25th SwissSed Meeting

Bridging Gaps and Generations in Swiss Sedimentology

Saturday, 25 February 2017

Fribourg

Programme

PROGRAMME

09.30 - 09.55 ***Morning coffee and croissant***

09:55 - 10:00 ***Opening***

10:00 - 10:25 **El Kateb, A., Stalder, C., Neururer, C. and Spezzaferri, S.**: Industrial phosphate treatment waste discharge into the Gulf of Gabes: impact on carbon and phosphorus cycling, sedimentary facies and eutrophication – **Twin-Talk**

10:25 - 10:45 **Slootman, A., Vellinga, A.J. and Cartigny, M.J.B.:** Chute-and-pools: the hybrid bedforms in between antidunes and cyclic steps

10:45 - 11:45 ***Coffee and posters***

11:45 - 12:10 **Martignier, A., Ariztegui, D., Jaquet, J.M. and Filella, M.:** From lacustrine chalk to stromatolites, ooids and micropearls: A SwissSed journey through carbonate biomineralization – **Twin-Talk**

12:10 - 12:30 **Stutenbecker, L., Berger, A. and Schlunegger, F.**: A detrital garnet fingerprint of the Central Swiss Alps

12:30 - 14:00 ***Lunch and group picture***

14:00 - 14:45 **Twin Keynote:** ***Kroon, D. and Hayman, S.***: Development of The Maldives carbonate platform architecture and South Asian Monsoon winds in a global climate change context

14:45 - 15:10 **Garfalakis, P. and Schlunegger, F.**: Controls of sediment flux on changes in style of alluvial megafan sedimentation and shifts in surface slopes – **Twin-Talk**

15:10 - 15:30 **Golreihan, A.,** Claes, H., Marques Erthal, M., Swennen, R. and Foubert, A.: Travertine formation in the vicinity of the Sahand volcano and hypersaline Urmia lake (Azarshahr, NW Iran)

15:30 - 16:30 ***Tea and posters***

16:30 - 16:55 **Feenstra, E., Foubert, A.,** Heindel, K., Jaramillo, D., Birgel, D., Frank, N., Grobety, B, Wehrmann, L. and the Eurofleets Gateway MD 194 Scientific Team: Early diagenesis of CWC carbonate mounds in the Gulf of Cadiz: the interplay between methane seepage and bottom water hydrodynamics – **Twin-Talk**

16:55 - 17:20 **Fentimen, R.**, Lim, A., El Kateb, A., Wheeler, A., Foubert, A. and **Spezzaferri, S.**: Benthic foraminiferal assemblages from small-scaled cold-water coral habitats: the Moira Mounds - **Twin-Talk**

17:20 - … ***Closure and apéro***

POSTERS

Boivin, S., Lathuilière, B., Durlet, C., Lazar, I., Martindale, R., El Khmidi, K. and Martini, R. : Hettangian-Sinemurian coral association of Amellago area (High Atlas, Morocco): first results

El Kateb, A., Stalder, C., Neururer, C., Rüggeberg, A. and Spezzaferri, S.: High resolution monitoring of water parameter using a Lander System: a case study from Lake Murten

Foubert, A., Makovsky, Y., Rüggeberg, A. and the SEMSEEP-Eurofleets Scientific Team: SEMSEEP – Seafloor methane seeps, carbonate buildups and deep-sea corals in an oligotrophic marginal sea – the case of the southeast Mediterranean Eratosthenes Seamount and offshore Israel

Gallegos Montoya, J., Rendon, A., Valla, P., and Anselmetti, F. S.: Sedimentologic evidence for recent tectonic activity of the Sabanalarga fault-system (W-Colombia)

Garefalakis, P. and Schlunegger, F.: Controls of sediment flux on changes in style of alluvial megafan sedimentation and shifts in surface slopes

Hall, E., Feenstra, E., Fentimen, R., Rüggeberg, A., Spezzaferri, S. and Foubert, A.: Paleo-environmental characterisation of cold-water coral carbonate mounds (Melilla Mound Field, Alboran Sea)

Ho, S., Blouet, J.-P., Imbert, P., Hovland, M. and Löwemark, L.: First direct evidence of methane gas conduit formed along endobenthic burrow

Homewood, P., Vanden Berg, M., Mettraux, M., Foubert, A. and Schaegis, J.C.: From Travertine ridges to Microbialite reefs: a source–to-sink record from Pleistocene GSL shorelines at Lakeside, Utah

Koestinger, A.-S., De Boever, E., Jaramillo-Vogel, D. and Foubert, A.: Characterization of ancient hot spring travertine deposits in Gardiner, Montana (USA): Impact of diagenesis on travertine facies

Maillet, M., Wentao, H., Zhuowei, M., Enpu, G., Changqing,G., Yongli, Z., Xiaohong, C. and Samankassou, E.: Evolution of Pennsylvanian carbonate platform and reefs in Southern China

Mencin Gale, E., Jamšek Rupnik, P., Bavec, M., Anselmetti, F.S. and Šmuc, A.: Bridging the gap in Plio-Quaternary stratigraphy at the junction of Alps, Dinarides and Pannonian basin (eastern Slovenia)

Morlock, M.A., Vogel, H., Nigg, V., Ordoñez, L., Hasberg, A.K.M., Melles, M., Russell, J.M., Bijaksana, S. and the TDP Science Team: Climatic and tectonic controls on source-to-sink processes through space and time in a tropical lateritic lake catchment: Lake Towuti, Indonesia

Peyrotty, G., Peybernes, C., Ueda, H. and Martini, R.: Upper Triassic limestones from the northern part of Japan: new insights on the Panthalassa Ocean and Hokkaido Island

Rüggeberg, A. and Foubert, A.: Cold-water corals and mud volcanoes in the Mediterranean Sea – accidental life on a dynamic substrate

Schöllhorn, I., Gertsch, B., Adatte, T., Houben, A., Spangenberg, J., Schwennicke, T. and Föllmi, K.B.: Depositional mechanisms and environmental conditions leading to the formation of phosphorite in the El Cien Formation (Oligocene-Miocene; Baja California-Mexico)

Shawwa, N.A., Chesnel, V., Šegvić, B., Merino-Tomé, O., Fernández, L.P. and Samankassou, E.: Linking subaerial exposures to paleoenvironments and paleoclimates (Valdorria carbonate platform, northern Spain)

Slootman, A., Cartigny, M.J.B., de Boer, P., Samankassou, E. and Moscariello, A.: Upper flow-regime structures in a Pleistocene carbonate ramp (Favignana, Italy): diagnostic criteria and implications

Surdez, M., Beck, J., Koutsoumba, D., Sakellariou, D., Birchler Emery, P., Vogel, H. and Anselmetti, F.S.: Sedimentary response to Holocene sea-level rise in Kiladha Bay, Greece: Implications for coastal sedimentology and archaeological reconstructions

Zwaan, F., Schreurs, G. and Adam, J.: Influence of sedimentation on rift and transfer zone development: Insights from 4D analogue tectonic models

ESPP SwissSed Meeting 2017 - List of participants

Akcar, Naki	Bern	Deleau, Erica	Edinburgh
Aldana, Martin	Fribourg	Lauper, Bruno	Fribourg
Andres, Myriam	Zürich	Maillet, Marine	Geneva
Anselmetti, Flavio	Bern	Marchegiano, Marta	Geneva
Ariztegui, Daniel	Geneva	Martignier, Agathe	Geneva
Bläsi, Hans Ruedi	Bern	Martini, Rossana	Geneva
Blouet, Jean-Phillipe	Fribourg	Matter, Albert	Bern
Bolland, Alexander	Bern	McKenzie, Judy	Zurich
Brentini, Maud	Geneva	Mencin, Gale	Slovenia
Buechi, Marius	Bern	Moradi, Gelare	Lausanne
De Boever, Eva	Fribourg	Morlock, Marina	Bern
Deplazes, Gaudenz	Wettingen	Mulhauser, Leo	Fribourg
Del Pietro, Nocolo	Geneva	Ramseyer, Karl	Bern
El Kateb, Akram	Fribourg	Reber, Regina	Bern
Fabbri, Stefano	Bern	Rime, Valentin	Fribourg
Feenstra, Eline	Fribourg	Rüggeberg, Andres	Fribourg
Fentimen, Robin	Fribourg	Samankassou, Elias	Geneva
Foubert, Anneleen	Fribourg	Schawwa, Nabil	Geneva
Gallegos Montoya, John	Bern	Schöllhorn, Iris	Lausanne
Garefalakis, Philippos	Bern	Slootman, Arnoud	Geneva
Golreihan, Asefeh	Fribourg	Spezzaferri, Silvia	Fribourg
Hall, Efraim	Fribourg	Strasser, Andre	Fribourg
Hayman, Stephanie	Fribourg	Stutenbecker, Laura	Bern
Homewood, Peter	Fribourg	Surdez, Morgane	Bern
Honegger, Louis	Geneva	Vogel, Hendrik	Bern
Immenhauser, Adrian	Bochum	Wetzel, Andreas	Basel
Jaramillo-Vogel, David	Fribourg	Wyler, Patrizia	Fribourg
Koestinger, Anja-Sara	Fribourg	Zwaan, Frank	Bern
Kroon, Dick	Edinburgh		

Hettangian-Sinemurian coral association of Amellago area (High Atlas, Morocco): first results.

Simon Boivin*[(1)], Bernard Lathuilière[(2)], Christophe Durlet[(3)], Iuliana Lazar[(4)], Rowan Martindale[(5)], Khalid El Khmidi[(6)], and Rossana Martini[(1)]

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This contribution is part of the long-term research project on reef and carbonate build-up development (REEFCADE to RM), started in 2007 and supported by the SNSF.

The end-Triassic mass extinction is one of the five largest mass extinctions of the Phanerozoic. The end of the Triassic and Early Jurassic are intervals with profound biotic and environmental changes, characterised by a dramatic decrease in marine fauna diversity. Corals especially suffered very high extinction rates; thus, compared with those of the Upper Triassic, the Early Jurassic is traditionally defined as exhibiting a “reef gap”.

In the literature, there are few occurrences of reefs in the Early Jurassic. In order to better understand these stages, the aim of the REEFCADE project is to study these poorly known corals. The Alpine Tethys area is investigated because genuine frameworks for colonial coral are scarce and concentrated in the western Tethys. During the previous research, conducted as part of a PhD thesis (M. Gretz, 2014), three localities have been investigated: the Isle of Skye in Scotland (Gretz et al. 2013), the Ardèche region in South of France (Gretz et al. 2015) and the Mas de Messier in Languedoc, South of France. In the Hettangian and Sinemurian time, these sites were located in the northern margin of the Tethys (Figure 1).

During this project (S. Boivin, PhD Thesis), we investigate the Hettangian-Sinemurian series cropping out in the Amellago area (Moroccan High Atlas), located in the southern margin of the Tethys (Figure 1). The geological context of Amellago is already known (Sarih et al. 2007; Lachkar et al. 2009; Pierre et al. 2010), but the coral associations have not been studied. To reach the set goals of the on-going project, and taking into account the good results already obtained, an integrated approach involving palaeontology and palaeoecology alongside sedimentology and biogeochemistry, is used to study the new coral association of Amellago. Hettangian-Sinemurian corals from Apuseni Mountains (Romania) discovered by Popa (1981) will be also considered. The poster presents the first results from the field work in Morocco.

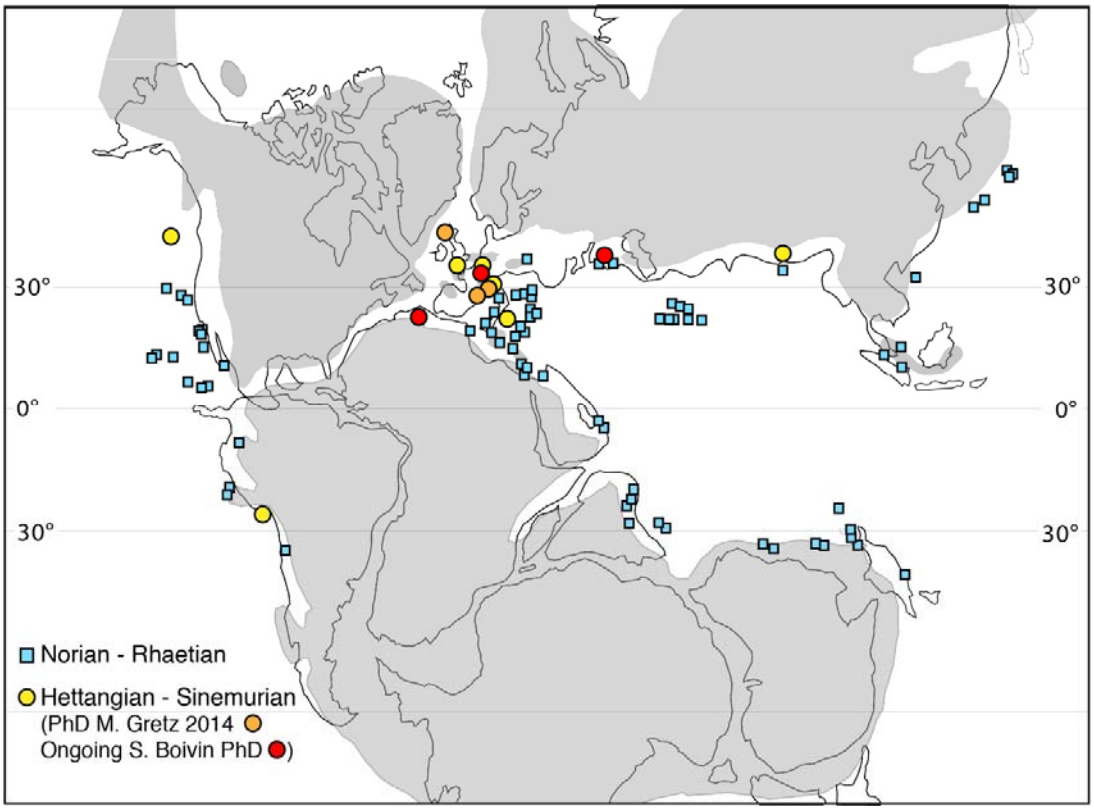

Figure 1. Distribution of coral reefs during Late Triassic and Early Jurassic. Among the Hettangian and Sinemurian reefs plotted with circle, our contributions are showed in red and orange (modified after Lathuilière & Marchal 2009, updated with Popa 1981).

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Gretz, M., Lathuilière, B., Martini, R & Bartolini A. 2013: The Hettangian corals of the Isle of Skye (Scotland): An opportunity to better understand the palaeoenvironmental conditions during the aftermath of the Triassic–Jurassic boundary crisis. Palaeogeography, Palaeoclimatology, Palaeoecology, 376: 132–148.

Gretz, M., Lathuilière, B., & Martini, R. 2015 : A new coral with simplified morphology from the oldest known Hettangian (Early Jurassic) reef in southern France. Acta Palaeontologica Polonica, 60 (2): 277–286.

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Popa E. 1981. La biostratigraphie des formations mésozoïques de la partie orientale de Padurea craiului (monts Apuseni). Anuarul institutului de Geologie si geofizica 58: 203–281, pl. 13–16

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Industrial phosphate treatment waste discharge into the Gulf of Gabes: impact on carbon and phosphorus cycling, sedimentary facies and eutrophication

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The Gulf of Gabes, located in the southern part of Tunisia, can be considered as the most impacted site by phosphate industry in the south of Mediterranean Sea. Several studies show the direct impact of phosphate industries on the marine environment in the Gulf of Gabes. Nowadays, three major factories located at Sfax, Skhira and Gabes produce phosphoric acid along the Gulf of Gabes. During the phosphate treatment, a large amount of phosphogypsum is produced as a waste product. The phosphate industries located at Gabes can be considered as the most polluting because the totality of the waste is directly discharged into the Sea without any preliminary treatment. We decided to study the waste discharge area at Gabes and to compare it with the eastern coast of Djerba which can be considered as a pristine open marine environment. Coastal stations along the Gulf of Gabes and two transect of approximatively 16km long (in front of phosphate industries of Gabes and on the eastern coast of Djerba Island) were investigated in January and July 2014.

Sedimentary phosphorous sequential extraction (SEDEX), Rock-Eval, C/H/N elemental analysis, carbon isotopic composition on organic matter were measured on sediment samples. In addition, X-ray diffraction was performed on sediment samples to identify and to quantify the mineralogical composition. Thin sections were also realized on carbonate nodules found in front of the industrial waste discharge. Water parameters (water temperature, pH and dissolved oxygen) were measured at the sea-floor of each station along the both transects during the expedition in July 2014. In addition, seawater was sampled to measure phosphorus, iron, calcium, strontium, and heavy metals concentrations by ICP-EOS. Video survey was also performed to evaluate the environmental conditions.

Results show a heavily impacted environment in front of the Gabes phosphate industries. Total organic carbon is significantly higher around the polluted site. Phosphorus reservoirs and carbon isotopic signature of the sediments from Gabes are different from Djerba and they are the consequence of industrial waste discharge from the phosphate treatment. Nodule formations are also the consequence of industrial waste discharge where a cyclical mechanism of micritization takes place due to the pH fluctuations. Water analyses indicate a high level of pollution especially in the vicinity of the waste discharge. However, the results indicate also the transport of pollutants by marine currents, from the waste discharge area to the open sea around Djerba Island. In addition, many eutrophication signs were clearly observed or described in the Gulf of Gabes which is the direct consequences of the industrial waste discharge.

High resolution monitoring of water parameter using a Lander System: a case study from Lake Murten

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Water quality parameters provide fundamental information for many aquatic environmental studies. The benthic Lander System we present here is able to record autonomously four main water quality parameters (water temperature, pH, dissolved oxygen and electrical conductivity) in high resolution (every 30s). It can be deployed in different aquatic environments, from normal marine to freshwater environments (e.g., lakes and rivers) but also in marginal environments such as e.g., hypersaline lagoons. The aluminum frame of the Lander System including the tripod provides stability against currents and waves and allows the monitoring in high-energy environments. Three different configurations were tested at Lake Murten in Switzerland. The two first configurations are only related to the location of the batteries: 1) on the aluminum frame of the Lander system and, 2) on a buoy which allowed to change the batteries without to take the Lander System out of the water. For the third configuration, the Lander System was equipped with modem and antenna for transmission of data through the GSM network. The "*Service de l'environnement de Fribourg"* (SEN) monitors Lake Murten since several years. On a monthly basis a water profile is performed at the deepest part of the lake. Usually, strong water mass stratification is observed during the spring season until the beginning of winter. During this stratification, the bottom layer and even the entire hypolimnion became anoxic.

To better understand internal processes and the influence of the atmosphere on the water properties, our Lander System was placed in front of the village of Mur on the south-western part of the lake at 20 m water depth. Additionally, a video survey was performed in the deployment area to collect information of the nature of the lake bottom. Water parameter data were collected from April 9th until September 10th, 2015. Detailed atmospheric data obtained from Meteo Suisse were synchronized and compared to the monitored water parameter. A positive correlation between water temperature, dissolved oxygen and wind speed could be identified. A model was created to better understand the relation between the wind and the water temperature and our results indicate that wind induces a down-welling current, which gradually weakens with increasing stratification. Additionally, a significant decrease of dissolved oxygen was recorded during the monitored period. Indeed, the concentration of dissolved oxygen was at 11 mg/l in April and decreased to 3 mg/l in September. In addition, significant pH fluctuation was recorded for a few days at the end of July 2015 and can be related to three main factors: 1) atmospheric conditions (increase in temperature), 2) combined effects of respirations and increase of planktonic organisms and 3) intensification of microbial activities.

Early diagenesis of CWC carbonate mounds in the Gulf of Cadiz: the interplay between methane seepage and bottom water hydrodynamics

Eline Feenstra*[(1)], Anneleen Foubert[(1)], Katrin Heindel[(2)], David Jaramillo-Vogel[(1)], Daniel Birgel[(3)], Bernard Grobety[(1)], Laura Wehrmann[(4)] and the Eurofleets Gateway MD 194 Scientifc Team

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Modern CWC carbonate mounds are carbonate build-ups on the continental slope at intermediate water depth (below the photic zone), composed by framework builders (cold-water corals), pelagic ooze and detrital material. The interaction of aragonitic cold-water coral (CWC) skeletons, the geochemistry of interstitial pore waters and the alternating carbonate to siliciclastic-rich matrix sediments creates a micro-environment where precipitation of authigenic minerals, e.g. calcite, dolomite, pyrite, and/or dissolution prevail, provoking early stage diagenesis and affecting the paleo-environmental record of the mound. Currently, early stage diagenesis is not yet well understood in CWC carbonate mounds. It is important to study how these diagenetic processes affect the mound record to understand how the mound facies and fabric will be preserved in the ancient mound record.

This study explores early stage diagenesis in two modern cold-water coral (CWC) carbonate mounds, i.e. Alpha and Beta Mound, in the Gulf of Cadiz, Morocco through the study of gravity cores. Because these mounds are subjected to methane seepage (Wehrmann et al. 2011; Pirlet et al. 2012), they provide a unique opportunity to study the interplay between methane seepage and bottom water hydrodynamics in a mound system.

Through microbial lipid marker analyses and $\delta^{13}C$ compositional data, we demonstrate the past and presence occurrence of the anaerobic oxidation of methane (AOM) in response to a fluctuating sulphate methane transition zone (SMTZ) leaving a strong imprint on the mineralogy and fabric of the sediment. The mound sediments are locally semi-lithified and brecciated, and rich in authigenic Mg-calcite, dolomite and pyrite. Aragonitic coral skeletons are only moderately preserved in zones affected by methane seepage.

In the same core sections, we see evidence of classical oceanographic hardgrounds which consist of strongly lithified mud-supported fossil bearing wackestone in which the bioclast-matrix ratio is much higher than the surrounding sediments. Carbonate cements are rich in Mg-calcite and dolomite. Dissolution of the coral skeletons and bioclasts have caused moldic porosity. Hardgrounds evidence that potentially repeated seawater influx and erosional surface processes have been responsible for their formation.

This study shows the tight interaction between methane fluxes and strong hydrodynamic action on the fabric of CWC carbonate mound sediments.

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Benthic foraminiferal assemblages from small scaled Cold-water coral habitats : the Moira Mounds

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Cold-water coral ecosystems are well developed along the North-east Atlantic continental margin, particularly along the Irish margin. Giant to small and numerous cold-water carbonate mounds are located in this deep sea environment. This work focuses on the Moira Mounds, these are small scaled (up to 10 m high and 35 m wide) cold-water carbonate mounds situated between 930 and 1070 m depth and located in the Belgica mound province, Porcupine Seabight. These small carbonate build-ups are mostly formed by living corals and colonize hard substrates creating a network of small patchy mounds. This in turn provides an ecological niche for a diverse fauna, including benthic foraminifera.

We are currently investigating stained (living) and unstained (dead) benthic foraminiferal assemblages from surface samples (0-1 cm; >63 µm, >125 µm and >250 µm size fractions) from the Moira mounds (Eurofleets cruise, 2012) along a North-South transect. Living benthic foraminifera from the Moira mounds are entirely non-documented. Thus our aim is to provide a thorough inventory of live benthic foraminifera in this region in order to better understand these complex environments. Assessing taphonomical biases and different transport processes in such current influenced environments is also a main objective. Furthermore, foraminiferal assemblages prove to be a good tool to better understand current dynamics in the region and their role on mound development. In comparison to larger, better developped mounds in their vicinity, the Moira mounds demonstrate a different bio-sedimentary facies distribution. Thus, in the midst of previous studies of other mounds on the Irish margin (Schönfeld et al. 2011, Margreth et al. 2009), we aim to complete the knowledge of facies distribution, preservation in mound environments and the impact of current dynamics on these environments.

The Moira Mounds were sampled during the cruise funded by the European Union Seventh Framework Programme (FP7/2007-2013), under the EUROFLEETS grant agreement n°228344 (to the University of Fribourg, University of Milano-Bicocca and University College Cork). This study is funded by the Swiss National Science Foundation (project n° FN- 200020_153125).

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Seafloor methane seeps, carbonate buildups and deep-sea corals in an oligotrophic marginal sea – the case of the southeast Mediterranean Eratosthenes Seamount and offshore Israel (SEMSEEP)

Anneleen Foubert*[(1)], Yizhaq Makovsky[(2)], Andres Rüggeberg[(1)], and the SEMSEEP-Eurofleets Scientific Team

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The EUROFLEETS2 SEMSEEP Cruise aimed to exploit the environmental differences between the active and inactive seep areas at the Eratosthenes Seamount south of Cyprus and at the Palmahim Disturbance offshore Israel, constraining the controls and impacts of both systems now and in the recent past. Due to technical constrains, the research has been focused on the Palmahim Disturbance at the Israeli continental margin to study (i) the setting and environmental impact of gas seepages, and particularly their relation to the possible current and past presence of methane hydrates, (ii) the particular environmental conditions allowing the growth of deep-sea corals, and (iii) the relations between the two phenomena in the context of recent global and local environmental changes.

Four overarching objectives have been investigated: (1) Habitat mapping and discrete sampling of seep-related features, carbonate mounds and deep-water coral sites at Palmahim Disturbance, (2) Determination of the physical and chemical environment at active seeps and inactive, deep-water coral sites, (3) Geochemical characterization of carbonate crusts, carbonate mounds, sediments and waters, (4) Characterization of seep and deep-water coral-related (micro- and macro-) fauna.

The EUROFLEETS2 Expedition SEMSEEP with R/V AEGAEO and ROV MAX ROVER is part of a multi-disciplinary investigation of the recently discovered but until now poorly investigated or sampled seafloor gas seeps, associated carbonate structures and deep-sea corals at the Palmahim Disturbance at the Mediterranean continental slope of Israel. The recent discovery of proximate seafloor methane seeps and deep-sea corals in the southeastern Mediterranean Sea provided an exceptional opportunity to investigate their underlying environmental mechanisms.

The SEMSEEP cruise provides new indications for additional presence of these phenomena and carried out detailed controlled sampling of geologic, biologic and sediment samples through the operation of ROV Max Rover and targeted box corer and CTD sampling. Ten ROV dives at five different working areas resulted into a total of ~44 hours video data across 50 km dive transects. Additionally to the collected carbonate crusts, push cores, water samples and hydrographic data by the ROV, twelve box corer and eleven CTD stations complete the station work at the active and inactive seep sites at the Palmahim disturbance and at deeper channel sites.

The huge set of samples collected are currently processed in the home labs for a variety of geochemical analyses on pore waters and sea waters, identification of internal sediment structures and composition using computer tomography and core logging on the box corer cores, micro and macro fauna investigation on and in the sediments, biogeochemical characterization of bottom and surface waters.

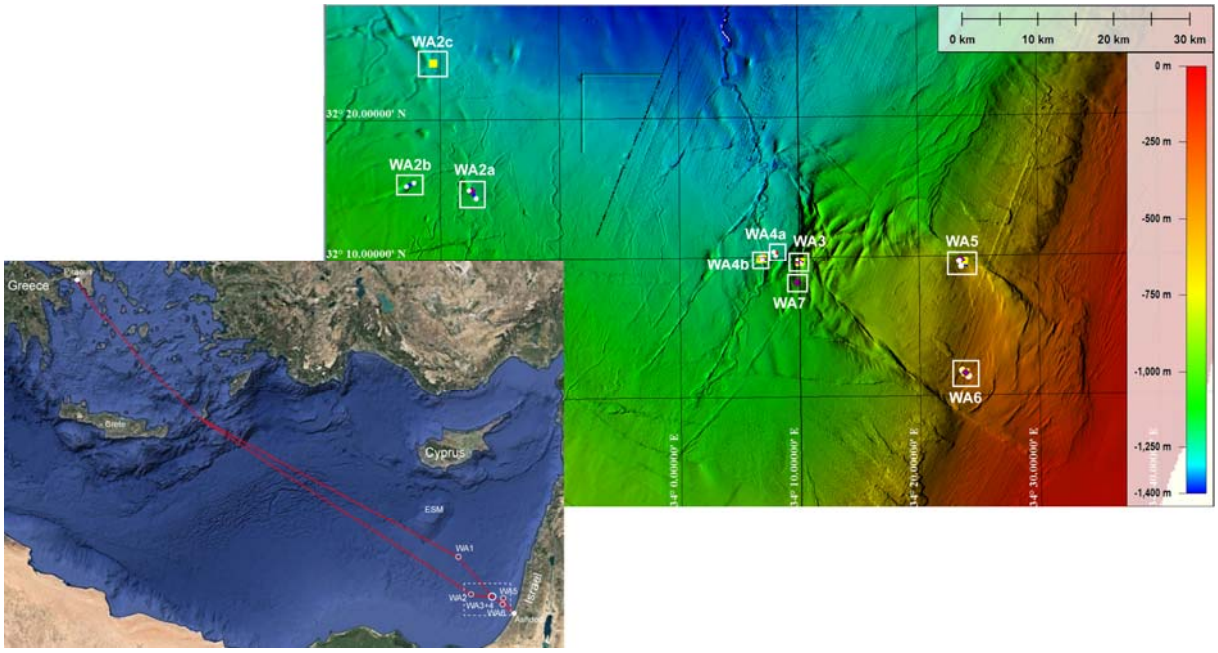

Figure 1. Working areas (WA) and track chart of cruise EUROFLEETS2 SEMSEEP with R/V AEGAEO and ROV MAX ROVER. (Map source Google Earth Vers. 7.1.7.2602 and color-coded bathymetry based on Hall et al., 1994; Hall et al., 2015; and Gvirtzman et al., 2015).

Acknowledgements

We would like to acknowledge substantial and tireless efforts by the captain and crew of R/V AEGAEO and ROV MAX ROVER. The outstanding support of the crew during the preparation and realization of the cruise was a major contribution to this successful expedition. We are also grateful that the cruise was without any accidents and all returned well back to the harbour. We gratefully acknowledge funding for this EUROFLEETS2 cruise from European Union FP7 Programme under grant agreement n° 312762; the University of Fribourg granted project Fonds de recherche n° 609, and The Helmsley Charitable Trust and Charney School of Marine Sciences, University of Haifa, and the Israel Oceanographic and Limnological Research for additional financial support of the cruise; The Israeli Ministry of Infrastructure, Energy and Water for IOLR support; Yoni Esakow and Coral Group Ltd. for donating their in port support; Paradigm for geophysical software sponsorship; the State of Israel Ministry of Foreign Affairs, through their Embassy in Cyprus and the Embassy of Switzerland in Cyprus for their dedicated backing.

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Sedimentological evidence for recent tectonic activity of the Sabanalarga fault-system (Western Colombia)

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Since 1730, historical records of severe infrastructure damage in Medellin city and several regions in northwestern Colombia point to the occurrence of at least five earthquakes of moderate magnitude and intensity around VII in the Mercalli scale. However, knowledge of the seismic sources and processes are still scarce, especially for historical earthquakes with epicenters in the western region of the country. According to previous studies of seismic microzonation in Medellin area, the most hazardous events may originate from the faults located to the west. Moreover, previous studies in the vicinity of the city identified evidence of neotectonic activity and deformations in alluvial sediments within the Cauca River canyon (Woodward-Clyde Consultants, 1980; Suter et al., 2011).

This study investigates the east bank of Cauca River throughout the Sabanalarga Fault System (SFS), which is one of the most prominent active faults in western Medellin city. It aims to evaluate the recent tectonic activity of the SFS through three complementary aspects: (1) regional compilation of historical seismicity, (2) morphotectonic mapping of the surface traces that compound the SFS and (3) paleoseismological assessment of two new trenches with evidence of recent (Holocene?) faulting and liquefaction in fluvial-lacustrine sediments (Figure 1).

Preliminary outcomes show that the SFS can be divided mainly into two branches of strike-slip N-S trending motion with additional vertical components. The Sabanalarga East Fault has a noticeable morphotectonic expression, where the active zone is expressed by linear markers such as sag ponds and structural shutter ridges. Additionally, the important vertical displacement of the fault is expressed by active mountain fronts with triangular facets of different sizes and inclination. In contrast, the Sabanalarga West Fault is obliterated by alluvial fills of the Cauca River, and, for that reason, it does not appear as clearly in the relief expression. However, evidence of faulting in recent alluvial deposits and paleo-landslides relicts (potentially damming the Cauca River in the past) have been identified along this fault.

In order to assess the activity of this fault from a neotectonic perspective, several samples have been collected in the trenches for radiocarbon (charcoal) and OSL (laminated fluvial silty sands) dating, to determine the deposition age of the sediments and thus providing temporal constraints on characteristic earthquakes along with the recurrence periods and their relationship with the different branches of the SFS.

On the basis of empirical relationships of rupture length and vertical displacement (Wells and Coppersmith, 1994), at least one seismic event is identified in two trenches with a Richter magnitude ranging between 6.6 and 7.0, represented in vertical offsets of the fluvial-lacustrine sediments that vary from mm to dm scale. Associated with the seismic event, there is also an indication of liquefaction in the soft sediments of the Cauca River indicating a strong shaking in the area as a coseismic deformation.

These findings at 50 km distance of Medellin city (4 million population) may have strong implications on how government entities consider the hazard in the frame of seismic hazard assessment. Additionally, the Ituango Dam is being built 60 km upstream from the study area, which will be the most important hydroelectric dam of Colombia. Therefore, it is necessary to consider local earthquake sources, which we could only assess through paleoseismology, as instrumental and historical seismic records are insufficient in temporal coverage.

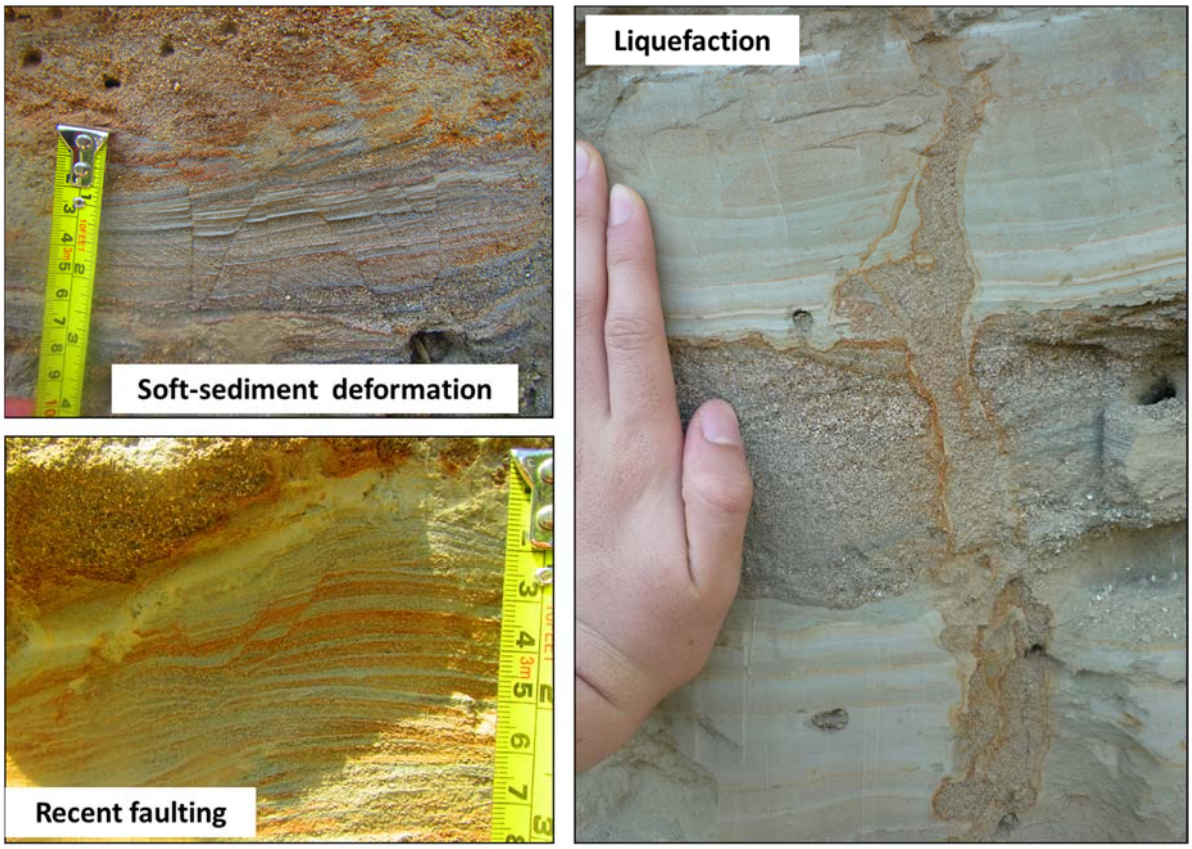

Figure 1. Recent faulting and liquefaction of fluvial-lacustrine sediments in the Cauca River Basin, Western Medellin city.

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Controls of sediment flux on changes in style of alluvial megafan sedimentation and shifts in surface slopes

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Large-scale coarsening and thickening upward megasequences in foreland basins have conventionally been considered to reflect megafan progradation. This is particularly the case for the Late Oligocene, c. 4 km-thick suite of the Rigi megafan conglomerates, situated in the North Alpine Foreland Basin in Central Switzerland, where previous authors have inferred a tectonic control. Although these explanations have been frequently proposed, much less attention has been paid on elaborating the controls of the changes in the volumes, the granulometric composition and the concentration of the supplied sediment on megafan progradation. Here, we link published information about magneto-polarity based chronologies with new observations on (i) changes in stacking patterns of conglomerates, (ii) shifts in depositional style and (iii) fan surface slopes to interpret an increase in sediment flux. We then apply principles of conservation of mass and energy in sediment transport to reveal that this inferred augmentation in sediment flux was also associated with an increase of the concentration and the granulometric composition of the supplied sediment. We conclude that the large-scale coarsening and thickening upward trends at Rigi reflects a change in erosional processes and related shifts in the volumes and composition of the supplied material rather than a tectonic control.

We identified the depositional mechanisms from the stacking pattern and the fabric of conglomerate beds, the occurrence of cross beds, and from dips of erosional scours. We determined changes in megafan gradients using hydrological concepts for bedload entrainment. Related principles predict that a sediment particle with diameter D will be transported if the ratio between the fluid's shear stress and the particle's inertia force ranges between 0.03 and 0.06, which is referred to as the Shields variable ϕ. Following Meyer-Peter and Müller (1948), the fluid's shear stress depends on the hydrological radius, which equals to water depths d for wide channels, and the surface slope. As a consequence, the surface slope S can be computed using Shields criteria for the incipient motion of bedload particles paired with data about channel depths and grain size to be collected in the field (Paola et al., 1992).

However, a non-unique solution for this problem requires that for a given grain size, the corresponding water depth can be independently constrained by observations in the field. Among the various possibilities of water depth, the situation during bankfull discharge is best recognized in the field. We proceeded through measurements of channel heights, which set uppermost constraints on flow depths during high stage conditions, and estimates of thicknesses of foresets and longitudinal bars, which returned lower bounds. Consequently, we used the aforementioned thicknesses and the diameters of the largest grains D_{max} to solve eq. 27 by Meyer-Peter and Müller (1948) for sediment transport, mainly because bankfull

discharge is likely to yield flow strengths large enough to entrain the coarsest-grained fraction of the bedload material, where:

$$S = \Phi \frac{(\rho_s - \rho_w) D_{\max}}{d \rho_w} \quad (1)$$

Here, the variables ρ_s and ρ_w denote the sediment and water densities, respectively. We also determined the sediment calibre for c. 50 sites, where we measured a total of approximately 4500 grains using the point counting method.

The field survey shows that the lowermost conglomerates are arranged as individual and amalgamated stacks of 3 to 4 m-thick beds with a clast-supported, massive bedded fabric. Where visible, conglomerate beds are m-deeply scoured into the bordering mudstones. Towards the top, the conglomerate beds thin to < 1 m. They display shallow scours, a clast-supported and massive fabric, and imbrications in places. Interbedded mudstones are mostly absent. These changes reflect a shift in depositional style from channelized, confined flow at the base of the section, to braided and thus non-confined flow in a more proximal environment towards the top. In addition, the change in depositional style was associated with an increase in the maximum grain size from <15-20 cm at the base of the sequence, to >20-50 cm towards the top. Likewise, bankfull flow depths decreased from > 2 m to < 1 m, albeit with a large scatter. Calculations of fan slopes (eq. 1) reveal that these changes were associated by a >100% steepening of the fan from originally <1±0.25° at the base of the section to >2±0.5° towards the top. The mean grain size remained stationary between 4 and 6 cm, while the sorting decreases from 1-4 $cm^{0.5}$ to 2-5 $cm^{0.5}$ towards the top of the section.

We consider the change in depositional style paired with the augmentation in depocenter surface slope, and the increase in maximum grain size as a consequence of a shift towards a higher sediment flux (Church, 2006). This interpretation is consistent with the results of numerical modelling where large scale coarsening and thickening upward megasequences at constant sediment accumulation rates, as was the case at Rigi, point towards a sediment flux rather than a tectonic control (Paola et al., 1992). In addition, the supply of larger volumes of sediment Q_s and material with larger diameters D conditions that stream power, which is a function of water discharge Q_w and surface slope S, also increased. Lane (1955) proposed that at transport-limited conditions, transport energy and volumes of supplied sediment are proportional. Accordingly, any temporal changes in these variables yield:

$$\frac{\partial}{\partial t}(Q_w S) \propto \frac{\partial}{\partial t}(Q_s D) \quad (2)$$

Because the upsection increase in mean grain size D is much less than the steepening of the fan surface S (~100% form <1° to >2°), the sediment concentration Q_c, which is the ratio between sediment Q_s and water flux Q_w, had to increase through time to follow the proportionality denoted in (2). Accordingly, the ensemble of these changes: a larger sediment flux, higher sediment concentrations and the supply of poorer sorted material implies a surface control in the hinterland through faster erosion and changes in erosional mechanisms. These shifts not only controlled the changes in the depositional style, the fan's morphometry,

but they also influenced the large-scale architectural development including changes in stacking patterns of conglomerates at Rigi. We thus conclude that this megafan evolved primarily as response to changes in Earth surface dynamics in the hinterland.

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Travertine formation in the vicinity of the Sahand volcano and hypersaline Urmia lake (Azarshahr, NW Iran)

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Sub-aerial carbonates, among which travertines, have been envisaged as a Pre-Salt reservoir analogue, alternative to the more conventional lacustrine to brackish stromatolites. The Pre-Salt limestones are covered by a thick package of evaporites forming a very effective seal. However, up to now, no exact environmental analogue has been found. Non-marine carbonates occur in a large range of continental depositional settings. These depositional environments include fresh water, alkaline and saline lakes, sub-lacustrine and subaerial thermal and freshwater springs, karstic deposits, etc. Compared to conventional carbonate reservoirs, the formation and alteration of continental reservoirs is understudied and poorly understood. Due to heterogeneities from µm to kilometer scale, upscaling, modelling and prediction of these reservoirs are challenging. Consequently, well exposed reservoir analogue studies of both active and fossil systems are essential.

The purpose of this study is to determine the origin and characterize reservoir properties of travertine deposits in the Azarshahr Plain (Iran). The Azarshahr Plain is one of the sub-basins of the Urmia Lake basin located in the north-western part of Iran. Spring deposits formed in and around the hypersaline lake Urmia in the vicinity of the Sahand volcano. The Azarshahr's spring carbonates are dominantly fissure-ridge types and occur related to step-over zones of strike-slip and normal faults. They formed (and still are forming today in some places) as seismic scaled structure that can have a length of 2km and a height of 150m. A travertine fissure ridge inside the lake has been observed through seismics and occurs between clay-rich sediments and dolomite-rich units covered by salt deposits.

During this study several active travertine springs and quarries were sampled. Geochemical, elemental, petrological and petrophysical investigations have been carried out on selected samples using ICP-OES, SEM, transmitted light microscopy, Klinckenberg corrected permeability analysis, µCT and XRD.

Based on these observations, topography, chemical composition, gas content, flow rate, vegetation and the input of organic matter in and around the springs are the controlling factors on the formation of different lithofacies and lithotypes. Different lithotypes have been identified, such as conical domes, micro- and macro-terraces, ponds, sub-horizontal and vertical travertine layers, layered travertine along small streams, coated bubbles, pisoids, paper thin raft, shrubs, reeds, soft sediments and crystalline crusts. The spring waters have an ambient T (21-28 ◦C), are highly saline with TDS (g/L) of about 1.6-2.8, and are enriched in iron

and in CO2. The petrophysical properties and colors of the travertine varies according to the location. The colors are between red, creamy and white. Green and white aragonite layers interfinger with the calcite travertine.

Remarkably, this area is one of the rare places where travertine deposits occur in close association to hypersaline lakes with early dolomite and volcanic rocks.

Paleo-environmental characterisation of cold-water coral carbonate mounds (Melilla Mound Field, Alboran Sea)

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Cold-water coral carbonate mounds have been extensively described along the European continental margin and in the Mediterranean Sea. It has been widely postulated that CWCs respond to changing paleo-environmental, paleoclimatic, and hydrodynamic conditions. Therefore, CWC records provide unique environmental records for the deep-sea. This study focuses on the paleo-environmental characterisation of gravity cores from a cold-water coral (CWC) mound on Brittlestar Ridge I in the Melilla Mound Field at the southern margin of the Alboran Sea.

Three cores were recovered within the framework of the EuroFLEETS campaign 'The Mediterranean-Atlantic Gateway Code: The Late Pleistocene Carbonate Mound Record' aboard the R/V Marion Dufresne in 2013. The cores show intervals rich in cold-water coral fragments (mainly *Lophelia pertusa* and *Madrepora oculata sp.*) and intervals characterised by bryozoan framework, both interspersed with thick layers of siliciclastic material.

The cores will be characterized in terms of qualitative elemental variations of the bulk fractions (XRF-logging) and geophysical variations (MSCL-logging) to decipher the major sedimentological changes. Combined macro- and micro-CT-scanning will allow a quantification of the coral and bryozoan occurrences. U/Th dating will be performed on individual coral fragments to constrain the paleoclimatological framework. We hypothesise that the transition from CWC to bryozoan dominated reef growth, as shown in Fig. 1 from core MD13-3455, will provide valuable insights into important paleo-environmental changes in the Mediterranean Sea at intermediate water depths.

First direct evidence of methane gas conduit formed along endobenthic burrow

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Methane-derived authigenic carbonates are by-products of anaerobic methane oxidation combined with bacterial sulphate reduction (Judd and Hovland, 2007). Methane seepage conduits are commonly fossilized as branching tube networks which manifest methane migration pathways (Aiello, 2005). In this study we investigate the formation process of a branching tube network from an outcrop in South Central Taiwan. Two hypotheses for the formation of methane-derived authigenic carbonate tubes have been proposed so far: cementation along faults/fractures (e.g. Aiello, 2005) or bioturbation (e.g. Wiese et al., 2015). The hypothesis of hydraulic fracturing is supported by alignments of tubes parallel to fractures and faults (Aiello, 2005), while the one of bioturbation stems from the similarity observed between the morphology of carbonate tube networks with known networks made by burrowing organisms (Wiese et al., 2015). However, none of the previously described tubes contain remains of fauna attesting to their bioturbation origin. In this study, we present direct evidence of surplusmethane gas using burrows as migration conduits.

One outcrop of the Mio-Pliocene Yenshuikeng Shale Fm. in the south central mountain area of Taiwan, contains networks of carbonate tubes, is located close to a palaeo seepage zone that has been reported by Chien et al. (2013). A vertical seep carbonate tube that is found in this locality terminates in a nodule containing a shell of *Loripes goliath* (Yokoyama). This tube has a diameter of 10 cm with a preserved (minimum) length of 55 cm before being damaged, and a central channel (1 cm in diameter) filled by sparite. The two valves of the bivalve are connected; their longitudinal axis is vertical, i.e. parallel to the tube, indicating that *Loripes* remains in life position (Johnson, 1995). X-ray diffraction shows that the tube and the nodule essentially consist of dolomite.

The $\delta^{13}C$ values of the dolomite are as low as -29 ‰ indicating a methane derived origin, while the blocky sparite in the central channel yielded a value of -13 ‰ along with -10 ‰ for $\delta^{18}O$ suggesting a late diagenetic origin. We interpret the central channel in the tube concretion as the infill of the siphon that *Loripes* used for exhalation/inhalation and filter particles. As an open pathway in sediments, the siphons were used by upward migrating gas as a pathway around which seep carbonates precipitated. We hypothesize that similar tubes in this area are originated from bioturbation, although it cannot be excluded that vertical tubes with larger and longer sizes could have been produced by fracturing by overpressured fluids. This

assemblage is believed to represent so far a unique example demonstrating tubular seep carbonates of biological origin, related to burrowing organisms.

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From Travertine ridges to Microbialite reefs: a source–to-sink record from Pleistocene GSL shorelines at Lakeside, Utah.

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Spectacular outcrops of travertine are directly linked to microbialite biostromes both at and between headlands jutting out along the shoreline of the Great Salt Lake at Lakeside, Utah. Alkaline fluids flowed out from a network of fractures in Mississippian Great Blue Limestone to build travertine vent and apron systems along the paleoshoreline, but also to mix with nearshore lake waters to nourish microbialites and make extensive reefal biostromes.

Travertine spread onshore from fractures, Figure 1, where microbially mediated clotted and bubble-rich facies have acicular crystal cement. A "common ion" effect from groundwater and gypsum Ca^{++} combined may have promoted extremely high depositional rates of aragonite. Travertine conduits led out to 0.5m to 10m-scale shoreline mounds on the lake floor. The largest mound is about 2m in height and 30mx15m in plan view, Figure 2. Fissure vents cut up through the dome with a criss-cross pattern. The dome top shows a conformable layering that built the dome underwater, but the steep final dropwall shows a change in deposition and lake level fell during sedimentation, while the mound built out. Mineralogy of the dome, like the vents, was first aragonite, but repeated exposure and flooding caused extensive synsedimentary replacement by non-stoichiometric dolomite. Metre-scale terracettes with novel facies successions and vertical dropwalls stepped down the flanks of the mound. These facies indicate periodic cessation of alkaline fluid input, while lake level fell and rose to expose and cover the ponds during growth. Clotted calcite shrubs coated the terracette dropwalls, and one has been dated at 12,5kyrs (radio carbon age) [1].

Embayment deposits record a lakeward succession of travertine facies: upper beach aprons with small feeder channels and terracette ponds, mounds and crusts; inner shore zone layered "monk's head" microbialite reefs, Figure 3; intermediate shore zone "molar tooth" columnar microbialite reefs; outer shore zone, scattered m-scale low relief microbialite mounds. The microbialite reefs are shore-parallel biostromes. Associated sedimentary structures indicate lower beach environments for "monk's head" mounds. Wave rippled substrates suggest deeper water for the "molar tooth" mounds while wave front directions deduced from ripple crests and tabular foresets fit well with the dominant fetch directions[2].

Microbialite distribution, layering and stable isotopes, Figures 4 & 5, show the role of frequent lake level fluctuations and longer-term fall. Onshore travertines have preserved aragonite. But non-stoichiometric dolomite is a more stable mineral phase in the lacustrine microbialites, Figure 6. Crucially, microbial and chemically deposited facies developed concurrently, but were then rapidly modified by cycles of flooding, exposure and caliche formation. High Mg>Ca ratios in lake water probably caused progressive dolomitisation [1].

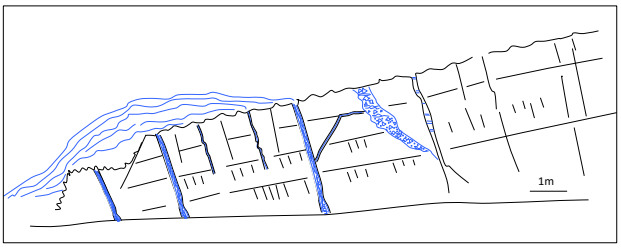

Figure 1.

Figure 2.

Figure 3.

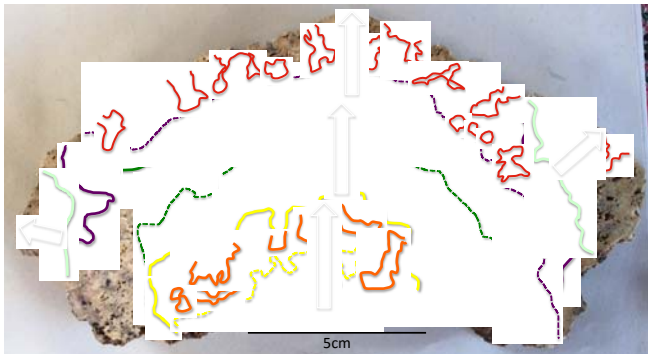

Figure 4.

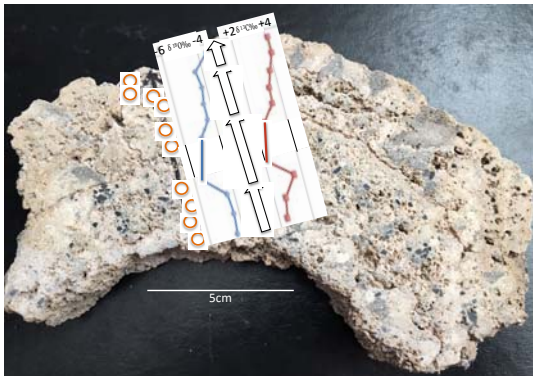

Figure 5.

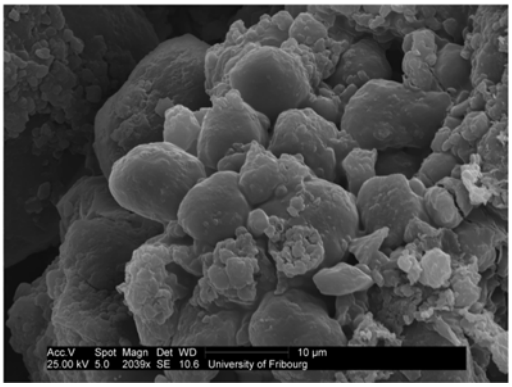

Figure 6.

Figure Captions:

Figure 1. Outcrop sketch of bedrock fracture system feeding travertine deposition.
Figure 2. 15mx30m Travertine dome with lateral terracettes.
Figure 3. Monk's Head microbialite reef linked to onshore travertine. Kneeling person for scale.
Figure 4. Monk's Head microbialite internal layering
Figure 5. Monk's Head microbialite stable isotopes
Figure 6. Round faced non-stoichiometric dolomite crystals

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Characterization of ancient hot spring travertine deposits in Gardiner, Montana (USA): Impact of diagenesis on travertine facies.

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Mammoth Hot Springs (MHS), close to the northern boundary of Yellowstone National Park (YNP), Wyoming (USA), are one of earth's largest sites of active travertine formation (Fouke et al., 2000, De Boever et al., 2016). Less known are the Pleistocene counterparts of these active springs, exposed in Gardiner, Montana (USA) and situated only a few miles from the North Entrance of the Park. Patches of travertine deposits are exposed along roads and in former small-scale quarries over an area of 3 km^2. They overlay basalt columns and quartzite deposits and interfinger with glacial, coarse grained diamictite. In contrast to the well-known sub-recent deposits of the Mammoth Terraces, the ancient springs deposits show a variety of colors ranging from whitish – similar to the recent deposits – to yellow and red, and different degrees of diagenetic modification, including cementation, recrystallization and dissolution.

This project aims to (i) understand controls on the diversity of ancient travertine fabrics and diagenetic processes and trends and (ii) to place it in a regional, structural, magmatic and climatic context based on detailed mapping, petrographical and geochemical study. Reconnaissance work by Butler (2007), in a smaller area, has shown that the "5 Facies Model" as proposed by Fouke et al., (2000) for active travertine deposition at MHS, is a valid starting point to map travertine depositional facies in the study area. Preliminary mapping results confirm the alignment of most travertine outcrops along ESE normal faults and allow distinguishing principal flow paths of ancient springs as well as the spatial distribution of the distinct colored travertine types.

Low to high-resolution 2D-3D petrography, mineralogy and detailed carbon-oxygen isotope geochemistry focus on a selected number of outcrops, namely the White-Rubble Quarry (area I and II), the Red Quarry and a more complex zone including travertine deposits mixed with volcanic deposits named Volcanite Outcrop. This will permit to unravel the fluids involved in the travertine precipitation and the potential impact of diagenetic processes on primary $CaCO_3$ fabrics and geochemistry. First results suggest the importance of meteoric diagenesis and possibly volcanic basement interaction on the modification of primary travertine fabrics.

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Evolution of Pennsylvanian carbonate platform and reefs in Southern China

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Following the Frasnian/Fammenian (F/F) extinction event, the Carboniferous is currently considered as a 'reefless lag time' (Copper, 1986; West, 1988). Shallow-water coral-bearing bioconstructions are overall small and scarce (Copper, 2002; Webb, 2002). However, Pennsylvanian coral reefs have recently been discovered in Guizhou and Guangxi provinces, China, challenging earlier interpretation of the impact of the F/F extinction event on coral reef evolution. This project aims to explore factors controlling this conspicuous occurrence in Southern China, constrain the sedimentation dynamic during Late Paleozoic and evaluate the implications on the current knowledge of the F/F extinction event.

The study focuses on a Pennsylvanian carbonate platform located in the Dian-Qian-Gui basin (Figure 1). In this basin, the sedimentation occurred in the passive continental margin of a craton, recording near shore siliciclastic and carbonate platform facies (Shen and Qing, 2010). During the Carboniferous, this area was an epicontinental sea, which became shallower from the SW to NE (Xianghe and Wenyi, 1984).

Methods to constrain the stratigraphic and sedimentological context of these extended coral reefs in South China include measuring stratigraphic sections, petrography, biostratigraphy and geochemistry. A section of about 1.25 km, called Gondangzi section (Langping area, Guangxi province), ranging from late Devonian to Early Permian in age, has been measured, described and sampled.

The Platform reconstruction, focus of the present presentation, is based on microfacies analysis of about 130 thin sections. Cathodoluminescence and SEM are used to investigate the microtextural preservation of brachiopod shells along with marine cements and select suitable samples for O and C isotope analyses.

Seven Microfacies Types (MFT) were identified: oncoid grainstone, lithoclastic breccia, skeletal grain packstone to wackestone, micritized bioclast packstone to grainstone, crinoid packstone, mudstone, coral and bryozoan boundstones. Grain assemblages and textures allow to infer, for each MFT, paleoenvironments and hydrodynamic conditions (Flügel, 2010). Field data and microfacies analysis led to interpret the depositional environment as a platform margin. The MFT allowed to identify environmental variations along the platform margin, likely driven by local and global parameters.

A total of 24 samples of brachiopods and marine cements from the Gondangzi section spanning the Carboniferous interval were selected for C and O isotope analyses as a next step. Brachiopod shells evaluated using petrography, SEM and cathodoluminescence point to preservation of original calcite, thus suitable to provide the original isotopic signatures (Brand, 2004; Veizer et al., 1997).

The next steps of the project will be to extend the study in including two additional sections in the Langping area, one comprising an extended coral reef (about 30 m wide) and another

section comprising three coral patch reefs located close to Shadong village. The expected dataset will allow to reconstruct the entire platform, constrain its temporal evolution and evaluate the composition of the ambient seawater.

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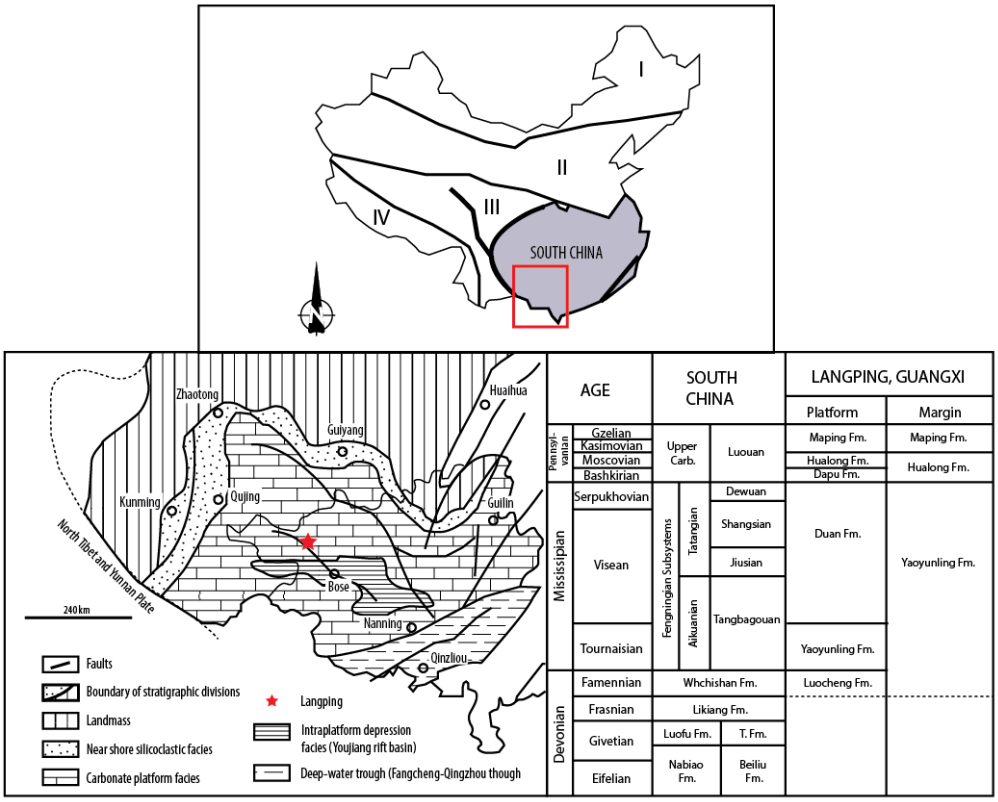

Figure 1. Carboniferous paleogeography in South China, Guangxi and Guizhou provinces. Star indicates the location of the Gondangzi section, Langping area. T.Fm: Tungkanling Fm. Modified from Shen and Qing (2010).

From lacustrine chalk to stromatolites, ooids and micropearls: A SwissSed journey through carbonate biomineralization

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Today new molecular microbiology methods and technical advances in microscopy allow us to look into the carbonate realm in a different manner than in the past. However, most of the critical observations first started at a macroscopic level. F. Nipkow, who operated a drugstore near the ETH-Zürich, started in the early 20th century limnological investigations in Lake Zürich as a hobby. He extracted the first short cores from the lake. By carefully cutting the black ooze he discovered the now world-famous carbonate laminae which characterized these biogeochemical varves (Nipkow, 1927). He attributed this to the rain of calcite which clogged the plankton net of his friend, city water chemist, Leo Minder who further developed the theory of biologically-induced calcite precipitation (Minder, 1923; 1926).
In a similar fashion, F.-A. Forel described the presence of well-rounded sand grains composed of a nucleus surrounded by concentric laminae of carbonate composition or ooids in Lake Geneva. He suggested a strong biological role precipitating these carbonate coats (Forel, 1904). Many years later and with the aid of detailed microscopical observations, Davaud and Girardclos (2001) first pointed the presence of biofilms filling up depressions in the surface of the nucleus. They were interpreted as clearly representing the starting point of the development of low-Mg calcite ooid cortex. More recent laboratory and field studies using cutting edge microscopical, microbiological and geochemical techniques have allowed reproducing this early stage of ooid cortex formation (Plee et al., 2008; 2010; Ariztegui et al., 2012; Pacton et al., 2012). Similarly, these new techniques are now used to study living and fossil stromatolites - some of the oldest evidence for life on Earth - providing new and very valuable information (e.g., Pacton et al., 2016). But how far have we gone? What is new in the fascinating carbonate world?

Recent discoveries showed clearly that amorphous calcium carbonate biomineralization can take place not only around cyanobacteria cells, but also inside the cell of specific cyanobacteria species (Couradeau et al., 2012). Unicellular phytoplankton species of Lake Geneva have also been signaled to form intracellular inclusions of amorphous carbonates (Martignier et al., 2016), a novelty for eukaryotic unicellular organisms. These granules, formed by unicellular phytoplankton, have been named micropearls. They are rich in calcium, strontium and barium and show concentric and oscillatory zoning on a nanometric scale (Figure 1). Being widespread in certain species of phytoplantkton present in Lake Geneva, they represent a previously unknown type of non-skeletal biomineralization, revealing an unexpected pathway in the geochemical cycle of alkaline-earth metals.
Results obtained so far suggest that several planktonic organisms form micropearls of different chemical composition (Figure 1). Only one micropearl-forming organism has been identified to this day: *Tetraselmis cf. cordiformis* (Chlorophyta, Prasinophyceae) produces

micropearls containing strontium ([Ca,Sr]CO_3). Barium and strontium concentrations measured in micropearls are extremely high compared with the undersaturated water of Lake Geneva. For example the Ba/Ca ratio in the barium-rich micropearls is up to 800,000 times higher than in the surrounding lake water. This can only be explained by a high biological pre-concentration of these elements.

Besides the discovery of a new biomineralization pathway with plausible impact on geochemical cycles of various elements, these results might be of interest to develop alternative bio-remediation methods. Thus, there are still lots of things to discover, to keep SwissSed young, as well as sedimentology in general!

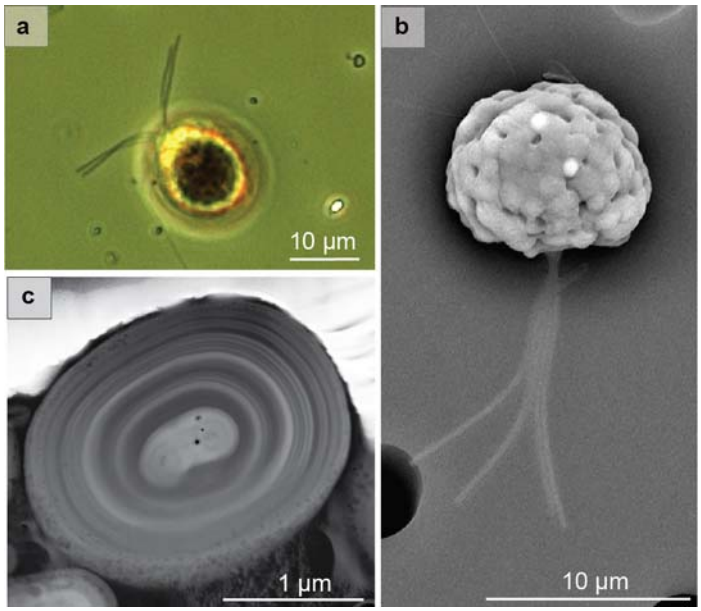

Figure 1.
a) Live unicellular phytoplanktonic organism Tetraselmis cf. cordiformis(TC), viewed with optical microscope.
b) TC fixed with glutarhaldehyde, viewed with SEM (backscattered image). Sr-rich micropearls appear in white.
c) Cross-section through a Ba-rich micropearl, viewed with TEM.

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Bridging the gap in Plio-Quaternary stratigraphy at the junction of Alps, Dinarides and Pannonian basin (eastern Slovenia)

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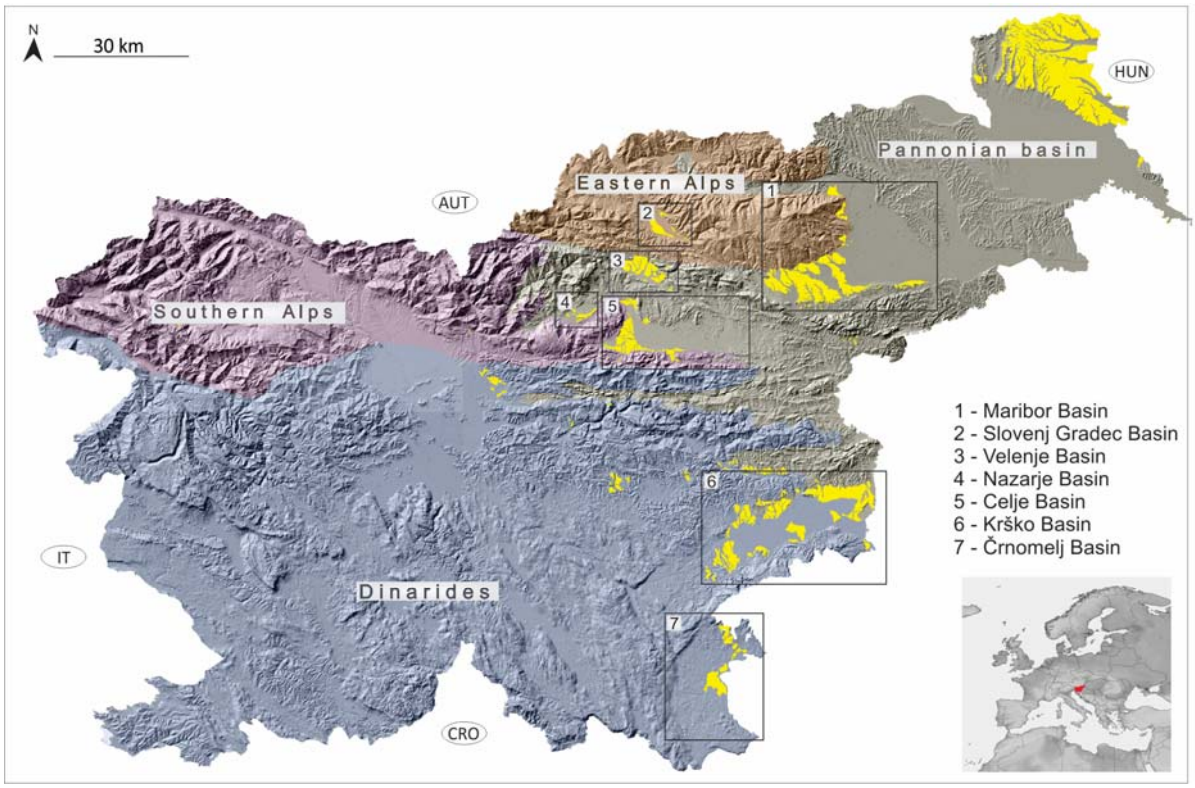
Slovenia lies at the junction of three large entities: the Alps, the Dinarides and the Pannonian basin (Placer, 2008). The landscape evolution was strongly influenced by the formation of the Alps and Dinarides resulting in a hilly and mountainous terrain with depressions providing space for various sedimentary archives. The onset of youngest terrestrial sedimentation on this area is represented by the deposits informally called the "Plio-Quaternary". It comprises a succession of alluvial clastic sediments and is preserved in topographic depressions, as well as on higher areas indicating base-level lowerings and post-sedimentary deformations (e.g.: Vrabec, 1999; Verbič, 2005). Plio-Quaternary sediments in Slovenia are preserved in several intramountain basins: Maribor, Slovenj Gradec, Velenje, Nazarje, Celje, Črnomelj and Krško basins (Figure 1). State-of-the-art studies targeting their composition, provenance, genesis and age are, with few exemptions (e.g. Krško basin), nonsystematic and questionable. This study therefore aims to thoroughly enhance the understanding of the Plio-Quaternary sedimentation and the environmental evolution of the proposed intramountain basins.

The ongoing research is based on multi-methodological approach. Clast lithological analysis will be used as a tool for stratigraphic correlation and provenance studies. The data will be presented as raw count data and as percentages, which will enable both qualitative and quantitative comparison between various datasets (Evans & Benn, 2004). In addition, the roundness and shape of the pebbles and weathering surfaces will be analyzed. Heavy and light minerals analysis will be used as an additional method for interpreting provenance. As a complementary method to heavy and light minerals assemblages, X-ray diffraction will be conducted. Moreover, X-ray fluorescence analysis will provide data about elemental chemistry of the sediment matrix, which can be used for both provenance and correlation studies. Samples taken from vertical profiles will serve for analysis of changes in the elemental composition with depth which can be used to quantify post-depositional weathering (Evans & Benn, 2004). Carbonate content in the matrix will also be measured, addressing the enigmatic lack of carbonate pebbles in most of the Plio-Quaternary deposits.

Preliminary results based on fieldwork indicate that Plio-Quaternary sediments were deposited in fluvial and lacustrine systems. Comparison of the composition of the sediments reveals two major source areas. For sediments deposited in Slovenj Gradec, Velenje, Nazarje, Maribor and Celje basins the source area are the Eastern Alps and deposits in Krško and Črnomelj basin derive from the Southern Alps.



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Climatic and tectonic controls on source-to-sink processes through space and time in a tropical lateritic lake catchment: Lake Towuti, Indonesia

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Lake Towuti (2.75°S, 121.5°E) is one of the oldest and deepest lakes in Indonesia, with lake sediments promising uninterrupted lacustrine sedimentation over several glacial-interglacial cycles. Cores of the entire sediment infill have been recovered in the ICDP Towuti Drilling Project in 2015. Here we present results from a comprehensive dataset of Lake Towuti surface sediments as well as characteristic bedrock and soil samples from the catchment, and two sediment cores, extending to 30,000 and 60,000 years BP, respectively. We studied the catchment morphology, geotechnical properties, geochemistry, clay and bulk mineralogy, and Fourier-Transform-Infrared-Spectroscopy (FTIRS) in order to understand how changes in climate boundary conditions and the region's hydroclimate alter the style and intensity of erosion and the sedimentary composition in and around Lake Towuti. We find that mass movement processes, tectonically influenced river incision, and climate-induced remobilisation of fluvial gravel deposits strongly influence today's sedimentation in the lake. Material from the Mahalona River, the lake's largest inflow, dominates recent and modern sediment composition in Towuti's northern basin. The river transports Al-poor and Mg-rich sediments to the lake, and serpentines are dominant over kaolinite, indicating river incision into the Mg-rich serpentinised peridotite bedrock. A small but important additional contribution of material comes from direct laterite-derived input and the Loeha River, which both supply Al-rich and Mg-poor sediments to the lake. These sediments are rich in kaolinite from the deeply weathered tropical soils. Over time, the Al/Mg and kaolinite-to-serpentine ratios vary strongly in response to lake-level fluctuations, which are related to hydroclimatic changes. In the past 60,000 years, both the Al/Mg and kaolinite-to-serpentine ratios show quasi-cyclic variations sensitive to changes in climate boundary conditions across glacial-interglacial cycles as well as higher frequency changes, possibly related to a half-precessional forcing during marine isotope stages (MIS) 1 and 2 and millennial-scale changes during MIS3.

Upper Triassic limestones from the northern part of Japan: new insights on the Panthalassa Ocean and Hokkaido Island

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In comparison with the well-known Tethyan domain, Upper Triassic limestones from the Panthalassa Ocean are still poorly known. However, these carbonates represent a unique opportunity to have a more accurate view of the Panthalassa Ocean during the Triassic. Their study will allow comparison and correlation of biotic assemblages, biostratigraphy, diagenesis, and depositional settings of different Triassic localities from Tethyan and Panthalassic domains. Moreover, investigation of these carbonates will provide data for taxonomic revisions and helps to better constrain palaeobiogeographic models.

One of the best targets for the study of these carbonates is Hokkaido Island (north of Japan). Indeed, this island is a part of the South-North continuity of Jurassic to Paleogene accretionary complexes, going from the Philippines to Sakhalin Island (Far East Russia). Jurassic and Cretaceous accretionary complexes of Japan and Philippines contain Triassic mid-oceanic seamount carbonates from the western Panthalassa Ocean (Onoue & Sano, 2007; Kiessling & Flügel, 2000). They have been accreted either as isolated limestone slabs or as clasts and boulders, and are associated with mudstones, cherts, breccias and basaltic rocks. Two major tectonic units forming Hokkaido Island and containing Triassic limestones have been accurately explored and extensively sampled: the Oshima Belt (west Hokkaido) a Jurassic accretionary complex, and the Cretaceous Sorachi-Yezo Belt (central Hokkaido).

The Sorachi-Yezo Belt is composed of Cretaceous accretionary complexes in the east and of Cretaceous clastic basin sediments deposited on a Jurassic basement in the west (Ueda, 2016), both containing Triassic limestones. The origin of this belt is still matter of debate especially because of its western part which is not in continuity with any other accretionary complex known in the other islands of Japan and also due to the lack of data in this region.

One of the main goals of this study is to investigate and characterise Triassic limestones, particularly from western part of Sorachi-Yezo, in order to provide new crucial data allowing us to define the origin of this belt. The comparison (i.e. biotic assemblages, preservation, diagnesis, associated lithologies) of the Triassic limestones in Oshima and Sorachi-Yezo belts might highlight differences in their depositional setting as well as in geodynamic evolution of the western part of Sorachi-Yezo Belt.

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Cold-water corals and mud volcanoes in the Mediterranean Sea – accidental life on a dynamic substrate

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Reef-building cold-water corals are prominent features within the Mediterranean Sea and the Gulf of Cadiz. Main habitat of the coral reefs is at intermediate depths between 250 and 650 m and has been described on banks and ridges (Foubert et al., 2008), on knolls (De Mol et al., 2012) and mounds (Taviani et al., 2005), at cliffs and canyons (e.g., Freiwald et al., 2009) and on mud volcanoes (e.g., Wienberg et al., 2009). First report of ahermatypic coral debris overlying mud breccia on an inactive mud volcano from the Gulf of Cadiz offshore Morocco was given by Gardner (2001).

Mud volcanoes (MV) are one possible niche for cold-water corals to inhabit. In the Mediterranean Sea and the Gulf of Cadiz they have been frequently reported in areas evidencing a dynamic sub-seafloor with active seepage of fluids and hydrocarbons. In the Eastern Mediterranean, MV are active since 1 Ma at the Mediterranean Ridge (Robertson and Ocean Drilling Program Leg 160 Scientific Party, 1996) or even longer since 3 Ma along the Calabrian Arc (Praeg et al., 2009). In the Western Mediterranean, MV are relative scarce features only reported from the Alboran Sea, where they are related to mud diapirs and active sediment and fluid flow in a back-arc basin setting (e.g., Comas et al., 2010). The MV in the Gulf of Cadiz are associated with recent compressive tectonics on shale and salt deposits of the accretionary system (Maldonado et al., 1999; Somoza et al., 2003).

MV are dome-shaped formations on the seafloor of up to 10 km in diameter and 700 m in height, which are created by the release of fluids charged with mud derived from the sub-seafloor. During their active phase MV have periodical eruptions of mud and fluids with rock fragments, the so-called mud breccia (Cita et al., 1981). Successive episodes of mud flows as a result of degassing processes in the deep sub-seafloor and the progressive accumulation of extruded mud breccia build up the cone-shaped edifice, forming the mud volcano. During the dormant phase the mud volcano may continue to emit fluids at cold seeps. These fluids are usually rich in gases (predominantly methane), which are the source for a rich ecology based on chemosynthesis and the microbial processing of the gases (e.g., Boetius et al., 2000), forming authigenic carbonates increasing the sedimentary and habitat complexity.

This habitat complexity may provide the basis for new life – as hard substrate for a new community of cold-water corals and/or other species to grow and develop. If substrate availability would be the only factor, we would expect much more coral patches and reefs on the summits and flanks of mud volcanoes. Comparable to Becker et al. (2009) mud breccia and authigenic carbonate substrates together with hydrodynamic processes at the interface between two water masses (surface or upper intermediate with lower intermediate) drive the cold-water coral communities at mud volcanoes in the Western Mediterranean and the Gulf of Cadiz. The nucleation of corals on mud breccia in the fossil record has been described by Margreth et al. (2011) for mud volcanoes in the Western Alboran Sea indicating that the coral reef development lasted for some thousands of years, before environmental conditions changed and they became buried by a hemipelagic sediment cover.

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Depositional mechanisms and environmental conditions leading to the formation of phosphorite in the El Cien Formation (Oligocene-Miocene; Baja California-Mexico)

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Phosphogenesis and the accumulation of phosphorite is a widespread phenomenon in the Late Cenozoic and three main episodes have been discerned during the Late Oligocene-Pliocene interval. Phosphorites of the first one (Late Oligocene-Early Miocene) occur in different regions in the southern part of Baja California. However, there are still uncertainities about the mechanisms and the link with global environmental change. Therefore, in order to better constrain the sedimentary processes and environmental conditions which have led to the formation and accumulation of phosphorus and to obtain a better age control, a core drilled in the phosphate mine of ROFOMEX near San Juan de la Costa (Baja California Sur, Mexico) was studied using sedimentological, mineralogical and geochemical techniques.

This section is composed by muddy siltstones with intercalated phosphorite beds (Figure 1), tuffs and coarse detrital wackestone. The study of microfacies revealed that the sediments were deposited on the outer shelf below the storm-wave base level. The siltstone was deposited as the result of hemipelagic sedimentation, whereas the phosphorite and wackestone were transported and brought in by turbidity currents. The turbidite deposits are generally associated with tuff layers, which suggests that their origin was often related to a phase of seismic activity linked with volcanic activity. The absence of benthic organisms, the presence of fine laminations, the enrichment in organic matter and redox-sensitive trace elements in the siltstone suggest deposition in an oxygen-depleted environment.

ICP-MS analyses on three tuffs bearing zircons (27.08 ± 0.30 Ma, 26.94 ± 0.51 Ma and 27.19 ± 0.34 Ma) have evidenced that the sediments from core BS-343 have been deposed in the Chattian, Late Oligocene, at the eve of the late Oligocene warming event which started around 26 – 27 Ma. Therefore, the formation of the phosphatic particles and nodules occurred in a cooler climate.

Palynology, Rock-Eval, carbon and nitrogen isotope records important and rapid turnovers in marine organic matter production in the region of deposition. The low values of the alteration index (CIA: 45-55) indicates that chemical weathering remained low and that the detrital sediments were largely formed by mechanical alteration. This evidences a dry climate during deposition of the studied succession right before the warming episode which is characterised by a tropical evaporation regime (Martinez-Cabrera and Cevallos-Ferriz, 2008).

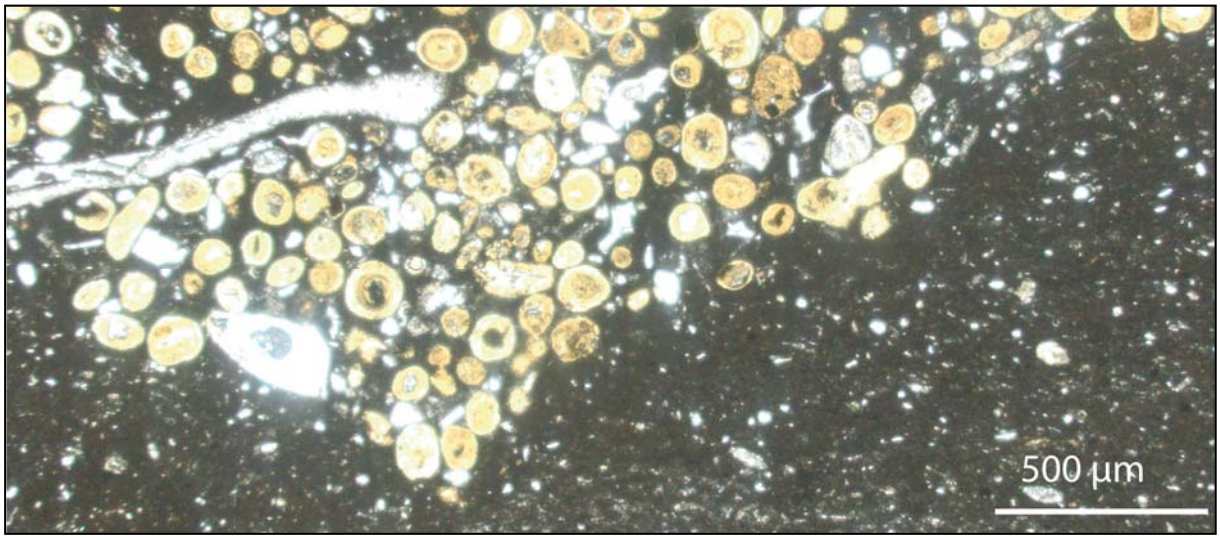

Figure 1. Turbidite composed of phosphate-coated grains deposited on top of a clay-rich siltstone.

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Linking subaerial exposures to paleoenvironments and paleoclimates (Valdorria carbonate platform, northern Spain)

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The Valdorria carbonate platform is an isolated system found in the Cantabrian Mountains, Northern Spain. It is part of the Valdeteja Formation, which is stratigraphically overlying the Barcaliente Formation and underlying the San Emiliano Formation. The platform developed during the Bashkirian (Pennsylvanian) in the Variscan foreland basin, which is nowadays known as the Cantabrian Zone (Chesnel et al. 2016a). The platform was buried by the San Emiliano Formation prior to being exhumed to surface by Variscan tectonism, which consequently exposed a lateral and vertical transect of the platform (Chesnel et al. 2016a).

Milankovitch cyclicity has recently been revealed throughout the carbonate platform exhibiting subaerial exposure features at the top of each cyclothem (Chesnel et al. 2016b). Subaerial exposures are of interest for a diagenetic interpretation of the platforms history because they can display a complete paragenetic sequence of a carbonate succession. Observed features of interest range from marine deposition to vadose, phreatic, and burial cementation. At Valdorria, 13 different subaerial exposure surfaces have been identified, predominantly as subtle to deep immature dissolution surfaces and mature karstic and/or calcretic dissolution surfaces. Compacted immature dissolution surfaces are present but rare.

Transmitted light and optical cathodoluminescence petrographic studies show the presence of various cement generations. More specifically, cathodoluminescence is able to discriminate between meteoric and burial cements within many samples. Vadose and upper phreatic cements can be confirmed due to a lack of luminescence indicating an oxidized environment where Mn and Fe are being incorporated into oxide minerals. Lower phreatic to shallow burial cements can also be confirmed where bright luminescence is found indicating reduced poor water because Mn is highly abundant in this environment. Deeper burial cements can also be observed when sparitic cements are more duly luminescent indicating an enrichment in Fe, typical of the burial realm.

Furthermore, X-ray diffraction techniques demonstrate a climatic evolution of the platform. Older subaerial exposures displaying a thick calcrete profile that possess illite-smectite (reminiscent of smectite) and lack kaolinite record a semi-arid climate during the respective stages of platform development. Whereas the youngest subaerial exposure found at the platform-top exhibits an extensive karstic system with kaolinite present throughout, which indicates that the platform evolved to a wet climate before drowning.

Major and trace element geochemistry of Ca, Fe, Mg, Mn and Sr have been acquired to confirm the sequence of cementation for the various diagenetic realms. Linking this information to the petrographic and mineralogical framework provides a paragenetic relationship related to the relative timing of diagenetic and pedogenetic events, and subsequently to how the past environments and climates of the platform evolved overall.

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Upper flow-regime structures in a Pleistocene carbonate ramp (Favignana, Italy): diagnostic criteria and implications

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This work presents key diagnostic criteria for the recognition of upper flow-regime sedimentary structures in clastic cool-water carbonate accumulations, illustrated by the excellent exposures of the Pleistocene carbonate ramp succession of Favignana Island (Italy). Cool-water carbonate sedimentation has dominated Mediterranean shelves since the Early Pliocene. Of the various types of marine limestones, cool-water carbonates behave most similar to siliciclastics. They typically develop ramp morphologies with skeletal sand and gravel, consisting of the remains of heterozoan organisms. Resedimentation of this loose carbonate debris during high-energy events such as storms and, more rarely, tsunamis is the norm. Off-ramp supercritical sediment density flows are important contributors to basinward sediment transport as evidenced by the prevalence of backset-stratification bounded by composite erosion surfaces, locally defining spoon-shaped scour-fills, in beds exceeding several metres in thickness. Sedimentary structures created by upper flow-regime bedforms like antidunes, chute-and-pools and cyclic steps as seen on Favignana Island, which form in association with in-phase waves and hydraulic jumps, are not commonly mentioned in carbonate ramp depositional models. For each of the bedforms we present diagnostic criteria to explain otherwise enigmatic sedimentary structures. Thick beds deposited by supercritical sediment density flows have major implications for the distribution of porosity and permeability in carbonate sandstone bodies, especially where they host hydrocarbon and/or water accumulations. The correct identification of upper flow-regime sedimentary structures in carbonate ramp accumulations is therefore important.

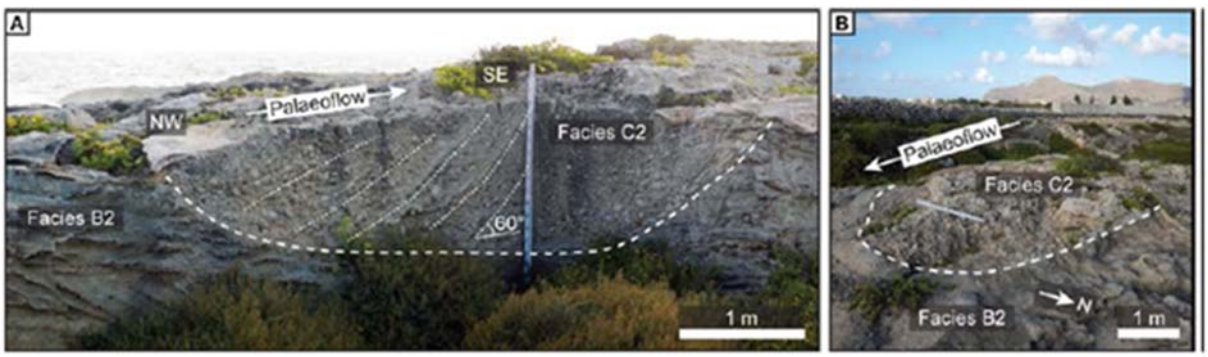

Figure 1. Scour-and-fill structure interpreted to have been generated by a hydraulic jump in a chute-and-pool bedform by a supercritical density flow on the Favignana carbonate ramp.

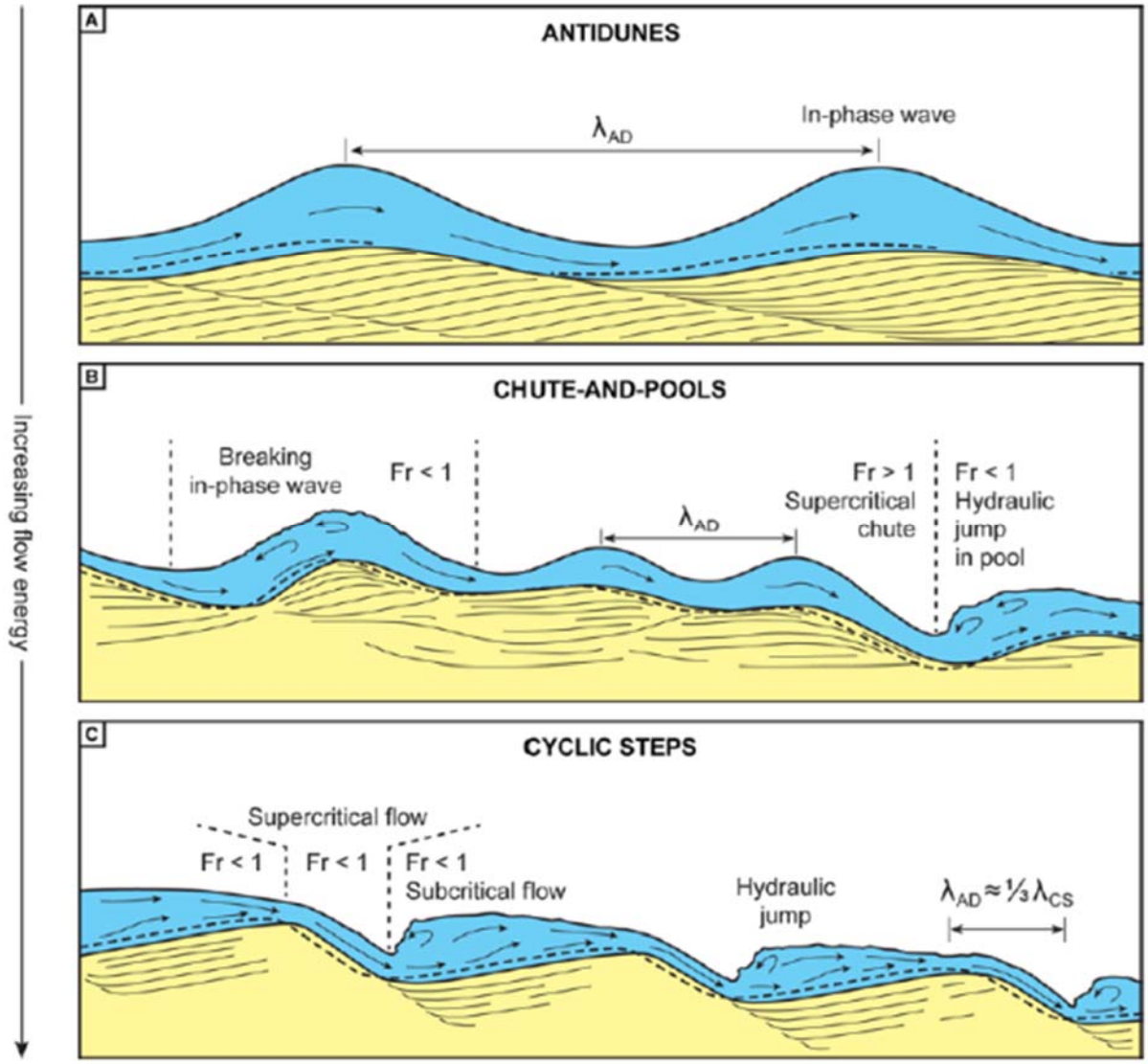

Figure 2. Upper flow-regime bedforms and resulting sedimentary structures.

Figure 3. Three sets containing backset-stratification interpreted to have been formed by the upslope migration of a series of cyclic steps that were created by density flows on the Favignana carbonate ramp.

Chute-and-pools: the hybrid bedforms in between antidunes and cyclic steps

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Froude-supercritical flows create upslope-migrating bedforms such as antidunes, chutes-and-pools, cyclic steps and rhomboidal patterns, which lead to the formation of upper flow-regime sedimentary structures. Theory and experiments predict that for density currents the critical slope for the transition of subcritical to supercritical flow is less than 0.5°. Since most subaqueous slopes in Nature exceed such steepness, natural density currents are intrinsically biased to becoming supercritical.

As a result, bed undulations observed in oceans, lakes and reservoirs affected by turbdity currents are interpreted as antidunes and cyclic steps, which are the two 'stable' end-member bedforms of the upper flow-regime stability field. Chute-and-pools, on the other hand, are 'unstable' hybrid bedforms that prevail in a significant range of the upper flow-regime, occupying the stability field in between antidunes and cyclic steps. Chute-and-pools are manifested by supercritical flow (chute) down the lee side and subcritical flow (pool) on the stoss side, linked through a hydraulic jump in the trough.

The past few years have seen a proliferation of contributions that interpreted bed undulations, observed through bathymetric surveys, as antidunes or cyclic steps. Such interpretations, however, are based on mere snapshots of bed morphology on the basis of which flow conditions were invoked. This approach is in cases too simplistic and prone to misinterpretation. Experimental evidence suggests that antidunes and cyclic steps are very rarely (if ever) stable over long time scales. We advocate, therefore, that hybrid bedforms such as chute-and-pools should be incorporated in the mind set of surveyors of deep sea floors and lake bottoms.

To support our ideas we present upper flow-regime sedimentary structures generated at the toe-of-slope of the Pleistocene Favignana carbonate ramp (Italy), which is dominated by the resedimentation of skeletal sand and gravel by supercritical density underflows. Excellent quarry exposures enable the timewise morphodynamic reconstruction of the bed (Figure 1). This allows inferences to be drawn on the behaviour of the flow as upper-regime bedforms evolved. We show that wave-breaking on growing antidunes occurred without the destruction of the antidune as is commonly observed in free-surface (subaerial) flows. This led to the formation of chute-and-pools that are not preceded by intense upstream scouring, interpreted to be the result of high bed aggradation rates. We propose the term aggradational chute-and-pools for these bedforms, associated with the formation of build-up-and-fill structures consisting of interstratified convex-upward (in-phase wave regime) and concave-upward (hydraulic jump regime) lenses (Figure 2). Our field observations are supported by depth-averaged numerical simulations.

In this contribution, we aim to lay the foundations for a more complete interpretation of the upper flow-regime bedform stability field. In doing so, we demonstrate that caution is needed for interpretations based on 'snapshot' observations of the bed in environments where supercritical flows occur. Such environments include practically all subaqueous slopes affected by density flows.

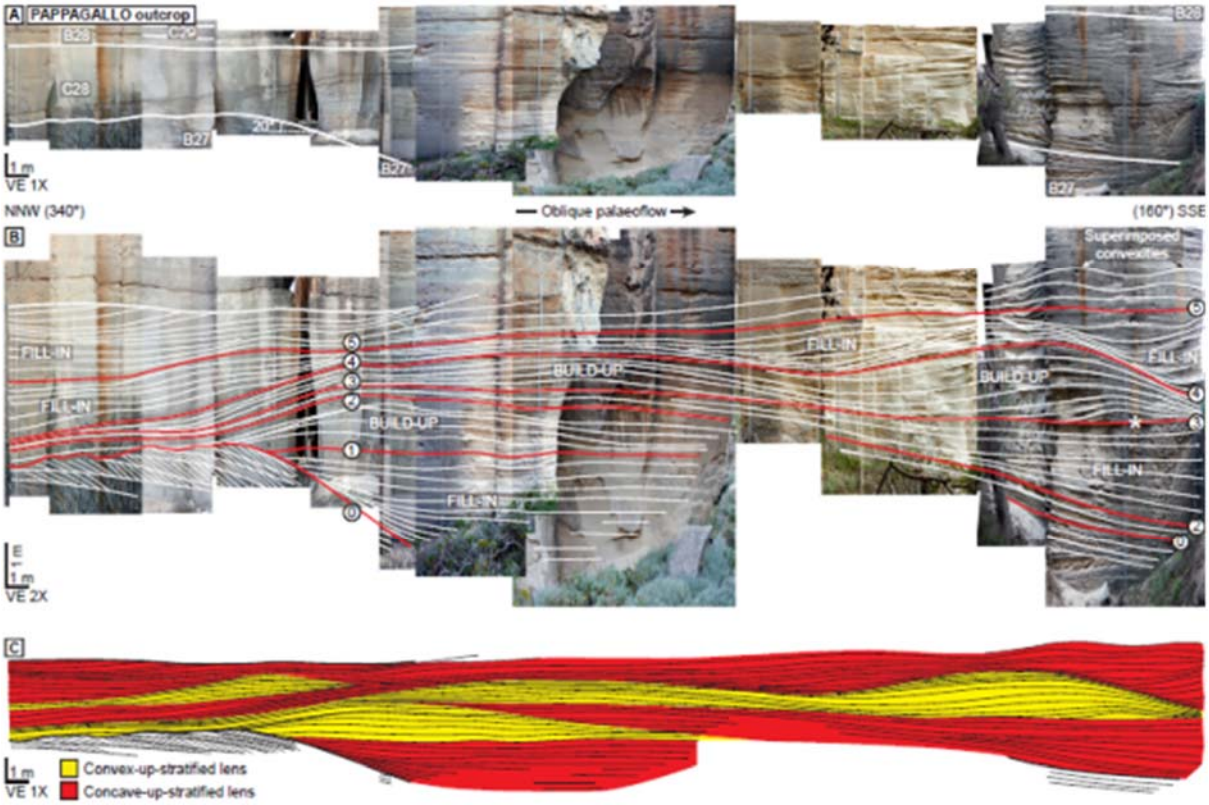

Figure 1. Build-up-and-fill structures interpreted to be generated by aggradational chute-and-pool bedforms in supercritical density flows. Lines represent time lines.

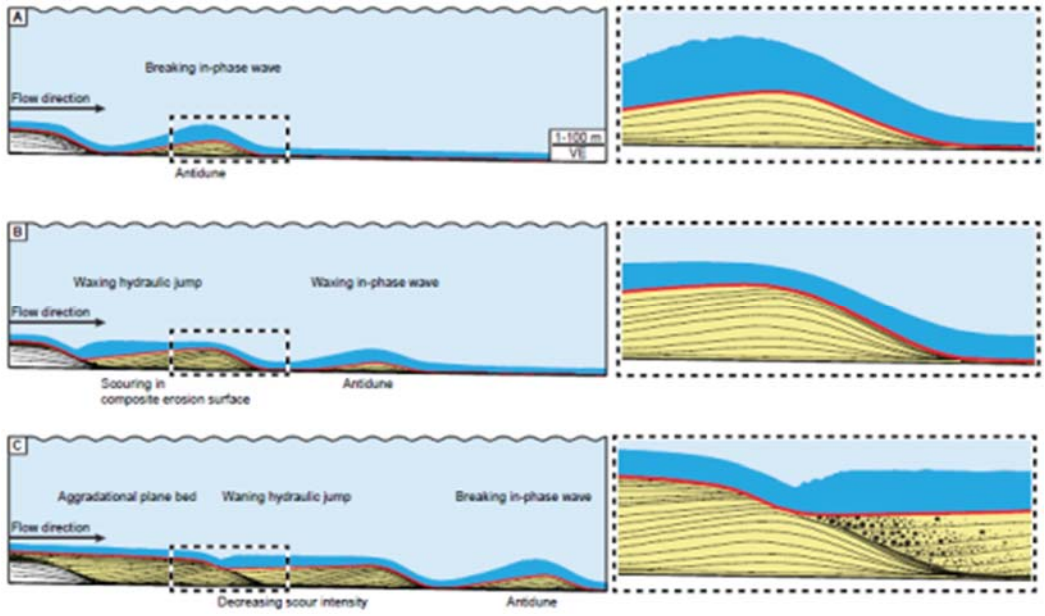

Figure 2. Conceptual model for the formation of build-up-and-fill structures by aggradational chute-and-pool bedforms.

A detrital garnet fingerprint of the Central Swiss Alps

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Ever since the convergence of the European and Adriatic continents started, the Alpine orogen has been one of the most important sediment factories in Europe. Associated sediments have been either incorporated into the orogenesis, deposited in the foreland basins, or have been transported out of the Alpine system into connected sedimentary sinks. Several fingerprinting techniques are available for the reconstruction of sediment sources, transport and dispersal patterns of any of those deposits. The wide range and similarity of some of the lithologies within and outside the orogen, however, has offered a challenge for defining unequivocal Alpine fingerprints.

Detrital garnet is a promising candidate to address this problem: Garnet is present in most Alpine sediments, easy to identify, fairly stable and, most importantly, reflects the type and the metamorphic grade of its source rock in its chemical composition. In the Central Alps, several studies have investigated garnet compositions from individual outcrops, which provide valuable petrological details, but rarely information representative enough for provenance studies.

This study aims to establish fingerprints based on detrital garnet composition for the most important tectonic units of the Central Alps, including European, Penninic and Adriatic basement rocks and their respective meta-sedimentary cover. Sediments collected from modern rivers, which drain representative portions of the individual tectonic units, contain a natural mixture of the various garnet populations present in each unit. We selected six catchments in southwestern Switzerland draining the External Massifs, Helvetic sediments and the Penninic nappe stack at the transition of Alpine greenschist- to amphibolite-facies metamorphism in order to test the variability of Alpine garnets and the role of inherited (pre-Alpine) garnets. Extraordinary grossular- and spessartine-rich garnets of the External massifs, which experienced greenschist facies metamorphism, are clearly distinguishable from generally almandine-rich garnets supplied by the higher-grade metamorphic Penninic nappe stack. The variable pyrope-, grossular- and spessartine-components of these almandine-rich garnets can be used to further distinguish pre-Alpine, Alpine eclogite-facies and low-grade metasedimentary garnets.

This fingerprint has the potential to be used for reconstructing sediment sources, transport and dispersal patterns in a variety of settings throughout the Alpine sedimentary record.

Sedimentary response to Holocene sea-level rise in Kiladha Bay, Greece: Implications for coastal sedimentology and archaeological reconstructions

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Franchthi Cave, bordering Kiladha Bay, in Greece, shows traces of human presence from ca. 40'000 to ca. 5'000 yrs ago, making it one of the longest occupied archaeological sites in Europe (Farrand, 2000). This long time span includes the Last Glacial maximum and the Late Glacial period that were characterized by a very dynamic sea level, thus strongly modifying coastlines. This geophysical and sedimentological study of Kiladha Bay documents changes in the coastal sedimentary system through time and contributes to a better understanding of how humans interacted with such landscape changes.

The first evidence for agriculture was found in the Near East around 11'000 yrs ago. This new way of life, called Neolithic, was accompanied by settlement of humans in the first villages, quitting nomadism. From the Near East, it propagated westwards. One of the earliest dates for the Neolithic in Europe (ca. 9'000 yrs BP) was discovered in Franchthi Cave (Perlès, 2013). However, archaeologists found no decisive evidence that the cave was used as a dwelling place during the Neolithic, although there were signs of human activity there. Therefore, they made the assumption that the Neolithic people may have built a village inside the bay, which is now submerged under ~10 m water, but which was at that time exposed due to lower than present sea level.

During the 2014 Terra Submersa Expedition, swath bathymetry data and seismic profiles (boomer and chirp) were acquired in order to study the evolution of the submerged landscape around Franchthi Cave (Beck et al, forthcoming; Sakellariou et al, 2015). These profiles (Fig. 1) enabled to visualize the former relief of a prehistoric landscape including an exposed substrate, a transgressive coastline, an ancient river valley and a marine Holocene flooding sequence. On the basis of the seismic profiles, eight sediment cores, up to 6.3 m long, were retrieved in August 2015 inside the Bay of Kiladha, using a piston-coring system. These cores were analyzed with petrophysical (MSCL-scanning, CT-scanning), sedimentological (macroscopic description, sieving, smear slides), geochemical (carbonate and organic matter contents, XRF-scanning), and chronostratigraphic (^{14}C-dating) methods.

The longest and most thoroughly studied of these cores, KI15-2, was retrieved at the southern part of the Bay of Kiladha. It is composed of sediments from ~8'500 yrs BP to the present. The

base of the core consists of almost 1 m carbonate rubble in partly finer matrix representing weathering processes at or above the exposed surface. Dated organic remains place this unit at ~8'500 yrs BP. This unit is overlain by ~2 m of very stiff silty mud containing few shells interpreted to represent a freshwater or brackish environment in a river or estuarine setting. This mud is capped by a 30 cm-thick blue-grey layer with roots revealing the presence of an exposure surface. At ~6'280 yrs BP, a shell-layer consisting of bivalves and gastropods overlies this terrestrial sequence and represents the marine transgression. This 1 m thick shell layer is overlain by 2 m of finer-grained marine carbonate-rich sediments, containing a few shells coarsening up in the topmost 50 cm of the core.

This landscape evolution can now be put in the context of human occupation of the area. In fact, a pottery sherd (with some flint fragments) was retrieved at the bottom of core KI15-5 (Fig. 1), on the exposed surface. It has been identified as dating to the Early to Middle Neolithic period. This finding shows that humans were present in this dynamic landscape with a migrating coastline. Even if the artifacts are isolated, future investigations of the submerged landscape might lead to the discovery of Neolithic villages, which eventually became buried under the marine sediments.

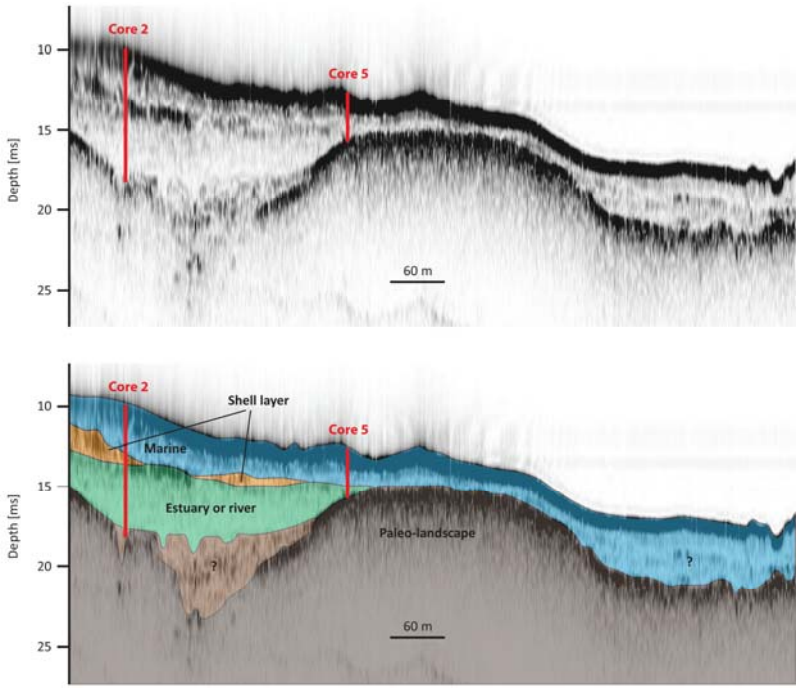

Figure 1. Chirp subbottom profile (2-7kHz) and location of cores KI15-2 and KI15-5.

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Influence of sedimentation on rift and transfer zone development: Insights from 4D analogue tectonic models

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During the early stages of rifting, rift segments may form along non-continuous and/or offset pre-existing weaknesses. It is important to understand how these initial rift segments propagate, interact and connect to form a continuous rift system leading to continent breakup. Previous modelling efforts have shown the dominant influence of extension direction on rift and transfer zone development. However, these studies did not incorporate syn-tectonic sedimentation, which can have important implications for rift evolution and associated processes. Therefore we present a series of analogue model experiments to investigate the influence of sedimentation on rift and transfer zone development.

Our set-up involves a base of compressed foam and plexiglass that forces distributed extension in the overlying analogue materials when the model sidewalls move apart. A sand layer simulates the brittle upper crust and a viscous sand/silicone mixture the ductile lower crust. One of the underlying base plates can move laterally allowing oblique extension. Right-stepping offset and disconnected lines of silicone (seeds) on top of the basal viscous serve as inherited structures since the strong sand cover is locally thinner. We apply syn-rift sediments by filling in the developing rift and transfer zone basins with sand at fixed time steps. Models are run either with sedimentation or without to allow comparison between both modes. X-Ray CT-scanning techniques allow us to analyse the 3D internal structuration with time (hence 4D).

The first results show that the gross structures in our models are similar with or without sedimentation, suggesting that sedimentation has no large-scale impact on rift development and rift propagation. However, the structures within the rifts show a rather different evolution when sedimentation is applied. The extra sedimentary loading in the rift basin prevents the viscous sand/silicone layer from isostatic rising as observed in the models without sedimentation. In fact, syn-rift sedimentation causes the rift wedge to sink deep into the viscous material below. Surface structures and CT-sections indicate that sedimentation also influences the fault structures within the rift. Models without syn-rift sedimentation develop more complex faulting as the rift wedge is smaller and breaks up much easier than when syn-rift sedimentation is applied. These finding concerning rift evolution also hold for transfer zones.

Next to these first results, our CT-data will allow a thorough 4D surface and internal evolution assessment, including Digital Volume Correlation techniques (DVC) and tomographic strain analysis, to reveal the detailed effects of sedimentation on the structural evolution of our modelled rifts and transfer zones.

SwissSed is an informal group of (not only) Swiss sedimentologists. It promotes contacts, exchange of ideas, and information on current developments in sedimentology. Membership is free, but SwissSed lives by the interest and initiative of its members.

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