sulfide and sulfate concentration in pore water, methane concentration, and iron reactivity were measured. Three different fractions of reactive iron were extracted on separated subsamples, according to Holmkvist et al, 2011. i) highly reactive Fe (III): the fraction of iron minerals most readily soluble in acid was extracted, ii) dithionite reactive iron: this fraction is mainly composed of crystalline iron oxides (goethite and hematite), $FeCO_3$ and FeS and, iii) total reactive Fe: fraction including both the more readily reactive iron fractions and reactive silicate-bound iron.

In the corer without methane (C10), iron values tend to decrease with depth except at 230 cm where there is a significant increase, mainly dithionite reactive iron and total reactive iron (with 403.8±5.24 and 523.5±15.9 mmol kg^{-1}, respectively). Dithionite reactive Fe and total reactive Fe values were positively correlated with sulfate contents (r = 0.701 and 0.7495 respectively). At the corer with methane (C8), a slight increase of dithionite reactive iron was observed in the sulfate-methane transition zone (between 60-90 cm). Above this zone, all the reactive irons analyzed were positively correlated with $SO_4^=$ and negatively with SH_2. However, below this zone, no correlations were found excepting a negative correlation between dithionite reactive iron and SH_2 (r = -0.644), which causes this iron become available for relatively fast diagenetic transformations in sediments and particularly for reactions with SH_2.

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Sediment dynamics and dispersal patters on the Grand Banks continental shelf and slope were tied to the Laurentide Ice-Sheet margin

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The expansion and contraction of the late Pleistocene Laurentide ice-sheet (LIS) was the crucial determining factor for the geomorphic features and shelf and slope sediments' mobility on the eastern Canadian continental margin. Shaw et al. (2006) suggested that the ice-margin of the LIS crossed the outer shelf in the northeast Grand Banks and adjacent regions. As a result, numerous mass-transport deposits, glaciogenic debris-flow, and turbiditic deposits were found on the shelf, slope, and basin floor of the Orphan Basin. Here, we provide an assessment on the sediment dynamics and mass-transport deposits from the northeast Grand Banks shelf and slope, areas facing the Salar and Carson basins. We used seismic profiles such as air-gun, Huntec (deep-tow seismic) and high-resolution bathymetric data, and ground truthing piston cores. Centimeter-scale X-ray flourescent, grain size, and oxygen isotopes data allow us in providing fine-scale assessment on the sediment dynamics for the last glacial-interglacial cycle. Geotechnical measurements such as atterberg limit, consolidation and multi-stage isotropically consolidation tests from piston cores show slightly underconsolidated sediments indicating that the continental margin may be prone to instability. One of the important contributions of our study is characterizing the nature and stability of surficial sediments which has the potential to represent a significant constraint during offshore exploratory drilling and for subsequent seafloor installations for production.

Secondary origin for hematite in the 3.46 billion-year-old Marble Bar Chert, Pilbara Craton, Australia: Evidence for post-depositional oxidation of iron-bearing minerals by surface fluids

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The ancient history of atmospheric oxygen is not fully understood and is highly controversial. The most robust constraint, based on the sulfur isotope record of diagenetic pyrite in marine shales, suggests that atmospheric oxygen concentrations were exceedingly low prior to ~2.45 billion years ago, the onset of the so-called Great Oxidation Event (GOE). However, some data from the early Precambrian sedimentary record have been used to argue that atmospheric oxygen was present much earlier, and may have fluctuated significantly during the Archean.

An important source of information in the debate about ancient oxygen concentrations has been the origin of hematite in jasper bands from the 3.46 billion-year-old Marble Bar Chert from a NASA-funded drill hole (Archean Biosphere Drilling Project [ABDP] no. 1) in the Pilbara Craton, Western Australia. The presence of hematite has been cited by some researchers as evidence for an oxygenated ocean 3.46 billion years ago, however, others argue that isotopic data from the same hematite-bearing chert indicates that the ocean was anoxic. It is agreed that hematite in jasper bands is an original constituent of the precursor sediment, representing either a direct hydrothermal precipitate proximal to a vent system or a dehydration product of Fe(III) oxyhydroxide particles that formed during anoxygenic photosynthesis.

New sedimentological and petrographic work on drill-core samples from the Marble Bar Chert in drill-hole ABDP1 indicates that jasper bands contain hematite that formed during post-depositional alteration. A secondary origin for hematite is suggested by: i) the presence of residual cores of magnetite in hematite crystals; ii) the presence of octahedral crystals composed of hematite (i.e., “martite”), iii) the occurrence of magnetite in jasper layers that have undergone various stages of replacement, from unaltered octahedral inclusions in quartz grains to magnetite with hematite rims to hematite pseudomorphs along quartz grain boundaries; iv) the occurrence of hematite in fractures and along sedimentary bedding; v) the distribution of micron-sized particles of hematite (“dusty hematite”) around the outer margins of polygonal clusters of greenalite; and, vi) the lateral transition from laminated chert containing Fe(II)-rich minerals such as greenalite, siderite and magnetite to hematite-bearing chert. These observations are consistent with hematite replacement via fluid-mediated oxidation of iron-rich precursor minerals.

If hematite in jasper bands from the Marble Bar Chert are secondary in origin, as suggested by our results, then arguments for an oxygen-bearing ocean ~3.46 billion years ago need to be critically reassessed. A post-depositional origin for hematite in the Marble Bar Chert may have implications for ferruginous cherts elsewhere, providing an alternative mechanism for the formation of Archean jasper bands. We conclude that it is critical to establish a primary origin for hematite in early Precambrian cherts, otherwise interpretations could lead to false conclusions about the redox state and composition of the ancient ocean and atmosphere.

Sedimentary characteristics and the main controlling factors of gravity flow depositional system for the first member of Upper Miocene Huangliu Formation in Dongfang area, Yinggehai Basin, northwestern South China Sea

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Great attention has been paid to the Dongfang area in the Yinggehai Basin because of the recently discovered DF132 gas field relevant to turbidity current in neritic continental shelf setting, which was mainly developed in the lowstand systems tract (LST) of the first member of Upper Miocene Huangliu Formation (Ehl[1]). Using integrated analysis of cores, logging and 3D seismic data, the sedimentary characteristics of the gravity flow be identified and described. And the sedimentary micro-facies types composed of neritic sandbar, continental shelf mud, main channel, bifurcated or cross-cutting distributary channel, overspill, and natural levee are revealed under the constraint of high precision sequence stratigraphic framework in the Ehl[1].

This study show that the spatial evolution rule of the gravity flow is dominantly constrained by the integrated function of sediments supply of the large rivers in the LST, the development of local gradient change in sea floor, and the fall in relative sea level. More specifically, (1) The Blue River delta was formed by Blue River source of Central Vietnam in the basin margin, which has provided high sediment input for the gravity flow in the LST. (2) The flexure slope break between the Lin'gao Uplift and Central Depression, developed a gradient of 2°~3°, had created a favorable slope for the formation of the gravity flow system. (3) The gravity flow deposit system in the LST is divided into three evolution stages corresponding to periods of three parasequence sets. The gravity flow deposit was induced in the early LST, expanded rapidly in the middle LST and decreased slightly in the late LST. But its developing scale decreased sharply in the transgression systems tract (TST) and finally vanished in the highstand systems tract (HST).

As a result, the Blue River shelf delta is defined as "background source", the incised valley in the Yingxi Slope as "transporting channels", and the shallow marine turbidite submarine fan in the low-lying Dongfang area as "sedimentary sink". The sedimentary model is established as an optimal component of "source-channel-sink" for shallow marine turbidite submarine fan, which will provide guidance for the future exploration efforts in this area.

Targeting the right grain size in detrital-geochronology studies

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Sampling is the first and crucial step in detrital-geochronology research. In modern-sand studies, the temptation to collect heavy-mineral-rich sand in the field to simplify sample treatment and speed up laboratory procedures may be strong, but may lead to severely biased results. In order to be sure that enough material is recovered, large samples are collected usually in the field. Only specific grain size classes (commonly 63-250 μm or 250-500 μm) are generally processed in the laboratory for separation, in the belief that precision can be increased by standardizing procedures and narrowing the analyzed size-window.

These preliminary actions have not received much attention so far, which may explain why in several cases separation procedures end up with insufficient amounts of the targeted mineralogical species (e.g., apatite, zircon). Even when enough material is retrieved for analysis, the incorrect selection of the analyzed size-window may lead to biased results and to miss the information stored in other size-fractions.

MinSORTING is a simple Excel® spreadsheet devised to calculate size-frequency distributions of detrital components in sediments according to the physical rules that govern particle setting in fluids. The required input parameters are: 1) sediment mean size and sorting; 2) density of detrital components (chosen from a given selection); 3) depositional fluid (i.e. air, seawater or freshwater), and; 4) bulk sediment composition (selected from an array of given compositions typical of different tectonic settings). MinSORTING calculates settling velocities and size-density relations of detrital grains according to Cheng's empirical formula for sand, to Stokes' law for fine sand to silt laid in water, and to the Impact law for eolian sediments. The software's output is the size-frequency distribution at the desired 0.25, 0.5 or 1 ϕ intervals of 27 different detrital components, including quartz, feldspars, zircon, apatite, hornblende, muscovite, biotite, rutile, monazite and titanite. Users can thus select the most suitable size window for their samples, retrieve most of the mineral of interest, assess the amount of material missed in other size classes, and evaluate the representativeness of the results for any type of analysis.

Correlative subaquatic landslide and sediment expulsion deposits as paleoseismological tool (in the Lake Neuchâtel region, Western Switzerland)

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Lake sediments are key archives of environmental changes and geological events, such as earthquakes. Previous studies in the marine, as well as in the lacustrine realm, have calibrated the use of subaqueous mass transport deposits as indicators of past seismic events. Other studies have documented links between seismicity and activity of subsurface sediment mobilization structures (e.g. mud/sediment volcanoes), both onland and in the subaquatic realm. However, limited outcrop availability and the lack of detailed high-resolution sedimentary archives often hamper our ability to test the usage of subaquatic event deposits of such sediment/fluid expulsion processes as paleoseismological tool. In this study, we present the spatio-temporal distribution of event deposits from (1.) such sediment expulsion processes and (2.) subaqueous mass transport deposits archived in the sedimentary record of Lake Neuchâtel, Western Switzerland, and discuss potential paleoseismological implications.

A geophysical approach using multiple tools provides precise high-resolution lake floor morphologic data and subsurface information of the sedimentary infill of Lake Neuchâtel. Radiocarbon dating on piston cores provides the base for the age-model. These data allow for a systematic spatial and temporal mapping of mass-movement deposits and sediment expulsion structures. Our data reveal strong evidence for at least two distinct events with multiple, basin-wide subaquatic landslides. These multiple landslide events are interpreted as the fingerprint of past earthquakes. Furthermore, seismic reflection and swath-bathymetry data image large, crater-shaped morphologic depressions of up to 160 m in diameter and 30 m depth. The levees of these crater-shaped depressions are characterized by several distinct overflow deposits, clearly showing multiple phases of sediment expulsion during discrete periods throughout the Holocene. Seismic-stratigraphic and core-to-core correlation between the event deposits reveals that the base of some of these levee-type overflow deposits correlate with the multiple landslide horizons. This correlation suggests that onset of sediment expulsion from the crater-shaped depression is simultaneous with or shortly after multiple landsliding in the lake. Therefore, we hypothesize a causal link between multiple landsliding and expulsion of subsurface sediment, likely triggered by past earthquakes. To further test this paleoseismological hypothesis, we discuss the event catalogue of Lake Neuchâtel in the context of general paleoseismology of the wider Western Swiss Molasse Basin.

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Transitional heterozoan-photozoan facies from the upwelling region of Galápagos, Eastern Pacific

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We highlight alternative sedimentary outcomes along a natural tropical upwelling gradient in the tropics. The facies patterns are not only important to understand future outcomes of eutrophication and ocean acidification, but also for deciphering tropical paleooceanography and paleolatitude. Contrasting carbonate environments on the Galápagos Archipelago are studied where a pronounced west to east upwelling gradient exists. Strongly influenced by seasonal and interannual (i.e. El Niño-Southern Oscillation) upwelling, the equatorial setting of the Galápagos Archipelago is cut into regions of defined temperature, nutrients and saturation state (Ω). To understand the relationship between oceanographic properties and the sediment deposition we analysed the sediment composition of shallow water (<15mwd) sea-bottom samples collected from 25 locations around 10 islands spanning the main geographical regions of the archipelago. The shallow water rocky reefs of Galápagos are characterised by coarse carbonates sands and mixed carbonate–siliciclastic sands. Although there is little difference in the amount of carbonate production, there is a major difference in the distribution and composition of key carbonate producing biota. This dynamic oceanographic setting is a distinctive tropical heterozoan facies with the injection of coralline red algae and phototrophic corals. Unlike other tropical reefs, there is a complete absence of *Halimeda* and an extremely low abundance of benthic foraminifera. The western side of the archipelago, which is strongly influenced by nutrient rich, low carbonate-saturated, subtropical temperature, resembles 'cold-water' carbonates facies (i.e. balanid, serpulid, echinoderm, gastropod, and bryozoan rich facies). The eastern, less upwelling-influenced side is composed of a transitional mixed (predominated by coralline red algae) facies, while the oligotrophic far northern shows a more closely resembling tropical facies with a greater proportion of heterotrophic and phototrophic corals. Although the temperature gradient would allow for a broader distribution of photozoan facies, the increased nutrient and in turn reduced light attenuation favours heterozoan carbonate factories.

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Tide-Dominant Ancient Mahakam Delta Successions as Analogues for Transgressive Reservoir Successions in the Subsurface

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The stratigraphy succession of the Grand Taman Sari Circuit (GTC) and Stadium Utama Kaltim (SUK) outcrops indicate that transgressive deltaic successions in the middle Miocene Mahakam Delta province have good reservoir potential, especially in the Balikpapan Formation which is a major exploration target. High resolution measured sections were created for both outcrops from centimeter-scale lithofacies observations. In general, both outcrops comprise thick (GTC almost 280 m, SUK nearly 170 m), highly aggradational and retrogradational parasequence sets deposited during transgressive conditions.

The tide dominated transgressive successions consist of four general facies: 1) Cross-bedded coarse sandstone interpreted as back-filled distributary channels characterised by a wedged shape and erosive, sharp basal contacts. Grain size gradually fines upward from coarse to medium sand, whilst mud drapes and mud and organic flasers become more upward; 2) Alternating sandstones and mudstones that are characterised by a sheet sandstone geometry, abundant flaser bedding, lenticular bedding, asymmetrical ripples, mud drapes and moderately abundant bioturbation and interpreted as tidal sand flats; 3) Lenticular bedded and laminated mudstone that is interpreted as tidal mud flats, and 4) Bioturbated medium-grained, tabular sandstones that are highly and diversely bioturbated, gradually coarsen upward from fine to medium sand and are flaser bedded, wave and current rippled. They are interpreted as tidal bars.

In both outcrops, there are two facies that have reservoir potential with respect to porosity and permeabilty. One is the back-filled distributary channels with thicknesses that vary from 10 – 20 m and the other is the tidal bars that are 2 – 5 m thick. Back-filled distributary channels can be up to 2 km wide with a straight to meandering channel shape whilst tidal bars are shoreline-perpendicular and up to 1 km wide, based on modern Mahakam Delta analogues. Deposition during transgressive back-stepping means that both facies can occur as isolated sandstones within a mudstone succession and are potential stratigraphic traps.

It can be difficult to distinguish back-filled distributary channels from fluvial channels in the subsurface because they generate nearly identical, fining-upward well log signatures. Similarly, tidal bars can be mistaken for crevasse splay sands because they both generate coarsening-upward log patterns. However, an integrated sedimentologic and biostratigraphic analysis will often distiguish the transgressive and regressive facies.

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Controls on sedimentation of a fluvial system: the case of salt related mini-basins, Sivas, Turkey

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Marine or continental sedimentary successions deposited on top of a thick salt layer tend to generate separated mini basins with differential subsidence controlled by salt flow. A limited number of mini-basins provinces have been described, especially with fluvial dominated infill. The evolution of mini-basins is dependent on local factors such as salt tectonic, which influences the rate and style of mini-basin subsidence and the surface topographic expressions. It is further dependent on the modification of regional factors such as climate, tectonic regime and rates of sediment input. To better understand the relative importance of allocyclic vs. autocyclic factors on sedimentation in a mini-basin, the study of salt tectonic provinces is essential. Most of the published papers refer to the three following classical examples: the Paradox Basin (USA), the PriCaspian basin (Kazakhstan) and the German and North Sea Permo-triassic basins.

A spectacular outcrop analogue, recently re-interpreted, is the mini-basin province of the Sivas basin (Central Anatolian plateau, Turkey). The Sivas basin is an elongated Oligo-Miocene basin showing numerous mini-basins separated by evaporites structures such as welds and diapirs of various shapes. The mini-basins can be precisely mapped with aerial photos and fieldwork and these record a variability of fluvial dominated facies constituting the infill of the mini-basins.

Our work focuses on six of the well-exposed mini-basins, which present a 1km to 2.5km sedimentary pile of continental sediment unconformably capped by marine deposits. The infill of these mini-basins began during the late Oligocene over an older basal evaporite layer, with (1) a playa-lake system deposited under arid climatic conditions, followed by (2) a braided fluvial system occurring during a humid period (Karayün Fm.), (3) then a lacustrine system that is finally capped by (4) shallow marine deposits (Karacaören Fm.) during the Early Miocene. This fluvial system with a lack of distinct river channels incision and related drainage patterns look like of distributary fluvial systems. The abrupt facies changes bounding stratigraphic units are related to base level changes in relation with regional climatic events modified locally by salt tectonics. Climatic as well as tectonic-driven variations at regional scale modify the rate and style of sediment supply and the regional subsidence, but all this events are recorded in a coeval manner by the fluvial system in each mini-basin. In contrast, the salt tectonic modify locally sedimentary record and associated stratal pattern within each mini-basin.

Late Triassic carbon cycle stability with orbital control prior to the mass-extinction

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We established a new high-resolution carbonate isotope record from the lower Norian to the upper Rhaetian in the Northern Calcareous Alps in Austria. The new curve has an excellent biostratigraphic control based on ammonoids and conodonts. Among the four sections sampled was the proposed GSSP section (Steinbergkogel) for the Norian-Rhaetian Boundary. The middle Norian to lower Rhaetian is composed of a sequence of different Hallstatt-type limestone. These consist of fine-grained bioclastic wackestone deposited from periplatform ooze. The Rhaetian terrigenous event of the Zlambach Formation ended the Hallstatt facies deposition. Its background sedimentation of alternating marls and subordinate micritic limestone is episodically overlain by allodapic carbonate sedimentation. The Zlambach sequence was deposited in a toe-of-slope to basin environment. The carbon isotope curve display a gentle decrease from the late early Norian (3.5‰) to the base of the Rhaetian (1.8‰) with two accelerated steps, one in the middle Norian and the other one just after the Norian-Rhaetian Boundary. This last 1‰ decrease correspond however to a change in lithology between the Hallstatt facies and the alternation of marls and limestone. The values show then a small increase during the early Rhaetian, with a maximum in the middle Rhaetian (at 2.4‰). The general stability of the curve even through the Norian-Rhaetian boundary crisis event describes a stable oceanic structure prior to the mass extinction.

Superposed to this long-term trend, the d13C isotopic curve in the Zlambach Formation records distinctive cycles of various thickness. Spectral analyses reveal a prominent 7 to 8 m thick cyclicity corresponding to 400 kyr orbital eccentricity modulation. These cycles occurring in the mid-Rhaetian Zlambach Formation show strong similarities with those observed in several Cenozoic and Cretaceous records, suggesting that a link between orbital forcing and carbonate cycling existed also in the Late Triassic time. These 400kyr cycles in the Late Triassic could have been linked to sea-level changes influencing the carbonate export from the platform or, as during the Cretaceous, be related to a fluctuating monsoonal regime.

CO_2-decline and the origin and abundance of Devonian-Mississippian carbonate mud mounds

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Carbonate mud mounds were unusually large and abundant ~350 Ma ago, during the Late Devonian-Early Mississippian (LDEM). An origin by sediment baffling was suggested, but a suitable source of off-mound carbonate mud has been difficult to identify. Late Devonian atmospheric p_{CO2} reduction and p_{O2} increase were sufficiently large to induce CO_2 concentrating mechanisms (CCM) in cyanobacterial phytoplankton. CCM act to maintain photosynthesis, and include bicarbonate transport into cells. This promotes extracellular pH rise that can cause water column precipitation of fine-grained carbonate ('whitings') if aquatic carbonate saturation state is elevated. It is proposed that imported off-mound whiting mud substantially augmented and may have exceeded LDEM on-mound carbonate production.

Typical features of LDEM mud mounds that are consistent with current-driven accumulation of fine-grained carbonate include their (i) layered structure; (ii) geometries such as orientation, asymmetry, progradation and amalgamation, (iii) grainstone haloes; (iv) presence of current-reliant filter feeding organisms (bryozoans, crinoids, sponges); (v) formation over a wide depth range; and (vi) internal collapse structures (stromatactis and slumps). Carbonate mud derived from phytoplanktic whitings can be rich in organic matter which could have promoted microbial lithification (e.g., by bacterial sulfate reduction, BSR) that produced widespread development of clotted-peloidal microfabric. Off-mound carbonate mud production mediated by cyanobacterial oxygenic photosynthesis could therefore have been augmented by on-mound syndepositional lithification mediated by BSR mineralization of whiting organic matter.

In addition to increase in carbonate mud mounds, CO_2-induced changes in phytoplankton during the LDEM can potentially be linked to diverse and broadly coeval events in the marine realm whose relationships were hitherto unsuspected. These include black shale deposition, crinoid diversification, and acritarch and reef extinction. It is proposed that the proximal stimulus for these changes was CO_2-decline that induced CO_2-concentrating mechanisms in cyanobacteria, promoting their productivity by allowing them to overcome carbon-limitation. Increase in cyanobacterial sheath-calcification (and in whiting mud) is consistent with CCM induction. Proliferation of planktic cyanobacteria during this interval is suggested by increases in cyanobacterial biomarkers, positive $\delta 13C_{PDB}$ excursions, and organic-rich black shale accumulation. Cyanobacterial picoplankton could have contributed to the diversification of camerate and advanced cladid echinoderms by increasing the abundance of fine food particles. Phytoplankton community restructuring is also implied by marked decline in diversity of acritarchs, which may have been ill-equipped to respond to reduced CO_2 availability. Changes in phytoplankton food supply (and in toxic bloom formation) could also have contributed to extinction of reef-building sponges and corals. Whether or not Late Devonian reef demise was linked to changes in phytoplankton, it would have left surplus $CaCO_3$ in solution in seawater, favoring whiting precipitation.

This reasoning, based on LDEM conditions, should not be applied to carbonate mud mounds in general or even to all LDEM mounds. Furthermore, an off-mound mud source in biogenic whitings does not exclude additional on-mound processes of carbonate production. Nonetheless, an external mud source appears consistent with many features of LDEM mounds, and assists development of an integrated explanation linking otherwise apparently unrelated contemporaneous global changes. It may also be applicable to episodes of increased carbonate mud and silt abundance at other times in the geological record. Not least, support for an off-mound mud source at a time when mounds were exceptionally abundant calls for reappraisal of concepts of on-mound origin that have dominated interpretation of carbonate mud mounds for decades.

Ocean acidification and the late Quaternary decline of microbialite crusts in tropical reefs

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Ocean acidification by atmospheric carbon dioxide since the last glacial maximum, 21,000 years ago is expected to significantly impair tropical reef development, but effects on reefs at the present-day and in the recent past have proved difficult to evaluate. In contrast to major reef-builders which relatively closely control their calcification, such as coralline algae and corals, bioinduced bacterial calcification is very sensitive to ambient changes in carbonate chemistry. Cryptic microbialite crusts in reefs have declined in thickness over the past 14,000 years, with largest reduction 12,000 to 10,000 years ago. We interpret this as an early effect of deglacial ocean acidification and infer that crusts are likely to have been thicker when seawater carbonate saturation was elevated during earlier glacial intervals, and thinner during interglacials. Well-dated IODP cores through reefs at Tahiti show decline in crust thickness from 12 to ~2 cm between 12.5 and 6 ka ago. Global data are more limited, because most Holocene reefs are at or below sea-level and few have been cored, but information collated from tropical reef worldwide also indicates similar progressive reduction in crust thickness over the past 12 ka. This trend matches that of decline in calculated tropical surface ocean pH and carbonate saturation for the same interval. In addition to their relatively weakly controlled calcification, these microbialite crusts are composed of soluble Mg-calcite, increasing their susceptibility to ocean acidification. Crusts are most conspicuous in cavernous reefs in high-energy reef margins where seawater flushing is intensified, and locally constitute up to 80% of the solid reef structure. They can substantially strengthen reef structure by rigidly connecting and stabilizing the skeletal framework. Quaternary seawater was more alkaline during glacial periods and more acidic during interglacials. Thus, reef crusts should have been thicker during glacial periods, when seawater carbonate saturation was elevated, thereby strengthening reef frameworks, and thinner in response to interglacial acidification, leaving reefs weaker.

Microbialite crust decline reveals previously unrecognized millennial-scale acidification effects on tropical reefs. Previous studies attributed the thinning of bacterial crusts to reduction in nutrient and alkalinity supply when slowing Holocene sea-level rise caused decline in terrestrial runoff and/or deep-water upwelling. We do not rule out these local effects, but the global extent of tropical crust decline, its correspondence with calculated ocean acidification rate and compatibility with dependence of bioinduced bacterial calcification on the degree of carbonate saturation, all implicate a progressive global factor, such as deglacial ocean acidification, as the more likely proximal cause. This suggests that reefs have been impacted by acidification that long pre-dates any effects so far observed in more controlled reef calcifiers such as corals and coralline algae. As anthropogenic carbon dioxide release exacerbates the current long-term 'natural' cycle of interglacial ocean acidification, it could extend its effects to organisms, such as corals, that until now appear to have maintained close control over their calcification. Evidence for similar interglacial acidification effects on calcification and reef structure could be preserved in earlier Quaternary glacial cycles and even for those much deeper in the geologic record.

The Martin Bridge Carbonate Platform (Wallowa terrane, Northwestern USA): reassessment for a better understanding of the evolution of the Blue Mountains Province

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The Wallowa terrane, 7-9 kilometer thick Lower Permian to Upper Jurassic volcano-sedimentary sequence, is one of the four allochtonous tectonostratigraphic terranes of the Blue Mountains Province (Oregon and Idaho, USA). It includes remnants of a Upper Triassic Panthalassan carbonate platform, known as the Martin Bridge Formation, whose development and drowning are believed to be tectonically controlled by an intra-oceanic arc-arc collision.

Rocks of the Martin Bridge Carbonate Platform, extensively metamorphosed, are widely affected by Late Triassic–Early Cretaceous tectonic events, preventing accurate correlations and limiting our understanding of the 4D evolution of the platform. Unaltered outcrops have yet provided abundant and diversified reef, lagoon, slope and basin faunas including corals, sponges, foraminifers, gastropods, bivalves, algae, brachiopods, echinoderms, radiolarians, conodonts, and ammonoids, many conspecific with Tethyan taxa.

For the first time, field investigations of the whole Martin Bridge Carbonate Platform have been undertaken. From the most famous outcrops of the Wallowa Mountains and Hells Canyon to smaller, isolated, or recrystallized localities, all limestone exposures have been meticulously sampled (~850 samples) and studied petrographically (~1000 thin sections), providing new data for the stratigraphic resolution, facies distribution, and geographical extant of the Martin Bridge Formation. Significant mix-ups between olistoliths, olistostromes, tectonical lenses, and Martin Bridge outcrops have been corrected, leading to a reinterpretation of the Wallowa terrane sequence, which has important regional implications.

Syn-rift to post-rift sedimentary record of the Oligo-Miocene rifting of the Gulf of Aden (Dhofar area, Sultanate of Oman)

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The southern stretched margin of the Arabian plate results from an Oligo-Miocene rifting phase that led to the setup of Ocean-Continent Transition (OCT) and to the oceanic opening of the Gulf of Aden since the Early Miocene.

The Oligo-Miocene syn-rift to post-rift deposits preserved in the Ashawq Graben (Dhofar region, South Oman) offer the possibility to investigate the evolution of the sedimentary systems during the formation of the proximal northern margin of the Gulf of Aden. A new detailed sedimentological, stratigraphic, biostratigraphic and isotopic analysis of these Oligo-Miocene deposits has strongly improved the understanding of the evolution of vertical movements affecting a stretched margin during its formation. Moreover, the absence of terrigenous influx in this area during the rifting phases gives a rare opportunity to study the carbonate systems and their response to these vertical movements.

After a period of aggradation of lacustrine deposits around the Eocene-Oligocene boundary, the beginning of the main rifting phases is marked by a regional retrogradation of the sedimentary systems during the Rupelian (Early Oligocene).
During the Early Chattian, the development of a platform-basin system in the Ashawq Graben highlights a major transgressive phase recording an increase of the tectonic subsidence rate, related to the stretching of the continental crust (rifting climax).
Then, the late Chattian syn-rift deposits record the inversion of this transgressive trend, marked by the beginning of the fill of the graben. This filling is made by the progradation of the carbonate platform over deeper carbonate slope deposits, followed by the onset of a Gilbert delta system during the Burdigalian.

This sedimentary system evolution records the progressive decrease of accommodation space related to the decrease of the subsidence rate and then to the uplift of the proximal margin domain during the Early Miocene. The major uplift that occurred during the Burdigalian is associated with a phase of major activity along the Ashawq Graben normal faults and could be synchronous with the emplacement of the Ocean-Continent Transition since 19,6 Ma. These Early Miocene differential vertical movements led to the building of the current margin morphology and finally to the regional uplift and exposure of the proximal margin, including the whole Ashawq Graben.

Finally, in the proximal domain of the margin, the post-rift stage (since the Late Burdigalian) is characterized by the aggradation and then by the progradation of a thin fan delta system. These deposits fossilize the major normal faults activity and record a new low subsidence phase, posterior to the Early Miocene major uplift. This thin post-rift unit, preserved in the Ashawq Graben, pass laterally toward the distal part of the margin to several thousand meters of deep gravity sediments overlying the oceanic crust.

Burrowing beetles in saline lake shores: effects on the preservation of mat-related structures

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The formation of dense aggregations of salt beetles on the sea shores is a widely known phenomenon, although the impact of their digging activities in inland saline lakes deposits is poorly reported. Here we describe the presence of dense populations of the subsocial staphylinid beetle, *Bledius*, in the littoral zone of shallow saline lakes from central Spain. *Bledius* is the dominant macrobenthic animal thriving in the intertidal environment, but some solitary bees can also bioturbate the sediment. In Lake El Longar, the beetles are associated with shore flies that proliferate at the water´s edges.

The smooth surfaces of the ephemeral lakes host a veneer of microbial mats that show a green, purple and a black layer with depth; the latter indicates sulphate reduction processes by bacteria. The mat types and related sedimentary structures change seasonally according to a variety of processes. The main saline precipitates consist of gypsum, a suite of Mg and/or Na-bearing sulphates and chlorides, all commonly embedded in the organic-rich mat laminae.

During the spring and summer the beetles (adults and larvae) persistently dig burrows on the moist and microbial mat-covered sediments. Burrows can be located by distinguishing piles of excavation pellets left behind. The most common piles are rounded but elongated tumuli are also excavated in the zone of proliferation of *Salicornia.* In the rocky zones the beetles dig their burrows under the rocks for refuges.

The bioturbation zone is crowded with a complex network of irregular burrows averaging 2–5 mm in diameter (maximum 10 mm). The burrows extend some 5 cm deep into the black layer of sulphate reduction, which favours the oxidation of the sediment around them and provides pathways for seepage of groundwater seepage that triggers sulphates precipitation.

The bigger burrows show a distinct wall-lining stabilized by mucus, sulphate and halite crystals. Adults form vertical to oblique cylindrical tubes that may contain passive infill resulting from sediment collapse, and sediment transported backward. Smaller galleries produced by larvae are vertical to horizontal, straight to tortuous.

The beetles harvest the bacteria and the diatoms from the surface, storing it in the excavated chambers, which leads to the destruction of the sedimentary structures. Instead the sediment show a peloidal texture, where the irregular peloids are formed by a mixture of organic biomass, sulphate crystals and beetle feces and debris.

Beetles destruct the microbial mat structures and lamination through their burrowing, thus reducing the potential of preservation of them in the geological record. As a result, they create an unstructured mix of sulphate crystals, peloids and clay which can be analogous of some typical gypsiferous mudstone and marl facies found in the Cenozoic continental record. Cenozoic facies show L-shaped traces, attributed to coleopterans, where the intervening branches varies from 3 to 7 cm and the diameters range from 0.5 to 3 cm (Rodríguez-Aranda and Calvo, 1998). The presence of microbialites within these Cenozoic deposits is not as common as can be expected, probably due to burrowers activity.

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From travertine to tufa: a proximal-distal model in a volcanic ravine (Gran Canaria, Canary Islands, Spain)

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Downstream variations of various characteristics of fossil spring and related fluvial carbonate deposits from Azuaje ravine of volcanic island of Gran Canaria (Canary Islands, Spain) have been studied. Downflow trends through these carbonate deposits reflect environmental, and physic-chemical changes along the system and show a clear transition from travertine to tufa textures. Carbonate samples have been taken along 3 km of ravine. Petrographic observations were done using optical microscope and SEM. XRD and stable isotope (C, O) analysis were performed over selected samples. All results were compared among outcrops, and different trends were observed.

Our study indicates that the system contains:

1. Proximal deposits dominated by coarse crystalline facies (rafts, dendrites, coated bubbles, crystalline crusts, shrubs, alternating laminations), barely identifiable biological remains. Microbial remains are not well preserved. Porosity is relatively low and small sized, mainly primary, intercrystal, interparticle and growth framework, but also secondary due to dissolution (vug) and fracturation processes. These deposits formed under disequilibrium at high precipitation rates and strong degassing rates, with relative high water temperature.

2. Medial deposits appear as finer crystalline facies, with more identifiable biological remains and strongly cemented plant-mould related deposits, with increasing downstream fabric-selective porosity, including intercrystal, inter- and intraparticle, growth framework and moldic. This facies reflect lower disequilibrium conditions, and lower degassing, precipitation rates and temperature.

3. Distal deposits are dominated by boundstones of stems and microbial related facies, commonly microcrystalline with high primary porosity. These deposits precipitated close to chemical and isotopic equilibrium under low precipitation rates enabling high fossil preservation and minor dissolution.
The mineralogy of the system varies from aragonite-dominated in the proximal deposits to only calcitic in the distal ones. There is also an increase in delta^{18}O values downflow. delta^{13}C values increase strongly in the proximal facies from perched deposits (4 per mil VPDB) to cascades and pools at the ravine bottom (12 per mil VPDB) of the medial facies. In the distal deposits the delta^{13}C signal decreases to more constant values (4-6 per mil VPDB).

Proximal deposits underwent more intense diagenetic processes (neomorphism and dissolution) than distal ones as corresponds to its more instable mineralogy.
The Azuaje ravine is a good example of the transition of fossil hot spring (travertines) to fluvial related deposits (tufas). Along this transition it is possible to study the changes in physic-chemical and biochemical controls that account for the downstream evolution of travertines to tufas.

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Paleolimnology of Lake Iznik during the late Pleistocene to Holocene transition

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Lake Iznik, situated in the Marmara Region (NW Turkey), has mesotrophic character. With circa 310 km^2 in size and an average water depth of 50 m, the water column is subject to complete mixis once a year. The lake has a low salinity of about 0.5 to 1 mg/L, contributed by the ionic composition as follows: for the cations $Na^{+}>Mg^{+2}>K^{+}\geq Ca^{+2}$, and anions HCO_3, $CO_3>>Cl^{-}>SO_4$. The distinctive water chemistry and a pH ca. 8.8 induce primary carbonate precipitation in the water column during the dry summer seasons. The endogen carbonate accumulation, e.g. aragonite, is expected to document past climate information.

In order to differentiate site specific signals and responses to climatic forcing, a detailed understanding of the limnological system was achieved. This understanding relies on geochemical and mineralogical evidence from a continuous composite profile in a decadal to centennial time scale. A novel improved age model shows that the sediment record reaches up to ca. 31.5 ka cal BP.

The endogen carbonate production proved to be a sensitive climatic indicator. Changes in carbonate concentration are timely associated to the inferred fluctuations in water column depth. The aragonite concentrations are most likely related to regional temperature, catchment hydrology and the mixing dynamics of the lake. The physical mixing dynamics of the lake is reflected in (a) behavior of elements mobile under oxic/anoxic conditions, and (b) geochemical patterns for carbonate bound elements in hardwater lakes, and (c) stability of various minerals.

From ca. 31 ka cal BP until the deglaciation at ca. 18 ka cal BP, Lake Iznik is characterized by low productivity and higher detrital load, in association to a low carbonate accumulation. Thicker epilimnion and lower supersaturation states are inferred in association to a deeper water column. During the last glacial, i.e. from ca. 26 to ca.18 ka cal BP, Lake Iznik passes through prolonged stages of incomplete mixing of the water column, whereas the lake level is most likely maintained during most of the last glacial. In addition, the crystal structure of carbonates reflects mineral instability. At the Last Glacial Maximum (ca. 22 ka cal BP) carbonate accumulation in the lake is nearly absent.

During the deglaciation, starting at ca. 18 ka cal BP, dynamic and pronounced lake level variations occur. A shallow water column is inferred at 16.5 ka cal BP, and a possible low stand is identified for the period between ca. 14 and ca. 9 ka cal BP. Generally, Marine Isotope Stage (MIS) 1 is marked by increased aragonite concentrations and enhanced chemical weathering. The terrestric organic load increases gradually and is accompanied by lake trophic conditions.

Lake Iznik climate event stratigraphy highly correlates with the regional geological record. The endogen carbonate accumulation seems to occur in phase to Northern Hemisphere climate variability, for instance warm interstadials and cold stadials are depicted. In general, the cold phases are associated to a higher input of detrital calcite, likewise during the Younger Dryas cold event (ca. 12 ka cal BP).

The early Holocene (from ca. 12 to ca. 9 ka cal BP) is characterized by pronounced summer stratification and higher epilimnion carbonate supersaturation. Recurrent stages of good lake mixing are accompanying a shallow water column. The middle Holocene is generally more humid, as indicated by enhanced chemical weathering and by two distinct lake level increases.

This study established the current knowledge of the geochemical evolution of Lake Iznik. It further adds to the understanding of paleoclimate evolution in the Marmara region on a millennial time scale.

The role of organic and inorganic deposition on salt marsh processes: insights from the northern Venice lagoon (Italy)

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Salt marshes are typical features of the tidal landscape governed by the interaction between physical and biological processes. These crucially important ecosystems provide valuable services but are currently exposed to possibly irreversible transformation due to the effects of climate changes and human interferences. The increasing rate of relative sea level rise (RSLR) and the decreasing sediment supply are the dominant factors controlling the drowning of salt marshes and their disappearance worldwide. Improving current understanding of salt marsh biogeomorphic processes is a critical step to address a salt marsh response to changes in the environmental forcing. Although in the last decade a numbers of studies have analyzed the biomorphological evolution of salt-marsh systems, a complete understanding of the two-way feedbacks between physical and biological processes is still elusive. The temporal evolution of marsh elevation is governed by the balance between inorganic and organic accretion rates, and the rate of RSLR. Field observations and numerical models suggest that, under equilibrium conditions, the marsh inorganic deposition and the related platform elevations decrease with distance from the main creek, whereas the organic deposition gradually increases. In order to analyze the salt marsh response to the effects of physical and biological processes, a number of sediment samples were collected along three transects (about 40 m long) on the San Felice salt marsh (Venice Lagoon). GPS coordinates, surface elevations and the density of vegetation cover were measured for each sample, along with grain size distribution and organic/inorganic sediment content. Loss On Ignition and a double treatment with H_2O_2 and NaClO were used to estimate the amount of organic matter in each sample. Particle size analysis was carried out with a Mastersizer on the inorganic fraction. Our results show that all the transects are characterized by a concave-up profile, with highest elevations along the boundary, where the banks of tidal channels occur. The inorganic deposition, which is maximum along the outer marsh, decreases with distance from the channel edges, because as water moves across the marsh, the velocity is reduced and sediment particles are deposited. In contrast, the organic deposition gradually increases with distance from the channels to balance the decrease of inorganic deposition and to help the marsh to keep pace with the rate of RSLR. Interestingly, we note that the amounts of organic and inorganic sediment display non-monotonically trends and, regardless of the method used, the amounts of organic matter show the same qualitative trend, although characterized by different values for a single sample. The grain size of inorganic sediment shows a variable distribution between medium sand and clay. The grains along the marsh edge are coarser and become gradually finer toward the inner marsh. The distribution of vegetation over the salt marsh surface is organized in characteristic spatial patches. The above-ground biomass is greater along the marsh edge and reaches minimum values in correspondence of the pool zones, bringing new insight on the spatial distribution of organic and inorganic deposition.

Tectonic control on the evolution of Late Pleistocene-Holocene fluvial terraces in the main southern Amazonian tributary

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Late Quaternary sedimentary deposits from Amazonian lowlands are important geological archives for understanding the origin, evolution and controls of the largest fluvial drainage basin on Earth. Climate has been most often claimed as the main factor affecting river evolution in this region. An increasing volume of publications have also highlighted tectonics as a relevant control. This work investigates the late Quaternary evolution of the Madeira River, the biggest southern tributary of the Amazonas Basin and a major waterway in South America, with the goal of discussing the factor with highest potential of influence on its development in space and time. The approach consisted of carrying out a detailed morphological, sedimentological and chronological characterization of terrace deposits. Three terraces were recognized, which record sandy/pebbly channel, muddy channel/oxbow lake, point bar, floodplain, as well as crevasse channel, crevasse splay and levee deposits. The topographically highest terrace T1 formed in the time interval before 43,500 and 31,696−32,913 cal yrs BP, the intermediate terrace T2 between 25,338−26,056 and 14,129−14,967 cal yrs BP, and the lowest terrace T3 between 12,881−13,245 to 3,158−3,367 cal yrs BP. These terraces are the testimony of successive downcutting and sediment aggradation. Episodes of terrace erosion and deposition cannot be fully accommodated within the framework of fluctuating river base level tied to Late Pleistocene−Holocene global or regional climate fluctuations. Changes in tectonic subsidence rates might have played an important role in the equilibrium state of this particular fluvial system. Hence, activity along pre−existing tectonic faults provided unsteadiness and caused overall valley incision. The recurrence of this process would have modulated variations in stream discharge and sediment loading, modifying the base level and the capacity of the river to erode and transport sediments. As a consequence, a succession of terrace downcutting and sediment aggradation took place. The data presented herein serves as a word of caution concerning the interpretation of late Quaternary paleoclimate in the Amazonian lowlands with on terrace successions. Similar investigations applied to other Amazonian rivers should be encouraged in order to improve time resolution of neotectonics in the region. This approach integrating geomorphological, sedimentological and chronological developments focusing terrace development of rivers from the Amazonian drainage basin might contribute in discussions of controlling mechanisms involved in the evolution of other mega river systems worldwide.

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Process variability in a sand-rich mixed-energy delta system: the Lajas Formation, Argentina

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Because tides are an important agent of erosion and sand transport/sorting in many shallow marine environments, there are both commercial and scientific reasons to improve our knowledge of tide-influenced processes, environments and depositional successions. Mixed-energy, tide-influenced depositional environments, specifically river delta systems, deposit sandstones and mudstones within architecturally complex stratal packages.

This study focuses on the architecture and evolution of the mud-poor, Bajocian Lower Lajas Formation in the Neuquén Basin of Argentina. The outcrop dataset consist of 30 stratigraphic sections linked to high resolution photo-mosaics. Rich paleocurrent data have been measured to determine the direction and accretion style of these bodies (forward versus lateral accretion) in order to discriminate between large compound tidal dunes and tidal bars. The 300 m thick succession, exposed along a 7 km outcrop belt at Lohan Mahuida in the southeastern part of the Neuquèn Basin, is interpreted as a series of stacked subaqueous delta deposits, dominated by cross-stratified sandbodies, and intervening transgressive intervals. The succession is very sand-rich (80% Net to Gross) with relatively thin (dm up to two meters thick) intervening mudstones. Sandbodies thickness ranges between 3.5 and 15 m, and maximum width of 3 km.
The Lower Lajas Formation shows mixed signals of wave, tidal and river currents, and each of these dominate or show influence in different stratigraphic intervals or sub-environments. *The prodelta and offshore-transition* deposits are dominated by wave processes, and characterized by fine-grained sandstones with wavy/lenticular bedding, HCS, and ripple-cross-lamination with a high degree of bioturbation. *The delta front* deposits along the main sediment fairway are tide-influenced and extensively cross-stratified. They are characterized by sharp-based sandstone bodies with upward trends from heterolithic facies to clean, medium-grained cross-bedded sandstones; they are interpreted as tidal bars where growing laterally or large compound dunes where growing forward. *The associated distributary channels* are fluvial-dominated and tide-influenced, characterized by broad and shallow, upper-medium and coarse-grained sandstones in which tidal modulation of river flow is recognizable as increasing/decreasing concentrations of organic fragments on the forests of cross-strata. *The subaqueous delta*, away from the axis of the system, is characterized by tide-influenced channel and bar deposits, which show lateral accreting cross-sets with double organic drapes or a pronounced alternation of river-flood deposits (decimeter thick structureless or cross-stratified sandstone beds) and inter-flood deposits (tidal rhythmites). *The lower delta plain* is characterized by low-relief (1-2 m), fluvial-dominated channels cutting into heterolithic fine-grained sediments. During transgressive intervals tidal inlet deposits and stacked estuarine bars are developed, characterized by large scale inclined cross-strata. The trace fossil assemblages throughout the deposits are dominated by *Dactyloidites ottoi*, *Thalassinoides*, *Planolites*, *Paleophycus*, *Skolithos, Macharonichnus* and minor *Ophiomorpha* and *Cruziana*.
Careful and detailed use of sedimentary structures allows the separation of wave, river and tidal signals, thus giving a more accurate environmental reconstruction. The Lajas deltas show that complex interfingering of the sub-environments (locally dominated by waves, rivers and tides) can change dramatically over few hundred meters.

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Tidal straits (structural controlled basins) facies and architecture

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Straits are tectonically controlled marine passageways between two larger bodies of water where tidal currents can be amplified due to restriction of the cross-sectional area. Few studies provide conceptual models for strait facies architecture, despite their importance for paleogeographic reconstructions and as potentially good hydrocarbon reservoirs. The main depositional areas in a strait are characterized by large dune fields, which are located close to the strait ends.

Here is proposed a three-fold facies partition based on the occurrence of erosional-, tidal-, or wave-dominated lithofacies, which are controlled by base level changes (tectonic or eustatic) through time. The proposed model maps the tripartite facies at one time, as well as their variation through time. The relative base level changes controls the strait cross-sectional area, and therefore the distribution of the tidal energy in its various parts. Variations in the average strait depth possibly control the interplay of processes related to erosion, traction of the tidal flows and waves, with direct influence on the distribution of the tripartite facies associations.

The paleostraits in southern Italy (Amantea, Catanzaro, Siderno and Messina straits) developed as narrow grabens and half-grabens 2-3 km wide and 5-10 km long in relation to the migration of the Calabrian Arc towards the south-east, during the Middle Miocene. The stratigraphic infill developed during two transgressive episodes in the Lower Pliocene to Lower Pleistocene and it consists of mixed carbonate-siliciclastic sandstones and mudstones organized into stacked 2-D and 3-D cross-strata sets up to 8-9 m tick and characterized by tidal bundles.

In particular, the Siderno paleo-strait has recognizable strait geometry with well-defined margins due to its young age (Plio-Pleistocene). The strait-fill stratigraphic succession has not been studied in detail despite the presence of a series of spectacular (1-2 km long cliffs) exposures. Detailed sedimentological sections measured along the depositional paleo-strike and dip of the paleostrait show cross-strata thickness which are useful to find the most energetic (tidal) facies, paleocurrents, grain size and sorting patterns, and facies association distribution through time (vertically). High-resolution photomosaics (Gigapan) of cliffs and of specific sandbodies can be used for detailed facies architecture mapping.

This study will test the validity of the proposed model, providing a new and strong predictive tool for tidal facies distribution (in time and space) in tectonically confined basins. This approach combines a “static” model, based on facies distributions in modern straits, and a “dynamic” model, that consider tidal current speed changes induced by the basin (strait) cross sectional area variations.

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Anthropogenic-driven changes in the coastal zone of the Campania region (southern Italy)

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As most of the Mediterranean coastal areas, the Campania Plain (southern Italy), and particularly coastal plain and back-dune system, escaped direct human impacts until the beginning of the last century, as it was site of swamps and ponds bearing a high incidence of malaria. The main river feeding the above coastal plain is the Volturno River, the largest river of the southern Italy. The related delta plain is characterised by an outer delta formed mainly by beach ridges, and an inner plain containing numerous depressions of drained marsh regions.

The remarkable thickness of marine sands with mollusk shells cored along the present day beach-dune system suggests the location of inner continental shelf and the associated coastline has been relatively stable and was accompanied by the development of a significant prograding sequence during the Latest Pleistocene – Holocene. In particular, a beach-dune system that sheltered a lagoonal area persisted at least up to the Roman times. This is also confirmed by the the tracks of the two major Roman roads crossing the Volturno plain (i.e. Appia and Domitiana Roads) that were either running along the sandy coastal belt (e.g. Domitiana Road) or completely avoided the wetland area, by crossing the coastal plain upstream, along its inland margin (e.g. Appia Road).

No significative landscape and hydrographic changes of the above environmental system occurred since the end of the XVI century, when during the Spanish vicereign by Count of Lemos, Don Pedro from Toledo, ambitious reclamation works were carried out, as the entire area was subjected to ponding and swamping.

Most of these marshy areas were reclaimed from 1811 until the early 1900s. Such interventions were achieved by earth accumulation by flooding; part of the river water was diverted and channelled, with the aim of elevating the land surface by filling the marshy areas with alluvial sediments. More than 150 km of canals were realised. The land surface in the area became about 120 cm higher and a particular kind of human-induced soil derived from the materials used in reclamation.

Of the wide lagoon system that once developed within the Volturno delta, especially south of the river mouth, before the XVII century, only a few wet areas are preserved to date. A strong coastline retreat has been documented since the beginning of the 1900, following the reclamation of the channels and the interventions along the Volturno river course (dams, sand excavations, among others).

The availability of reclaimed lands along the coastal alluvial plain favoured the development of agriculture and farming, with associated processing industries, to the detriment of the buffalo herd. Since the 60s, a strong coastal urbanization took place, along with the building of a touristic village with the related harbour.

The cartographic restoration and the spatial analyses performed in a GIS environment underline the great relevance and importance of the informatic tools in such an analysis and provides an evolutionary framework of the geological history of a coastal sector of the Campania Plain, of considerable interest from the point of view of both scientific and socio-economic development. Such documentation and the results achieved could easily form the knowledge base for a rational management of the entire area.

Recent evolution of a delta plain and a coastal zone: the Volturno delta system (southern Italy)

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The Campania Plain plain has developed following the Holocene glacio-eustatic sea level rise after the Last Glacial Maximum. The establishment of the coastal progradational phase, in the last about 6000 ky BP, allowed the formation of a wave-dominated delta system of the Volturno River, with flanking strandplains forming beach-dune ridges partially enclosing lagoonal-marshy areas. The progradation of the Volturno alluvial delta created favourable conditions for the development of continental environments, characterised by marshes and wetland as an integral part of the alluvial flood plain within the lower Volturno delta system. The formation of a mature sand bar complex offshore caused a progressive isolation of the former coastal lagoonal area from the open Tyrrhenian Sea. About 2 ky cal BP, beach and lagoonal environments still persisted along the present coastal zone.

Most of the marshy areas were reclaimed from 1811 until the early 1900s. As a result of the reclamation interventions, the development of agricultural and farming, with associated processing industries, took place as well as a strong urbanization. Among the morphological changes of the landscape induced by land reclamation, the Volturno River delta plain and related strandplain variation is perhaps the most striking. The analysis of the historical cartography and the comparison with recent maps up to the present, provide a sufficiently exhaustive picture of the evolutionary trend of the studied littoral.

From the Roman times to the last century, the entire coastline has experienced progradational trends, with decreasing values from 100 m at 10 m per century, proceeding from southeast to northwest, with 15 m/year progradation speed recorded in the period 1809-1907. The GIS based comparison of georeferenced cartography has allowed to record the peak of progradation of the Volturno delta system during the 1800's, after which it began to evolve from cuspate to arcuate in a strongly asymmetric form. In fact, the first anthropic interventions along coastline and the catchment area reduced the volume of sediment available for the sedimentary balance, so that in the last century the erosion at the delta mouth triangle was registered. The eroded sediments of the cuspate delta apex were gradually stored by longshore transport along the lee-side; at the end, the shoreline has become parallel. In fact, from 1907 to 1954 the shoreline near the mouth area is suffering erosion phenomena with a rate of about 2 m per year, with the left mouth area subjected to a less conspicuous retreat (about 1m a year). From 1954 to 1982 the backward trend is continuing with values between 1 and 6 m/year in the right mouth area, and 1 to 19 m/year in left area. This phenomenon is partly due to massive urbanization and building of defensive works on the right side which have “hardened” the coast. Conversely, the establishment of the natural reserve on the other side has left the coastal area exposed to the erosion process. The comparison between the results of bathymetric measurements conducted in the 1887 and in 1987 enabled a detailed assessment of the morphological changes occurred during the last century showing the sea bed most severely eroded near the wings of the Volturno river delta; by contrast, in the northern and southern parts more sediments were deposited offshore.

Paleowinds from magnetic fabric of Late Cenozoic eolian sediments in China

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The eolian loess-paleosol sequences and underlying red-clay formation ranging in age from Miocene to Holocene has been widely accepted as a unique geologic archive for understanding the history and variability of the East Asian palaeomonsoon climate. While there is still no a direct evidence, for example, a proxy tool to identify which direction of the paleowind (westly jet, northerly winter monsoon, southeastly Asian summer monsoon and southwestly Indian summer monsoon) played a major role for the formation and fabric in the eolian sediments.

The measured anisotropy of magnetic susceptibility (AMS) was compared to theoretically derived magnetic fabrics occuring in airflow conditions. The major and minor ellipsoid axis orientations were used to evaluate the paleowind direction in the Chinese Loess Plateau and northwestern China. In the new interpretation, the stronger southeastly monsoon is able to reorient particles which are on the ground until they are immobilized by the summer rain and vegetation. The stronger summer monsoon was responsible for the magnetic fabric formation of loess-paleosol sequence. The westly and northerly only brought the eolian material to the area while the sedimentary particles including magnetite were rearranged, settled, and fixed during the windy and rainy summer time. While for the underline red clay, the measured AMS apparently reveal that the maximum susceptibilities group in the NW quadrant and the minimum susceptibilities are clustered in the SE quadrant. It evidently showed that westly planetary wind still played a major role for the formation of the AMS ellipsoid orientation before the Pleistocene. We aim to construct the continuous process and to validate and clarify the time limit of the three climate system: planetary wind, ancient Asian monsoon and East Asian monsoon in the Loess plateau in turn from the dominant role. This will offer the Precision in the geologic record evidence for the prediction of evolution of our modern climate.

Stratigraphy and Chemostratigraphy of the Valanginian record from open platform and hemipelagic sections of the Betic External Zones (southern Spain)

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Short Episodes of Environmental Change (EECs sensu Föllmi, 2012) have been identified along the Early Cretaceous. One of them, the "Weissert Episode" is characteristic of the early-late Valanginian transition. According to Föllmi (2012), the Valanginian "Weissert Episode" is defined by a positive $d^{13}C$ excursion, which started in the late early Valanginian *Busnardoites campylotoxus* Zone and ended in the early late Valanginian *Saynoceras verrucosum* Zone. In this contribution the $d^{13}C$ profiles of two Valanginian sections from the Betic External Zones, in southern Spain, are presented. One of the sections comes from the northernmost Prebetic, near Oliva, in the south of the Valencia province, and the other from the Subbetic, near Cehegín (Murcia), in the Loma de Solana area. The Oliva section records the drowning of the lower Valanginian shallow carbonate platform that is overlaid by a set of shallowing upwards sequences of open platform environments of late Valanginian age well dated with ammonoids and calcareous nannofossils. The Loma de Solana composite section is made up of typical marl and marly limestone alternations of hemipelagic origin coming from two partial sections, one recording the lower Valanginian and another the upper Valanginian. This composite section is accurately dated with ammonoids and shows apparent stratigraphic continuity between the two partial sections making it. The $d^{13}C$ profiles show that the "Weissert Episode" is recorded in both sections. Nevertheless some differences can be traced when both curves are compared. The Loma de Solana section shows a $d^{13}C$ curve that follows closely the standard morphology of curves from others alpine basinal sections (e.g. Vocontian basin, Duchamp *et al*., 2007). On the contrary, the $d^{13}C$ profile of the Oliva section shows an increase in the values of $d^{13}C$ that embraces most of the late Valanginian. Also other differences in the geochemistry of the sediments making up both sections can be highlighted. Thus, the RSTE, redox sensitive trace elements, analyzed in the Loma de Solana sections do not show any particular increase, as is typical of anoxic events, and consequently we conclude that anoxia did not exist in that part of the Subbetic basin during the Weissert EEC. The section of Oliva is, on the contrary, relatively rich in organic matter with evidences of anoxia-dysoxia, which reaches a maximum in the upper Valanginian *Neocomites peregrinus* Zone, coinciding with the end of the $d^{13}C$ positive excursion. From the comparison of the studied sections we conclude that the platform environments recorded a relative enrichment in organic matter and the "Weissert Episode" lasted longer than in the open marine pelagic environments.

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Applying Chemostratigraphy to Define Facies and Facies Architecture in Mudrock Systems: Upsides and Downsides

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Studies of outcrop and subsurface mudrock successions illustrates that the nature and distribution of depositional facies in these rocks is variable and complex. Although such heterogeneity is also present in coarser grained sandstone and carbonate systems, both our understanding of the processes and products responsible for this complexity in mudrock systems and the validity of conventional methods to characterize it must be re-evaluated. Traditional methods of rock description and thin section petrography are inadequate for defining facies and stacking patterns in these rocks and cannot form a basis for interpreting geophysical data nor defining stratal architecture and continuity. Although such conventional approaches should be used wherever possible, they must be considered secondary, although important, adjunct to the information provided by chemostratigraphic methods.

We have collected comprehensive suites of chemostratigraphic data (including major, minor, and trace elemental concentrations, stable isotopes of carbon, oxygen, and nitrogen, and organic carbon abundances) from subsurface cores and outcrops in mudrock systems ranging in age from Devonian to upper Cretaceous age and used them to define high resolution variations in facies and the conditions under which these rocks were deposited. We complimented these analyses with biostratigraphic and geochronologic (U-Pb) data to constrain temporal relationships.

Major elements (Ca, Al, Si, Mg, P, Fe) define shifts in mineralogical assemblages (dominantly carbonate, quartz, and clay minerals) and allow facies stacking patterns to be defined with high precision and correlated to subsurface borehole log response. These data are thus fundamental to correlating facies and determining their continuity.

Redox sensitive trace elements (Mo, V, U) define changes in bottom water chemistry. In systems like the upper Cretaceous Eagle Ford and Upper Devonian Woodford formations where nutrient supply rather than eustasy and platform shedding control sediment flux and the application of sequence stratigraphic concepts is thus problematic, redox indices may be the best tools for temporal correlation.

Once established, a chemostratigraphic facies framework provides a key template for studies of depositional process, diagenesis, organic matter type and distribution, pore development, hydrocarbon distribution, rock strength, etc., When supported by biostratigraphy and geochronology, such an integrated approach to mudrock characterization based on chemostratigraphic analysis is the only rigorous way to devise and test predictive models for rock attribute distribution in these highly complex sedimentary successions.

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Rock Typing of Deep Geothermal Reservoirs in the Greater Geneva Basin

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In line with the current Swiss government strategy with regard to energy balance, a multistage program called GEothermie 2020 has been initiated by the State of Geneva (Switzerland). It aims at developing the deep geothermal energy resources of the trans-border (Swiss-French) Greater Geneva basin.

Two research projects have been initiated to study the subsurface geology of the region. The first project focuses on seismic and basin structural analysis, fault-related fractures and their geometrical characteristics and properties. The second project focuses on characterizing facies distribution, petrophysical and thermal properties of the sedimentary sequence ranging from Permo-Carboniferous to Lower Cretaceous units. The study encompasses well logs and cores investigation for detailed petrophysical analysis, a micro-facies study using both conventional petrography and automated QEMSCAN analysis, diagenetic study by optical cathodoluminescence and sediments provenance analyses (QEMSCAN combined with ICPMS). The results of these multidisciplinary approaches will be used to build a consistent stratigraphic, facies and paleoenvironmental model of the study area. Furthermore, it will allow us to identify pore distinctive features and highlight paragenetic sequences of sedimentation and diagenesis. Both these outputs will be ultimately used to build a predictive model of reservoir characteristics across the Greater Geneva Basin.

Previous studies already indicated potential reservoirs in different layer of the Mesozoic units. Based on these observations, 36 wells in France and 7 in Switzerland were selected for further investigations according to their depth and location. 14 cored wells were described, which are geographically distributed along a N-S transect across the Greater Geneva basin. The macro-facies core study highlighted lateral facies variations in the Muschelkalk and Raethian sediments, showing a proximal to distal trend towards the South. This trend could correspond to a likely NW-SE axe of the plate-form at this period. This observation is less evident in the Dogger and the Malm interval, although they show several different facies. In Cretaceous deposits, the “Urgonian” formation shows remarkable karsts with breccia and “Sidérolithique” continental sandstone infill, but also some hydrocarbons occurrence associated with fractures network. More than 200 plug samples were collected representing each different facies, and micro-facies and petrophysical properties are still under investigation.

All parameters collected are being integrated in a 3D subsurface model, also containing seismic and structural analysis of the basin. Regional facies mapping based on reconstruction of depositional environment evolution through time coupled with structural analysis of the basin will help to understand better the distribution of productive reservoir facies and fractured zones within the Greater Geneva basin.

Stratigraphic and geoacoustic model at the DH-1 long-core site in the Korean continental margin of the East Sea

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A long core of 23.6 m was acquired at the DH-1 site in the Korean continental margin of the western East Sea. The core site is located near the Donghae City and the water depth is 357.8 m deep. The long-core sediment was recovered using the Portable Remotely Operated Drill (PROD), a fully contained drilling system, remotely operated at the seafloor. The recovered core sediments were analyzed for physical, sedimentological, and geoacoustic properties mostly at 10~30 cm intervals. Based on the long-core data and stratigraphic analysis with subbottom and air-gun profiles at the DH-1 core site, a geoacoustic model was firstly reconstructed including water mass. In the Korean continental margin of the western East Sea, the geoacoustic model with the long-core data helps fulfill acoustic works of underwater and sea bottom such as undersea surveillance system or geoacoustic inversion.

The uppermost Unit A shows a sheet-draping reflector of relatively uniform thickness (average ca. 0.1 s twt) with well-stratified continuous reflector of high to moderate amplitude. This reflection configuration was interpreted as turbidite and hemipelagic sediments formed by relatively uniform sedimentation. The lower boundaries of the overlying Units A-1 and A-2 represent a progressive onlap termination against the apex of the anticlinal folding. The 3.5 kHz SBP profile shows the upper part of Unit A-1 and the uplifted lower units of Units B-1 and B-2. The upper unit is characterized by distinct, slightly dipping bottom echoes with continuous, parallel/subparallel subbottom reflectors. Sound penetration depth is about 30–40 m. Acoustic characteristics of the upper unit show continuous or partly discontinuous layering. In the study area, these acoustic characters of SBP are similar to the echo type of Chirp profile which was interpreted as hemipelagites and pelagites.

The DH-1 core penetrated to the middle part of Unit A-1. The long core comprises alternating sediment units of dominant mud (M) and dominant sandy silt (sZ). The mean grain size of muddy units ranges from 7.0 φ to 8.7 φ and that of sandy units is 3.7–6.7 φ. Some particles of volcanic ash and pumice clasts, foraminifera, and peat are present in the core. Porosity is in a range of 36–79% and wet bulk density is 1.35–1.99 g/cm^3. According to K/Ar-based ages of the tephra sediment, the lowermost subunit at the subsurface depth of 20.1 to 20.5 m in core DH-1 can be assigned an age of 1.49 Ma. The boundary of the subsurface 17.5 m in depth was interpreted as the Brunhes-Matuyama boundary (778 ka), based on paleomagnetic data of the DH-1 core.

In the Korean continental margin of the western East Sea, a geoacoustic model of 7 geoacoustic units was reconstructed, located at 37°36.651´N and 129°19.709´E. The detailed geoacoustic model on the DH-1 core site was based on vertical data of the 125 P-wave velocities and 121 P-wave attenuations of 23.6 m core sediments. The geoacoustic model DH-1 probably contributes for reconstruction of geoacoustic models reflecting vertical and lateral variability of acoustic properties in the Korean continental margin of the western East Sea.

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