New stratigraphic data from the fossiliferous Oligocene sequence at Ulantatal, Inner Mongolia, China

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Since the discovery of the mammalian fossils from the Ulantatal region, Inner Mongolia, in 1970, several expeditions have collected fossils from the low-relief exposures in this area. Although the area has produced a significant collection of vertebrate faunas, the stratigraphy, ages and depositional environments have remained poorly known or nearly non-existing. This study presents preliminary results of the magneto-, litho-, and biostratigraphy from the Ulantatal area and provides age estimations for the fossil-bearing horizons.

Our field investigations in Ulantatal have yielded over 5500 specimens including insectivores, lagomorphs, rodents, artiodactyles, perissodactyls, carnivores etc. The sequence produces fossils along much of the section with richest fossil occurrences in the lower half of the sequence. Five biostratigraphic units can be recognized by evolutionary level of taxa, faunal composition, and lithostratigraphic distribution. Lithologically, the sequence shows a rather uniform pattern characterized by interbedded reddish to yellowish brown claystones and siltstones with minor fine-grained sandstones.

Paleomagnetic samples were collected every 20–50 cm through several local sections 20–25 m thick and analyzed using alternating field demagnetization. Samples yielded characteristic remanent magnetization carried by magnetite. Our magnetic section suggests a correlation in the magnetozones C15n through C9n with an age range of about 35–27 Ma and places the lowermost fossil site in Ulantatal to the latest Eocene. Sedimentation rates derived from these preliminary magnetostratigraphic results are in order of 1–6 cm/kyr.

This correlation places for the first time a precise temporal control on the Oligocene stratigraphy of the Ulantatal area and provides a unique area to investigate in detail the physical and biotic changes during a period of major global paleoenvironmental changes.

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Geochemical characteristics of historical inundation events from eastern Kyushu and western Shikoku Islands, Japan

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The Nankai Trough, the subduction zone of the Philippine plate beneath the Eurasian plate, generates earthquakes (M>8), which then cause tsunamis that flood coastal areas of Honshu mainland and Shikoku Island in Japan. Historical accounts suggest that such earthquakes occurred every 100 - 200 years since 684AD that affect vast areas of western Japan. Further, it is suggested that somewhat smaller (~M>7) earthquakes have occurred every ~200 years since 1498AD along the coast of Kyushu Island. Although the historical accounts are pervasive in Japan, using such records, neither assessing the tsunami risk associated with Nankai Trough earthquakes nor determining the earthquake focus is straightforward, as these accounts are often objective and inconsistent with flood elevations derived from tsunami inundation models, particularly at eastern Kyushu and within the Bungo Channel.

We present results from sediment cores from 1) Lake Ryugubi (32.844°N, 131.982°E), a freshwater pond located along the eastern coast of Kyshu Island and within the Bungo Channel, 2) a transect of Sakura River bank (33.417°N, 133.305°E) in Susaki, Kochi, approximately 1 km inland from southern coast of Shikoku Island, and 3) Lake Kaniga (33.427°N, 133.454°E), a freshwater pond located 13km east of Susaki and facing the Pacific coast of Japan. We use a multi-proxy approach to identify event deposits in the cores, based on unusually denser or coarse-grained clastic layers. We particularly focus on characterizing geochemical signatures of these events using an Itrax™ micro-XRF core scanner, high-resolution X-radiograph imagery, backscattered scanning electron imagery (BSEI), and Energy Dispersive Spectrometry (EDS) coupled with a Scanning Electron Microscope (SEM). We use these event deposits to assess the damages and provide constraints of one of the most prominent tsunami along the Nankai Trough generated by the Hoei earthquake of 1707AD.

Morphological types, lithotypes, mineralogy and possible bio-mineralization processes in simple and iron-rich travertines from active thermogenic travertine-forming systems in Greece. The cases of Northern Euboea and Eastern Central Greece

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In Greece, many hot springs occur because of the magmatic, volcanic processes and active fault systems which favor the rise of the water. Thermogenic travertine deposits near to the hot springs, where the hot water cools, degasses and rapidly precipitates calcium carbonate.
Edipsos (N. Euboea; T=50.8-82^{o}C, pH=5.6-7.5) and Thermopylae (Eastern Central Greece; T=32.8-33.5^{o}C, pH=6-6.2) are probably the biggest active travertine-forming systems in Greece, while Ilia (N. Euboea; T=61-63^{o}C, pH=6.1-6.4) is a smaller one. They are presenting great variety of morphological types and lithotypes, similar to Yellowstone. Indicative of the deposition size is the fact that many buildings have been constructed with the local travertines in Edipsos.
According to Greek mythology these hot springs have been created by God Hephaestus after request from Goddess Athena, so Hercules could go and regain his powers. Also, Aristotle mentions the Edipsos hot springs in the book "Meteorologica" in an attempt to explain how they work.
The main mineral phases are aragonite and calcite, which in many cases coexist. In Edipsos the predominant phase is aragonite (hexagonal prisms, which at many times create radial spheres), while calcite usually creates rhombohedral crystals, but also the rare form of Gothic arch bars was identified. In Ilia iron-rich travertine deposit and in some cases in Edipsos, in addition to $CaCO_3$ mineral phases, amorphous ferrihydrite was identified, as main mineral phase. In Thermopylae samples, only calcite was identified as the main mineral phase. The presence of aragonite or calcite as dominant mineral phase is associated with the temperature and Sr content of the hot water and the presence of ferrihydrite with the iron concentration of the hot water. The chemical composition of $CaCO_3$ minerals varies. Additionally to Ca, C, and O, in Edipsos $CaCO_3$ minerals contain S and/or Si and/or Na and/or Cl and/or Fe, in Ilia they contain Fe and/or As and/or Si and/or S and/or Sr and/or Na and/or Cl and in Thermopylae they contain Mg and/or S.
In the studied areas, 11 main morphological types of travertines were identified. Some types exist in all areas or in two of them, like dams, terraces, cascades etc., while some others are rare and exist only in one of them e.g. caves, speleothems, remoras etc. The main morphological types of the studied travertines are: i. spring mounds, ii. cascades, mainly keeled cascade and remora types, iii. dams (barrage), iv. fluvial crusts, v. lake deposits (terraces), vi. reefs, vii. paludal deposits, viii. cemented clasts, ix. allochthonous (clastic) travertines, x. travertine caves and xi. speleothems. In Edipsos straws, stalactites, stalagmites and flowstones with lamination forms were identified.
The lithotypes that were found were of great variety, especially in Edipsos. Nine main lithotypes were identified, namely: i. crystalline crusts, ii. rafts (or calcite ice), iii. foam type, iv. shrubs, v. lamination, vi. spicular types, vii. pisoliths, viii. sinuous streamer fabric, and ix. framework.
Until recently signs of biological processes were recorded both directly (growths of cyanobacteria and/or algae) and indirectly (lithotypes and crystal forms), suggesting possible inorganic and organic controls on carbonate precipitation in the studied systems. Recent data come to verify that fact. Ongoing research is conducted now in order to verify the contribution of organic processes on the formation of the iron-rich travertines.

Origin and REE geochemistry of phosphorites from the South Korea Plateau, East Sea

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Physiographic features of the East Sea (Sea of Japan) are continental and island shelves, continental slopes and rises, the borderland of Japanese Islands, deep-sea basins (Japan, Yamato, and Ulleung), troughs, and seamounts. The geological structure of the bottom of the East Sea is determined by pre-Cenozoic consolidated basement and Cenozoic volcanic and sedimentary cover sequences. In previous study, phosphorites were found in the basal layers of the Upper Miocene deposits represented by gravels, sandstones, siltstones, diatomites, and rocks of intermediate types, mainly on submarine highs: Eastern Korea, Northern and Southern Yamato Plateaus, and the Oki Ridge.

Phosphorites from the East Sea have been divided into three major groups: (1) massive phosphorites (hereafter Diatomite); (2) nodular phosphorites (Nodule), and (3) coarse-fine grained rocks with phosphatic cement (Rock). Most common are phosphorites of the first group as fragments of various form, dimension, density, and color. These phosphorites consist of a phosphatic matrix (70-80%) in which silt or fine-grained non-phosphatic material is randomly dispersed, including terrigenous grains of quartz, feldspars, glauconite and its relicts, glauconitized sedimentary rocks, and granites, rarely. The phosphatic matrix contains dispersed relics of diatoms, sponge spicules, and radiolaria replaced by phosphate, indicating that phosphorites had been formed by phosphatization of oozes during diagenesis. The second group is represented by friable nodules. In the center, it usually contains nuclei consisting of fish bones, mollusk shells or foraminiferal tests. The phos phatic matrix contains numerous diatom frustules, some terrigenous material, and relics of glauconite grains. The third group of phosphorites is represented by slightly lithified rocks consisting of poorly-sorted terrigenous clastic material of fine-grained-pebble-size. The phosphatic matrix is the same as in phosphorites of the first group, with numerous inclusions of relics of diatom frustules.

The representative phosphorites (D1 and D2) with high P_2O_5 contents were collected from the eastern South Korea Plateau (SKP). Based on the major element contents, P_2O_5 (29.4%) and CaO (37.9%) contents from D1 were similar or close to types of Diatomite and Nodule. However, the elemental compositions, especially high Al_2O_3 (10.2%) and, relatively, lower P_2O_5 (7.4%) contents, from D4 indicated a typical Rock type. The CaO/P_2O_5 ratios (~1.3) from the investigated samples showed authigenic origin rather than diagenetic origin, which is usually over 2.

The structure and microstructure of phosphorites found within the East Sea indicated a diagenetic nature of the phosphatization process took place in unconsolidated clayey-diatomaceous oozes enriched in phosphorus and organic matter during the Miocene. In this study, elemental studies including rare earth elements (REEs) on phosphorites from the SKP have been conducted. From this REE geochemical approach, we provide a feasible scenario for their genesis.

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Late Pleistocene ice sheet decays, transport mechanism and provenance changes studied via heavy mineral geochemistry of central Arctic Ocean sediments

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The marine sediments are the most reliable recorders for major past environmental changes. The detailed study of marine sediments via different proxies provides valuable information for paleoenvironmental reconstruction. The sediments deposited in the seas and oceans or marine sediments provide the most continuous record of Earth surface processes because: there is nearly always accommodation space to put the sediment; sediment is always being transported from the land to the sea; and further sediments are being produced biologically and chemically in the ocean waters. The mechanisms for transport of sediments from the land to the sea are rivers, ocean currents, as well as sea ice and icebergs in high latitude environments. The detailed geochemical composition of heavy minerals in marine sediments provides information for prominent provenance areas with further reconstruction of the transport ways.

The detailed study of two decays of Eurasian Arctic ice sheet by investigation the central Arctic Ocean sediments during Marine Isotopic Stages (MIS) 4-3 and 5-6 for their provenance and transport processes is the main aim of current research. The mineralogical and geochemical data generated from the sediment core (AO96-12pc1, Lomonosov Ridge) make it possible to evaluate the Barents-Kara Ice Sheet history and to make assumptions about those probable sediment drainage and provenance changes. Detailed study of sediments via heavy minerals proxy allows the best implications of the above mentioned aims. The obtained dataset of heavy minerals compositions by Electron Probe Microanalyzer (EPMA) were compared with previous published data generated from the study of rocks of the prospective provenance areas. Correlation of the generated data allows to assume the distinct source areas and also the prominent pathways of the central Arctic Ocean sediments of terrigenous origin by sea ice and iceberg transport.

'Clumped isotope'-based thermometry of travertine and tufa deposits: calibration of a new and water-independent method

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Terrestrial carbonates (travertines, tufa and speleothems) are among the most important continental climate archives. Although speleothems are generally better suited for detailed reconstruction of paleoclimate, travertines and tufa also provide useful proxies for paleoenvironment and past climatic changes. Their $\delta^{18}O$ values are widely used in paleoclimate research due to the temperature dependence of calcite–water oxygen isotope fractionation. However, there is a lack of consensus if the travertines and tufas are precipitated in isotopic equilibrium, which is crucial to the accuracy of calculations. Besides, for the temperature calculations, the $\delta^{18}O$ of palaeowaters has to be estimated, which introduces further uncertainty to the calculated temperatures.

The formation temperature of carbonates can be also estimated using the recently developed clumped isotope method, which requires no assumptions about the $\delta^{18}O$ of water from which the carbonate precipitated. However, there is still some uncertainty in the published clumped-isotope calibrations. Furthermore, the clumped isotope temperature relationship has not been assessed for tufa and travertine deposits.

Here we present a study of stable and clumped isotopes from recent calcitic and aragonitic travertine and tufa deposites forming from natural springs and wells, as well as their depositing karstic waters (5-95^{o}C) from Italy, United States, China, Hungary and Turkey. Samples were measured with a Thermo Fisher Scientific Kiel IV device connected to a Thermo Fisher Scientific MAT 253 dual inlet mass spectrometer at ETH Zürich and on a Thermo Fisher MAT 253 dual–inlet gas–source isotope ratio mass spectrometer at Imperial College London.

47 data of 51 travertine and tufa samples show an excellent correlation with T (r^2>0.9), indicating precipitation under equilibrium conditions in the vents. The slope of our calibration line is intermediate between the published ones. In general, Δ47 values decrease away from the springs, which may be related to kinetic isotope fractionation due to CO_2 degassing in the different depositional sub-environments. Our empirical calibration based on vent samples significantly extends the calibration range of the clumped isotope thermometer to 95 ^{o}C and can be used to derive the isotopic composition of the depositing waters from ancient travertine and tufa deposits to reconstruct variations in meteoric water compositions and the palaeohydrological regimes of the study areas.

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Recent Morphological Changes of the Nice Continental Slope

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Frequency, size and impact of small-scale landslide are not well-known and difficult to detect using classical tools. However it leads to regressive motion of continental slope, to the deposition of high-frequency turbidites in the basins and could generate local tsunami. The continental slope offshore the city of Nice (South East of France) has been studied to address the problems of recent landslides triggering and volumes that could be remobilised during an event.

Nice is located between the Southern French Alps flank and the Northern continental slope of Ligurian sea (western Mediterranean). With a reduced continental shelf this area has been affected on October 16th 1979 by a submarine landslide which partially destroyed the international airport complex of Nice and triggered a 2m tsunami. We focused our study on this high vulnerability area, affected by recent instability to define and understand actual erosion process.

Time-series bathymetric data acquired between 1991 and 2011 have been used to evaluate the recent morphological evolution. We compared four high-resolution bathymetric maps compiled from datasets acquired in 1991, 1999, 2006 and 2001 with vertical resolutions of 10 m, 2 m, 2m and 1 m, respectively. Mapping was undertaken to identify the morphology of landslide scarps and the location of the shelfbreak. Map comparisons were performed using the subtraction tool of ArcGIS "raster calculator" in order to calculate volume of missing deposits from slope variations through time.

Sediment remobilization on the upper slope (up to depths of 200 m) is fast and significant; landslide scars with volumes greater than 25,000 m^3 can appear with a frequency less than 8 years. Shelfbreak migration toward the coastline can reach rates of 60 m over 7-8 years where the continental shelf is over 200 m wide. Furthermore, this quantitative analysis reveals large variations in landslide frequency over short time periods (less than 7-8 years). Periods of enhanced landsliding (1999-2006) can increase erosion rates by a factor of 10.

Such cycle-like landslide activity raises the issue of the triggering processes. On the Nice continental slope thick poorly consolidated beds rapidly deposited on a steep slope, earthquakes and rainfall leading to fresh water circulation below the shelf were identified as potential triggers.

Our 4D bathymetric analysis reveals landslide processes that are still quite active and significant over the last 20 years. Their frequency and volume can change on very short periods of time. The triggering processes study suggests that over the last 20 years the greatest impacting factor may be freshwater outflows.

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Calibrating a paleotsunami record to a modern example – a case study from south central Chile

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In addition to sedimentary records that can be retrieved from beach systems, coastal plains, estuaries and lagoons that are commonly used to determine tsunami recurrence times, coastal lake records are fruitful archives for this purpose (e.g. Kelsey et al., 2005). Coastal lakes provide a rare, but invaluable source of information for paleotsunami studies, because of their high preservation potential and their unmatched temporal resolution due to a thick Holocene stratigraphy.
From the risk point of view, understanding the recurrence pattern of tsunamis is essential. Equally important is the magnitude of these tsunamis. However, it is disproportionately more difficult to extract solid information on the magnitude of a tsunami by interpreting the deposit in areas that are as tectonically active as subduction zones. Vertical and horizontal shoreline displacements can affect the sensitivity of paleotsunami archives on very small time scales. This study is an attempt to extract information on paleotsunami magnitudes using a calibration approach with modern examples as end members.
Our study area is located on the west coast of Chiloé Island, Chile (42.5 °S). Two coastal lakes, Lago Cucao and Lago Huelde, were repeatedly inundated by tsunamis and archived event deposits. The study area has experienced two near-field tsunamis in modern times: i) the 1960 Valdivia Earthquake (M_W 9.5) tsunami, which had a wave height of 10 to 20 m on the Chiloé west coast, inundated both lakes, caused loss of life (also in Cucao) and vast infrastructural damage (Sievers et al., 1963; Weisner, 2003) and ii) the 2010 Concepcíon EQ tsunami, which was extremely destructive further north, but only produced a maximum wave height of 0.62 m (NOAA) and did not inundate either lake. These two tsunamis, one being extreme the other being comparatively small in the study area, frame the range of possible tsunami heights and are therefore suited as end members.
The data available for this study includes sidescan sonar and 3,5 kHz pinger data from the lakes and more than 160 m in short cores, piston cores and short onshore push cores. The cores were analysed for magnetic susceptibility, grainsize and sedimentary features, such as mud rip-up clasts or event deposit thickness. Solid age control is provided by a combination of radionuclide analysis, radiocarbon dating and OSL-dating.
The combined core data (onshore as well as lake cores) quantitatively describe the deposits of the modern example from 1960 with high spatial resolution. The sedimentary characteristics and physical properties of the 5300 year long paleotsunami record from the two lakes are used to describe semi-quantitatively each tsunami deposit down-core and tentatively assign a relative magnitude to each event.

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Microbialites and rapid environmental change in carbonate systems: palaeogeographic and palaeoecological perspectives

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Microbialites in carbonate systems show complex relationships with environmental change, explored here in different scenarios. After the Permian-Triassic Boundary (PTB) extinction, microbialites (PTBMs) formed rapidly as a well-organised microbial-based shallow marine warm-water ecosystem, but disappeared soon after formation for unclear reasons, possibly due to Early Triassic sea level rise, because microbialites were facies-controlled. Abundant in low-latitudes in Tethys, they are not confirmed in latitude-equivalent western Pangaea. PTBMs are rare in higher latitudes, expected if temperature-influenced, but evidence of extreme warming for the extinction interval make uniformitarian interpretations problematic. Conflicting evidence of small-scale control on PTBMs is co-existence of low & normal oxygenation indicators in the same samples, requiring further work.

PTBMs show significant palaeogeographic differences in types and sequences around Tethys; renalcid-group calcimicrobes dominate in S. China platforms in eastern Tethys, but in Iran & Turkey of western Tethys PTBMs are dominated by stromatolites and thrombolites, also with notable morphological and constructional differences. However, all three areas (China, Turkey, Iran) were in similar shallow marine settings, so migration of microbial organisms by currents in Tethys either did not occur, or local controls restricted microbial types. Finally, recent work interprets the mid-Permian extinction to be more significant than the end-Permian, but is not accompanied by a flourishing microbial community, why not?

Microbialites grew after the Frasnian-Famennian extinction, but developed poorly after the Late Ordovician event. The Late Triassic extinction is accompanied, in England, by a spectacular very thin microbialite (Cotham Marble) proposed as a post-extinction microbialite, yet it occurred in a large inland sea as Late Triassic sea-level rose. Its association with extinction is equivocal, and like the PTB microbialites is facies-controlled.

In deposits not associated with extinctions, questions regarding microbialite controls are shown in two examples:

1) Silurian of Europe: microbialite-rich reef facies in the Wenlock of Gotland & England developed with stromatoporoid-coral faunas in shallow marine reefs. These contrast shallow marine Ludlow stromatoporoid/coral-dominated reef biostromes in Gotland & Estonia where microbialites are almost lacking; so far there is no clear reason for this difference.

2) Pleistocene of Perachora Peninsula, Gulf of Corinth, central Greece: likely-unique calcified-cyanobacterial constructions of *Rivularia* as huge mounds, 10 m high, contrasting the few-cm sizes of modern *Rivularia*. Controversy about whether these grew in freshwater or partially marine conditions is unresolved (*Rivularia* is a freshwater cyanobacterium), coupled with remarkable occurrence of pendant bioconstructions of peloidal micrites and coralline algae.

Decline of microbialite dominance after Cambrian-Ordovician time is commonly attributed to metazoan rise in the Great Ordovician Biodiversification Event, yet comparisons made here show no clear relationship between environmental change and microbialites. The proposed control by raised carbonate saturation may be the primary governing factor, but over-generalising is dangerous, each case needs consideration of potential governing controls.

Microbially Mediated Iron-Oxide Bands at Petra (southern Jordan) are Oxidation Products of Late Diagenetic Siderite

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At Petra, a world-famous archaeological site, ancient Arabs carved elaborate edifices into quartz arenite of the Cambrian Umm Ishrin Formation. The carvings reveal elaborate, scalloped patterns of diagenetic iron oxide that most geologists would call Liesegang banding. We have seen similar patterns developed in the Triassic Shinarump Member of the Chinle Formation and the Jurassic Navajo Sandstone of the Colorado Plateau, USA. In all these rocks, accumulation of iron oxide along joints indicates that they developed after lithification, during late diagenesis. As in both of the North American sandstones, rinded iron-oxide concretions and iron oxide pseudomorphs after siderite ($FeCO_3$) are spatially associated with the scalloped patterns in the Umm Ishrin Formation at Petra. SEM images of the convex edges of dense iron-oxide bands from Petra reveal structures closely resembling the twisted stalks of the iron-oxidizing microbe *Gallionella*. The scallops that comprise the patterns in the Umm Ishrin Formation are an order of magnitude larger than those within the Colorado Plateau sandstones. Large iron-rich dendrites and manganese oxide concretions are also present in the Jordanian sandstones. Unlike the Shinarump Member of the Chinle Fm. (where siderite developed early due to methanic floodplain deposits), the fluvial Umm Ishrin was deposited before the appearance of land plants. Like the Umm Ishrin, the Navajo Sandstone was also deposited in a setting with little or no syndepositional organic material. Bleached Cambrian sandstone and iron-oxide banding are present not only in Jordan, but also west of the Gulf of Aqaba in Egypt and the bleached rock (Disi Fm) is present at least 250 km south of Aqaba in Saudi Arabia. Trapping of methane and CO_2 in the sandstone of the overlying Disi Formation bleached that unit. As CO_2 dissolved in the formation waters, they became more dense and carried Fe^{++} downward from the Disi into the Umm Ishrin, where the waters reached saturation for siderite. CO_2 likely came from Neogene magmas associated with opening of the Red Sea Basin. As uplift along the eastern shoulder of the Dead Sea fault zone and the Red Sea rift continued, oxidizing ground water started to reach the iron carbonates, initiating the formation of the bands and dendrites. When iron-oxidizing microbes were able to stabilize a redox boundary, they precipitated a dense, several mm-thick accumulation of iron-oxide cement. When oxygen broke through the colonies, a decimeter- to meter-thick zone of true Leisegang banding formed beyond them. Microbes then established themselves at the distal edge of those bands, regained control of the redox boundary, and precipitated another dense layer of iron oxide cement . The complex patterns of microbial iron-oxide and Liesegang bands exposed at Petra are broken by active strike-slip faults associated with the Dead Sea Fault Zone. At Petra, bands are no longer forming because they lie above the water table, where diffusion of ferrous iron is not possible and all siderite has been oxidized. It is likely, however, that the process continues in the subsurface.

Oxfordian Anoxia in Gotnia Basin, Kuwait

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The Oxfordian is represented by highly kerogen rich sediments in Gotnia basin in Kuwait. These sediments are having variable thickness with overall increasing thicknesses towards south and southwest Kuwait. These sediments have poor reservoir quality and are excellent source rocks. The sediments are represented by Najmah Formation, which is having a complex subdivision in various part of Kuwait, hence a simplified subdivision is proposed. A depositional model for these sediments is proposed representing part of Kuwait. The depositional architecture for Lower and Middle Najmah was different in the southern part of the basin, suggestive of area to be closed to margin of the basin. The Upper Najmah was deposited on a gentle ramp over entire Kuwait with moderate to high energy conditions prevailing during the deposition of this unit. Petrographic features of fractures, paragenetic relations of the fracture system, and widespread sediment-hosted mineralization of these sediments are consistent with a hydrothermal basinal fluid source. Hydrothermal venting stratified the water column and might have created the widespread anoxic conditions. Partially and completely mineralized cracks are suggestive of early cohesive sediment ruptures rather than lithified rock fracturing for these sediments. The effect of diagenetic events on altering porosities is not very evident except fractures that have modified the porosity to some extent and permeability to a larger extent leading to a good productivity inspite of poor matrix porosities.

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Structural-lythological geological-dinamic modeling of heavy minerals placers

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Actuality of this project is related with the need to develop a methodology for informational support for geological activities aimed at mineral resources increasing in accordance with modern requirements and technical capabilities of recent technologies. This task is solved on the example of placer deposits of titanium and zirconium, gold and zinc.
The target of the paper is the presentation of main results of the joint Russian-Ukrainian project "Structural-lythological geological-dinamical modeling of heavy minerals placers" (Russian and Ukrainian funds for fundamental researches, 2012-2013). The idea of the project was the combination of two authorized scientific directories: digital structural-lythological modeling (DSLM), Ukrainian working team and geological-dynamical modeling (GDM) (Russian working team).
Methodology of DSLM is based upon copyright principles target dismemberment of geological objects on a wide range of lythological, geological, metallogenical and other characteristics. As a result of computer processing of target databases having been prepare on these principles by the special author programs, DSLM is obtained presents the most appropriate reflection structure and material characteristics of the object, with reflecting the spatial distribution of some elements of its structure and composition, including mineralization, processing characteristics, etc. Also characteristics, various parameters and coefficients, which may serve basis for the deposits prediction can be obtained.
Created model is a high-tech, as provides instant broad range of derivatives of cartographic materials in accordance with the set of commands as well as some secondary derivatives, including automatic reserves calculation, resource assessment, forecasting various functional properties for specific characteristics based on regression, etc.
Methodology of GDM for coastal-marine placers of heavy minerals is based on the studies of dynamical mechanisms of the main stages of placer forming (from the mobilization of ore material in primary sources up to sedimentation in the terminal basin). The purpose of modeling is to build a predictive spatial model for placers zonal and local rank (fields, deposits) with displaying their (mineral and geochemical) composition and other properties by defining of tectonic regimes, hydrodynamic mechanisms, lithodynamic and structural conditions of their formation.
An important methodological principle of *GDM* is different-scales aspects, which consists of union of traditional methods of paleoreconstructions providing small-and medium-sized display of placer processes as a hole copyright methodological approaches display of geological dynamic processes of placer forming and the objects (placers) in medium and large scale. Last methodological aspect comprises two author's methods: masses balance and diffusion-convective model.
Thus, geological-dynamic modeling provides the possibility of supplementing the structural-lithological models by identification and precising of tectonic, paleogeographic, geomorphological, lythodynamic, structural-sedimentary, facies conditions of the placer formations.
The experimental patterns of specific geological objects (titanium-zirconium, cassiterite, gold placer) DSLM are demonstrated (according to three groups: structural and lythological digital models, geological and dynamic models, and combined (structural-lythological geological and dynamic).
Opportunities, prospects and the main directions of further development of integrated forecasting retrospective statistical modeling have been designated.

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Early Jurassic Staffelegg Formation in Northern Switzerland: New Results from Deep Boreholes and Reconstruction of Depositional Regimes

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One of the most promising formations in Switzerland for disposing of radioactive waste is the Middle Jurassic Opalinus Clay. Since the Staffelegg Formation (formerly known as 'Lias') is the lower confining unit of the Opalinus Clay, it is important to know the main characteristics of this unit and where potential flow paths might exist. Additionally, the Staffelegg Formation is important for oil and gas companies, particularly if unconventional gas reservoirs are considered.
Lower Jurassic marine sediments have been characterised previously in the Jura Mountains as well as in Alpine regions. However, the knowledge about the distribution and facies of these marine deposits in the underground of the Swiss Plateau is still very limited. Conceptual models exist, but the data density is very low.
In order to improve the state of knowledge about the Staffelegg Formation, core sections from Berlingen-1, Herdern-1, Lindau-1, Pfaffnau-1, Schafisheim and Weiach in Northern Switzerland were analysed macroscopically and with thin sections. Additionally, clay mineral contents calculated from geophysical well logs were used to correlate different members of the Staffelegg Formation. This study includes geophysical well logs from 18 boreholes in Northern Switzerland, from Pfaffnau in the SW to Herdern in the NE.
The Staffelegg Formation is of reduced thickness (only around 30 m) in Northern Switzerland and condensed parts as well as some hiatuses exist. These characteristics, as well as the sequence of inter alia claystones, sandstones, (laminated) limestones, bituminous limestones and marls, hard ground and iron oolitic horizons, indicate different depositional regimes influenced by sea-level changes. At least some of these changes can be related to varying subsidence and uplift rates. Variable thicknesses of different members may point to synsedimentary tectonic movements.
In a first step, two general facies areas were distinguished, a calcareous-sandy variant and a more clayey one. Three distinguishable clay-rich members can be found over most of the area in Northern Switzerland. The calcareous-sandy facies seems to be restricted to certain regions, namely the western part of the study area (Pfaffnau to Schafisheim boreholes and outcrops in the Weissenstein and Passwang area further north in the Jura Mountains) and in the region south of Lake Constance (over 60 km NE of Schafisheim). South of Lake Constance (e.g. Berlingen-1), a very sand-rich facies in the lower units of the Staffelegg Formation has been found, that had previously not been known to occur so far to the south. Because of similar characteristics to those of the lower Liassic units in SW Germany, it is proposed to use the stratigraphic names of the Swabian Jura there.
The sediments of the Staffelegg Formation were deposited in an epicontinental sea. High sand content in the region Solothurn / Aargau may point to a land mass in the south (Allemanic islands) and the quartz content of the calcareous-sandy facies south of Lake Constance could indicate that a land mass (N)E of this region existed.
This study clearly shows the potential of a correlation with clay mineralogy logs. A compilation of all collected data led in a second step to a schematic facies and thickness map for Northern Switzerland.
Acknowledgments: Special thanks to SEAG for making their core materials available and to the University of Bern for providing their facilities.

Anatomy of a sub-marine mixed carbonate-siliciclastic channel fill deposit in the Spurs Formation, the Mariner Group (Cambrian), northern Victoria Land, Antarctica

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Early Paleozoic Ross Orogeny-related successions of northern Victoria Land, Antarctica are represented by an accretionary complex of sedimentary rocks in three tectonic terranes: Wilson, Bowers, and Robertson Bay terranes, from inboard to outboard. The Bowers Supergroup of the Bowers Terrane has been divided into the Sledgers, Mariner, and Leap Year groups in ascending order, which spans time period from Cambrian Series 3 (middle Cambrian) to the Lower Ordovician. The Mariner Group is subdivided into three units: Edlin, Spurs, and Eureka formations. The upward coarsening succession from shale of the Spurs Formation to rippled and burrowed sandstone and mudstone of the Eureka Formation has been interpreted as regression from deep marine to shallow marine environments. This study deals with the detailed sedimentology and stratal architecture of a submarine channel-fill deposit of the Spurs Formation exposed at the head of Mariner Glacier.

An outcrop in the Eureka Spurs shows the NW end of transverse exposure of channel, which is ca. 100 m in width and ca. 20 m in thickness. The lower boundary is erosional contact to the underlying shale, with a stepped channel margin while the upper boundary gently undulates. The channel-fill deposit consists of breccia, diamictite, and thin bedded sandstone. The breccia is subdivided into oolite breccia, oolite breccia with sand blocks, and oolite breccia with limestone blocks. The breccia is clasts-supported, disorganized, and poorly sorted and composed of polymictic clasts (oolite, lime mudstone, sandstone, and mudstone) with variable size and shape. The matrix is fine sandstone or oolite. The diamictite is subdivided into diamictite with pebble-sized clasts and diamictite with boulder-sized clasts. The diamictite consists of a folded muddy matrix with varying concentration of well rounded, pebble- to boulder-sized clasts. The diamictite contains a lot more amount of matrix comparing to that of the breccia and is matrix supported. Facies packages of the underlying breccia and the overlying diamictite form meter-scale fining-upward cycles. The lower boundary of each cycle is irregular, sharp, and erosional. The vertical transition from breccia to overlying diamictite is abrupt. These cycle packages are continuous in the channel and thin out toward the NW channel wall. Vertical stack of 10–11 packages fills up the channel.

A number of textural and sedimentary features of breccia, including erosional base, clasts-supported texture, and disorganized clast fabrics seem to indicate involvement of traction flow and related deposition in the axial part of the channel. Non-erosional base, folded matrix, folded sandstone raft, and boulder-sized limestone blocks in the matrix of the diamictite are suggestive of muddy debris-flow type deposition. Cyclic succession of fining-upward channel-fill packages is supposed to result from repetitive pulses of mass-flows. Further investigation on the detailed processes of the exceptional channel-fill deposit may reveal unique submarine channel system sourced from both carbonate and siliciclastic shallow part.

Topography of buried valley under the postglacial sediments in Tokyo area, Japan

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A deep valley stretches north-south beneath the urban area of Tokyo. It was incised at the last glacial maximum more than 60 m deep, filled with soft unconsolidated sediments during the following postglacial age. Above the deep buried valley one of the most populated city in the world has been developed for recent several hundred years.

Because valley fills have never undergone much compaction and have quite low density, they amplify strong ground motion when an earthquake occurs. For example the Kanto Earthquake in 1923 the collapse rate of houses above the buried valley is remarkably high in spite of a great distance from the epicenter.

On the other hand, water-saturated soft sediments of valley fill may cause severe ground sinkage when a water table goes down by groundwater pumping. In 20th century the ground level in the eastern area of Tokyo had been sinking, up to 4 m from original level, due to shrinkage of the postglacial valley fill sediments caused by groundwater pumping for industrial use, extraction of natural gas. Although water pumping was banned in 1970s, the subsided ground level had never been recovered at all.

From the view point of disaster prevention described above, the information about the precise topography of the incised valley and properties of valley fills inside is important. Geological Survey of Japan has been investigating the incised valley and postglacial valley fills beneath the Tokyo area from 2004. The topography of valley is revealed based on the existing borehole data and all-core boring survey, except for the most coastal part, which is now under research. The number of borehole data is 9870, which is from local government offices, national research institutes (ex. NIED) and others. The postglacial valley fill is discriminated from underlying Pleistocene based on standard stratigraphy in all-core borehole survey and extrapolation according to lithofacies, N-value, and lateral continuity of them. Borehole data population is controlled as possible as one point in 250 m square each. Topography of the valley is calculated from these point data (locality and elevation of the boundary) using ESRI ArcGIS software with the kriging interpolation method.

The bottom of the incised valley is covered with conglomerate of several meters thick. The altitude of their top surface is -65 m and the width is about 3 km at 7 km upstream from the coastline. The axis of the valley bifurcates into two tributaries at 14 km from the coastline, the slope of two tributaries are around 1/1000 both.

Nummulitic Banks of the Crimean-Caucasian Region

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Nummulitic facies are widely distributed from Pyrenees to Caspian region. Within the Eastern Black Sea area they are dated as Late Ypresian-Early Lutetian. Nummulitic limestones could be good collectors with high porosity and permeability in certain geological situations. Therefore they acquire a great interest in the region.

Detailed lithologic and sedimentological description of 10 sections of the Crimea Peninsular and 4 outcrops of South-Western Caucasus was done. More than 100 thin sections of Crimean samples and 15 thin sections of West-Caucasian rocks were described.

Ratio of various genera of Larger Benthic Foraminifera (LBF) and an analysis of distribution of their micro- and macrospheric forms and other fossils in the sections were studied using published data.

Nummulitic limestones of studied area correspond to "nummulitic banks" formed in shallow warm-water sea basins. Crimean nummulitic bank has a minimum size of 120-150 km and it is assumed to be a single isolated carbonate platform. It was a relatively flat bank formed within quiet hydrodynamic conditions below fairweather wavebase (less than 50 m). Facial changes reflect variations in water depth. Different facies of the Crimean bank are clearly distinguished: a shoal, its lee- and windward side slopes, a shelf plain in the rear of the bank and a relatively deep basin-ward slope with predominant terrigenous sedimentation. *Nummulites*, *Operculina*, *Assilina* are common. *Discocyclina* and *Actinocyclina* are less abundant, their appearance related to a deepening of the basin.

West-Caucasian nummulitic banks (Sukhum-Novy Athon, Bzyp and Tquarchal structures) are differed from Crimean bank. They aresmaller (i.e., 25-30 km in diameter) and the are mainly composed by *Discocyclina*, *Nummulites* with total absence of *Operculina* and *Assilina*, with occasional presence of red algae, echinoids and bryozoans. West-Caucasian banks formed in deeper conditions than the Crimean bank. Abundance of bioclastic limestones indicates higher hydrodynamic activity, presumably storm-induced. They were formed upon the local basement uplifts within the shelf basin of Georgian massif edged by deep troughs with active terrigenous supply. So the Georgian massif acted as a carbonate platform with local nummulitic banks within it.

Reservoir properties of nummulitic limestones are very good to excellent within Central and South-Western Crimea. The age-equivalent nummulitic limestones of Western Caucasus do not possess such properties as they are strongly condensed in the post-diagenetic changes.

Appearance and position of Crimean and West-Caucasian banks were tectonically controlled. Tectonic movements of Palaeocene-Eocene transition and early Eocene, related to the compressional event in Pontides, resulted in blocky movements, which created uplifts. These uplifted blocks were subsequently drowned during the Middle Eocene transgression allowing the development of nummulitic banks. The structure of the banks and the dominant contributors were governed with local tectonics, depositional depth and hydrodynamic condition.

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Depositional Environment of Organic-Rich Rocks in Different Basins From West of Turkey: Using by Carbon and Nitrogen Isotopes

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Organic-rich rocks from the Bolu (NW of Turkey) and Denizli (W of Turkey) were compared for organic carbon content (TOC, %), carbon and nitrogen isotopes ($\delta^{13}C$, $\delta^{15}N$) and pristane/phytane (Pr/Ph) ratios. Studied samples were taken from oil shales of Kabalar Formation (Göynük/Bolu, NW of Turkey), Tokmaklar Formation (Mengen/Bolu, NW of Turkey) and carbonaceous rocks of Hayrettin Formation (Denizli, W of Turkey). Organic matter content (TOC, %) of Kabalar Formation samples range from 0.15 % to 10.78 %, Tokmaklar Formation samples range from 0.21 % to 19.14 %, Hayrettin Formation samples range from 0.21 % to 39.61 % and they show rich source rock quality in terms of organic carbon content. $\delta^{13}C$ values of Kabalar Formation samples range from -31.37 ‰ to -34.07 ‰, Tokmaklar Formation samples range from -19.92 ‰ to -30.16 ‰ and Hayrettin Formation samples range from -23.88 ‰ to -26.06 ‰. When samples have compared with $\delta^{13}C$ datas from various organic-rich sedimentary environments, it has also been identified to be similar with C3 vegetations. Most photosynthetic plants incorporate carbon into organic matter using the C3, Calvin pathway, which includes temperate shrubs and trees. $\delta^{15}N$ values of the Hayrettin Formation samples range from 2.63 ‰ to 3.33 ‰, and these are similar to $\delta^{15}N$ values of humic acid in the modern swamp environments and also the pristane to phytane ratio (Pr/Ph) is high (0.79-7.85) in the Hayrettin Formation and indicate that organic-rich rocks were deposited in a suboxic environment. Pr/Ph (0.65-0.3) ratio of the Kabalar Formation is low and indicate that organic-rich rocks were deposited in anoxic environment.

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Water depths, sea floor conditions and climate change as recorded in mixed siliciclastic/carbonate sequence, Pelsonian (M. Triassic), northern margins of Gondwana

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35 m of mixed siliciclastic/carbonate sequence from the Balatonicus ammonoid subzone of early Pelsonian, fr Ra'af and the Gevanim formations in southern Israel, was studied by thin sections, trace fossils, stable isotopes and grain size analysis.

Vermicular carbonates (~90% carbonate) at the lower part of the section with Low-diverse ichno-fauna changes into a punctuated performance in which vermicular units alternate with siltic fossiliferous pavements. The sequence is topped by siliciclastic sediments (80-90% siliciclasts) and overlain by the siliciclastic dominant Gevanim Fm. Mass movements intercalate throughout the whole section.

Calibration of the insoluble residue fraction of Ra'af Fm samples with grain size analysis samples from the present eastern sub-tropical Nile littoral cell of south-eastern Mediterranean offshore enabled the attribution of paleo-water depths. The lowermost vermicular part of the section is correlated with water depths of 80-100 m, the middle punctuated part is surprisingly assigned to a 100 m depth or more, whereas the upper part of the section (>90% siliciclasts) was found to be analogous to 40-50 m water depths at present Mediterranean off-shore settings.

These average water depths are also supported by the filling with sediments in more than 100 m of accommodation space roofed by the occurrence of paleosol, some 110 m above the top of the current section, as shown by previous studies. This Balatonites zone deepening event could be well correlated with the event of MFS – 9 (An-3) that has already been identified in the Southern Alps.

The mass movements are characterized throughout the whole section, expressed by mesostructures of emplacement and by the richness of transported macro- and microfauna. These transported units were originated by the abrasion of the sea floor at some 50-60 m water depth before bed transportation.

The general carbonate dominance of the whole Ra'af Fm in the subsurface indicates a flourishing carbonate factory under less humid conditions. Hence, the current 35 m exposure at its uppermost part indicates climatic transition which acted over a 100 m water-depth subsiding basin.

The low diverse vermicular pattern is interpreted as showing the arid climate that has influenced and dictated starvation of terrigenous supply and water stratification leading to reduced sea floor oxygenation and to low rate of siliciclastic supply.

The overlaid punctuated unit indicates a turn-over to more humid conditions, ventilating the sea-floor and enhancing carbonate production on narrow margins together with mass movement phenomena.

It is therefore suggested that the transition from the Ra'af to the overlaying Gevanim Fm in the Negev of Israel, shows a simultaneous drop-down in basin water depth together with a climatic shift to more humid conditions in the hinterland, during the Bindosus ammonoid subzone.

Asymmetry in modern river deltas: patterns, controls, and stratigraphic effects

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Understanding controls on sediment distribution in river deltas is paramount to predicting facies relationships and stratal architecture. Traditional classification schemes emphasize subaerial morphology, nearshore sand distribution, and proximal-distal facies trends, but new work is revealing the importance of subaqueous deposits and shore-parallel sediment distribution. Delta asymmetry has emerged as an important characteristic reflective of patterns of sediment transport, initial deposition, reworking, and long-term net accumulation. Asymmetry has been described from onshore and offshore environments from several different types of modern deltas, but aspects of asymmetry have not been fully documented and the degree to which these patterns are recorded in deltaic strata is not yet known. This study is the first comprehensive literature review of sediment distributions in modern deltas focusing on studies with high resolution geomorphic, geophysical, and geochronological datasets. We studied 27 deltas using over 100 papers primarily from the past 15-20 years. Morphological, facies, and stratigraphic aspects were analyzed across the entire spectrum of deposits from the delta apex to the most distal muds of the prodelta. We define quantifiable indices of asymmetry describing updrift vs. downdrift distribution of sediment volume, sediment area, sediment caliber, and distributary channels. All deltas in this study are asymmetrical to some degree with respect to one or more of these parameters. Many deltas are increasingly skewed toward the downdrift side from proximal to distal parts. Some deltas are skewed toward the updrift side in one part and toward the downdrift side in another part. Sand is preferentially deposited on the downdrift side of most deltas, but distributary channels tend to develop toward the updrift side. The highest sand:mud ratios are often on the updrift side in the lower delta plain, but in the delta front these ratios are highest on the downdrift side. These complex patterns of asymmetry reflect different combinations of controls including discharge partitioning, lobe abandonment and localized transgression, the influence of coastal physiography, plume deflection by littoral currents, dominance of longshore drift direction, variable subsidence, and anthropogenic factors. These processes may result in updrift-downdrift variations in clinoform geometry, rates of progradation, and stratal lapping relationships. Asymmetry has multiple aspects, manifestations, and controls—even within a single delta—but the long-term preservation potential of these patterns likely varies depending on depositional setting and shoreline trajectory. Studies of ancient deltas will be better-informed by recognizing the wide variety of controls on sediment distribution and avoiding the tendency toward a single model of delta asymmetry.

Understanding Microbial Lacustrine Carbonates through Stratigraphic Forward Modelling: Mound Distribution in a Syn-Tectonic Setting

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Models of lacustrine microbial carbonates do not fully explain the variety of depositional settings where these rocks are found, probably because controls on non-marine carbonate deposition are inherently complex and our understanding of the processes that lead to their formation throughout the geological record is rather poor. Stratigraphic forward modelling (SFM) calculates the response of modelled geological processes to an initial set of conditions to produce digital strata that can be compared to the rock record. Therefore, it is a useful tool to test hypotheses concerning the conditions that led to the formation of these rocks.

Studies on the Upper Jurassic to Lower Cretaceous Purbeck Formation outcropping in Southern England are being used to develop new SFMs to investigate basin-scale stratal architectures and outcrop-scale microbial build-up development. The lower part of the Purbeck limestones are dominated by levels containing microbial mounds, and associated intermound facies, separated by exposure surfaces. Evaporites and packstone-grainstone laminated and cross-bedded limestones overlie the mounded deposits. A variety of microbial textures, mound shape, sizes and spatial distributions are exhibited. New depositional models support the hypothesis that subsidence-driven water depth variations were a key control on facies distribution and thickness, and palaeotopographic and palaeoenvironment maps suggest that east-west normal fault activity was a key control on subsidence patterns.

Seismic-scale features are investigated using a forward model based on Carbo-CAT. Two main characteristics of this program are the incorporation of a cellular automata algorithm that allows us to model carbonate factories interplay and the resulting facies clustering and migration, while a built-in module replicates subsidence associated with normal faulting and a relay ramp. Other geological processes include lake-level oscillations, depth and neighbouring facies dependent carbonate production rates and sediment transport. We are using this new forward model to better understand how synsedimentary normal faults and associated relay-ramps influence the accumulation of in-situ carbonate production and transported material.

Three-dimensional SFMs are being developed to interrogate the interpretations made regarding the controls on mound morphology and distribution in lacustrine systems. Following field observations, and in concordance with previous work, microbial growth is set on local highs, while topographic lows are filled with transported sediment. Water depth, microbial growth rates, detrital sediment deposition and colonization are among the processes and controls that can be evaluated.
Both models will feed information into each other, and comparison between mound development under conditions derived from different sectors within the seismic-scale model will help to validate and refine the depositional models based on outcrop data.

The role of cyanobacterial mats in precipitation of authigenic silicates

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The fossil record of benthic cyanobacterial mats throughout Earth history indicates their intimate association with various mineral phases. Studies of modern cyanobacterial mats show that these minerals are usually precipitated within the extracellular polymeric substance (EPS) as a result of metabolic activity of mat-forming microbes. Such a process can be defined as biologically induced/mediated mineralization. A large spectrum of minerals can be created in this way, with carbonates, sulphates, sulfides, and iron and manganese oxides as the most common phases.

Our comparative studies on modern and fossil cyanobacterial mats suggest that these microbial systems play a role in the formation of silicate minerals. In Lake Van (Turkey) microbially mediated calcium carbonates are massively formed with crucial role of benthic coccoidal cyanobacteria. These mats precipitate mostly micrometer-sized aragonite grains, but in their common mucilage sheaths microgranules of Al-Fe-silicates also occur. Microscopic, SEM and spectral observation showed the presence of authigenic carbonates and Al-Fe-silicates close to the mat surface. The primary silicates that nucleate in Lake Van mats are visible as amorphous or poorly ordered nano-granules. With time, the granules transform into more crystalline phases with a more specific chemical composition, making the silicates particularly distinct in older and subfossil parts of mats. Similarly, our study of early Silurian cyanobacterial mats occurring in black radiolarian cherts revealed that they also contain authigenic silicates often replacing organic remnants. The presence of silicates significantly increased the fossilization potential of the cyanobacterial sheaths and capsules, visible particularly well after etching the surface with a mild hydrofluoric acid. The detailed process controlling the formation of silicates in microbial mats is however poorly studied. It seems that heterotrophic bacteria occupying and degrading the EPS layers of cyanobacteria may bind various ions and serve as nucleation centers for the silicates. Besides, cyanobacteria themselves may *complex* or chelate various metals thus causing their local enrichment. Since silica solubility increases significantly with pH, diffusion of SiO_2 into layers of the mat with heterotrophic reactions, i.e. reactions that generate CO_2 and therefore lower the pH, could be the process controlling this phenomena. In Lake Van the ambient waters have a pH of 9.7 and therefore are a high-concentration source of SiO_2 for the mats.

Our studies showed explicitly that both in modern and Silurian cyanobacterial mats the silicate formation was an early diagenetic process which in the Lake Van mats proceeded almost simultaneously with precipitation of aragonite and in the Silurian mats with their silicification.

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4000 years of mass movement history in deep Lake Geneva (France-Switzerland)

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Lake sediments are excellent archives of past natural hazards. Mass transport deposits recorded in lake sediments represent traces of past events such as slope and delta failures triggered by sediment overload, rockfalls, earthquakes etc. Thus, the study of mass movements in lake sediments provides insights into past natural hazards at historic and prehistoric timescales.
In Lake Geneva, high-resolution (3.5 kHz) seismic profiles were combined with sediment core data and radiocarbon ages from organic remains in order to study the mass movement history during the late Holocene.

Seismic reflection profiles reveal the upper ~ 30 upper meters of late Holocene sedimentation history, which is divided into two sequences:

Sequence A comprises the upper 5 meters and is characterized by parallel, continuous and high-amplitude reflections intercalated with transparent horizons. This seismic facies is interpreted as hemipelagic sediments interbedded with cm to dm-scale turbidite deposits. Two small-scale mass transport units are recognized in this sequence based on the transparent to chaotic seismic facies with irregular lower boundaries and associated to small slope failures. Using the seismic to core correlation, these units are interpreted as mass transport deposits (MTD). Based on the age model, this sequence covers the timespan from 563 AD to present.

Sequence B forms the lower 25 m thick sequence consisting of a succession of six large MTDs that are associated to five different events that occurred from around 4000 cal BP to 563 AD. These MTDs are caused by (1) lateral slope failures: MTD B at 3895 ± 225 cal BP and MTDs A & C at 3683 ± 128 cal BP, most probably triggered by an earthquake and (2) Rhone delta collapses: MTDs D to G dated at 2650 ± 150 cal BP, 2185 ± 85 cal BP, 1920 ± 120 cal BP, 563 AD, respectively. MTDs D to F are likely due to sediment overload with unknown external triggers. For MTD G, a rockfall known from historical records (Tauredunum event in 563 AD) acted as external trigger.

Independent of their origin and triggers, numerical simulations show that all recorded MTDs were large enough to have generated tsunami wave heights of up to several meters.
Thus, the sedimentary record of the deep basin of Lake Geneva show that during past 4000 years, at least six tsunamis were generated by mass movements. This shows that the tsunami hazard in the Lake Geneva region should not be neglected, although they are not frequent.

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Major eustatic sea-level drop in the wake of the Toarcian Oceanic Anoxic Event: Are hyperthermal events rooted in icehouse climate?

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The Toarcian ocean anoxic event (T-OAE, ca. 181 Ma) corresponds to a major perturbation of the C-cycle as reflected by a marked decrease (2 to 7‰) in carbon-isotope ratios of micrite, total organic matter and wood. Massive input of clathrates in the exogenic reservoirs has been invoked as a cause for this perturbation. However, the potential origin and setting of these clathrates have never been studied.

Here, we present clear sedimentological evidences possibly linking the T-OAE hyperthermal to its preceding cold climate. Eleven stratigraphic sections located in the Central High Atlas Mountain in Morocco were investigated, making advantage of their outstanding exposure and continuity. The focus was on lateral as well as stratigraphic facies changes, sedimentary and textures, biota, trace fossils and diagenetic features. The sections are correlated based on biological and chemical ($\delta^{13}C_{micrite}$ and $\delta^{13}C_{org}$) stratigraphy. A 60 meters-deep incised valley fill was thus observed within the uppermost Polymorphum ammonite zone, just prior to the T-OAE. This incision is filled by shallow marine facies and finally capped by the tempestite-rich interval associated to the T-OAE.

Together with published data of carbon isotope chemostratigraphy, pCO_2 level, seawater paleotemperature reconstruction and the duration of the considered interval, our results indicate a glacio-eustatic cause for the incision that, beside of the paleo-tropical setting of Morocco, can also be observed in North Sea and Greenland basins. Moreover, due to the creation and storage of methane in permafrost, we hypothesise that the rapid thawing of ice coeval to the onset of the T-OAE warming was responsible for a rapid release of ^{13}C-depleted carbon from polar regions into the atmosphere, leading to the Toarcian hyperthermal state.

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Toarcian extreme warmth led to tropical storm intensification

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It has been modeled that tropical storm frequencies, trajectories and intensities should be modified in a warming planet. Observing this relationship remains however a difficult task since no clear trend is yet emerging from the anthropogenic record. Because tropical storms leave an imprint in the sedimentary archive often preserved after diagenesis, the geological past offers the opportunity to test the relationship between storm activity and rapid global warming.

Here, we present sedimentological evidence accounting for an increase of the strongest tropical cyclones during the Toarcian Oceanic Anoxic Event (T-OAE, Early Jurassic, ca. 181 Ma) hyperthermal. In the Central High Atlas Mountains (Morocco), three sections forming a 17 km proximal/distal transect were logged and described bed by bed. All sections are time constrained using brachiopod and carbon isotope stratigraphy ($\delta^{13}C_{micrite}$ and $\delta^{13}C_{org}$).

In the western Tethyan realm, increased occurrence of tempestites is systematically observed within the neritic sediments deposited during the T-OAE, notably at its onset. In the tide-dominated High Atlas Basin of Morocco, outstanding exposures allow to trace a drastic increase in the occurrence of storm related deposits, as well as the deepening of the effective mean storm weather wave base (MSWWB) during the onset of the T-OAE. The palaeolatitude of the High Atlas Basin (18° North during the Early Jurassic) rules out winter storms as the driving mechanism behind the formation of tempestites. Altogether, these observations unequivocally support a significant increase of tropical storms intensity associated with the Early Toarcian hyperthermal.

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Depositional environment and oceanography of the Vaca Muerta Formation (Neuquén Basin), Southwest Argentina

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The Vaca Muerta Fm. is one of the most prolific source rocks in the Neuquén Basin (southwest Argentina). It is Tithonian-Berriasian in age and consists of organic-rich, dark brown to black shales and mudstones deposited during a major transgression (Leanza, 1981).
In the Picún Leufú Anticline (southern part of the basin), the Tithonian-Berriasian interval is interpreted as deposited on a low-angle ramp with gradual passage from shallow marine area along the southern margin, to the deepest area to the north, where the deep waters were anoxic. However, anoxia reached the south of the basin owing to progressive relative sea-level rise (Spalletti et al., 2000).
The geometry and spatial relationships in the Tithonian–Berriasian interval were studied along the Picún Leufú Anticline through the analysis of seven sections. One of them was sampled for TOC, clay-mineral characterization and inorganic geochemistry to constrain the paleoenvironmental conditions.
The close examination of the sections allowed defining 12 facies associations in a setting evolving from a clastic-dominated ramp to a mixed clastic-carbonate rimmed ramp. The siliciclastic setting collected mainly silty grey shales typical of outer ramp, with storm beds and channelized bodies attributed to mid-ramp environment. The rimmed ramp contrasts with the previous setting by the occurrence of silty green shales attributed to the outer ramp and evidence of lagoonal and tidal influence for the shallowest environments.
Visual correlation of key markers (satellite images) and facies-association distribution in between allowed to split the Vaca Muerta Fm. into two large intervals. The lower one shows a prograding geometry with dip increasing towards the top. In detail, several m-scale sequences are observed with a high lateral variability; they define an overall transgressive-regressive pattern.
The upper interval is characterized by the occurrence of green shales. It records first a transgression, then a regression and evolves at the top to aggrading tidal, shoal and lagoonal deposits.
Besides, the stratigraphic evolution of the clay-mineral assemblages (kaolinite vs. smectite) links the evolution of the depositional environments of the study area to a paleoclimatic evolution of the basin at this period. The development of a siliciclastic ramp was associated to warm temperate conditions, where seasonal rainfall caused high runoff to the basin. In contrast, during drier periods, reduced runoff, hence low terrigenous supply, allowed the development of a mixed clastic-carbonate rimmed ramp. This result is consistent with published paleogeographic reconstitutions for the lower Cretaceous (Cuneo 2003; Sagasti, 2005).
Trace-metal proxies (U vs. Mo diagram), indicate oxic conditions within the water column and reducing conditions at shallow depth below the sediment-water interface for the lower part of the Vaca Muerta Fm. In addition, a [TOC] vs.[Mo] diagram (Algeo and Lyons, 2006) suggests moderate water-mass restriction during deposition of the bottom part of the section, suggesting episodic limitation of water mass circulation during the first part of the Vaca Muerta deposition.
To sum up, during the Tithonian-Berriasian times, the ramp setting of the SW Neuquén Basin collected silt-dominated, mixed clastic and carbonate sediments under normal marine conditions with occasional limited connections with the open sea. With ongoing sea-level rise, these limitations vanished and fully open marine conditions could be established.

Toarcian-Aalenian condensed deposits in the Pieniny Klippen Belt of Ukraine and Tatra Mountains of Poland – their sedimentological characteristics and synsedimentary tectonic implications

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The Pieniny Klippen Belt (PKB) and the Tatra Mountains (TM) belong to the Inner Carpathians and their Mesozoic evolution represents a fragment of history of the northernmost part of the Western Tethys. During this time several tectonic events took place, which are well documented by sedimentological features such as: synsedimentary breccias, neptunian dykes, hard grounds, ommission surfaces, condensed carbonates etc. Thin layers of carbonates, especially multicoloured limestones, are full of nectonic faunas (e.g., ammonites, belemnites) which indicate several biostratigraphical zones, moreover there occur ferruginous-manganese concretions and/or crusts, numerous ommission surfaces as result of erosion and/or non-deposition, microbial structures – stromatolites and coated grains/nodules (oncoids). One of these tectono-sedimentary events was related with Toarcian-Aalenian episode of rift-related movements within the Ukrainian part of the PKB (e.g. Priborzhavskoye) and in the TM of Poland (Lower Subtatric – Krizna nappe). The uppermost Pliensbachian–Aalenian rocks of the Ukrainian PKB locality are represented by yellow-red condensed limestones (maximum to 25 cm in thickness) with stromatolites, several omission surfaces, ferro-manganeous oncoids and crusts, and ferruginous ooids in some places. These features indicate the extremely low sedimentation rate (or even a lot of gaps in sedimentation), and this horizone marks the important change of sedimentary regime after deposition of a thick sequence of clastic-carbonates of the Alpine *Gresten*-type facies and pelagic limestones/marls of *Fleckenkalk*/*Fleckenmergel*-type. Biostratigraphical control of this sequence is based on rich ammonite faunas. The discussed condensed facies could reflect an episode of initial extensional, rift-related regime and could be correlated with uplift effect of tillted blocks originated during first step of such rifting process. In the same time in the TM basin sedimentation of condensed cherry-red limestones full of large ferro-manganouse oncoids and crusts of the Toarcian age (dated by ammonites) took place. This unit is underlain by *Fleckenmergel*/*Fleckenkalk*-type spotty marls and limestones whereas the Aalenian deposits are missing, most probable due to rifting and non-deposition effect. In more deeper part of the TM basin some calcareous turbidite-type resedimentation occured formed by downslope transport from shallower zones. In both cases, the big contrast between pelagic sedimentation of *Fleckenkalk*/*Fleckenmergel*-type facies and condensed episode deposits took place and was an effect of isochronous rift-related event.

Volcanogenic debris flows and pyroclastic turbidites in the Ukrainian Carpathians

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Debris flows and turbidites are immanent part of the orogenic system full of flysch-type deposits. Relationships between source areas with their erosion and depositional system in surrounding basins are a crucial for interpretation of such type of mass movements. The Outer Flysch Carpathians of the northernmost part of the Carpathian arc is one of the biggest belt of stack of flysch nappes in Europe. This belt is almost exclusively constructed by siliciclastic flysch-type rocks represented by different kind of thin-, medium- and thick-bedded sandstones intercalated by conglomerates and shales. Debris flows are proximal type of such kind of mass movements and represent chaotic apron-type deposits which contain a lot of gravels, pebbles and olistholites which occur usually within fine-grained matrix (e.g. different kind of gravelstones with well-rounded pebbles and/or exotics). The Kaminnyi Potik Unit (Nappe), in the frontal part of the Marmarosh Massif in the Ukrainian Carpathians, is full of volcanogenic debris flows. It is the most internal and structurally highest unit of the Fore-Marmarosh units and in many places is directly covered by the Marmarosh nappes of the Central East Carpathians. In the Ukrainian Carpathians they occur in vicinity of Rachiv city and its SE prolongation of the Chyvchynian Mountains (Ukrainian-Romanian transborder zone). Volcanogenic debris flows are volcano-sedimentary breccias/conglomerates ("gravelstones") with volcano-tuffitic matrix and different size of blocks, pebbles and olistholites of limestones (often with corals and other benthic fauna; even huge blocks over 5 m), basic rocks (e.g. basalts – sometimes as pillow lavas), small fragments of radiolarites etc. From sedimentological point of view this type of sediment represents classical proximal-type of mass movements very close to source area, and records apron-type submarine debris flows with cohesive mechanism of sedimentation. On the opposite side are thin-bedded layers full of pyroclastic materials with classical features of turbiditic beds manifested by graded fractionation, sharp erosive base of beds, subtle cross-bedding structures, intercalations of shaly-pyroclastic materials between beds – typical Bouma sequence development. The most distal-type of such coarse/fine-grained calcareous pyroclastic flysch turbidites occur within thin-bedded micritic limestones (of the Alpine character *Maiolica*-type facies). Generally, pyroclastic flysch is very rare example among Phanerozoic world-wide known turbiditic systems. Contrary to intercalations of thin tuffitic leyers, which are popular in several flysch deposits, huge amount of pyroclastic material necessary to origin of pyroclastic turbidities indicate strong volcanic activity in source area and their proximity. This volcanogenic-flysch-type sequences have been formed during the transition Jurassic/Cretaceous time in the Outer Dacide-Severinide part of the Carpathian basins. In this case such volcanic activity could be one of the best proof for geodynamic history of the northernmost part of the Western Tethys.

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Cretaceous dinosaurs in Shandong province, China: their ages and environments

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Shandong province is situated in the middle eastern North China Craton(NCC). Tectonically, the province is divided into eastern and western segments separated by the famous Tan-Lu Fault Zone, namely the Yi-Shu Fault Zone(YSFZ) by local geologists. In the western terrain, Mesozoic (Lower Triassic, Jurassic, and Cretaceous) terrestrial deposits lay on the base of the North China Craton; whereas in the eastern terrain, only Cretaceous deposits exist in the Jiaolai Basin.

The Cretaceous stratigraphy in Shandong is subdivided, in ascending order, into Lower Cretaceous Laiyang, Qingshan/Dasheng, and Upper Cretaceous Wangshi groups. Dashang Group is finger-interbedded with Qingshan Group. Wangshi Group is mainly composed by purple sandy conglomerates, coarser-grained sandstone, yellowish siltstone and mudstone deposited in a restricted area such as Zhucheng and Laiyang graben in the Jiaolai Basin. Mafic lavas, basalts dated as 73.5 Ma are locally interbeded with the sedimentary rocks.

Dinosaur bone, footprint and egg fossils were widely found in the Jiaolai Basin. Theropod, sauropod and ornithopod footprints(or tracks) were mainly preserved in the middle Lower Cretaceous Laiyang Group in the Jiaolai Basin and in the upper Lower Cretaceous Dasheng Group inside the YSFZ. They well existed in fine sandstones to siltstones of delta front-shore and shallow lake environment, and often accompanied by abundant mud cracks, wave ripples, rain-prints and bioglyphs. *Psittacosaurus* and fragmentary sauropod fossils were mostly unearthed in the purple red and yellow green fluvial and lacustrine sandstone-mudstone deposits of upper Qingshan Group. However, Four bonebed quarries (Kugou, Longgujian, Xijiantun and Zangjiazhuang) (yielding *Shantungosaurus*, *Zhuchengtyrannus*, *Sinoceratops* and *Zhuchengceratops*) are excavated from the lower Hongtuya Formation of the Wangshi Group in Zhucheng,where bone fossils deposited in a succession of rhythmic lacustrine sandstones-siltstone-paleosoils and alluvial fan-braided channel sandy conglomerates and debris flow conglomerates. Bone fossils (*Tanius*, *Tsintaosaurus*, and *Micropachycephalosaurus*) and increasing-upwards dinosaur egg fossils together were also found in red alluvial fan sandy conglomerates of the middle-upper part of the Hongtuya formation in Doushan, Jiangjunding, Jingangkou and Hongtuya of Laiyang.

Sedimentary and dinosaur bio-palaeogeographic researches indicate that Jiaolai Basin is an extensive lake with broad lake shore and delta environment and suitable warm-humidity climate in Laiyang period of the Early Cretaceous. In the Qingshan and Dasheng period, volcanisms were intensive along the YSFZ and Jiaolai Basin. Sudden flood water and mud flow took place frequently under hot and drought climate in the Wangshi period of Late Cretaceous. The earth surface ecological system deteriorated gradually toward the end of the Cretaceous.

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Key words: dinosaur; Shandong; Wangshi Group; Qingshan Group; Laiyang Group

Late Quaternary landscape evolution along the Indus River, Ladakh Himalaya

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The river Indus flowing NW in a longitudinal valley along the Indus Tsangpo Suture Zone (ITSZ), which represents the first order geomorphological feature of Ladakh Himalaya. The Indus River arises from Mount Kailas and drains through Karakoram zone, Ladakh Batholith and tectonic units of ITSZ and sink into Arabian Sea via plains of Punjab (Pakistan). The Indus valley has a very large (1×10^6 km^2) catchment area. Thus the landscape along this river has potential to unravel responses of the neotectonic evolution of ITSZ and climatic variability (arid – humid - arid) of Trans-Himalayan zone.

The study has been done using ASTER DEM (1 arc second), SRTM (3 arc second) and Survey of India toposheets (1:50,000), geomorphological mapping and Optically Stimulated Luminescence (OSL) dating. The study area includes ~ 400 km stretch along Indus River from village Nyoma to Dah. In this stretch the river shows marked changes in channel pattern and geomorphic configurations. On the basis of geomorphologic and sedimentologic studies of this Quaternary landscapes, we have divided the studied terrain into two major zones- (i) it includes the valley aggradation phase of wide braided channel of upper reaches Indus between Nyoma and Leh (ii) bedrock strath terraces from downstream reaches from Nimmoo to Dah, where it flows into a narrow gorge. The former has been taken to reconstruct the climatic fluctuations by using palaeo-hydrologic approach that includes geometrical method on imbricated clasts of aggraded deposits and coupled with the observation made from the sand ramps. The later has been taken as a proxy to evaluate the tectonic history along the ITSZ. The Zanskar River cuts the Indus molasses orthogonally and resulted in the formation of a narrow gorge, indicate the history of deformation in response to northward movement of the Indian plate.

The dating of strath terraces indicated the bedrock uplift rates varying from 2-5 mm/y, unexpectedly matches with the incision rates (2-12 mm/y, Burbank et.al, 1996 and Leland et.al, 1998) of NW Himalayan syntaxis. The high incision rates during Late Quaternary reveals that the thrust contact between the Ladakh Batholith and Indus Molasses was neo-tectonically active. Most likely it has suffered equal tectonic forces as in Nanga Parbat syntaxis. We therefore propose the bedrock incision in this zone is in response to the Pleistocene-Holocene uplift and crustal shortening of the Indus Molasse.

Variations in coarse-grained clastic sediments and their tectonic control along the eastern periphery of the Miocene rift system of the Sea of Japan, Niigata, Japan

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The Miocene and younger sediments of the Niigata sedimentary basin, northeast Japan, experienced rapid rifting during the early phase of the basin development, resulting in localized, substantial deposition of coarse-grained clastic sediments (Takano, 2002). This stage is economically important on account of being associated with the most significant hydrocarbon reservoirs in Japan. This study is based on surface mapping of selected areas along the eastern periphery of the Niigata basin, and discusses the variations in lithofacies and sediment thickness, as well as their control from basin geometry and tectonics.

In the northern part of the Niigata basin, the Miocene and younger clastic sediments are exposed in two zones: the zone along the Shibata–Koide Tectonic Line (zone A) and the Tsugawa area (zone B). In these areas, the sediments are generally composed of conglomerates in the lower part and sandstones in the upper part. The fossil records of these area indicate an age range of 15–17 Ma and a warm paleoclimate (Kobayashi and Tateishi, 1992). This study also partly included previous data from the Tsugawa Collaborative Research Group (1979) and the Sasakami Collaborative Research Group (1980).

The conglomerate beds in the lower part are mostly composed of debris flow deposits, as evidenced by their very poor sorting, lack of internal structures, and presence of outsized clasts, among other features. A major portion of the conglomerates and the overlying sandy facies is of shallow marine origin as indicated by the presence of large burrows and marine dinoflagellates (Kurita and Ishikawa, 2010). Collectively, these coarse-grained sediments represent fan systems, which were initially alluvial fans and then became fan deltas after submersion. This upward-fining trend likely resulted from the decreasing activity in the rift-border faults and resultant sediment build-up, with a consequent decrease in gradient and depth of the fan delta front (Prior and Bornhold, 1990). The fan delta deposition was followed by the rapid deepening of the entire basin because of post-rift thermal subsidence.

In spite of the overall similarity in facies and vertical trend, lateral variations between the areas were present. The thickness of coarse-grained sediments in zone A ranged 240–305 m, except in an area where it reached 700 m. In contrast, zone B had a thickness of 40–180 m. This difference may be attributed to the variation in both the creation rate of accommodation space and the rate of clastic supply. Zone A was located along the large fault that delineates the major basin border, favoring the accommodation space. In addition, the clastics in zone A were fed laterally into the basin by channels cut along the relatively major syn-rift faults, which may be connected to large drainage areas. In contrast, the basins in zone B corresponded to small grabens formed as intra-rift depressions ~10 km wide, where the rate of deformation and the extent of the drainage areas tended to be limited.

One of the major factors that affected syn-rift sediment accumulation in the Niigata basin, where normal faults of different scales and trends were simultaneously active during its genesis, was the basin geometry, controlled by the size and combination of faults involved in the creation of a given accommodation space. The most significant clastic accumulation occurred in areas where a rift-normal fault was directly connected with the major basin-border fault.

Reservoirs rocks and reservoir properties of carbonate tidal flat facies: Examples from the Vendian-Cambrian (East Siberia Plate) and Devonian (Timan-Pechora Basin)

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The microbial origin of shallow-water deposits is often deduced from particular features of rock record, e.g. in tidalites. The latter are considered to be deposited in very shallow intertidal and subtidal sediments.
This work focuses on facies and reservoir property distribution for Vendian-Cambrian (the Berezov Depression, the Nepa-Botuoba High, the East Siberian Plate) and Lower Devonian (the Varandey-Adzva Zone, the Timan-Pechora Basin Province) carbonate rocks, identified as tidalites.

Study was based on petrographic (polarizing microscope with transmitted light and scanning electron microscopy) and petrophysical analyses of core samples. For the latter, conducted tomography was used, along with investigation of scanned images of core samples. Analysis of pore space structure was carried out to characterize porosity and permeability connections.

The origin of studied rocks was interpreted as shallow tidal flat with carbonate deposition and they were considered as tidalites. The prevalent type of rock is micritic limestone with a diversity of textures including numerous desiccation cracks and bioturbation. Rarely dolomitic muddy limestones occur.
Laminations are interpreted as a result microbial films that contented coccoid bodies and accumulations of filamentous bacteria.

These accumulations led both to carbonate deposition and clay accumulation, but also to trapping of organic material. It resulted in irregular distribution of muddy-organic material. Particular microbial conditions contributed to the formation of diagenetic dolomite, framboid pyrite and rarely anhydrite.
Poor reservoir properties are determinate by micrograin texture. Relatively large pores occur, predominantly linked to caves, dolomitization and moldic pores.

Small pores have isometric and simple shape whereas large pores are characterized by framework complexity.
However the most important feature of these rocks is occurrence of subhorizontal pores in microbial muddy-carbonate layers, resulting in high values for permeability in such horizons.
Concentration zones of subhorizontal pores form distinctive areas on tomography images. These zones are supposed having eogenetic origin and oriented along the microbial layers.

Stratigraphic variability of tide dominated depositional systems within Miocene sandy succession of Bas Dauphine basin (Miocene Peri-Alpine foreland basin) SE France

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The Bas Dauphiné basin constitutes one of the wider sub-basins within the Peri-Alpine Tertiary Molasse basin located in SE France, in Front of Chartreuse-Vercors sub-alpines Ranges. The basin is connected toward the north with the Swiss Molasse Basin and to the south to the Rhodano-Provencal basin. Tidal influence have been already reported, Rubino 1985; Lesueur et al. 1990. But no updating was done prior to this new work carried out in the framework of CO2 storage appraisal.

Because we are quit North and marginal (i.e close to the forebulge) within the foreland basin, the flooding only occurs during Mid Miocene leading to the deposition of offshore marls of Langhian age (St Lattier Marls). This marls regionally belong mainly to the high stand system tract (HST) of what we call sequence S3 and proximal facies are not preserved. The second stratigraphic unit corresponds to Saint Donat Sandstones Fm. This formation starts with a bioclastic tidal dune complex sharply resting over St Lattier Marls. They are interpreted as transgressive transverse compound dunes. Above this unit, a siliciclastic wave and storm dominated shoreface progrades. Both define the sequence 4 of Lower Serravallian age. Still within the St Donat sandstones, the next sequence (S5) includes: a tide dominated transgressive shoal complex overlain by a prograding sandy HST with a mixed influence (fluvial and tidal) still within a large scale sandy shoal. A Mid Serravallian age is attributed to this sequence. The next sequence (S6) starts with a coarse to very coarse sandstones forming the base of the Hauterive-Cognet Sandstones Fms; like the basal sequence, these transgressive sandstones are compound dunes system; occurrence of channelized sandbodies suggest that they are probably form in distal estuary rather than in open shelf setting. The overlying HST sandstones show significant lateral facies changes, in the proximal part, they are constituted by superimposed channels bodies with a mixed influence grading distally in a pure tidal dominated shoal. Both systems belong to the distal part of a large scale fanglomerate (Notre Dame de l'Osier Conglomerates Fm.) feds by the subalpines ranges. The last sequence (S7) begins with transgressive tidal sandstones, Dionnay Sst Fm. (shoal or proximal tidal bars) grading upward into marines shales around Lower Tortonian maximum flooding. Significant facies changes occur at the basin scale with the local development of extensive tidal flats with tidal creeks and larger tidal channels like south of Lyon (St Fons Sandstones Fm.). The overlying HST includes: a new large scale prograding fan delta complex (Toutes Aures Conglomerates) grading into mixed tidal and fluvial dominated deposits. Finally, these sandstones grade toward the west into the Tersanne sandstones Fm. where, above a shallow water flooding still with tidal influence, continental conditions prevail with regressive fluvial deposits including brackish to fresh water pelycipods.

In conclusions within few exceptions a strong tidal influence is recorded with the tertiary of Bas Dauphiné however tidal influence appears to be modulated according to the stratigraphy and the system tracts; basically transgressive system tracts are almost only tide whilst prograding HST according to the proximality gradient shows a balance between tidal and fluvial influx. Storm influence is weeks, HCS only occurs during the second order transgression climax around Langhian-Serravallian boundary when the basin is wider.