Characterization and Formation of longitudinal pinch-out geometries in turbidite systems: the Peïra Cava syncline (Annot Sandstone Formation)

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The Grès d'Annot sandstones of Late Eocene/early Oligocene is a well-known example of turbidite accumulations deposited in a foreland basin setting. In such settings, turbidite systems are usually laterally control by syntectonic activity generating lateral pinch-outs of the infilling accumulation against the basin walls. Such tectonic activity together with progradation and retrogradation stages of the whole turbidite system could also lead to local disconnection between the continental-slope and the basin deposits and to the formation of sealed potential sand-rich reservoirs. The aim of the work is to better constrain how turbidite systems pinch out longitudinally, in both upstream and downstream directions and to characterize some typical lithofacies evolutions.

Our work focused on the Peîra Cava syncline (Maritime Alps, France) where particles are sourced from the Maures, Esterel and Corso-Sarde mountains and flow towards the north following structurally-controlled conduits. Thirty lithological logs 100-m thick were acquired following the western N170-trending side of the syncline. Correlations made between the various sections allowed reconstructing the topography of the top of the blue marls that existed before the emplacement of the turbidite accumulation. This reconstruction revealed the occurrence of two types of longitudinal pinch-out geometries against relatively high-slope angles, and trending either downcurrent or upcurrent.

The strongest evolution of depositional facies is observed close to upstream pinch-out surfaces. Here, turbidite deposits thin and fine longitudinally while cohesive debris-flow deposits stop over distances as short as 200 m. Then, going upward in the serie above the pinch-out surface, both turbidite and debris-flow deposits are lesser affected and finally become continuous.

These observations allowed defining a depositional model for gravity flows within a confined basin. It revealed similarities with the "fill and spill" model by Sinclair and Tomasso (2002), characterized by several stages of infilling. In a first stage, a pre-existing topography consisting in several depressions 1-2 km long controlled the longitudinal-facies evolution by blocking the highest-concentrated flows along their reverse-slope flanks. As the depression is infilled, flows are able to overtop the reverse-slope flank to settle down in the following depression. Once the pre-existing topography is buried, channelized bodies prograde within the basin with alternating incision and by pass processes.

This work allowed us to better constrain the formation of longitudinal pinch-out surfaces during the first stages of a basin infilling and the impact of a pre-existing topography on the deposition of thick sand-prone basin accumulations.

Filling up the Abrolhos depression – Holocene sedimentation in a palaeolagoon on the eastern Brazilian shelf

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Sediment accumulation patterns along the continental shelf are mainly a response to a combination of sediment supply and relative sea level changes. In this context, carbonate and siliciclastic systems respond differently to relative changes in sea level. The Abrolhos Shelf is a mixed-sedimentation shelf located along the Brazilian eastern margin. The shelf morphology along its southern portion is characterized by the Abrolhos Depression, which represents a palaeolagoon. According to previous studies based on benthic foramimifers, the Abrolhos Depression was a mixohaline lagoon between 11,000 to 8,000 years BP, becoming an open marine environment throughout the last 8,000 years.

This work revisits the Abrolhos Depression by discussing post-glacial sedimentation patterns through the analysis of a sedimentary core and high-resolution seismic data. The main objective is to investigate the sedimentary response during deglaciation and to determine when the palaeolagoon was flooded. A sediment core location was determined utilising high-resolution seismic data. A piston-corer was used in 55 m water depth to recover a 3.5 m long core. Sediment samples were analyzed for grain size, calcium carbonate and organic matter content. The seismic interpretation revealed that the last glacial maximum (LGM) unconformity lies at approximately 60 m depth in the Abrolhos Depression. The Holocene deposits range approximately in thickness between 2 to 9 m in this area and a high-amplitude reflection was mapped above the LGM unconformity. In terms of facies analysis, three depositional sequences can be distinguished: a shallow-estuarine sequence, a mixohaline lagoon sequence and a marine carbonate sequence. The sedimentary facies indicate the transition of typically terrigenous sediments at the bottom to mixed facies and carbonate sediments at the top.

The shallow-estuarine sequence is predominantly composed of terrigenous facies at the base of the core (3.4 to 3.5 m core depth). This facies is composed of sandy sediments with a high siliciclastic and organic matter content. This sequence corresponds to lowstand deposits and is bounded at the top by a well-marked transgressive surface in the seismic record (high-amplitude reflection surface). Hence, this facies indicates a very-shallow environment where accommodation space was low and the lowstand deposits were either missing or reworked as transgressive sediments. This transgressive surface marks the transition between lowstand and transgressive deposits.

The mixohaline sequence is observed between 3.4 to 2.4 m. It is composed of sandy sediments with an increase in calcium carbonate content, which characterizes mixed sediment of a lagoon system. The base of this sequence (0.4 m thick) is defined by an intercalation of two facies: a siliciclastic facies overlaps carbonate facies and so on. This intercalation implies high-frequency sea-level oscillations, which probably occurred during middle post-glacial transgression.

The marine carbonate sequence corresponds to the upper 2.4 m of the sediments and is mainly composed of high-carbonate-content sediment. Considering its deposition during the last post-glacial transgression and its thickness, two scenarios are possible: high sedimentation rates and/or high-frequency sea-level fluctuations during that time. It is notable that a definitive maximum flooding surface is not observed, but the relatively increase of mud content and decrease of sand content in the upper 0.3 m of the sediments may indicate maximum flooding.

Facies-specific acoustic and petrophysical properties in continental spring carbonates based on a travertine dome core section in the Ballik area (Denizli, Turkey)

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Continental microbial carbonate deposits gained recently interest due to their potential as reservoir rocks, e.g. for hydrocarbons. Travertines are a particular type of continental carbonates that form at relatively hot springs. In these settings, the interplay of physico-chemical processes and micro-organisms along the downstream flow path influences the fast-precipitating carbonate fabric and its petrophysical properties. Diagenetic overprinting may, in addition, drastically affect the primary fabric and porosity. Until present, very little information has been available about the parameters controlling the acoustic and petrophysical properties of these rocks. Earlier work suggested that velocity variations in continental carbonates are primarily linked to sample heterogeneity, i.e. differences in fabric and pore types and, as such, reflect the facies succession along the spring downstream flow path. This study uses drill cores (total length of 120 m) from two wells in one of the key travertine exposures in the northern flank of the Denizli Basin (Turkey) to investigate and understand facies-specific acoustic and petrophysical signatures in continental travertine deposits. Representative core sections (± 60 m in total) were described in detail and logged for p-wave velocity and gamma ray density with a resolution of 1 cm (GEOTEK MSCL). The time-equivalent quarry exposures nearby allow up-scaling through the direct link between 3D facies architecture and 1D core-/well-based output.

The core sections document, from bottom to top, the presence of large-scale pond facies intercalated with different levels of alluvial conglomerates and marly deposits. This system evolves into a domal build-up, in which macrophyte-dominated distal and slope deposits are dominant. In places, typical white crusts composed of dendrites are recognized in the core sections. Towards the top, highly porous sections composed of 'streamer-like' fabrics occur. Porosity and permeability analyses on plugs (1.5 inch diameter) allowed calibrating porosity estimations based on the logged parameters. Specific core sections where imaged by medical computer tomography to visualize and quantify the (macro)-pore structure and pore types in 3D. The presence of microporosity (mainly based on petrographical observations) is playing a primordial role in particular fabric types. The most common microporosity types (interdendritic and intracrystalline due to zonal leaching) have been found in dendritic crusts (proximal slope and pond facies) and distal slope facies with macrophyte fabrics. Likewise, these facies correspond to highest permeability values and show horizons of important pore clustering as derived from 3D micro-tomographic analyses. Trends and variations in overall porosity can be identified in the P-wave velocity and gamma ray attenuation log records.

System-Scale Travertine Facies Distributions: a comparison of modern (Mammoth Hot Springs, Yellowstone, USA) and ancient deposits (Denizli Basin, Turkey)

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The facies and carbonate fabrics of (hot) spring deposits change along the downstream flow path as a function of environmental conditions and the interplay of physico-chemical and microbial processes. This study links System-scaled facies distributions from a modern and ancient key 'travertine' complex to understand the architecture, preservation and controls on the 3D facies distributions. A km-scale map of modern to Holocene travertine depositional facies has been constructed for Mammoth Hot Springs (MHS) at Yellowstone (USA), and directly compared and contrasted with travertine depositional facies distributions observed in the Cakmak quarry (Pleistocene,Ballik area, Denizli, Turkey). Whereas the active system at MHS provides highly detailed observations on short-term dynamics and spatial variability, the vertical cross-section in Cakmak quarry (+/- 50m high, 200 m length) provides insight into longer time-scale patterns. A process-based approach to facies distributions provides the necessary context for better understanding of the microbial, physical and chemical mechanisms that create and preserve the (micro)porosity and fabrics at submicrometer to meter scales, and the stacking of facies-specific pore fabrics throughout travertine bodies at meters to hundreds of meters scale.
The MHS map incorporates geomorphology (domes, terraces, fissure ridges), surface hydrology and a five-fold facies model (Vent, Apron-Channel, Pond, Proximal Slope and Distal Slope). This facies succession is consistently formed along downstream flow paths as the spring water rapidly cools (T = 73-25^{o}C), degasses CO_2 (pH = 6-8), and precipitates travertine (up to 5 mm/day), and the associated microbial communities exhibit 90% partitioning with respect to each facies. It represents an idealized downstream sequence along a 2D (unidirectional) primary flow path.

The Cakmak quarry facies map shows the terraced system stepping down to the western corner. At the scale of tens to hundreds of meters, different packages can be identified. The lower part of the active pit reveals a large pond-like facies that evolved in a sloped system marked by the decimeter-alternation of porous layers of encrusted macrophytes and dense (dendritic crust) layers (no equivalent at the recent MHS deposits). Subhorizontal layers overprinted by molds of former reed plants mark the distal end of these slope deposits. The nature of the slope deposits changes vertically to typical proximal slope dendritic crusts and granular fabrics. Prograding surfaces with streamer–like fabrics, similar to the Apron-Channel facies, occur near the top.

Detailed mapping demonstrated: the hundreds of meters scale terrace geomorphology with different terrace systems developing one onto the other, the high density of vents in active systems and their poor preservation in the geological record, the small areal coverage of active springs at any one moment in time when compared to the total body of travertine deposits, the important breaks in slope gradients systematically marked by prograding Apron-Channel facies, and the aereal/volumetric dominance of proximal slope, distal slope and to a lesser extent pond facies in travertine complexes.

Triassic-Jurassic reservoir quality evolution in Central East Greenland

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In the North Atlantic region it is well established that Triassic sandstones form poorer quality reservoirs for hydrocarbon than Jurassic sandstones. However, the reasons for this are not clearly understood. The best place in the region to investigate the cause for this improvement in reservoir quality is the Jameson Land Basin of East Greenland. The Triassic and Jurassic clastic successions are thick, well-exposed and there are few breaks in sedimentation.

The Jameson Land Basin is located between 71º12' and 72º25'N. It is a north-south aligned rift basin about 280 km long and 80 km wide. Development of accommodation space during the Triassic and Jurassic was driven by rifting in the Early Triassic, Mid Triassic and Middle to Late Jurassic. During this time there is a shift in depositional environment from continental to shallow marine with the transition occurring in the Early Jurassic. Greenland drifted northwards from around 30ºN, in the northern arid climatic belt in the Early Triassic to around 60ºN by the Late Jurassic.

To investigate the changes in reservoir quality, sandstones were analysed petrographically and porosities and permeabilities measured using core plugs. This was combined with clay mineralogical work on sandstones and mudstones throughout the succession and by heavy mineral analysis to investigate the controls on reservoir quality. Petrography, porosity and permeability work indicate the main improvement in reservoir quality occurred between the Late Triassic and Early Jurassic. The clay mineralogical work reveals that this change is controlled by a trend towards more humid climatic conditions. Provenance variations do not have a significant influence. A strong link is therefore shown between climate and the improvements in reservoir quality.

Seismic geomorphological reconstructions at Goban Spur: implications for Plio-Pleistocene MOW bottom current variability

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The Goban Spur shelf break forms a gentle terraced environment, located at the boundary between the canyon-incised Celtic margin, and the relatively smooth Porcupine Seabight to the north. Bathed from 1000 to 1500 m water depth, it is currently lying within the Mediterranean Outflow Water (MOW) lower interface, along its northward pathway. IODP Exp 307 has proven that MOW assisted the development of large cold-water coral (CWC) mounds in the Porcupine Seabight since the late Pliocene. However, the precise timing of MOW introduction remains difficult to assess due to regionally large hiatuses at the CWC mound base. On the other hand, the DSDP site 548 on Goban Spur recorded a more complete sequence, especially regarding the Pliocene to Pleistocene transition.

High-resolution single channel sparker seismic data revealed the presence of large-scale sediment waves nearby DSDP site 548. Downhole geophysical data of DSDP site 548 and the seismic stratigraphic analysis allowed the proposition of a Time/Depth correlation chart. Based upon the seismic geomorphological characteristics of the observed seabed and the buried sediment waves, the relative bottom current variability may be assessed throughout time.

Energetic alongslope bottom currents are thought to be the driving mechanism for the sediment waves development. These currents are driven on their turn by an enhanced internal tide regime that could be attributed to the MOW introduction which indicates the presence of a strong pycnal gradient. The seismic units are bounded by local erosional events, frequently associated with mass wasting events, which seem to synchronously occur to well-documented global climatic rearrangements, respectively at: the Lower Pliocene Revolution (LPR at ~4.2 Ma), the Upper Pliocene Revolution (UPR at ~2.7 Ma), and the Middle Pleistocene Revolution (MPR from ~1.2 to 0.8 Ma). The lower sequence (from ~4.2 to ~2.7 Ma) shows no morphological evidence of bottom current driven sedimentation. From the intermediate sequence (i.e. UPR to MPR) large scale sediment waves are gradually developed in close association with palaeo-seafloor irregularities, inferring that the sedimentation resumed with a marked large bottom current energy increase. The latest sequence demonstrates active sediment wave formation, strongly mimicking the previous sequence. Although the Goban Spur sediment waves cannot be regarded as a contourite drift as such, the stratigraphic evolution shows striking similarities to well-known MOW induced contourite drift systems all along the northeast Atlantic margin. Within the Porcupine Seabight, IODP Exp 307 (Belgica mound province) showed that most of the Pliocene to middle Pleistocene series were absent and to which the present work may provide some key elements in understanding the past margin evolution.

The hydrothermal travertines of the Acque Albule basin (Tivoli, Central Italy): facies character and architecture

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The sedimentary succession of the extensional Acque Albule Basin (Tivoli, eastern periphery of Rome Basin) includes Pleistocene fluvial lacustrine deposits intercalated with K-alkaline pyroclastites, which are overlain by and partially coeval to tens of metres thick hydrothermal travertines. In the literature, travertine deposition is related to hydrothermal circulations hosted in the Mesozoic-Cenozoic carbonate bedrock, favoured by extensional tectonics and relatively high geothermal gradients linked to the Colli Albani volcanism.

To investigate the Acque Albule travertines, six boreholes were drilled and cored along a 3 km long N-S transect. The travertine unit is wedge-shaped (20-45 m thick) and gently dips towards the South, conformably to the topographic gradient. In the southernmost part , travertines are intercalated with fluvio-lacustrine siltstone and sandstone and overlay fluvial conglomerates of the Aniene river.

Stratigraphic relationship between the travertine unit and the underlying succession suggests that the onset of hydrothermal carbonate precipitation followed the deposition of organic matter-rich mudstones of marsh environment over the studied area. The travertine succession is pin-pointed by numerous centimetre- to a few metres thick intraclastic/extraclastic wackestone to floatstone/rudstone indicative of periods of non deposition and erosion, due to temporary interruption of the flow of thermal water out of the vents. Two major unconformities, 0.5-8 m thick, are recorded across the whole 3 km transect allowing lateral correlations. The travertine unit can be divided in three zones (proximal, intermediate and distal) with respect to facies composition and depositional environments. In the northern proximal area, close to the hydrothermal vents, travertines are characterized by facies types indicative of shallow ponds and pools of terraced slopes, such as clotted peloidal micrite dendrites boundstone, radial pisoid grainstone, coated reeds, clotted peloidal micrite grainstone to boundstone. The low-angle terraced system deposition alternates with a few metres thick, lens-shaped units, rich in coated vegetation and *Charophytes* boundstone to packstone. The intermediate depositional zone, nearly 1-2 km southward of the proximal area, is characterized by 10 m thick, smooth slope facies with crystalline dendrite cementstone, laminated boundstone and radial pisoid grainstone with dips up to 45°. Slope beds are overlain by shallow pool facies following a several metres thick unconformity. The distal zone, in the southernmost part of the studied transect, consists of travertine ponds dominated by coated vegetation and *Charophytes* due to cooled-down thermal water or to freshwater input, intercalated with siltstone and sandstone.

Evidences of low-angle terraced and smooth slope systems suggest that the Tivoli travertines did not accumulate in a shallow lake as proposed in previous studies. Intervals of shallow lacustrine/palustrine facies with abundances of carbonate coated vegetation and *Charophytes* characterize most of the distal pond succession in the southern end of the analysed transect, and are, only locally, comprised within the proximal and intermediate zones. This occurrence of facies comparable to the distal pond zone also in proximal areas might be related to the general low temperature of the Acque Albule thermal water at the vent (present-day 23°C) and/or to events, related to the Pleistocene climate or local hydrology, during which thermal water mixed with freshwater to allow the growth of plants and *Charophytes* also in proximity of the hydrothermal vents.

Microbial mats and carbonate precipitation in active hydrothermal systems from Central Italy

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The study of microbial mats and carbonate sediment formation in extreme environments, such as hydrothermal system, has significant implications for the understanding of the role played by microorganisms in carbonate precipitation. Three active travertine-precipitating hydrothermal systems were selected in Central Italy to investigate the products of probable abiotic processes of carbonate precipitation (thermal water CO_2 degassing and cooling) and biologically mediated and controlled mineralization. Carbonate and associated microbial mat samples were fixed in the field with formaldehyde and glutardialdehyde solutions, impregnated in resin for petrographic analysis, and dehydrated with increasing ethanol concentrations for SEM analysis.

Samples at Bullicame (Viterbo, Latium) were collected from a decimetre-wide channel departing from the vent pool at the centre of a travertine mound (300 m in diameter). Water temperature was 55^{0}C, cooling down to 50^{0}C, nearly 60 m from the vent; pH increased along the channel from 6.74 to 7.4, whereas alkalinity decreased from 15.6 to 14.52 meq/l due to CO_2 degassing and carbonate precipitation. The proximal channel centre was characterized by centimetre-size fans of filamentous microbes (sulphide oxidizing bacteria - SOX), encrusted by carbonate. The channel margins and the distal channel were draped by orange to green microbial mats with calcified gas bubbles and rafts.

Bagni San Filippo (Tuscany) vent temperature was 46-49.5^{0}C. From the vent pools, water flowed through a channel (10-30 cm wide, 25 m long). At the vent, pH was 6.5 (alkalinity 31.65 meq/l) and increased to 7.3 at 14 m from the orifices, where temperature had dropped to 41.4^{0}C and alkalinity to 21.55 meq/l. Carbonate precipitates consisted of micro-terraced crusts, rafts, coated gas bubbles and millimetre-size dendrites associated with green microbial mats.

The Gorello waterfall (Saturnia, Tuscany) is characterized by a decametre-scale travertine terraced slope system with metre-scale horizontal pools separated by decimetre-high walls. Water temperature was 33^{0}C and alkalinity 9.07 meq/l; pH values increased from 7.7 to 7.9 in the flow direction. The pool rims and walls were coated by green microbial mats alternating with millimetre-thick carbonate crusts. The pool floor included millimetre- to centimetre-size oncoids.

The three settings analysed are different for water chemistry, temperature and travertine morphology. At the microscale, carbonate precipitates are similarly dominated by calcite microsparite crystals (5-20 µm) organised in radial spherulitic structures associated with biofilm EPS and microbes. The lower temperature Gorello system is also characterized by nanometre-scale micrite precipitation. Despite similarities of the microscale precipitates, microbial communities are different. A first analysis exhibits three microbial associations of decreasing temperature: a) a proximal hottest water association (55-49°C) of filamentous and rod-shaped sulphide oxidizing bacteria, b) an intermediate association (50-40°C) dominated by *Spirulina* cyanobacteria, c) a cooler (38-30°C) association of filamentous cyanobacteria, including *Phormidium*, sparse *Spirulina* and diatoms. This study demonstrates that microbial communities vary as a function of thermal water temperature; carbonate precipitation is influenced by microbes acting as low-energy substrates for crystal nucleation, or it takes place within the biofilm EPS.

Tectonic and oceanographic influence on Middle Jurassic sediment deposition in Northern Switzerland

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During the Middle Jurassic (Bajocien-Bathonien) Northern Switzerland was covered by a shallow epicontinental sea at the northern shelf of the Tethys Ocean. In the study area east of the Burgundian carbonate platform dominantly fine-grained siliciclastic but also calcareous and iron oolithic sediments were deposited. There is an ongoing debate about the major governing factors of the depositional regime such as tectonic subsidence, eustatic sea level or ocean currents. More specifically, it is discussed to which account reactivation of deep-seated, tectonic structures (e.g. Permo-Carboniferous troughs) can explain the observed sedimentary facies changes.

The frame of this study is given by sedimentological analysis of numerous new and old drillcores, cuttings and outcrops in northern Switzerland (Olten to Schaffhausen regions). Correlation of cores is additionally supported by clay mineral content records which were calculated from geophysical well logs. Time control in major wells is improved essentially by palynological analyses. Sediment facies changes are then additionally traced by seismic facies analyses of new and existing 2D-seismic campaigns.

The new litho-, mineralo- and biostratigraphic correlation show distinct facies changes mostly in E-W direction. In the west the occurrence of a temporal carbonate platform can be traced by oolithic limestones (Hauptrogenstein Formation). Towards the east the influence of the platform diminishes but can partly be recognised (Klingnau Formation). In the east, more distal clay-rich sedimentation dominates (e.g. Parkinsoni-Württembergica-Schichten). However within the clay-rich sediments a series of sediment successions can be detected which are often separated by iron oolithic horizons. Iron oolithic horizons indicate periods with no or strongly reduced sediment deposition and their succession has been related to eustatic sea-level changes. The thickness distribution and sediment composition of time-equivalent successions show considerable lateral changes. This pattern is interpreted to indicate a large-scale separation of the study area in deeper subbasins and shallower ridges. Seismic facies analyses reveal dipping reflections and onlaps that can be traced over several seismic lines. In general, regions with dipping reflections build up a positive relief, which is filled up with sediment characterized by onlapping, horizontally layered reflections.

Most of the regional lateral facies changes are observed in a general E-W direction, which could hypothetically point to roughly north-south striking tectonic structures dividing the basin in subbasins. However, most of the effectively mapped tectonic structures in the area show a WSW to NNE strike and according to the analysis of available seismic data there is in most cases no evident direct relationship between seismic facies changes and identified tectonic structures. The bodies characterized by dipping reflections build up a positive relief on a more or less flat underground and are interpreted as big sand waves or dunes. Their occurrence may reflect paleo-oceanic current patterns. Although tectonic movements may have influenced the general Middle Jurassic depositional environment in Northern Switzerland, the observed regional facies changes cannot generally be directly related to underlying tectonic structures.

Geomorphological and geochemical evidence of paleo-vertisols in relationship with Quaternary climatic changes in Far North Cameroon

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Continental Carbonate Formations (CCF) containing nodules are observed in a carbonate-free watershed of the Mayo Tsanaga (belonging to the Chad basin, Maroua region, Far North Cameroon). The regional climate has a Sudano-Sahelian regime. CCF in the Maroua region have various morphologies, such as mounds, flat circles, and “whalebacks”. They are always surrounded or even buried by carbonate-free alluvial sediments. Calcium carbonate nodules, a centimetre to a decimetre in size, cover the CCF surface. They are also present in deeper horizons, but in lower quantities. These nodules represent an important quantity of calcium "trapped" as carbonate in a silicate watershed. According to the setting, CCF seem to be in disequilibrium both geomorphologically and geochemically with the present-day environment. The aim of this study is to identify processes leading to their formation and breakdown, by identifying the general characteristics of CCF, as well as the associated Ca distribution.

Characterisation of the soil matrix associated with CCF and nodules was performed using X-ray diffraction for the mineral content, X-ray fluorescence for the elemental chemistry, laser diffraction for grain size analysis, and mass-loss after HCl dissolution for carbonate content. pH_{H2O} was measured on the soil samples, and exchangeable cations were extracted by the cobaltihexammine chloride method and determined using ICP-OES. Radiocarbon dating on carbonate was also performed.

The structure and texture of soil matrix associated with CCF are massive and clayey. Soil pH_{H2O} ranges from 7.5 to 9.6 and soil carbonate content from 1 to 7 wt%. Calcium is the major cation in the exchangeable complex and ranges from 12 to 23 cmol+/kg. Total calcium content ranges from 8 to 24 mg/g in soils associated with CCF. The soil mineralogy is mainly composed of quartz, K-feldspar, Na-plagioclase, and phyllosilicates, as well as calcite and ankerite, but in smaller amounts. Smectites and kaolinite are the major clay components. On the other hand, the carbonate content is about 60 wt% in the nodules. Their mineralogy is dominated by calcite, quartz, K-feldspar, and phyllosilicates, and a small amount of Na-plagioclase and ankerite is present. Clays are mainly smectites, kaolinite, and illite. Dating of a carbonate nodule provides an age of 6029yr BP ± 33 BP, which puts CCF genesis likely during the African Humid Period (AHP ~10000 to 5500 BP). This supports the hypothesis that CCF must have formed in different environmental conditions than those observed today.

Interestingly, in another area near Maroua, vertisols developing on alkaline rocks with carbonate nodules have been mentioned in the literature. This type of soil, enriched in swelling clays (smectites), is known to concentrate soluble compounds (such as sulphate or carbonate) and ions (such as calcium and sodium). It is not surprising then to observe calcium carbonate precipitation. Regarding data previously presented, CCF characteristics are similar to those of vertisols, suggesting a potential genetic link. Consequently, CCF might have been vertisols in the past. In the present-day landscape, they seem to appear as a relict of different climatic conditions.

A PDC event in the Val d'Aveto Formation

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Val d'Aveto Formation (32 – 29 Ma, Northern Apennines, Italy) is a turbidite system, composed for its two thirds of volcanoclastic bodies. In the last 5 years, new studies have been carried on this formation, whose stratigraphic record seems to have been influenced, above all, by the Oligocene particular climatic circumstances and the onset of an explosive volcanism in the sediments source area. In brief, Val d'Aveto Formation represents the onset of a siliciclastic sedimentation in a deep-sea environment, in respond to the Oligocene sea level drops, rapidly exceeded by the incoming of high volcanoclastic supply. Because preliminary fieldwork and pebbles counts on both siliciclastic and volcanoclastic conglomerate bodies have highlighted only a general increase on average clasts size, unexpectedly without substantial changes in lithological associations in the gravel grain size classes, we have initially concluded that the role of an active syn-sedimentary volcanism in a source area may generally increase the energy in sediment transport, and may affect the sediments compositions strongly dependently on grain size. We present here the features of the central thickest volcaniclastic conglomerate body and discuss its probably depositional mechanism in relation to the preservation of the volcanic characteristics in the deep-sea record. After a new fieldwork pebbles count, a matrix sample has been collected in order to be optically observed and to compositionally characterized throughout XRD analyses. Fieldwork pebbles count confirms that gravel lithological association is mostly composed of metamorphic (orthogneiss, paragneiss and quarzites) and sedimentary (overall dark calcilutite limestone) clasts, with minor volcanic and plutonic detritus. Clasts average maximum dimension is around 20cm, and can reach 70cm (an ortogneiss boulder). Shape is generally sub-rounded to rounded, independently from dimensions and lithologies. Matrix analyses reveal that the sample is characterized by a volcanic felty texture, due to the devitrified nature of the ground mass. The mineral fraction is represented by phenocrysts of zoned plagioclase and amphibole, while ortogneissic fragments are included as accidental lithics. XRD results identified plagioclase (59.6%), illite/sericite (22.2%), clinochlore (7.1%), biotite (6.1%) and horneblende (5.1%) as mineralogical fraction. Rare metamorphic accidental lithics have been also documented. Ongoing SEM-EDS analyses will provide us better optical images of the volcanic glass eventually preserved. The matrix microscopical analyses and texture, strongly comparable with PDCs ones, reveals the primary volcanic nature of this conglomerate. Its occurrence and preservation in the deep-sea record of the Val d'Aveto Formation give us another time the opportunity to speculate on mechanisms that can help the flow to get to the water, as well as to preserve its volcanic characteristics. The enrichment in rounded substrate-derived lithic clasts (~80%) indicates that flow was channelized in a continental (mountain?) drainage, where fluvial deposits were incorporated. This process has probably also limited a shocking flow-water mix, as testified by the preservation of the primary volcanic microstructure and the absence of oxidation rims, triggering a low-temperature and, consequently, no-explosive flow-water interaction, once the current started entering the basin.

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Taveyanne sandstones: primary or secondary volcaniclastic turbidites?

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Cropping out from the SW French Alps to the E Swiss ones, Taveyanne Sandstones (Lower Oligocene) are thick volcaniclastic turbidite sequences deposited at the frontal margins of the submarine Alpine thrust wedge. Their significance is strictly related to Periadriatic Magmatism event, which affected the Alpine Chain between 40 and 28 Ma ca. The absence of surely primary volcaniclastic layers, gas pipes and volcanic shards has always been interpreted as the main proof of a post-volcanism erosion supply, strongly constraining the paleo-recostruction of the source area-basin system. However, rapid accumulation in the basin and the lack of time between magmatic primary crystallization, erosion and deposition of the same volcaniclastic material (ca. 0.5Ma) outline more complex interactions between the volcaniclastic supply and the depositional basins. In this work, we investigate the possibility to unravel their primary/secondary nature, also comparing them with modern cases, whose sedimentation is strictly controlled by pyroclastic/epiclastic events. So, new logs have been measured and facies analyses performed on three different localities across the French-Swiss Haute Savoie (Col de l'Oulette, Flaine, Taveyane), and 40 samples of sandstones and shales collected. On them, compositional analyses have been carried out through statistical point counts on sandstones and XRD diffraction on shales. Supplementary XRF analyses have been used to geochemically support the compositional analyses. In general, incomplete Bouma sequences, inverse to normal grain size distributions, angular andesite clasts, plurimetric shale boulders-front and density-stratified events are the main features alternatively characterizing the different turbidite facies of the Taveyanne Sandstones. Petrographic compositions show that the volcanic input (rock fragments and minerals) is definitively more important than the contemporary siliciclastic/carbonatic ones (basement, calcareous and bioclasts fragments) in sandstones deposits, while ratio significantly could decrease in some shales and thinner layers. Combining the dataset obtained with the ones on modern settings, we conclude that, while the siliciclastic/carbonatic sedimentation recorded the tectonic erosion of plutonic/metamorphic and sedimenary covers in the Alpine Belt, volcaniclastic signal was even related to more variable, higher energetic events, carrying on instantaneously huge quantities of material along up to hundreds kilometers down to the submarine Alpine thrust wedge. Moreover, even if probably the major supply was due to syn-volcanic or immediately after volcanic activity remobilitization processes (lahars), some facies could correspond to PDCs sub-acqueous deposits. The alternative presence of angular andesite clasts, inverse to normal grading, plurimetric shale boulders-front and density-stratified events, together with the absence of certain primary volcanic structures, may indicate that only distal, more “turbiditic” parts of the PDCs have been preserved in the Molassa basin, while the proximal ones were eroded together with the volcanic centers during the tectonic evolution of the chain. So, volcanic centers maybe were close to the shoreline, allowing the PDCs to get hot to the water, favoring the elutriation of the fines throughout hydrovolcanic explosions and their rapidly transformation into water-supported mass flows.

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Glacio-isostatically forced proglacial deltas: the example of the Portneuf-Forestville delta, North Shore of the St-Lawrence estuary, Québec, Canada

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Proglacial deltas differ from conventional models by (i) recurrent outburst-flow conditions, (ii) active aggrado-progradation during forced regression (glacio-isostatic rebound). Here we document such a setting based on the North Shore of the St-Lawrence estuary, an area characterized by proglacial deltas initiated during the retreat of the Laurentide Ice Sheet and marine invasion in this glacio-isostatically depressed basin. Our main exposure is an uninterrupted sea cliff, reaching 85 m in height, 7 km in length, allowing the characterization of a late Wisconsinian to early Holocene succession (architecture from panoramic photographs, sedimentological logs, geomorphology of the hinterland, ^{14}C dating). Marine limit (highest marine sediments) lies at 140 m.a.s.l. and correlatively deep prodeltaic deposits outcrop at the current shoreline.

The Portneuf-Forestville delta initiated at ca. 11.5 ka Cal BP reflects stabilization of the retreating ice margin on coastal basement highs. Two major structural valleys drained meltwater flows which differ in their stratigraphic development. At the shallower valley mouth (Forestville), the stillstand allowed the development of an outwash fan, initially subaqueous but rapidly growing into a fluvioglacial fan (outburst-related mega-conglomerates, kettle holes). Coeval facies of the delta front comprise sandy turbiditic lobes and channel-levees. In the axis of the deeper Portneuf valley, deposition of muds and ice-rafted debris reflect the activity of meltwater plumes in front of a marine-based ice margin.

A subsequent retreat of the ice-margin and the associated marine invasion farther inland turned the Portneuf valley into a fjord setting, while a proglacial lake formed in the Forestville valley. Proglacial streams carrying large amount of sand-sized sediments fed a fjord-head and a moraine-dammed lacustrine delta, respectively. The rapid progradation of these two adjacent but contrasted systems filled up the entire in-valley accommodation space.

Outwash deltas prograded beyond the mouth of the valleys (onto the wave-influenced marine shelf) and became coalescent. The two deltas merged in a single one with a tripartite architecture: delta plain (braided streams), delta front and bottomsets (settling from buoyant meltwater plumes under tidal influences, sandy turbidites). Delta front deposits are distributed along foresets with 8-12° slopes, including background-stage mouth-lobe deposits (upper part) and diversified facies suites reflecting proglacial outburst flow conditions (lower part): muddy channel-levees, turbiditic sandy lobes, debrites & slump. The proglacial delta migrated almost 10 km in 1000 years while rates of relative sea-level fall reached 5-10 cm/y. This system remained active until the ice-margin withdrawal outside of the Portneuf and Forestville river watersheds, at ca. 10.5 ka Cal BP.

Throughout the proglacial delta evolution, no major fluvial incision has occurred owing to a proglacial fluvial equilibrium profile that was steeper than the descending regressive accretionary shoreline trajectory. The large amount of glacier-derived sediments is responsible for such a stratigraphic architecture, despite coeval high rates of RSL-fall. Severe river entrenchment essentially resulted of the paraglacial evolution that was characterized by low sediment supply in a setting of decreasing rates of glacio-isostatic uplift.

The rules of "collapsed" karst reservoirs development in Ordovician strata, Daniudi area, Ordos Basin, West China

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Due to wide application of horizontal well fracturing technology in Ordovician strata, Daniudi area, Ordos Basin, West China, Karst reservoir exhibits its great potential of oil and gas production, regardless of its low porosity and permeability, strong heterogeneity. A series of research has been conducted, which include core observation combining with well-logging, lithofacies and reservoir petrophysical data analysis. The results suggest: (1) Karst reservoir is characterized by low porosity (averaged value of 3.8%) and low permeability (averaged value of 0.052md); the pore space is mainly composed by dolomite intercrystalline pores, intercrystalline dissolution pores and rare gypsum dissolution pores. (2) Related to the regional tectonic uplift, three Karst cycles can be identified in Majiagou Formation, late Ordovician strata. Upper two karst cycles formed in the earlier time, have larger scale than the lower cycle; therefore the development of karst reservoir is mainly related to the upper two karst cycles. (3)The long-term dissolution of gypsum-dolomite layers produces fractures in cave-roof zone and finally collapse of overlying strata, forming a thick layer of breccias. (4) Reservoirs mainly develop in crackle-mosaic breccias areas with relatively low karst effect, which distribute in monadnock of palaeogeomorphology slope and intact vadose zone of upper two karst cycles vertically. For the further exploration in this study area, the research on karst cycles and lithofacies will play significant role in the reservoir predication.

Key words: karst; reservoir; lithofacies; Ordovician; Ordos basin

Late Cenozoic tectono-stratigraphic evolution of the Western Alboran Sea basin: insights on the geodynamic history

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During the Neogene, the geodynamics of the Mediterranean Sea was marked by the development of backarc basins initiated after a major change in the subduction regime, during the Oligocene. The Alboran domain represents the westernmost termination of the peri-Mediterranean Alpine belt orogeny. Its arcuate shape, delimited by the Betic and Rif fold-and-thrust belts, is the result of subduction, collision and slab migration processes that mainly occurred during the Miocene. The thickest and oldest sedimentary depocentre, the Western Alboran Basin (WAB), has been created and developed coevally with the exhumation and denudation of its underlying metamorphic continental crust. The Western Alboran Basin formation has always been a matter of debate as it has been defined either as a backarc or a forearc basin. According to its internal geometrical configuration, authors differently interpreted its tectonic formation. Based on recent 2D seismic profile analysis, combined with older seismic database and field data compilation, we clarify the tectonic and stratigraphic history of the Western Alboran Basin. A thick pre-rift sequence is observed beneath the Miocene basin and interpreted as the topmost basement complex composing the Alboran domain (Malaguide/Ghomaride complex). The structural position of this unit by comparison with the exhumation history of the metamorphic basement underlying the basin, leads us to interpret the Early Miocene subsidence of the basin through an extensional detachment. Above the Early Miocene, a thick Serravallian siliciclastic sequence shows almost no extensional structures and its geometry is that of a sag basin, that evolved until the Late Tortonian and followed the migration of the slab during its westward retreat, subsidence being mostly driven by the downward pull of the steep migrating slab.

The Early Paleozoic Tectonic Transformation of the north margin of Tarim block, NW China: Constraints from detrital zircon geochronology and provenance system

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Basin depositions, especially the clastic sediments adjacent to the orogenic belts, record the orogenic tectonic evolution information in a great extent. Hence, provenance analysis has been a common means in studying paleogeography reconstruction and basin-range coupling. Tarim Block was located south to Central Asian Orogenic Belt (CAOB) adjacently during Paleozoic, thus the northern margin of Tarim Block is a key area for us to understand the basin-range coupling process and geodynamic mechanism between them. Massive studies have been conducted on whether the northern Tarim margin was passive or active during the Paleozoic, but the conclusions remain hugely controversial. With the aim to place tighter constrain on the above issues, we conducted studies on Ordovician-Silurian detrital zircon LA-ICP-MS U-Pb-Lu-Hf dating of several sandstone samples from the north margin areas of Tarim block, i.e., Quruqtagh and Tabei.

In Quruqtagh, two studied Upper Ordovician sandstone samples yield generally five age groups of 527–694 Ma, 713–870 Ma (peaking at 760 Ma), 904–1090 Ma, 1787–2094 Ma (peaking at 1975 Ma) and 2419–2517 Ma, which are highly consistent with those of the Tarim basement. Besides, no Early Paleozoic ages signifying subduction or collision events of the periphery tectonic-active belts were detected in the two samples, indicating that the Middle-Upper Ordovician detrital sediments in South Quruqtagh and northern Mangar depression were mainly derived from intracontinental uplifts, i.e., the North Quruqtagh uplift or the Tabei paleo-uplift. In terms of Hf isotopic compositions, 98 percent of 713–870 Ma detrital zircons are characterized by negative $\varepsilon_{Hf}(t)$ values ranging from −38.07 to −0.61, which can be matched well with those of Neoproterozoic granites from the Quruqtagh area. Consequently, we can conclude that the northeastern Tarim margin did not experience evident tectonic activities and acted as a passive continental margin during Late Ordovician. However, the Upper Silurian sandstone samples from Quruqtagh area yield entirely different U-Pb dating and Hf isotopic composition features from the Upper Ordovician ones. Specially, a small amount ages of 420-430Ma, close to the depositional age, are detected from the Upper Silurian detrital zircons, and CL images show the 420-430Ma zircons yield euhedral crystal and magmatic oscillation zone, indicating that the provenance are proximal magmatic rocks. Coincidently, the magmatic rocks owning the formation ages of approximately 420 Ma have been gradually discovered in Korla area during recent years. Based on those above, we consider that the 420-430Ma zircons are derived from the northeastern Tarim magmatic belts generated by the southward subduction of the South Tianshan Ocean.

Conclusively, the clastic rocks in northeastern Tarim margin did not reveal evident information of juvenile magmatic-arc material, indicating the South Tianshan area was of back-arc calm phase generated by the southward subduction of the Terskey Ocean in Late Ordovician. With the southward subduction proceeding, the South Tianshan Ocean formed due to the back-arc extension in early Silurian. To late Silurian, the South Tianshan Ocean conducted southward subduction to Tarim Block, causing the northeastern Tarim margin change into an active continental margin proved by the emergence of evident juvenile materials.

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Seismic Sedimentology Study of the Tertiary Hetaoyuan Formation in the central-south of the Biyang Sag, Nanxiang Basin, China

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The main objective of this article has been to demonstrate the utility of stratal slice images for exploring the sequence stratigraphy and sedimentology of complex depositional systems. A seismic-sedimentologic study was performed to map sediment-dispersal characteristics of the Tertiary Hetaoyuan Formation in the central-south of the Biyang Sag, located in the Nanxiang Basin of China. The Biyang Sag is underlain by a productive, petroleum-prone, non-marine Cenozoic-age stratigraphic section. Main data types in this study area are wire-line logs and 3D seismic.

A meaningful development in improving thin-bed seismic imaging is seismic sedimentology. The specific objectives of this investigation are to (1) construct the high-frequency 3D sequence-stratigraphic framework, (2) define the general depositional systems with each of four-order sequences and make clear their distribution and evolution on the basis of stratal slices and wireline-log facies patterns, and (3) develop the sequence stratigraphy and sedimentary models and predict the favorable area for further exploration and development.

The seismic attribute used in the stratal slicing was inverted AI. AI is a useful indicator of lithology in the process of demonstrating the sizeable difference between sandstone and shale. 4 representative AI stratal slices were selected for discussion in this article to provide support for prediction the lateral changes of the thin sandbodies. The study survey is dominated by three seismic facies: strongly negative amplitude (red), weakly negative amplitude, and positive amplitude (black). At the edge of the sag, appears weakly negative amplitude with mostly chaotic reflections. Strongly negative amplitude is abundant in the northeast study area, being imaged on one-third of the amplitude stratal slices. The center of the study area displays a broad positive amplitude. Note that the continuity of various seismic facies was damaged slightly for the existence of several faults.

1. The main study strata, the upper member 3 of the Hetaoyuan Formation, were divided into 4 fourth-order sequences.
2. Four types of depositional systems: near-shore subaqueous fans, braided deltas, slumped turbidite fans and shallow to deep lacustrine systems, were identified on well-based analysis of sedimentary facies.
3. Seismic sedimentologic study of the Hetaoyuan Formation in this study area highlights distribution of the most important reservoirs. The gentle- sloping north tectonic zone is composed of braided deltas. The steeply-sloping south is tectonic zone represented by near-shore subaqueous fans. In the deep central-depression of the Biyang Sag, the Hetaoyuan Formation is composed of slumped turbidite fans and shallow to deep lacustrine deposits.

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Pyroclastic dune bedforms from the 2006 eruption of Tungurahua

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Introduction

Pyroclastic density currents (PDCs) are fast and dangerous mass flows produced by explosive volcanic eruptions. They belong to the group of particulate density currents, i.e. mixtures of particles and ambient fluid that behave, as a whole, in a manner similar to a homogenous liquid flow, the source of momentum being their higher density compared to the ambient fluid, and the excess density agent being the particle load. Deposits of dilute PDCs (i.e., traction dominated basal boundary and low particle concentration) often exhibit cross stratification and dune bedforms (DBs) with a characteristic sedimentary signature. Analysis of DBs provides an essential insight for the understanding of the parental flow dynamics, yet they remain poorly understood and described. We document PDC cross-stratification from the 2006 eruption of Tungurahua (Ecuador) and suggest an interpretation for the main characteristics.

Methods

Our data comprises results from surface geomorphological eye-witness classification as well as terrestrial laser scanner (TLS) surveys for numerical quantification. Internal patterns are documented through freshly lain open outcrops for general description, lacquer peels that permit fine scale analysis and ground penetrating radar (GPR) surveys for the 3D evolution. Finally, we use results of wind tunnel measurements to support our interpretations.

Results

Four types of outer shapes are recognized in DBs, each of them outcropping in distinct parts of the depositional areas. TLS data analysed with Matlab permit the measurement of slope (0-35º), length (1-20m) and thickness (0.1-1.6m) of DBs without user bias. The internal structures mainly consist of stoss-aggrading patterns, either thick (up to 20cm) massive layers, or crudely laminated bedsets of ash. From lacquer peels, one can observe that many of the stoss-aggrading sets are in fact made up of ripple-sized foreset laminae. Overturned laminae (ca. 5cm expressions) are present and seem to result from basal shear instabilities, as also observed in other deposits. From GPR data, one observes that within a single DB, the patterns can laterally evolve from stoss-aggrading, to aggrading, to stoss-erosive. The internal images of individual surface expressions show that the outer shape is a record of late stage sedimentation, but the entire bedform is a complex composite structure made of several successive small scale packages with different sedimentary patterns. Wind tunnel measurements using pyroclasts suggest that the distinct shape of the latter has not a first order influence on the saltation threshold, but that the characteristic stoss-aggrading structure of DB is related to the bed shape and particulate density current nature of the parental PDCs.

Conclusion

Pyroclastic dune bedforms record various and detailed information about the flow dynamics during their sedimentation. However, their description has often been hindered by hasty interpretation as antidunes. We suggest an alternative genesis that is controlled by the basal boundary together with the particulate-density-current nature of the flows. This interpretation can thus hold for bedforms with similar characteristics from e.g. turbidity currents, glacial outbursts flows, and floods.

Soft-sediment deformation and overturned beds in deposits of dilute pyroclastic density currents

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Deposits of dilute pyroclastic density currents (PDCs) are commonly cross-stratified. This is often interpreted as indicating a tractional basal boundary layer of the parent flow (saltation dominated). Occasionally, this bedding can exhibit convolutions and distortion of a limited stack of beds, known as soft-sediment deformation (SSD). SSD has received considerable attention in recent years and has been documented for many types of sediments and environments. Several types of deformation exist and are generally interpreted as related to fluid escape, rapid loading of sediment, syn- or post- sedimentation shearing, or represent seismites. We document examples from deposits of dilute pyroclastic density currents, which are likely to have undergone any of the above mechanisms.

Examples from the Tungurahua (Ecuador) 2006 eruption consist of overturned beds in the downstream direction with a convolute shape. They have small amplitudes and seem to affect no more than 5 individual laminae of mm scale thickness, on a length of ca. 5 cm. They lie on the lee side of a dune bedform, around 20 cm down the crest. Curiously, 2 individual sequences of overturned beds lie almost on top of each others, separated by sets of undisturbed, planar laminae. They cannot be correlated with any impact sag and the eruption is known to have been “dry”, i.e. the deposits have never been water saturated. The Tungurahua overturned beds can clearly be identified as syn-depositional convolute stratification, most likely due to basal shear by a granular traction carpet.

The SSD structures from Ubehebe (USA) and Purrubete (Australia) craters also exhibit overturned beds in the direction away from the vent. They have amplitude of ca. 10 cm and repeat laterally at least 4 times in train. A slight size increase is visible between each “convolution”. Interestingly, the sequence in both cases consists of underlying and overlying massive ash with ca. 20 cm of planar stratification of fine and of coarse ash where the disturbance occurs. Small scale overturned bed with an eddy shape also occur around 40 cm below the main deformation for a single preserved strata in the Ubehebe outcrop. Numerous convolute beds with no specific orientation have also been documented there. Both craters are interpreted as related to phreatomagmatic eruptions. The SSD could thus result there from fluid (water) escape, with or without seismic triggering, some pressure drop related to the volcanic column, or correspond to shear instabilities at the base of the flows.

At Laacher See (Germany), SSD occurs as angular overturned beds with large amplitude (ca. 70 cm) for length of ca. 1 m. It encloses several thick (>10 cm) beds of ash and of lapilli. Overlying and underlying beds are undisturbed and planar. This single structure is anecdotic and only one other occurrence of overturned beds of smaller dimensions was found approx. 100 m away. This SSD event can be related to some kind of small-scale slumping, with or without seismic, flow shear or impact sag trigger, at the contact of a fine-grained sliding layer at the lower boundary of the deformation.

The interpretation of SSD structures in the pyroclastic context is complexified by the likely occurrence of many types of triggers. It can however bring fundamental insights into the parental flows’ particle-concentration, presence of water and seismic activity during or after deposition.

Using sedimentological principles to trace the transition from active rifting to post-rift tectonics: A case study from the Cambrian–Ordovician in northern Tasmania, Australia

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The Upper Cambrian–Lower Ordovician siliciclastic sequence in northern Tasmania, Australia, represents an excellent case study to trace the transition from an active rifting succession to a post-rift system.

The initial rifting event developed in response to a renewed phase of extension that followed the Late Cambrian Tyennan Orogeny. This rifting event created a complex system of graben and half-graben, providing accommodation space for large volumes of basement-derived material. These basins were initially infilled with extensive alluvial fan and low-sinuosity, multiple-channel braided river successions.

The stratigraphic architecture of the succession comprises a series of fining-up conglomerate, sandstone and (minor) siltstone/claystone cycles that display marked lateral variations in both thickness and grain-size, particularly of the lower conglomeratic sequences where the varying composition and texture suggests considerable relief on hinterland palaeotopography. The documented fining-up signature of the approximately 4,000 m thick siliciclastic sequence suggests denudation of the hinterland source area and a corresponding decrease in sediment supply, with the depositional environment changing from proximal to more distal braided fluvial characteristics with increasingly common marginal marine (tidal) to shallow marine incursions. However, the observed general decrease in grain-size is not uniform, and there are numerous changes in sedimentation as a consequence of uplift and subsidence in the source and basinal areas, resulting in the depocentres shifting and migrating both spatially and temporally as rifting continued.

The depocentres are defined by syndepositional bounding fault systems that are difficult to identify in the field since they are commonly covered with Quaternary scree and talus. However, the distribution of thickly-bedded, coarse-grained conglomerate sequences, the juxtaposition of differing lithological successions, and the construction of numerous geological cross-sections give insights to the location and position of several major bounding faults. These faults were subsequently reactivated during the Early–Middle Devonian Tabberabberan Orogeny, and a significant amount of reverse movement is recorded on the basis of structural restorations.

Provenance of detrital sediments is a vital tool in understanding the source terrain and basin-wide dynamics. Consequently grain-size, composition of clasts and populations of heavy minerals have been used to provide information on the nature of the bedrock and weathering processes operating in the source area. A fundamental difference in clast provenance is demonstrated in the more northern and western parts of the research area where chert predominates, compared to the southern section where the clasts are dominantly quartzite. The spatial and temporal migration of depocentres is documented in the Badgers Range where two fining-up successions are separated by a slight angular unconformity with a lower quartzite-rich sequence being succeeded by a chert lithic-rich sequence. It is apparent that depocentres were compartmentalised by topographic highs, and the sedimentary fill of these depocentres reflects the lithological composition of these highs.

Keywords: alluvial fan, braided fluvial, Cambrian–Ordovician, rifting, Tyennan Orogeny, Tasmania, Australia.

Comparing ooid formation processes in lake deposits of the Cretaceous Pozo D-129 Formation, Argentina: the role of microbes

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Several cores from the Cretaceous Pozo D-129 Fm. (Barremian-Aptian) at the northern flank of the Golfo San Jorge Basin underwent a detailed sedimentological analysis. Two of these cores (i.e., wells A & B) show the presence of several intervals of ooids. Ooid formation is still a matter of debate as they are generally assumed as resulting from purely physicochemical processes, while microbial activity has been recently identified to play a key role in freshwater ooid formation. Petrographic studies indicate in well A, that the presence of a nucleus is occasional, and in well B, ooids have a nucleus and some show polynuclei. Mineralogy of the ooid grains is quite different in both wells: ooid cortices in well A are composed of fibro-radiaxial calcite and sparite containing organic matter, while in well B, Mg-carbonates are dominating. Elemental mappings coupled with scanning electron microscopy indicates that the ooids in well A are mainly composed of Ca-carbonate, whereas the matrix encasing the ooids is mostly composed of Mg-Si phases. In well B, cortices are composed of low Mg-calcite, which is associated with extracellular polymeric substances (EPS), while no Mg-Si phases have been identified in the matrix. Well-preserved microbial remains have been found in these ooid facies as honeycomb-like arrangement of EPS, coccoid and rod bacteria, as well as microbial filaments closely associated with the Si-phases. Therefore, the presence of microbial remains and the high TOC content in the studied Cretaceous samples would support that microbes play an important role in ooid formation, which may have impacted porosity.

Impact of microbial activity on reservoir quality in tuffaceous sediments

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The Golfo San Jorge Basin (Southern Patagonia, Argentina) has one of the largest oil accumulations in Argentina. It contains a volcanic-sedimentary complex comprising an Upper Cretaceous fluvial system (Comodoro Rivadavia Formation and El Trebol Formation) and an overlying Paleocene marine system (Salamanca Fm. and Glauconitic Mb). The underlying Lower Cretaceous fluvial and lacustrine systems (Mina del Carmen Formation) have always been considered to be of secondary economic interest, although this formation displays, in certain areas, unusual high porosity and permeability. These reservoirs contain tuffaceous sandstones and vitric tuffs, which have been strongly impacted by diagenetic processes.

The research presented here focuses on the porosity and on the presence of microbes within organic matter (OM), which may have played a role in mineral dissolution. Characterization of these tuffaceous sediments has been made using microscopic (optical and electron) and mineralogical (XRD, Spectral Gamma Ray and Photoelectrical factor) approaches, in combination with gamma ray logs. Special interest has been focused on the abundance and preservation of microbial remains.

Preliminary results show dissolution of the vitric matrix and feldspars along with re-precipitation of rims around these crystals. Quartz also shows similar features suggesting pH variations triggered dissolution, which has occurred at an early stage Recrystallization occurred at a later stage with the precipitation of tiny crystals of feldespars, quarz and clays (smectite). These crystals also show dissolution along their euhedral faces. Extracellular polymeric substances (EPS) and filaments have been found within the porosity suggesting that this type of induced pH variations may have been the result of complex microbial processes. Precipitation of framboidal pyrite within the vugs was most likely of microbial origin and indicates that conditions were anoxic during oil migration.

Rapidly deposited layers from Western Hudson Bay (Canada): a possible record of floods from the Nelson and Churchill Rivers in the last 500 years

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Hudson Bay is a large shallow inland sea that receives about 30% of the total Canadian river runoff and experiences a complete annual sea-ice cover. With their mouths located in western Hudson Bay, the Nelson and Churchill Rivers drain watersheds across several Canadian provinces, making their hydrology and sediment discharge highly sensitive to climatic oscillations (NAO and AO) and environmental changes in central Canada. Moreover, these rivers were dammed in the 1970s, and a major part of the natural Churchill River flow has been diverted to the Nelson River channel. Here, by analysing radiocarbon- and ^{210}Pb-dated sediment cores recovered at their mouths on board the CCGS Pierre-Radisson as part of the ArcticNet program, we reconstruct variations in river dynamics in relation to climatic and anthropogenic changes during the last centuries or millennia. In order to achieve this goal, two gravity cores were collected near the Nelson River mouth (778 and 780), one at the Churchill River mouth (776), and a fourth one 200 km offshore from these rivers (772) that will serve as a witness core without the major influence of a river. Back in the laboratory, all the cores were imaged by CAT-scan, and their physical and chemical properties measured using a Multi Sensor Core Logger (MSCL). Discrete samples were also taken to determine the grain size, as well as the elemental and isotopic composition of carbon and nitrogen. Moreover, an Alternating Gradient force Magnetometer (AGM) was used on some samples to measure the rock-magnetic properties of the sediment, reflecting changes in magnetic grain size and mineralogy.

Preliminary results indicate that the offshore core (772) is homogenous and consists of fine silt, whereas the three river mouth cores (776, 778 and 780) exhibit greater sediment variability, alternating between finer and coarser silt with occasional fine sand layers. According to ^{210}Pb and ^{14}C data, core 772 spans the last 1700 years and most of the physical sediment properties do not show significant variability. However, elemental and isotopic C and N data indicate that the organic matter content in the sediment increases during the last 300 years, possibly reflecting an increase in primary production. On another hand, ^{14}C and/or ^{210}Pb data for cores 776, 778 and 780 suggest that they span less than the last 500 years. Most of cores 778 and 780 consist of sediment layers characterized by a coarsening-upward unit followed by a fining-upward unit, without traces of bioturbation and often laminated. These features are typical of hyperpycnal currents caused by river floods, and may have resulted from floods of the Nelson River since the last few centuries. These rapidly deposited layers may explain the ^{14}C age reversals obtained for these cores and the anomalous ^{210}Pb activity observed in core 780. Further work will focus on the sedimentology of core 776 (Churchill River) in order to assess the climatic and anthropogenic factors controlling the recurrence or magnitude of rapidly deposited layers at both river mouths.

The surface sediments of Lake Biel – 35 years later

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Lake Biel is a large lake (15 x 4 km, 31 m deep on average) located on the Swiss Plateau, whose watershed includes nearly 20% of Switzerland. Since the rerouting of the Aare River, engineered at the end of the 19th century, the lake-water has a relatively low residence time of 58 days. This rerouting considerably changed the sediment delivery from the catchment, with the Aare River now delivering 80% of the water and suspended sediment to the lake.

Studies of sediments and circulation patterns in Lake Biel were conducted more than 30 years ago, suggesting that inflow-induced currents play a key role in the dispersion and deposition of catchment-derived particles in the lake (e.g. Nydegger, Beitr. Geol. Schweiz, Hydro. 16, 1976; Weiss, Univ. of Bern, Switzerland, 1977).

In April 2014, we recovered 50 surface sediment samples throughout the lake. This contribution will not only compare the composition of surface sediments (using calcium carbonate content and particle-size distribution) to the results obtained 35 years earlier and thus retrace its evolution, it will also present results from additional tracers of particle provenance, transport and deposition within the lake. Sediment resuspension will be assessed using 7Be, a naturally occurring radioisotope. On the other hand, man-made radioisotopes such as 60Co and 137Cs will be used to investigate the distribution of river-borne pollutants, the nuclear power plant "Muehleberg" being located on the Aare River ~20 km upstream of Lake Biel.

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Paleoenvironmental conditions at the western margin of the Bangombe Plateau, Francevillan basin, Gabon: preliminary results from a new drill cores campaign

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The Franceville basin (2.1 Ga) in southeastern Gabon host exceptionally preserved unmetamorphised and almost undeformed shaley series covering a surface of ≈ 35 000 km2 with variable thicknesses from 400 to 1000 m. In particular, the FB formation contains a rich suite of black shale and associate Mn-carbonates deposits that represent the protore of the Mn-oxide ore mined on the Bangombe plateau. Since the discovery of the oldest multicellular fossils, this formation focused the interest of the entire scientific community for paleoenvironment characterization and oxygen emergence; in particular, the Lomagundi event was recently evidenced by isotopic analysis (Mo, C, O).
Despite these interests, the paleoenvironment and biochemical conditions of the FB unit and in particular, the depositional mechanisms, paleobathymetry, paleoatmosphere, oxygen conditions and associate biochemical processes still remain questioned or even disputed.
This work is the first systematic study on recently drilled cores through the upper part of the FB1 series along the western margin of the Bangombe Plateau with complementary results from outcrops and ancient drill cores. The objective is a detailed characterization of the paleoenvironmental conditions in particular of the upper part of the FB1 series.
Preliminary results based on sedimentological, petrological, mineralogical and geochemical studies on the first eight drill core, suggest a division in four major lithostratigraphic units. The bottom unit (Unit 1) is composed of alternating silty and clayey shales, and fine grained carbonate-quartz sandstone showing load casts, convolute bedding and overturned to partly draped current ripples. This facies association is typical for suspension settling processes periodically interrupted by bottom currents and nepheloid plumes, partly coming from the platform (carbonate sands) and indicating an overall deepening of the depositional system with emplacement of a current network. Unit 2 is mainly composed of clayey shales with very fine cross-bedded sandstone lamina set. Increased organic matter and clay contents indicate that suspension settling is the dominant process with some inputs of deltaic current, typical for prodelta deposits. Unit 3 corresponds to the Mn carbonates-rich black shale interval locally crossed by sandstone intrusions (injectites). This facies is massive or laminated with variable pyrite contents and typical fenestrae structures indicating microbial to algo-bacterian genesis on the seefloor. Locally some rippled sandstone layers show overturned structures, indicating shearing processes by strongly shearing bottom currents. Additionally, the sandstone layers contains tenth of micron large quartz shards indicating syndepositional volcanic activity. This unit is interpreted as a reducing and confined marine environment periodically submitted to deformation and input by bottom currents. Unit 4, at the top of recovered interval, is composed of sharp-based cross-lamination microconglomerates with dispersed mud casts grading into medium sandstone. It is interpreted as the progressive terrestrial input, with possible submarine channel development. The sedimentary succession evidenced in the western part of the Bangombe plateau recorded anoxic to suboxic conditions with isochronous Mn carbonate formation at the hinge point of the FB megasequence. It argues for deep marine high rate deposition and bottom current processes coming both from a major deltaic siliciclastic wedge and a lateral carbonate platform.

The hypersaline stromatolites of Storr's Lake (San Salvador, Bahamas): toward a unified ecological model of laminae formation?

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Storr's lake is a unique geomicrobiological laboratory that allows the study of stromatolites (laminated microbialites) in several stages of development: (1) early nucleation in metabolically-active *Scytonema* knobs, (2) formation of lamination resulting from iterative succession of two different stages of microbial growth at the top of the structure, (3) emerging microbialite morphology from small, fine-laminated knobs to larger, complex stromatolitic/thrombolitic buildups, and (4), finally, early diagenesis of these organosedimentary structures.

Comparison of modern and fossil stromatolites is often based on microstructure. However, do similar processes in mats always produce the same microstructure? Would different mats no be able to generate the same mineral precipitate? As a consequence, microstructural features alone may be not sufficient when comparing modern and fossil microbialites. As an example, the relevance of modern coarse-grained stromatolites is often questioned for the interpretation of fossil, fine-grained counterparts, because of microstructure differences. Coarse-grained stromatolites are rare in the fossil record and they could indeed represent an end-member in the 'stromatolite family'. However, our study suggests that succession of microbial communities is a defining and maybe a unifying feature of laminae formation in stromatolites. Our conceptual ecological model can potentially be applied to a variety of environments (from hypersaline microbialites to open marine stromatolites). Despite the obvious differences in microstructure, the emerging ecological model of laminae formation resulting from the iterative succession of microbial communities at the top of the *Scytonema* stromatolitic knobs of Storr's lake can be applied to the formation of coarse-grained, open marine stromatolites. Therefore, both fine- and coarse-grained living stromatolites can be used as model systems to understand the formation of fossil laminated microbialites.