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BOOK OF ABSTRACTS

ORAL PRESENTATIONS

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Project

06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 –, Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)

Status

Principal Investigator

Topic: Geodynamic, hydrothermal and biogeochemical processes

New insights into the radiocarbon calibration based on 14C and U-Th dating of corals drilled offshore Tahiti (IODP Expedition #310)

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Beyond the high-precision tree-ring calibration, the fossil corals are the most reliable archive that can be used to calibrate the radiocarbon time scale. Here, we present a new radiocarbon dataset based on paired 14C and U-Th dating of fossil shallow-water tropical corals drilled offshore Tahiti during the IODP Expedition 310 "Tahiti Sea-Level". We paid particular attention to the screening criteria applied before 14C and U-Th analyses in order to select pristine aragonitic coral skeletons and avoid those displaying any post-mortem diagenesis that could alter original ages. We use the calcite content, the U and Th concentrations, the initial (234U/238U)₀ values and the errors obtained on the 14C measurements as screening criteria following the recommendations of the Intcal Working Group [1, 2, 3]. A total of 80 paired U-Th / 14C dates were obtained on the coral samples from the drilled cores. The 14C analysis were processed at the Laboratoire de Mesure du Carbone 14 (Saclay, France) with the ARTEMIS AMS facility. The Tahiti record provides new data to the radiocarbon calibration for two distinct time windows: for the interval between 29,200 and 36,200 years BP and for the last deglaciation period, with especially, a higher resolution (40 data) for the 14,000 - 16,000 years BP time interval. These new data extend the previous Tahiti record beyond 13,800 years BP which was the oldest U-Th age obtained on cores drilled onshore in the modern Tahiti barrier reef [4, 5]. These results are compared with 14C chronologies from other corals, those of Barbados [6, 7] and those from other Pacific islands (Mururoa, Vanuatu, Marquesas, Christmas), and from the Cariaco Basin sediment [8], the Iberian Margin sediment [9, 10] and the Bahamian speleothem [11] records. The new 14C dataset from the corals drilled offshore Tahiti allows to validate the precision and accuracy of other records either directly dated by U-Th or tuned to a dated target, with a special emphasis for the Heinrich 1 event for which there is a debate about interpreting the discrepancies observed between the different records [3]. For this time period (15,000 - 17,500 cal ky BP), the Tahiti record supports the few data from the Iberian Margin record and from the Bahamas speleothems, but is in clear conflict with the Cariaco Basin record. The Tahiti record also allows to refine the significant variations of the atmospheric $\delta^{14}C$ during the Bølling warming period, that might be interpreted as changes in the global carbon cycle due to variations in the rates of exchange between the different carbon pools.

[1] Reimer et al. 2002, Radiocarbon 44, 653.

- [2] Hughen et al., 2004, Radiocarbon 46, 1059.
 [3] Reimer et al. 2009, Radiocarbon 51, 1111.
 [4] Bard et al. 1996, Nature 382, 241.
 [5] Bard E, Hamelin B, Delanghe-Sabatier D. 2010, Science DOI:10.1126/science.1180557.
 [6] Fairbanks RG et al. 2005, Quaternary Science Reviews 24, 1781.
 [7] Peltier WR & Fairbanks RG. 2006, Quaternary Science Reviews 25, 3322.

Topic: Land, ocean and climate records: interaction and forcing mechanisms

A dramatic ice sheet collapse at the onset of the Bölling warming at 14.6 kyr: New evidence from the IODP "Tahiti Sea-Level" Expedition

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Studying past sea-levels is the only way to document the disintegration of large ice-sheets in response to external climate forcing. Eustatic sea-level is a global integrator of volume variations of land-based ice that records instantaneously ice sheet collapses that may have punctuated the past glacial – interglacial transitions.

For the last deglaciation, the Barbados sea-level record is still the most complete and detailed sea-level record that encompassed that period [1, 2]. Based on cores drilled offshore from the Barbados coral reef, this record has revealed two dramatic accelerations of the sea-level rise, the so-called Melt Water Pulse events. The most extreme of these events, the MWP1-A, initially identified in the coral-based sea level record from the Barbados island, suggests a sea-level rise of ∼20 meters between 14.1 and 13.6 ka [3,4]. However, the occurrence, the hemispheric origin as well as the exact relationship between the MWP-1A and the global climatic evolution remain enigmatic and controversial. Finally, some doubts remains about the reality of the MWP 1A.

Located at a considerable distance from the major former ice sheets, the Tahiti Island has appeared as a plausible candidate for an alternative reference site [5]. Characterized by slow and regular subsidence rates, Tahiti provides an ideal setting to constrain MWP events that are thought to have punctuated the last deglaciation. The recent IODP Expedition 310 "Tahiti Sea Level" has extended the existing Tahiti sea-level curve, by drilling offshore three distinct areas around the Tahiti Island [6]. The previous Tahiti record based on two on-shore coring campaigns carried out throughout the modern barrier-reef in front of Papeete harbour, documenting the deglacial sea level rise for the last 13, 800 cal. yr BP [5, 7].

The new Tahiti data set includes more than 80 U-Th ages obtained on various types of corals characterizing shallow to deeper environments that extend the previous Tahiti record to 16 ka and allow to document

	<p>the sea-level rise during the key period of the MWP-1A. Our results confirm the occurrence of an acceleration of the sea-level rise during that period. However, the timing and duration of this event differ significantly from observations from Barbados [3,4]. These new results indicate that the MWP-1A occurred at about 14.6 ka BP, synchronously with the Bølling onset [8]. This allows us to revisit the relationship between the MWP-1A and the climate history of the last deglaciation [8]. Their implications in terms of the potential sources of the ice that generated the MWP-1A will be also discussed.</p> <ol style="list-style-type: none"> 1. Fairbanks, R.G., A 17,000-year glacio-eustatic sea level record; influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. <i>Nature</i>, 1989. 342(6250): p. 637-642. 2. Bard, E., et al., Calibration of the C-14 Timescale over the Past 30,000 Years Using Mass-Spectrometric U-Th Ages from Barbados Corals. <i>Nature</i>, 1990. 345(6274): p. 405-410. 3. Fairbanks, R.G., et al., Radiocarbon calibration curve spanning 0 to 50,000 years BP based on paired $^{230}\text{Th}/^{234}\text{U}/^{238}\text{U}$ and ^{14}C dates on pristine corals. <i>Quaternary Science Reviews</i>, 2005. 24(16-17): p. 1781. 4. Peltier, W.R. and R.G. Fairbanks, Global glacial ice volume and Last Glacial Maximum duration from an extended Barbados sea level record. <i>Quaternary Science Reviews</i>, 2006. 25(23-24): p. 3322. 5. Bard, E., et al., Deglacial sea-level record from Tahiti corals and the timing of global meltwater discharge. <i>Nature</i>, 1996. 382: p. 241-244. 6. Camoin, G., et al., in <i>Proceedings IODP. 2007, Integrated Ocean Drilling Program Management International, Inc.: College Station, TX.</i> 7. Bard, E., B. Hamelin, and D. Delanghe-Sabatier, Deglacial Meltwater Pulse 1B and Younger Dryas Sea Levels Revisited with Boreholes at Tahiti. <i>Science</i>, 2010. 327(5970): p. 1235-1237. 8. Deschamps, P., et al., A dramatic ice sheet collapse synchronous with the onset of Bølling warming. Submitted for publication
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<p>Fernando Barriga</p> <p>Universidade de Lisboa</p> <p>Creminer LA-ISR and Dep. Geologia, Fac. Ciencias Edificio C2, Piso 5 Campo Grande 1749-016 Lisboa Portugal Tel: +351 21 7500357/919906338 Fax: +351 2175 00119 Email: f.barriga@fc.ul.pt</p> <p>Project 06-EuroMARC-FP-011 / Ultraslow spreading and hydrogen based deep biosphere (H2DEEP)</p>	<p><i>Topic: Geodynamic, hydrothermal and biogeochemical processes</i></p> <p>Geological mineral exploration tools in the Arctic near Loki's Castle, 74 degrees N (South Knipovich Ridge)</p> <p>Fernando JAS Barriga^{1, 2}, Rita Fonseca^{1, 3}, Ágata S. Dias^{1, 2}, Ines Cruz^{1, 2}, Carlos Carvalho^{1, 2}, Jorge MRS Relvas^{1, 2}, Rolf B. Pedersen⁴</p> <p>1. Creminer FCUL, Lab Assoc Institute of Systems Research, Lisbon, Portugal. 2. Dep Geology, Fac Ciencias Univ Lisboa, Lisbon, Portugal. 3. Dep Geosciences, Univ Evora, Evora, Portugal. 4. Centre of GeoBiology, Univ Bergen, Bergen, Norway.</p> <p>Discovery of the Loki's Castle hydrothermal vent field (2008) was a great surprise, given its size and vigour of hydrothermal discharge. Several characteristics, including the fauna, separate it from either Atlantic or Pacific-type hydrothermal sites. Concerning size and grades, data are insufficient, but it appears so far that Loki's Castle is a very large system, about 200 m in diameter. The metal contents (in discreet samples, this study) are quite interesting, with Zn up to 5.4wt% and Cu estimated at several percent in some samples. Ag attains 25 ppm and Au 1.3 ppm. The tonnage of Loki's Castle may be, tentatively, in the range of 1-5 million tones. Loki's Castle is certainly worthy of study from a mineral resource standpoint.</p> <p>Very active hydrothermal discharge sites such as Loki's Castle raise the issue of the size gap between modern and ancient vms deposits (preserved in the geological record), with the latter often much larger than the former. For the land-based mining industry, a "large" vms deposit amounts to a least 25 Mt. The larger examples (supergiant deposits) exceed 150 Mt (Galley et al, 2007). We believe that this gap (by a factor of at least 20) is largely a consequence of incomplete knowledge of the present day systems. Too little attention has been given so far to deposits forming within the upper few metres of the oceanic crust, within sediments or other poorly consolidated rocks (e.g. volcanoclastics). We are studying sediments in detail to find clues of hydrothermal activity through them, and to test the possibility of some influence from within-crust microbial activity (deep biosphere).</p>
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Project

06-EuroMARC-FP-011 / Ultraslow
 spreading and hydrogen based deep
 biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Loki's Castle: A sediment-influenced hydrothermal vent field at the ultra-slow spreading Arctic Mid-Ocean Ridge

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The chemical composition as well as the stable and radiogenic isotope signatures of hydrothermal fluids from the Loki's Castle vent field, located at the Mohns-Knipovich bend in the Norwegian-Greenland Sea (73°N), are substantially different from sediment-starved mid-ocean ridge hydrothermal systems. Geochemical studies of the hydrothermal vent fluids and the adjacent rift valley sediments provide insights into the influence of sediments on the hydrothermal fluid composition and provide constraints on acting redox conditions. Here we present an overview of the geochemical characteristics of the hydrothermal and sedimentary components at Loki's Castle, obtained during expeditions in 2008, 2009 and 2010, with emphasis on the stable and radiogenic isotope signatures. We compare these data with other sediment-influenced and sediment-starved mid-ocean ridge hydrothermal systems. The hydrothermal vent fluids are characterized by a pH of \approx 5.5 and by elevated concentrations of methane, hydrogen and ammonia, which reflect a sedimentary contribution. $\delta^{13}\text{C}$ values of dissolved inorganic carbon are depleted relative to mantle carbon values, consistent with an organic carbon input. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are more radiogenic than those characteristic of un-sedimented mid-ocean ridge vent fluids. S-isotope data reflect mixing of a MORB source with sulphide derived from reduced seawater sulphate.

To document the background sediment input of the ridge system, short gravity cores and up to 18 m long piston cores were recovered from various localities in the rift valley. The pore-fluid isotope chemistries of the sediments show vertical gradients that primarily reflect diagenesis and degradation of organic matter. The vertical gradient is locally enhanced as a consequence of elevated temperature or higher organic carbon sediment concentrations. Our data suggests that buried rift valley sediments may significantly contribute to the Loki's Castle hydrothermal fluids leading to hydrothermal fluids distinct from un-sedimented mid-ocean ridge systems.

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Project

06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 – Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Formation of microbialites in post-glacial coral reefs induced by sulfate-reducing bacteria

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At Tahiti (Central Pacific), the post-Last Glacial Maximum (LGM) reef-succession typically consists of coral framework encrusted by coralline algae and later by thick (up to 15 cm) microbial carbonate crusts, so called reef-microbialites. These microbialites make up as much as 80% of the rock volume (Camoin et al., 1999). Similar deglacial microbialites occur in coral reefs off Vanuatu (South-West Pacific; Cabioch et al, 1999), whereas only thin crusts of microbial carbonates were observed in Holocene coral reefs off Belize (Caribbean) and from the Maldives (Indian Ocean; Gischler et al., 2008 a, b). After sea-level stabilized approximately 6000 years ago, microbialites ceased to form in coral reefs. Their occurrence in post-LGM reefs is believed to reflect environmental change during the rapid last deglacial sea-level rise (Cabioch et al., 1999; Camoin et al., 1999).

To improve our understanding of the genesis of reef-microbialites, we used lipid biomarkers extracted from the microbial carbonate and the stable isotopic compositions of sulfur and oxygen in carbonate-bound sulfate as well as the stable isotopic compositions of sulfur in sulfide minerals to identify the microbes and the processes inducing microbialite formation during the last sea-level rise. Detected sterols, saturated and monounsaturated short-chain fatty acids are predominantly derived from both marine primary producers (algae) and bacteria, whereas long-chain fatty acids and long-chain alcohols derive mainly from higher land plants representing the terrestrial input. Bacterially-derived branched fatty acids (10-Me-C16:0, iso- and anteiso-C15:0 and -C17:0) and mono-O-alkyl glycerol ethers (MAGEs) are biomarkers of intermediate to high specificity for sulfate-reducing bacteria (SRB). These branched fatty acids as well as MAGEs are exceptionally abundant in the microbial carbonates from Tahiti (Heindel et al., 2010) and Vanuatu compared to the deglacial inter-reef sediment from Tahiti. In microbial crusts off Belize and from the Maldives, the biomarker signal of SRB is weak. The isotopic values of the carbonate-bound sulfate in microbialites from Tahiti and Vanuatu ($\delta^{34}\text{S}$: 21.9 - 22.1‰, $\delta^{18}\text{O}$: 11.3 - 12.4‰) are higher than that of a coral ($\delta^{34}\text{S}$: 21.3‰, $\delta^{18}\text{O}$: 10.5‰), recovered from the same post-glacial reef-interval off Tahiti, and modern seawater ($\delta^{34}\text{S}$: 20.3‰, $\delta^{18}\text{O}$: 8.6‰), which indicates bacterial sulfate reduction. The sulfide minerals (mainly pyrite) in microbialites from Tahiti and Vanuatu yielded low $\delta^{34}\text{S}$ values from -43.2‰ to -42.1‰,

	<p>agreeing with bacterial sulfate reduction as major process, which led to carbonate precipitation, and thus steered microbialite formation. To conclude, lipid biomarkers and isotope ratios of carbonate-bound sulfate and sulfide reveal the involvement of SRB in the formation of thick microbialites in coral reefs off Tahiti and Vanuatu. The low quantities of biomarkers derived from SRB in the reef-microbialites from Belize and the Maldives suggest a less significant role of SRB in generating microbial crusts compared to the coral reefs off the volcanic islands Tahiti and Vanuatu.</p> <p>The contents of Al, Si, Fe, Mn, and Ba as well as the abundance of pyroxene, plagioclase, and magnetite in the microbialites of Tahiti reflect strong terrigenous influx with Tahitian basalt as the major source. Chemical weathering of the basalt most likely elevated the nutrient level. This fertilization presumably led to an increase in primary production and organic matter formation in the Tahiti reefs, boosting heterotrophic sulfate reduction (Heindel et al., 2010). Possibly, this pattern was also active off the volcanic island Vanuatu triggering the formation of reef-microbialites during the last deglaciation unlike off Belize and the Maldives.</p> <p>CAMOIN, G.F., GAUTRET, P., MONTAGGIONI, L.F., & CABIOCH, G. (1999): Nature and environmental significance of microbialites in Quaternary reefs: the Tahiti paradox. <i>Sedimentary Geology</i>, 126: 271-304.</p> <p>CABIOCH, G., TAYLOR, F.W., CORRÈGE, T., RÉCY, J., EDWARDS, L.R., BURR, G.S., LE CORNEC, F., & BANKS, K.A. (1999): Occurrence and significance of microbialites in the uplifted Tasmaloum reef (SW Espiritu Santo, SW Pacific). <i>Sedimentary Geology</i>, 126: 305-316.</p> <p>GISCHLER, E. (2008a): Accretion patterns in Holocene tropical reefs: do massive coral reefs in deeper water with slowly growing corals accrete faster than shallower branched coral reefs with rapidly growing corals? <i>International Journal of Earth Sciences</i>, 97: 851-859.</p> <p>GISCHLER, E., HUDSON, J.H., & PISERA, A. (2008b): Late Quaternary reef growth and sea level in the Maldives (Indian Ocean). <i>Marine Geology</i>, 250: 104-113.</p> <p>HEINDEL, K., BIRGEL, D., PECKMANN, J., KUHNERT, H., & WESTPHAL, H. (2010): Formation of deglacial microbialites in coral reefs off Tahiti (IODP 310) involving sulfate-reducing bacteria. <i>Palaios</i>, 25: 618-635.</p>
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<p>Gilbert Camoin</p> <p>CNRS Europôle Méditerranéen de l'Arbois BP 80 13545 Aix-en-Provence Cedex 4 France Tel: +33 4 42 97 15 14 Fax: +33 4 42 97 15 40 Email: gcamoin@cerege.fr</p> <p>Project 06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 –, Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)</p> <p>Status Project Leader</p>	<p><i>Topic: High resolution climate records and climate changes</i></p> <p>Reef response to sea-level and environmental changes during the last deglaciation. IODP Expedition 310 “Tahiti Sea Level”.</p> <p>Gilbert F. Camoin¹, Claire Seard¹, Pierre Deschamps¹, Jody M. Webster², Elizabeth Abbey², Juan C. Braga³, Yasufumi Iryu⁴, Nicolas Durand¹, Edouard Bard¹, Bruno Hamelin¹, Yusuke Yokoyama⁵, Alexander Thomas⁶ and Gideon Henderson⁶ ¹ CEREGE, B.P. 80, F-13545 Aix-en-Provence cedex ⁴ France. ² The University of Sydney, School of Geosciences, NSW 2006, Australia ³ Universidad de Granada, Estratigrafía y Paleontología, Campus Fuentenueva, 18002, Granada, Spain. ⁴ Nagoya University, Department of Earth and Planetary Sciences, 464-8601, Nagoya, Japan. ⁵ Ocean Research Institute and Department of Earth and Planetary Science, University of Tokyo, 1-15-1 Minami-dai Tokyo 164-8639 Tokyo, Japan. ⁶ University of Oxford, Department of Earth Sciences, Parks Road, Oxford, OX1 3PR, UK.</p> <p>The last deglaciation has been characterized by a rapid sea-level rise and coeval abrupt environmental changes. The Barbados coral reef record suggested that this period has been punctuated by two brief intervals of accelerated melting (Melt Water Pulses), occurring at ~14.2 and 11.5 ka, superimposed on a smooth and continuous rise of sea level. Although their timing, their magnitude, or even their existence have been actively debated, those catastrophic sea-level rises are thought to have induced distinct reef drowning events.</p> <p>The reef response to sea-level and environmental changes during the last deglacial sea-level rise at Tahiti is reconstructed based on a chronological, sedimentological and paleobiological study of cores drilled through the relict reef features occurring on the modern fore-reef slopes during the IODP Expedition 310.</p> <p>The last deglacial reefs from Tahiti are composed of two distinctive biological communities : (1) the corallgal communities including seven assemblages characterized by various growth forms (branching, robust branching, massive, tabular and encrusting) that form the initial frameworks; (2) the microbial communities developed in the primary cavities of those frameworks, a few meters (1.5 to 6 m) below the living coral reef surface, where they heavily encrusted the corallgal assemblages to form microbialite crusts.</p> <p>Changes in the composition of corallgal assemblages coincide with abrupt variations in reef growth rates and characterize the response of the upward-growing reef pile to a non-monotonous sea-level rise and coeval environmental changes.</p> <p>No major break in reef development occurred between 16 and 10 ka. Reefs accreted mostly through aggradational processes at growth rates averaging 10mm.yr⁻¹, thus precluding any catastrophic impact on reef development such as the temporary cessation of reef growth. An incipient drowning and a general backstepping of the reef complex have been evidenced during the 14.6-13.9 ka time window, coeval with the MWP-1A, implying that reef growth gradually lagged behind</p>
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	<p>sea-level rise.</p> <p><i>Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA</i></p> <p>The last deglacial sea-level and climatic changes. coral reef records in the south pacific : tahiti (french polynesia) - iodp expedition #310 –, australian great barrier reef – iodp proposal #519”-.</p> <p>Gilbert F. Camoin¹ and the CHECREEF Team ¹ CEREGE, B.P. 80, F-13545 Aix-en-Provence cedex 4</p> <p>The timing and course of the last deglaciation (23,000-6,000 calendar years BP - cal. yr BP) are essential components for understanding the dynamics of large ice sheets and their effects on Earth's isostasy as well as the complex relationship between freshwater fluxes to the ocean, thermohaline circulation and, hence, global climate during the Late Pleistocene and the Holocene. This proposal is related to the IODP proposal #519 concerning the coral reef records of Tahiti and the Australian Great Barrier Reef to establish the course of sea-level rise, climate variability and reef response during the last deglaciation. It includes :</p> <ol style="list-style-type: none"> 1) the study of more than 600 m of reef cores with an exceptional recovery that were retrieved from 37 holes ranging from 40 to 120 m water depth around Tahiti during the IODP Expedition #310 « Tahiti Sea Level ». Distinctive levels of relict reefs covering most, if not all, the last deglaciation were drilled and therefore confirmed the significance of these features as unique archives of abrupt global sea-level rise and climate change. 2) Complimentary investigations of the Tahiti reef slopes, and 3) a site survey cruise on the Great Barrier Reef to generate high resolution bathymetric and seismic data that will be used to select suitable targets for an IODP drilling expedition corresponding to the part 2 of the IODP drilling proposal #519. <p>The general scientific objectives of this proposal are threefold :</p> <ol style="list-style-type: none"> a) To establish the course of post-glacial sea-level rise during the Last Deglaciation . b) To define SSTs and SSSs variations during the Last Deglaciation when solar insolation, sea level, and atmospheric CO₂ levels were different from today. c) To analyze the impact of sea-level and environmental changes on reef development during the Last Deglaciation, with a special emphasis on the comprehensive reconstruction of environmental changes.
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Project

06-EuroMARC-FP-005 / Response of tropical Atlantic surface and intermediate waters to changes in the Atlantic meridional overturning circulation (RETRO)

Topic: High resolution climate records and climate changes

Tropical African rainbelt dynamics over the past 23,000 years

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The distribution of rainfall in tropical Africa is controlled by the African rainbelt, which oscillates latitudinally on a seasonal basis. The rainbelt has varied on centennial to millennial timescales along with changes in Northern Hemisphere high-latitude climate (Gasse et al, 2008) the Atlantic meridional overturning circulation (Mulitza et al, 2008) and low-latitude insolation (DeMenocal et al, 2000) over the past glacial-interglacial cycle. However, the overall dynamics of the African rainbelt remain poorly constrained and are not always consistent with a latitudinal migration as has been proposed for other regions (Haug et al, 2001). We use terrestrially derived organic and sedimentary markers from marine sediment cores to reconstruct the distribution of vegetation and dust availability in tropical Africa during extreme climate states over the past 23,000 years. Our data indicate that rather than migrating latitudinally, the rainbelt contracted and expanded symmetrically in both hemispheres in response to changes in climate. During the Last Glacial Maximum and Heinrich Stadial 1, the rainbelt contracted relative to the late Holocene, which we attribute to a latitudinal compression of atmospheric circulation associated with lower global mean temperatures (Frierson et al, 2007). Conversely, during the mid-Holocene climatic optimum, the rainbelt expanded across tropical Africa. In light of our findings, it is not clear whether the tropical rainbelt has migrated latitudinally on a global scale, as has been suggested.

<p>Trond Martin Dokken</p> <p>Bjerknes Centre for Climate Research Uni Research Uni Bjerknes Centre Allegatan 55 5007 Bergen Norway Tel: +47 55 58 98 01 Fax: +47 55 58 43 30 Email: trond.dokken@uni.no</p> <p>Project 06-EuroMARC-FP-005 / Response of tropical Atlantic surface and intermediate waters to changes in the Atlantic meridional overturning circulation (RETRO)</p>	<p><i>Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA</i></p> <p>What has been achieved, and future perspective for RETRO</p> <p>Dokken, T.(1), Oppedal, L. (1), Tisserand, A.(1), Collins, J.(2), Peeters, F.(3), Mulitza, S.(2), Waelbroeck, C.(4) (1)Bjerknes Centre for Climate Research, (2) MARUM, University of Bremen, (3) Vrije University, (4) CNRS/CEA</p> <p>This presentation will highlight some of the most prominent results from the RETRO project. Main aim has been to study thermocline changes in the tropical ocean associated to changes in the North Atlantic Meridional Overturning Circulation (AMOC). Further to investigate tropical responses to rapid changes in climate. Here we will further present plans for the continuation of RETRO.</p>
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Project

06-EuroMARC-FP-003 / The last
 deglacial sea-level and climatic
 changes. Coral reef records in the
 south Pacific: Tahiti (French Polynesia)
 - IODP Expedition #310 -, Australian
 Great Barrier Reef – IODP Proposal
 #519. (CHECREEF)

Topic: High resolution climate records and climate changes

Potential of last deglacial Tahiti corals for subseasonal climate reconstructions (IODP Expedition 310) - New approaches in screening for diagenetic alteration

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Fossil corals are unique archives of past seasonal climate variability, providing vital information about seasonal to interannual climate phenomena such as the El Niño-Southern Oscillation (ENSO) that impacts global climate on timescales relevant to society. However, submarine diagenetic processes can potentially obscure the original climate signals in fossil corals and lead to false interpretations. Here we demonstrate the potential of laser ablation ICP-MS to rapidly detect secondary aragonite precipitates in fossil Porites colonies recovered by Integrated Ocean Drilling Program (IODP) Expedition 310 from submerged deglacial reefs off Tahiti. High resolution measurements of coralline B/Ca, Mg/Ca, S/Ca, and U/Ca ratios are used to distinguish areas of pristine skeleton from those afflicted with secondary aragonite. Measurements of Sr/Ca in individual Porites colonies, from skeletal areas identified as pristine, reveal that the amplitude of the seasonal cycle of sea surface temperature (SST) in the tropical south Pacific during time intervals of the last deglaciation (11 ka, 12.4 ka, 14.2 ka, 14.7 ka, and 15.0 ka) was similar to that of today. A unique 15.0 ka Tahiti coral provides a monthly resolved Sr/Ca-based SST record for a time-window of 22 years, which is exceptionally long given the corals' age and recovery method. The monthly resolved SST reconstruction reveals significant interannual variability at typical ENSO periods. This finding indicates that, over the 22-year time window represented by the 15.0 ka coral, pronounced interannual variability at ENSO periods occurred in tropical South Pacific SST. This suggests that ENSO was operating during Heinrich stadial 1, a period at the end of the last glacial characterized by substantial weakening of the Atlantic Meridional Overturning Circulation.

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Project

06-EuroMARC-FP-004 /
 Multidisciplinary study of
 continental/ocean climate dynamics
 using high-resolution records from the
 eastern Mediterranean (MOCCHA)

Topic: High resolution climate records and climate changes

Recent geochemical compositional patterns and subrecent variability (0-400 yrs) of sediments in the Gulf of Taranto (S.Italy) and the South Western Adriatic Sea

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Causes and consequence of climate and environmental change and their underlying processes are still poorly understood especially on decadal to millennial time scales. To improve knowledge on these time scales constant and long records, with high resolution of climate variability are needed. Previous studies (Cini Castagnoli ,2002, e.g.) have indicated such paleoclimate records in the Gulf of Taranto (39N46;17E54.) High, continuous accumulation rates together with low disturbance permit high resolution studies. Furthermore this Mediterranean site is influenced by both the NAO and monsoonal climate system, making it an interesting study for short time scale climate variability studies.. In this study recent surface sediments elemental composition patterns from the area are compared with environmental factors. Correlations found can then be used for a paleoclimate reconstruction of the last 400 years using multicore NU-04-MC, a finely laminated core from the Gulf of Taranto with an age of approximately 400 years BP. Surface sediments from the first centimeter of 47 multicores recovered from the area and every 2.5 mm of multicore NU04-MC were analyzed for their elemental content and Bulk organic carbon/nitrogen. Preliminary results indicate an increase of known anthropogenic indicators and Ba/Al ratio's in the last hundred years.

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Project

06-EuroMARC-FP-004 /
 Multidisciplinary study of
 continental/ocean climate dynamics
 using high-resolution records from the
 eastern Mediterranean (MOCCHA)

Topic: High resolution climate records and climate changes

**Reconstructing climate change with ‘clumped-isotopes’
 in foraminifera from sediment cores covering the last
 2000 years in the Gulf of Taranto, Mediterranean Sea**

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The MOCCHA Project (Multidisciplinary study of continental/ocean climate dynamics using high-resolution records from the eastern Mediterranean) aims at reconstructing climate change from high sedimentation rate sediments in the Gulf of Taranto. This region is very promising for reconstructing Holocene climate variability, especially for evaluating the potential of anthropogenic influence on climate, because it records both marine and riverine influences. Here we present stable isotope and ‘clumped-isotope’ measurements of *G. ruber* (white) from a short sediment core covering the last 500 years and a section of a long sediment core covering the period 1200AD to 200BC, at 3.5 years resolution. Our data and a compilation of regional historical, geographical and archeological data indicate that during the Roman Classical Period the conditions were more humid in the Mediterranean and drifted towards drier conditions during the Medieval Warm Period (MWP). Additional counts of *G. ruber* (pink) support the assumption of much drier conditions during the MWP, which concords with higher $d_{18}O$ values of *G. ruber* (white) due to higher salinity in the Gulf of Taranto. The results of the short core, covering the LIA, correlate well with global temperature reconstructions. In addition to cool conditions during the LIA the influence of external forcing factors is most prominent in this period in the $d_{18}O$ record. Another indicator for the cool conditions during the LIA is the absence of *G. ruber* (pink) the amount of which increases again from 1900AD onward.

This work has been made possible thanks to the support from the European Science Foundation (ESF) under the EUROCORES Program EuroMARC and from the Swiss SNF.

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Project

06-EuroMARC-FP-002 / Mid latitude
carbonate systems: complete
sequences from cold-water coral
carbonate mounds in the northeast
Atlantic (CARBONATE)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Glacial cold-water coral growth in the Gulf of Cádiz, NE Atlantic

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A set of 40 Uranium-series datings obtained on the reef-forming scleractinian cold-water corals *Lophelia pertusa* and *Madrepora oculata* revealed that during the past 400 kyr their occurrence in the Gulf of Cádiz (GoC) was almost exclusively restricted to glacial periods. This result strengthens the outcomes of former studies that coral growth in the temperate NE Atlantic encompassing the French, Iberian and Moroccan margins dominated during glacial periods, whereas in the higher latitudes (Irish and Norwegian margins) extended coral growth prevailed during interglacial periods. Thus it appears that the biogeographical limits for sustained cold-water coral growth along the NE Atlantic margin are strongly related to climate change. By focussing on the last glacial-interglacial cycle, this study shows that palaeo-productivity was increased during the last glacial. This was likely driven by the fertilisation effect of an increased input of aeolian dust and locally intensified upwelling. After the Younger Dryas cold event, the input of aeolian dust and productivity significantly decreased concurrent with an increase in water temperatures in the GoC. This primarily resulted in reduced food availability and caused a widespread demise of the formerly thriving coral ecosystems. Moreover, these climate induced changes most likely caused a latitudinal shift of areas with optimum coral growth conditions towards the northern NE Atlantic where more suitable environmental conditions established with the onset of the Holocene.

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Project

06-EuroMARC-FP-011 / Ultraslow
 spreading and hydrogen based deep
 biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Diversity of microbial communities of Loki's Castle black smoker field at the ultra-slow spreading Arctic Mid-Ocean Ridge

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As part of the EuroMarc "H2Deep Project" we conducted organic geochemical studies of hydrothermal deposits from the Loki's Castle black smoker field, recently discovered at the Arctic Mid-Ocean Ridge (AMOR) in the Norwegian-Greenland Sea at around 73.2°N. Located at the Mohn-Knipovich Ridge, which is one of the slowest spreading ridge segments on Earth, Loki's Castle is the most northerly major hydrothermal vent field known to date. The vent field is composed of five actively venting (320°C) black-smoker chimneys that tower on top of a large sulphide mound of hydrothermal deposits. Loki's Castle is a basalt-hosted hydrothermal system, but extraordinarily high methane and ammonium contents of vent fluids strongly indicate a sedimentary source component below the volcanic ridge. In 2009, another low-temperature hydrothermal field hosting numerous barite chimneys was discovered in the vicinity of the black smoker, probably resulting from subsurface diffuse mixing of hydrothermal fluid with seawater.

In our study, microbial communities associated with the formation of actively venting, sulfide and sulfate chimneys in this essentially unexplored ultraslow spreading ridge system, are assessed based on biomarker lipid and compound-specific carbon isotope analyses. Lipid extracts from an active, high-temperature sulfide chimney yielded abundant archaeal di- and tetraether lipids as well as irregular isoprenoidal hydrocarbons (PMIs) that are associated with archaeal methanogens and methanotrophs. Predominant archaeal biomarker lipids were archaeol, sn-2 hydroxyarchaeol as well as glycerol dialkyl glycerol tetraethers (GDGTs) containing 0-4 cyclopentyl moieties. In addition, GDGTs with an additional covalent bond between the isoprenoid hydrocarbon chains, so-called H-shaped GDGTs, containing 0-4 cyclopentyl rings were also found to be abundant components, which is indicative for hyperthermophilic methanogens. Biomarkers indicating the presence of eukaryotes (sterols) and bacteria (fatty acids and hopanoids) were less prevalent in the sulfide chimney samples indicating a predominance of archaeal communities within the warmer interior zones of the chimney walls that are dominated by the iron sulfides sphalerite and pyrrhotite. In contrast, the low-temperature barite-bearing vents located at the slope of the massive sulfide mound revealed the dominance of a range of unusual branched and unsaturated fatty acids that are specific for sulfate reducing bacteria (SRB) and sulfur oxidizing bacteria (SOB) in the outer chimney wall. GDGTs, PMIs, archaeol, and sn-2-hydroxyarchaeol as typically observed in methanogenic and methanotrophic archaea (AOM) were the main lipids in the interior. Ongoing compound-

	<p>specific $\delta^{13}\text{C}$ analyses will give additional information about carbon sources and metabolism of microbial consortia inhabiting actively venting sulfide and barite chimneys at Loki's castle.</p>
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Project

06-EuroMARC-FP-002 / Mid latitude
carbonate systems: complete
sequences from cold-water coral
carbonate mounds in the northeast
Atlantic (CARBONATE)

Topic: High resolution climate records and climate changes

Holocene benthic foraminifers in the cold-water coral habitat and fjord trough deposits of the Stjernesund, northern Norway

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Holocene sedimentary records from the Stjernesund have been explored in great detail. Cold-water coral mounds comprising the azooxanthellate scleractinian *Lophelia pertusa*, thrive on top of a late glacial terminal moraine crest at 265 to 230 m water depth. During RV Poseidon cruise POS-325 a series of gravity cores have been taken in an E-W transect across the moraine and from the adjacent proximal fjord basin. The core-record comprises glaciomarine-deposits that are overgrown by Holocene coral mound deposits on the moraine crest, as well as muddy-silty fjord trough deposits. Paleoceanographic and climatic changes in the Stjernesund are investigated through down-core analyses of foraminiferal assemblages, high-resolution radiometric dating (AMS-14C and U/Th), grain size spectra, and stable isotopes measurements on foraminifera, XRD and bulk carbonate variations.

Two well dated cores were selected and investigated for their benthic foraminiferal assemblages (ESF-Project CARBONATE). Core POS-325-472 was recovered from the coral habitat on the moraine crest. It covers a time span between 9.9 and 1.6 ka BP, including several hiatus. The frequent hiatus are a common characteristic in coral-mound records, which has been observed e.g. in prominent mounds of the Irish Rockall Bank (e.g. Frank et al. 2009). The second core (POS-325-482) derives from the fjord basin (479 m water depth). This core is suitable for high-resolution Holocene studies for its continuous sedimentary record that covers the last 9.8 ka BP. The benthic foraminiferal assemblages in both cores will elucidate the environmental conditions during coral growth and erosion phases. A total of 114 samples were taken every 10 cm for these analyses.

About 95 species/genera of benthic foraminifera were identified from both cores. Planktonic species are rare, probably indicating low productivity rates in the surface brackish layer above the marine deeper waters in the fjord. The fauna of the on-mound core is dominated by epifaunally attached species like *Cibicides lobatulus*, *C. refulgens*, *Rosalina anomala* and *Discanomalina coronata* that are common in high-energy environments. The occurrence of *D. coronata* was proposed as an indicator species for cold-water coral habitats (Margreth et al. 2009). In the Stjernesund habitat its abundance is seemingly connected to frequently occurring hiatus. This is probably due to sedimentary processes that generally accumulate benthic foraminifers with robust tests from different microhabitats (e.g. *C. lobatulus* and *Trifarina angulosa*). Species with less durable tests like *Patellina corrugata* and *Spirillina vivipara* show a contrasting pattern and are often absent or rare in intervals where hiatus are assumed. The foraminiferal pattern reflects a continuous mound

	<p>growth in the Early Holocene (9,900 to 9,400 years BP) and a continued growth phase in the Late Holocene (3,400 to 1,600 years BP), which was interrupted by several hiati.</p> <p>In the fjord basin the fauna is dominated by (shallow) infaunal species like <i>Cassidulina laevigata</i>, <i>C. neoteretis</i> and in the first 70 cm of the core also by <i>Brizalina skagerrakkensis</i>. Subsidiary species are <i>Nonionellina labradorica</i>, <i>C. lobatulus</i>, and <i>Elphidium excavatum</i>. <i>N. labradorica</i> and <i>B. skagerrakkensis</i> are reported as dominant species in deep-water assemblages in arctic and temperate fjords in E Greenland and N Norway (Murray 2006). Both species are opportunistic and able to survive in oxygen deficient environments. In the on-mound core these species are rare and small sized or completely absent. The benthic foraminiferal pattern revealed from the fjord basin core reflects considerably warmer temperatures in the Middle Holocene (ca. 9,850 and 3,400 years BP), which is missing in the on mound core, than in the Late Holocene, where Arctic species (e.g. <i>Elphidium excavatum</i>, <i>Islandiella norcrossi</i>) are more abundant.</p> <p>References</p> <p>Frank, N., Ricard, E., Lutringer-Paquet, A., van der Land, C., Colin, C., Blamart, D., Foutbert, A., Van Rooij, D., Henriot, J.-P., de Haas, H., van Weering, T. (2009) The Holocene occurrence of cold water corals in the NE Atlantic: Implications for coral carbonate mound evolution. <i>Marine Geology</i>, 266, 129-142.</p> <p>Margreth, S.; Rüggeberg, A.; Spezzaferri, S. (2009): Benthic foraminifera as bioindicator for cold-water coral reef ecosystems along the Irish Margin. In: <i>Deep-Sea Research I</i>, Jg. 56, S. 2216–2234.</p> <p>Murray, J. (2006): <i>Ecology and Applications of Benthic Foraminifera</i>. Cambridge: Cambridge University Press.</p>
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Project

06-EuroMARC-FP-008 / Atlantic
 Meridional Overturning Circulation
 During Interglacials (AMOCINT)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Multiproxy reconstruction of AMOC's Upper and Lower Limbs in the Interior North Atlantic Ocean south off the Azores

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The Atlantic Meridional Overturning Circulation (AMOC) is an important component of the Earth's climate system, responsible for heat transport to higher latitudes via its surface currents and carbon partitioning in deep ocean reservoirs due to the modulation of bottom water ventilation. Climate fluctuations during the Holocene and previous interglacials are linked to variations in the AMOC Intensity. Several studies have investigated the role of AMOC surface and deep flow in the higher latitudes, due to the fact, that sediment drifts in the path of Nordic Seas overflow to the North Atlantic provide suitable high resolution sediment archives.

Contrary, little is known about the AMOC circulation in the Interior Atlantic at mid latitudes. This partly results from (i) the long held opinion, that these areas experienced little to no change even during glacial/interglacial transitions, and (ii) that sediment cores with reasonable sedimentation rates are missing from these oligotrophic areas.

Here we present a multiproxy reconstruction of surface- and deepwater conditions from two core locations in small basins on the Mid-Atlantic-Ridge south of the Azores. The basins from which the sediment cores were retrieved acted as natural sediment traps, providing sufficiently high sedimentation rates, that short term (centennial) changes in surface and bottom water properties could be traced. The core locations are situated at the Northern Rim of the Subtropical Gyre (STG), which in concert with the Subpolar Gyre (SPG) are responsible for the thermohaline properties of the North Atlantic Current (NAC), the northward flowing upper limb of AMOC. Surface water proxies (SST, SSS, Productivity) clearly show abrupt changes during the deglaciation and early Holocene in phase with high latitude forcing, due to a southward displacement of the STG or strengthening of the Azores Current System.

Bottom water variability is traced by benthic foraminifera stable carbon and oxygen isotopes ratios to reconstruct the different sources of the lower limb of AMOC at our sites. At the core locations the deglacial and early Holocene is characterised by fluctuating influence of southern sourced Lower Deep Waters (LDW) and well ventilated North East Atlantic Deep Water (NEADW). Since the Mid Holocene the deep water flow of NEADW to the study area is stabilized. The results of both surface and deep water circulation indicate, that the study area is highly sensitive to changes in AMOC intensity. Moreover the comparison between the last two interglacials indicate, that substantial differences exist between MIS 5.5 and the Holocene.

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Project

06-EuroMARC-FP-008 / Atlantic
 Meridional Overturning Circulation
 During Interglacials (AMOCINT)

Topic: High resolution climate records and climate changes

Magnetic properties and sortable silt and isotopes in the sub-polar North Atlantic and the relation with the deep oceanic circulation.

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One of the main goal of the AMOCINT project [ESF-EUROCORES programme, 06-EuroMARC-FP-008], was to reconstruct at the highest possible time resolution the variability of the North Atlantic circulation during interglacial periods and glacial inception in order to understand the mechanisms and external/internal forcing at the origin of this variability.

In this framework, we conducted analyses of stable carbon and oxygen isotopes and of magnetic properties coupled with sortable silt of cores either taken during the 2008 AMOCINT cruise and/or during previous oceanic cruises, all organized on board the R. V. Marion Dufresne (IPEV).

Most of the stable isotopes measurements have been performed on cores from the Voering plateau (MD08-3191). These data are interpreted in the framework of the collaboration with the Lisbon team (see the abstract from Nave et al.). The other focus is the Charlie Gibbs fracture zone, also studied from a sedimentological (magnetic and sortable silt) point of view.

As a first step we studied the changes in magnetic concentration and grain size through the Holocene period for a set of cores distributed along the path of the Iceland Scotland Overflow Water along the Gardar drift (P.I.C.A.S.S.O cruise) and the Charlie-Gibbs fracture zone (1977 Charcot and 2008 AMOCINT cruise). The magnetic results were published (Kissel et al., EPSL, 2009) during the second year of the AMOCINT project. We showed that the magnetic mineralogy of these sequences is carried by magnetites. We showed that the grain size of magnetites remains fairly constant in each core but, on average, progressively fines towards the south and downstream. Likewise the magnetic concentration and mean magnetic flux decrease towards the south. The spatial evolution of the magnetic concentration and of the magnetic grain size suggests a transport of these magnetites by bottom currents associated with the overflow water downstream from the source (Iceland-Faeroe basaltic sill between the Nordic seas and the north Atlantic) with progressive deposition of this magnetic fraction along the path of the ISOW. This study provides evidence that characterization of the magnetic parameters of sediments deposited in such an oceanographic context of a unique source upstream and a well-defined water mass may be used to detect and trace deep oceanic circulation changes.

These results pave the road for the high resolution time reconstruction of the Holocene changes in these properties via two of

	<p>the highest deposition rate sequences. This study is now underway. The age model for both cores is based on radiocarbon dating. In each core, we observe long-term and short-term changes in magnetic concentration and grain sizes (coupled with sortable silt) as well as variations in the benthic $\delta^{13}C$. These parameters will be discussed together as well as their relevance in terms of deep water current strength depending on the time period.</p> <p>Finally, we also investigated the magnetic properties of the AMOCINT core located North of the Agadir canyon . This core fully covers the Holocene and the last 4 interglacials. The detrital input in this core largely submitted to both the bottom currents and the eolian dust from the Sahara changes very significantly at about 15 m.b.s.f (MIS8-7 boundary) and the bottom of the core is completely different from the top part. From Holocene down to 15 m, the eolian dust almost systematically dominates at the orbital scale during the warm periods (interglacials) and it is modulated by arrival of less oxydized material (magnetite type). Below 15 m, no relationship whatsoever is observed between the magnetic mineralogy and the isotopic stratigraphy. An effect of changes in magnetic grain size is most probably superimposed to changes in magnetic mineralogy.</p>
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Project

06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 –, Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Stable Sr isotope fractionation in the marine realm

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Isotope fractionation taking place during biological calcification harbors important information about adjacent environmental parameters and the biomineralization process itself. We present stable strontium ($d_{88/86}\text{Sr}$) isotope data of fossil (*Porites* sp. ~15 ka B.P. from Tahiti, IODP Expedition 310) and cultured (*Acropora* sp.) warm water corals. Samples were analyzed with the Sr double spike technique (KRABBENHÖFT et al., 2009) and an external reproducibility of 0.025‰ (2SD, n=26, Carbonate standard JCp-1). For cultured *Acropora* sp. we determined a non-linear u-shaped $d_{88/86}\text{Sr}$ -temperature relationship of $-0.005\text{‰}/^{\circ}\text{C}$ ($r^2=0.92$) in the temperature range from 21 to 25°C and of $0.003\text{‰}/^{\circ}\text{C}$ ($r^2=0.53$) for 25 to 29°C. This trend is in sharp contrast to earlier reports for *Pavona clavus* in the temperature range from 23°C to 27°C (FIETZKE and EISENHAUER, 2006) where a strong positive correlation has been observed. For the fossil *Porites* sp. coral Sr/Ca elemental and $d_{18}\text{O}$ isotope ratios show a temperature variation like expected and in accordance with earlier observations. However, in support of the measurements on the cultured *Acropora* sp. the fossil $d_{88/86}\text{Sr}$ -record for the *Porites* sp. coral again show an inverse relationship to temperature when compared to other temperature proxies Sr/Ca (FELIS et al., 2010) and $d_{18}\text{O}$, respectively. In addition, our measurements on the ~15 ka old coral show a mean $d_{88/86}\text{Sr}$ value of 0.205(17) ‰ which is in agreement with modern corals (KRABBENHÖFT et al., 2010). This indicates that the extra supply of Sr from exposed shelves at low sea levels (about 130 m below present sea level) has no measurable effect on the $d_{88/86}\text{Sr}$ of seawater on these timescales.

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Project

06-EuroMARC-FP-009 / Tropical
 temperature history during
 Palaeogene global warming events
 (GLOW)

Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA

Tropical Temperature History during Global Warming (GLOW) Events

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Global warming (GLOW) is rapidly becoming a societal problem. Prediction of climate feedbacks, temperature, and the circulation state of the ocean is very difficult. Geological records give a significant framework to improve predictions in response to greenhouse warming. Past global greenhouse warming events can be regarded as analogues for the current warming event, and these past warming events can thus be used to improve prediction on the future state of the oceans. The Cenozoic geological record represents a climatically dynamic period in Earth history including rapid global warming events. Geological evidence for these warming events is sparse in the tropical realm. The offshore Tanzanian geological sequences have not been explored as yet for drilling. The GLOW project collected basic information on seismic sequences to understand the basic geological structures and basin infill offshore Tanzania. This basic information makes drilling for Cenozoic sequences possible at a later stage. Sediment cores were retrieved from the sea bed in areas where older reflectors are outcropping, to obtain ages of the sediments. We successfully explored the Davie Ridge and in-shore areas for seismic sequences by sailing a comprehensive network of seismic lines. We identified potential drilling sites for future drilling using the new seismic network. We conclude that the GLOW deliveries provide sufficient seismic and basic stratigraphic information to support the full proposal for drilling in the area within the International Ocean Drilling Program.

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Project

06-EuroMARC-FP-004 /
 Multidisciplinary study of
 continental/ocean climate dynamics
 using high-resolution records from the
 eastern Mediterranean (MOCCHA)

Topic: High resolution climate records and climate changes

**Assessment of climate variability for the last 500 years
 based on lipid biomarker proxies (Gulf of Taranto, S.
 Italy)**

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The Southern Italian shelf has great potential for high-resolution paleoclimate reconstructions due to undisturbed sedimentation rates of 0.06 cm per year enabling a temporal resolution of 4 years (e.g., Versteegh et al., 2007 and references therein).

In order to further exploit this paleoenvironmental archive, we studied the distribution of lipid biomarkers by focussing on the lipid-based temperature proxies UK'37 (from the haptophyte *E. huxleyi*) and TEX86 (from archaea) for the last 500 years, from the Gallipoli shelf (Gulf of Taranto). Based on a previous core-top calibration we interpret the downcore variations in terms of preservation and environmental changes (Leider et al., 2010). UK'37 based temperatures appear lower compared to TEX86 derived temperatures. Most likely this reflects different growth seasons of *E. huxleyi* and planktonic archaea occurring during winter and summer, respectively. We will use the combined lipid data to discuss changes in hydrography, seasonal patterns of temperature, productivity and preservation in this area.

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Project

06-EuroMARC-FP-008 / Atlantic Meridional Overturning Circulation During Interglacials (AMOCINT)

Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA

Paleoproductivity variations in the sub-tropical North Atlantic and the Nordic Seas and their relation to the Atlantic Meridional Overturning Circulation (AMOCINT)

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Paleoclimate records revealed that a considerable amount of long-term atmospheric CO₂ changes are driven by variations in biological productivity (Mix, 1989) as phytoplankton photosynthesis lowers the partial pressure of CO₂ in the upper ocean and thereby promotes the absorption of CO₂ from the atmosphere (Falkowski, 2000). Given the sensitivity of the climate system to CO₂ concentration changes, it is crucial to understand paleoproductivity variations and their relation to changes in ocean circulation not only over glacial-interglacial cycles but also during the interglacial periods and their demise themselves.

A high-resolution study was conducted within the AMOCINT project [ESF-EUROCORES programme, 06-EuroMARC-FP-008; through FCT EUROMARC/0002/2007] on three cores, located in the sub-tropical North Atlantic (MD08-3178: 31°17.09'N, 11°29.20'W, 2184m and MD01-2446: 39°03'N, 12°37'W, 3547 m) and Nordic Seas (MD08-3191: 67°24.50'N, 4°49.92'E, 1352 m). Calypso piston cores MD08-3178 (off NW Africa) and MD08-3191 (Vøring Plateau) were collected during the MD168-AMOCINT/XVII IMAGES cruise on board of R/V Marion Dufresne of the IPEV – Institut Polaire Français Paul Emile Victor. Core MD01-2446 was taken within the Pole-Ocean-Pole project (EU 5thFP, Contract No EVK2-2000-00089) during the MD123 Geosciences cruise on board of the R/V Marion Dufresne.

Samples from the Holocene, MIS5 and MIS11 periods were analysed for surface and bottom-water properties and for terrigenous input at sub-tropical latitudes. The paleoproductivity record (opal content) analysed in all cores, is used to reconstruct potential latitudinal gradients.

The benthic δ¹⁸O records are similar at both cores of the sub-tropical latitudes, while the surface water δ¹⁸O records indicate –as expected– colder conditions, in particular during the Holocene, at site MD01-2446 located off Portugal than off NW Africa. Benthic δ¹³C values were lower than at NW African core - MD08-3178, where ventilation was stronger during MIS11. Holocene and MIS5, however, presented a similar range.

	<p>At the subtropical latitudes, siliceous productivity is lower during interglacial periods, than during glacials. Holocene and MIS5 show similar productivity while MIS11 at NW Africa present the lowest values. Productivity variations appear to be linked to AMOC strength, because it increased during periods of depleted benthic $\delta^{13}C$, i.e., a higher contribution of the Southern sourced Water and less North Atlantic Deep Water production and thus an indication of reduced overturning.</p> <p>Productivity decreased from North to South, in particular during MIS11, with an anti-phase correlation (except during MIS 5) between the northern North Atlantic and sub-tropical latitudes.</p>
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Project

06-EuroMARC-FP-009 / Tropical
 temperature history during
 Palaeogene global warming events
 (GLOW)

Topic: High resolution climate records and climate changes

Offshore Southern Tanzania; Stratigraphy, Structure and potential Paleogene Sites. Results from the GLOW cruise 2009.

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Southern coastal Tanzania is a key area for high resolution Paleogene palaeoclimatic reconstructions. Key climatic intervals (E/O, PETM) have been recovered onshore during Tanzania Drilling Project (TDP) and were hypothesised to thicken and become conformable offshore. An extensive dataset consisting of legacy seismics and exploration wells were combined with newly acquired seismic data, boxcores and multibeam bathymetry to explore the geological evolution of this area.

A complete stratigraphic, sedimentological and tectonic framework for southern coastal Tanzania since the Cretaceous is presented here. New data shows a direct link between the development of the Southeastern branch of the East African Rift (EAR), climate changes and massive sediment load into the Somali Abyssal Plain.

Furthermore, using the GLOW Seismic Survey 2009 as a site survey a number of potential sites have been identified for use in IODP Proposal 778:Tanzania Offshore Paleoclimate (TOP): Tropical climate modes during greenhouse and icehouse condition (Wade, 2010).

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Project

06-EuroMARC-FP-011 / Ultraslow spreading and hydrogen based deep biosphere (H2DEEP)

Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA

The H2DEEP project: Ultra-slow spreading and hydrogen-based deep biosphere

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The overall objective of the H2DEEP project is to study geodynamic, hydrothermal and geomicrobial processes along a segment of the Arctic Mid-Ocean Ridge that is one of the most slow-spreading parts of the global ridge system. The project will lay the ground for a European lead proposal to the Integrated Ocean Drilling Program (IODP) aimed to test hypothesis on the geodynamics and the extent and nature of hydrothermal activity, water-rock interactions and the deep biosphere at the ultraslow end of the spreading rate spectrum. This collaborative research project (CRP) includes the following individual projects: 1) The magmatic, tectonic and hydrothermal architecture of the Southern Knipovich Ridge (Pedersen & Mjelde, Norway); 2) Core complex formation and evolution(Escartin, France); 3) Sulfide petrology, ore genesis and the deep biosphere (Barriga, Portugal); 4) Linking hydrothermal alteration, serpentinisation, and fluid fluxes to biological niches at the Knipovich Ridge (Fruh-Green, Switzerland); 5) Geomicrobiology: microbial communities and processes associated with basement alteration at the ultraslow spreading Knipovich Ridge (Thorseth, Norway).

The CRP has been based on data acquisition and sampling over the course of five cruises with the University of Bergen (UioB) research vessels. During these cruises a wealth of samples and geophysical data have been collected from the studied parts of the Arctic Ridge system. The achievements and findings of the CRP includes: 1) The discovery and detailed investigation of the first black smoker vent at an ultraslow spreading ridge; 2) Documentation of unusually hydrogen-rich vent fluids and associated novel ecosystems; 3) Discovery and documentation of one of the largest deep-sea hydrothermal mounds; 4) The successful core sampling of sediments that show the spatial and temporal variations in volcanic and hydrothermal activity along a 100 km long segment of the rift valley; 5) Documentation of relationships between the microbial community composition and the geochemical properties of pore water/sediment compositions that sheds light on the possible roles of dominant taxa within the sediment; 6) The successful collection of nearly 1000 km of seismic data across the sedimented parts of the Knipovich Ridge that provides a unique temporal framework for understanding the geodynamics of ultraslow spreading ridges.

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Project

06-EuroMARC-FP-008 / Atlantic
 Meridional Overturning Circulation
 During Interglacials (AMOCINT)

Topic: High resolution climate records and climate changes

Differences in Atlantic Meridional overturning circulation over Holocene and MIS5 - indications from the subtropical North Atlantic

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Our aim within the project AMOCINT is to trace the variability of Atlantic overturning circulation (AMOC) during interglacials. Although several studies exist on the formation area of the North Atlantic deep water (NADW), the polar and subpolar North Atlantic as well as in the equatorial western North Atlantic as key area for the North Atlantic Current (NAC), little is known about the interior North Atlantic Ocean and its response on AMOC changes.

Here we present high-resolution data from partially laminated sediment cores taken at two basins east of the Mid Atlantic Ridge (MAR) south of the Azores Islands (37.999°N; 31.1282°W, w.d. 3050m and 37.8495°N, 30.29°W, w.d. 2036m). The sites are situated at the boundary between well-ventilated North East Atlantic deep water (NEADW) consisting of Labrador Sea water and a small branch Iceland Scotland Overflow water propagating southward along the eastern flank of the MAR, and southern sourced Lower Deep Water (LDW). Thus our coring site is ideal to track changes in the lower limb of AMOC over Termination I and Holocene in comparison to MIS 5.

The site position at the northern rim of the North Atlantic subtropical gyre further enables us to track the influence of AMOC on the surface water circulation and its linkage to deepwater circulation changes.

We established a high resolution record of deep water temperature and ventilation by benthic Mg/Ca and stable Isotopes data, mixed layer depth by stable isotope measurements on planktonic subsurface and surface dwelling foraminifera, sea surface temperature (SST) by alkenones and reconstructed the Azores front position and SST using foraminiferal assemblages.

The data shows an increasing influence of NEADW over termination I until the Mid Holocene with superimposed millennial scale variability in NEADW with several ventilation minima until the mid Holocene (6ka). On the contrary deepwater temperatures remained rather stable over Holocene. Surface water temperatures show maxima during Bölling-Alleröd (19°C) and Preboreal (20°C) and stabilized after 8ka BP at around 18°C. Foraminiferal assemblages, mixed layer depth reconstruction and a stabilization of SST suggest a shift of subtropical gyre position after 6 ka. These changes coincide with a stabilization of the benthic $\delta^{13}C$ values pointing towards a linkage to NADW production rates and an establishment of today's AMOC after 6ka BP.

	<p>Preliminary data from MIS5 show abrupt changes between North- and South Atlantic sourced water masses reaching intermediate water depth. Low percentages of subtropical foraminifera in fauna assemblages and planktonic stable isotope values (0.0‰ PDB) remaining 0.2 ‰ higher than during Holocene indicate cooler SST during MIS5. The differences in SST could be related to a contraction of subtropical gyre or to SST changes in Azores current source region. This points to differences in the subtropical North Atlantic circulation pattern between MIS5 and Holocene, potentially related to changes in northward heat transport.</p>
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Project

06-EuroMARC-FP-009 / Tropical temperature history during Palaeogene global warming events (GLOW)

Topic: High resolution climate records and climate changes

Glacial to Holocene surface temperature evolution in the Western Tropical Indian Ocean.

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Alkenone and Mg/Ca derived SST trends from last Glacial into the Late Holocene are presented for four sediment cores from the northern part of the Mozambique Strait. This region is important for the transfer of heat from the Equatorial warm pool in the Western Indian Ocean into the Agulhas Current SYSTEM (ACS). The alkenone SST records from all four sites are very consistent between each other, suggesting a temperature difference between the Last Glacial and the Late Holocene of about 1 to 2 degree C in that region. Although a cooling during the Younger Dryas period is clearly recognizable in all alkenone-based SST records, the temperature decrease estimated is only about 0.5 to 1 degree C, which is close to the overall uncertainty of this method. For the Holocene the alkenone-based SST curves imply no temperature change at all. The one SST record based on Mg/Ca ratios of the planktonic foraminifera *Globigerinoides ruber* (white) available to us from the Mozambique Strait reveals by 2 degree C lower temperatures when compared with alkenone-based SST estimates for the Holocene. No clear cooling event is found in the Mg/Ca SST record for the Younger Dryas period. Instead, the Mg/Ca-based SST record even implies a slight warming during this period. The differences between the two SST proxy methods, which seem to have distinguished Holocene and deglacial patterns, require an explanation which is related either to different hydrographic conditions between seasons, between surface and subsurface water masses and/or to different ecological habitats of the two plankton groups providing the palaeotemperature signal. However, due to the lack of more Mg/Ca-based SST records and a regional calibration of the two proxy methods in the Mozambique Current region the reason for the differences between the methods is difficult to assess. Nonetheless, all SST records from the westernmost warm-water region of the Equatorial Indian Ocean feeding into the ACS imply only minor temperature change between the Glacial and the Late Holocene, as is true for the tropical ocean in general except within eastern boundary current or upwelling systems (e.g. MARGO 2009), and the absence of significant temperature variability during the Holocene. Therefore larger temperature variability in more southerly regions of the ACS should be considered as an effect of changes in the heat transport around the Cape or due to mixing with colder subtropical water masses reaching the ACS System south of Madagascar.

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Project

06-EuroMARC-FP-008 / Atlantic
 Meridional Overturning Circulation
 During Interglacials (AMOCINT)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Comparison of interglacial coccolith assemblages from the central subtropical North Atlantic and their relation to hydrographic and productivity changes

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The response of coccolith assemblages to changes in Atlantic Meridional Overturning Circulation (AMOC) was investigated in cores from the central subtropical North Atlantic. The cores were taken at the Mid Atlantic Ridge southwest of the Azores Islands (37,99°N/31,13°W and 37,85°N/30,29°W). Near the core locations the Azores Current System (ACS) is separating Subtropical Gyre Waters in the South from Northeast Atlantic Transitional Waters (NEATW) to the North. Today local primary productivity is low, with a pronounced maximum in early spring when winter mixing relaxes, overall the flux of biogenic material is only moderate.

A major shift in the coccolithophore assemblages occurs between 6 – 8 ka BP indicating more warm and oligotrophic conditions during the late Holocene. It is marked by a drastic decrease of the cold water species *G. muellerae* (proxy for NEATW) and an increase of *F. profunda*. Several independent paleoproductivity proxies (coccolith accumulation, XRF data) indicate more oligotrophic conditions after 8 ka. The 8,2 kyr event, as identified in the alkenone SST record, is also marked by a distinct coccolith assemblage with an increase in *C. pelagicus* and a decline of *F. profunda* pointing to cold, high productive conditions.

During MIS 5 the assemblage was considerably different from the Holocene. Small *Gephyrocapsas* (< 2,5 µm) dominated the assemblage. The shift in dominance between small *Gephyrocapsas* and large *Gephyrocapsas* (> 2,5 µm) coincides with the MIS 4/MIS 5 boundary. *G. muellerae* and *C. pelagicus* increased considerably during cold MIS4 and 6 and during colder phases of MIS 5. A first increase of *E. huxleyi* during MIS 5.5 is analogue to the increase of this species during the late Holocene where warmest and more oligotrophic conditions are reached. Similar to the Holocene low abundances of *G. muellerae* and *C. pelagicus* are observed during MIS 5.5. In contrast productivity seems to be higher during MIS 5.5 as compared to the Holocene based on the percentages of *F. profunda* and coccolith accumulation rates.

The shifts in the coccolith assemblages are paralleled by proxy estimates of temperature, salinity and nutrient inventory of the sea surface as well as deep water ventilation. The changes suggest that the ACS is highly sensitive to AMOC changes.

<p>Claire Seard</p> <p>CNRS Aix-Marseille University Paul Cézanne CEREGE Department of Geosciences Europole de l'Arbois BP 80 13545 Aix-en-Provence France Tel: +33 442 971 651 Fax: Email: seard@cerege.fr</p> <p>Project 06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 –, Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)</p>	<p><i>Topic: High resolution climate records and climate changes</i></p> <p>Impact of environmental parameters on coral reef development and drowning: Forward modelling of last deglacial reefs from Tahiti (French Polynesia; IODP Expedition #310)</p> <p>Claire Seard (a), Jean Borgomano (b), Didier Granjeon (c) and Gilbert Camoin (a) (a) CEREGE, UMR 6635, Aix-Marseille Université, CNRS-Collège de France-IRD, Europôle Méditerranéen de l'Arbois, BP80, F-13545 Aix-en-Provence cedex 4, France. (b) Géologie des Systèmes et des Réservoirs Carbonatés, Université de Provence EA 4234, 3 Place Victor Hugo, F-13331 Marseille cedex 03, France. (c) IFP (Institut Français du Pétrole), avenue de Bois-Préau, 92852 Reuil-Malmaison cedex, France.</p> <p>The sedimentological and chronological analysis of last deglacial reef sequences of Tahiti (French Polynesia) drilled during the Integrated Ocean Drilling Program Expedition 310 provided a high resolution data set allowing a constrained forward modelling study. This study concerns the first attempt to model in 3D the coral reef development during the last deglacial sea-level rise (23,000-6,000 cal. yr BP) using the software DIONISOS developed by the Institut Français du Pétrole (IFP, Paris). It allows the testing of the last deglacial sea-level curve and the different environmental parameters (e.g. wave energy, sediment fluxes) that could have influenced the reef development. The studied last deglacial reef sequences form two prominent ridges occurring seaward of the living barrier reef that consist of successive submerged reefs. These reefs have been prone to drowning as the window of maximum production rate is constrained by high water turbidity (sediment supply from a nearby river), low wave action depth and substrate availability. These factors, combined with rapid sea-level rise, have driven the formation of discontinuous backstepped reef pinnacles. Two types of drowning have been evidenced: a drowning caused by local factors (substratum nature, sediment supply and wave energy) for the inner ridge and a drowning caused by an interplay of local and global factors (acceleration of the sea-level rise) for the outer ridge. This acceleration of sea-level rise of 16 meters between 14.6 and 14 Ka BP is associated to the meltwater pulse 1A.</p>
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Project

06-EuroMARC-FP-011 / Ultraslow
 spreading and hydrogen based deep
 biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Microbial processes and biomineralisation associated with low-temperature hydrothermal venting and formation of barite chimneys at Loki's Castle vent field

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A low-temperature venting area with numbers of small chimney-like barite structures is located on the flank of the large sulphide mound of the Loki's Castle vent field at the slow-spreading Arctic Mid-Ocean Ridge (AMOR). The top of the barite chimneys and associated siboglinid tubeworms are covered by white microbial mats. The temperature was measured to 20 degrees C in the surface sediment and 0 degrees in the white microbial mats, just above the ambient bottom seawater temperature of -0.8 degrees. Samples of chimneys show black coloured interior flow channels surrounded by white outer sections of nearly pure barite. Scanning electron microscopy (SEM) of microbial mats demonstrates numerous microbial cells and large amounts of extracellular thread-like material with attached barite crystals. In the chimney material microbial cells are partially embedded in barite, and crystals are frequently covered by extracellular material. This indicate that the microbial activity could have an important influence on the nucleation of barite and thus on the formation of the chimneys. To reveal the microbial community structure and function, 16S rRNA gene sequence tag-encoded pyrosequencing followed by taxonomic classification were performed. Organisms assigned to a genus of sulfide oxidizers (*Sulfurimonas*) within the e-Proteobacteria were abundant in samples of the white microbial mats (86-96% of the reads), the white barite (36%), and of black flow channel (9.9%). The second most dominating taxon in the white chimney barite (26%) was anaerobic methanotrophs (ANME) of the ANME-1 clade, indicating anaerobic methane oxidation (AOM) as a major microbial process. The novel AOM associated clade, GOM-arc1 was also apparently highly abundant (14.3%). In the flow channel a more diverse microbial community was observed indicating methane, sulfur and ammonia oxidation as well as heterotrophic processes. To further clarify the relationship between crystallization, chimney growth and microbial activity, and the potential for preservation of biosignatures in barite formations, these data will be supplemented by geochemical characteristics, more detailed SEM observations and knowledge of In situ activities determine by analysis of community transcriptome.

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Project

06-EuroMARC-FP-004 /
Multidisciplinary study of
continental/ocean climate dynamics
using high-resolution records from the
eastern Mediterranean (MOCCHA)

Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA

Results of the Moccha Project

Versteegh G.J.M. and MOCCHA Members
Bremen University, Utrecht University, ETH Zürich

An overview of the MOCCHA project will be given with highlights

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Project

06-EuroMARC-FP-009

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Climate controls on moisture variability and vegetation changes in Southern Africa during the last 37 kyr BP

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Southeast Africa is increasingly affected by extreme hydrological events such as hurricanes, floods or droughts. Modern observations and climate modeling suggest that that Southeast African hydrological cycle is dominantly controlled by the sea surface pressure gradient and wind strength of the southwest Indian Ocean that in turn is induced by varying patterns of sea surface temperature gradients (SSTs). Tropical IO SSTs have steadily warmed by about 0.5°C basin-wide since 1948, consequently affecting the hydrological cycle over Southeast Africa. However, our understanding on the evolution of this land-ocean climate linkages as well as its response to continuously increasing SSTs is not yet clear in spite of potential far reaching socio-economic consequences. To investigate this links between past SST changes in the western tropical Indian Ocean and precipitation patterns in Southeast African we used a marine sediment core collected near the Zambezi river (GIK16160-3, 18°14.47'S, 37°52.27'W, 1334m water depth) from which we analyzed Mg/Ca and Uk'37 to derive SSTs, dD and d13C of multiple long-chain n-alkanes from higher plant leaf waxes as proxies for moisture variability and vegetation change, and $\delta^{18}O_{seawater}$ of planktonic foraminifera to reconstruct salinity.

Throughout the last 37 kyr BP, the seasonal range of SSTs varied between 0-4°C, coinciding remarkably well with the dry (35-31ka & 18-9ka) and wet periods (30-18ka & 8-0ka), This coincidence is supported by local salinity in relative amplitude and timing (Fig. 3D). The strong similarity between seasonal SST ranges and moisture variability over Southeast Africa suggests that large contrasts between summer and winter SSTs southwest Indian Ocean exerts an important control on past precipitation changes in Southeast Africa. Furthermore, the d13C records of n-alkanes implies changes from open grassland savannah (C4 dominance) to canopy woodland savannah (C3 dominance) during the Glacial to the Deglacial. The vegetation changes are not correlated with reconstructed changes in moisture variability, suggesting that vegetation changes in Southeast Africa were not controlled mainly by precipitation changes but rather a combination of multiple climatic factors such as precipitation, atmospheric carbon dioxide concentrations, and Western Ocean summer temperatures.

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Project

06-EuroMARC-FP-002 / Mid latitude
 carbonate systems: complete
 sequences from cold-water coral
 carbonate mounds in the northeast
 Atlantic (CARBONATE)

Topic: The 7 Collaborative Research Projects: H2DEEP, CHECREEF, AMOCINT, RETRO, GLOW, CARBONATE, MOCCHA

The CARBONATE project: an overview

Wheeler, A.J, Freiwald, A., Hebbeln, D., Swennen, R., Van Weering, T.C.E. & CARBONATE partners
 UCC, SAM, MARUM, Uni. Leuven, Royal NIOZ

The CARBONATE project addresses the research issues of cold-water coral carbonate mound development; biogeographical province evolution through time, the use of mounds as palaeoenvironmental archives and carbonate accumulation centres. The areas of study extends from offshore northern Norway to offshore Mauritania. Outlined below, we showcase just five of the significant highlights/achievements during the lifetime of this project.

Firstly, the full distribution of coral carbonate mounds in the Irish sector of northeast Atlantic (an area covering 640,500 km²) has been mapped for the first time based on high resolution multibeam echosounder data collected during the Irish National Seabed Survey (INSS). From this dataset, the first mound inventory has been generated, providing information on mound distribution and elevation and water mass relationships. In total, over 1000 mounds have been identified along the continental slope at intermediate water depths (<1500 m). These structures do not occur randomly but are grouped into distinct provinces. Within the provinces, the coral carbonate mounds often have comparable dimensions and morphologies. The vertical distribution patterns of mound summits in correlation with their heights indicate an upper growth limit for mounds at approximately 600 m water depth.

Secondly, several palaeo-environmental reconstructions from coral carbonate mounds in different settings and latitudinal contexts have been developed. New data for high latitude cold-water coral mounds (Stjærnsund, northern Norway), have revealed that azooxanthellate scleractinian *Lophelia pertusa*, thrive on top of a late glacial terminal moraine crest at 265 to 230 m water depth since the last deglaciation providing the first high resolution study of Holocene reef development from this key area. The faunal compositions of benthic foraminifers in these cores are indicative of high-energy current environments and suggest continuous mound growth in the Early Holocene (9,900 to 9,400 years BP) and a continued growth phase in the Late Holocene (3,400 to 1,600 years BP), which was interrupted by several hiatuses. The benthic foraminiferal pattern from a sediment core from the fjord basin reflects considerably warmer temperatures in the Middle Holocene (ca. 9,850 and 3,400 years BP) than in the Late Holocene, when Arctic species were more abundant.

Thirdly, CARBONATE has focussed on cold-water coral occurrences in other settings including, for instance, the Gulf of Cádiz. This is the first time that coral carbonate mound development histories have been studied along a latitudinal gradient with comparable datasets and

	<p>method protocols enabling and spatial/temporal model of model development and species migration. In contrast to the Norwegian and Irish mounds, the Gulf of Cádiz cold-water coral sites are characterised by the accumulations of fossil corals whereas up to now only very few living corals have been observed. The current almost complete absence of living scleractinian cold-water corals points towards unfavourable environmental conditions at present and can be explained by the current warm and oligotrophic conditions in the Gulf of Cádiz. The widespread occurrence of fossil corals indicates wider abundances during the recent geological past, implying that environmental and oceanographic conditions must have been more suitable during previous climatic periods. This is furthermore supported by a large data set of AMS radiocarbon and U/Th dates showing that the occurrence of reef-forming corals in the Gulf of Cádiz was dominant within the last glacial and prior glacial periods as opposed to interglacial periods when hardly any cold-water corals existed in this region. Comparisons of the coral age data set from the Gulf of Cádiz with coral ages from the Norwegian and Irish margins reveal a sustained prosperity of coral ecosystems right after the Younger Dryas. It appears that a northward shift of areas with optimum cold-water coral growth conditions took place during the transition from the last glacial to the Holocene and that cold-water corals responded very rapidly to climate change over just a few hundreds of years.</p> <p>With regards to diagenetic processes within coral carbonate mounds, one of the most important results is the advancing and reinterpreting our understanding of the formation processes of the widespread lithified layers present in the mounds. These layers are thought to be important for stabilising the steep mound slopes and thus play an important role in mound formation. Until recently, these layers were thought to form during periods of non-sedimentation and/or erosion, but studies on various short cores have revealed that they form as a result of sub-surface diagenesis, possibly in combination with periods of changing sedimentary conditions. The oxidation of organic matter appears to result in a lowering of the saturation state of the carbonate system causing dissolution of, under these conditions, unstable aragonitic coral skeletons. Depending on the openness of the pore water exchange system in the mounds, this in its turn can lead to the precipitation of more stable low-magnesium carbonate. The formation of these carbonates results in lithification of the mound sediments, formation of cemented layers and thus slope stabilisation.</p> <p>Additional diagenetic work on coral mounds from the Gulf of Cádiz suggested that several of these mounds were influenced by upward diffusing hydrocarbons leading to the installation of a shallow sulfate-methane transition zone (SMTZ) having a major impact on the early diagenetic processes within the mound sequence. This is the first time that the role of hydrocarbon seepage on mound diagenesis has been studied in detail. Moreover, the SMTZ seems to be dynamic and fluctuate through space and time.</p> <p>Fourthly, CARBONATE has undertaken core analysis on the Banda Mounds, offshore Mauritania. This is the first sedimentology/palaeontological study of these mounds whose</p>
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	<p>location in the far southern area of mound formation generates important knowledge on changes in cold-water coral biogeographic province changes in response to Quaternary climatic fluctuations.</p> <p>Finally, a major highlight of CARBONATE has been dissemination of information. CARBONATE was solicited to write an article on its topical achievements for the EGU on-line newsletter – The EGGS. The achievements made in CARBONATE have also attracted national news media including newspapers, radio and television broadcasts. Notably in Ireland, CARBONATE achievements in cold-water coral mapping received a news article on the main evening news on the prime national television station (Six One News, RTÉ 1).</p>
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Project

06-EuroMARC-FP-004 /
 Multidisciplinary study of
 continental/ocean climate dynamics
 using high-resolution records from the
 eastern Mediterranean (MOCCHA)

Topic: High resolution climate records and climate changes

Anthropogenic and natural induced changes in trophic conditions of the distal part of the Po-river discharge plume during the last 300 years

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To obtain insight in the trophic history of the Po-river discharge plume area a high temporal resolution reconstruction of the trophic state of upper waters have been established for the last 3 centuries. Changes in total organic carbon concentration of the sediment, cyst production rates and the cyst association have been compared with information about local air temperature and river discharge rates as well as with nitrate/ammonium/phosphate concentrations of Po-discharge waters and total Italian fertilizer use of the last 36 and 46 years respectively. We show that changes in dinoflagellate cyst production are strongly positively related to Po-river discharge rates throughout the study interval that have a cyclic character. We speculate these changes to be related to natural induced changes in precipitation rates.

Changes in the dinoflagellate cyst association composition provide insight in the water-quality of the river discharge waters. An increase in relative abundances of the species *Lingulodinium machaerophorum* which nowadays is characteristic for nutrient enriched waters in estuarine environments, indicates a change in water quality already as early as 1932. From 1955 – 1970 we reconstruct a strong change in water quality towards more eutrophic conditions. This increase corresponds to enhanced fertilizer use in Italy and a strong Italian population growth. From 1980 onward we observe a stabilisation of TOC concentrations, cyst accumulation rates and association composition followed by a decrease in relative abundances of the nutrient indicators suggesting a slight improvement of the water quality. We speculate this improvement to be related to a reduction in phosphate concentrations in river discharge waters as a result of governmental measurements.

POSTER PRESENTATIONS

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Project

06-EuroMARC-FP-008 / Atlantic Meridional Overturning Circulation During Interglacials (AMOCINT)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Sea surface temperature and oceanic productivity variations off the Iberian margin during the last 20.000 years.

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The aim of this study is a detailed reconstruction of the sea surface temperature (SST) and oceanic productivity off the Iberian margin during the last 20.000 years. Sediment samples from the Calypso giant piston core MD01-2446 (39°03.36'N, 12°37.44'W; 3547 m water depth) collected on the southeastern slope of the Tore Seamount, about 300 km west of Portugal, were analyzed qualitatively and quantitatively. For the quantitative analysis of the planktonic foraminiferal assemblages, 56 samples were counted in the combination of the >250 µm and 150-250 µm fractions, with the identification of the species accordingly to taxonomic criteria of Hemleben et al. (1989). The abundance data was then used to calculate the SST and export productivity variations using the Pflaumann et al. (1996, Paleoc.) SIMMAX transfer function technique. The modern analog data files used for the transfer function are extended versions of the Salgueiro et al. (2010, QSR) data files which combine samples from the Iberian and NW African margins with the North Atlantic surface samples set of the Margo project (Kucera et al., 2005a, QRS), resulting in a total of 1066 analogs for SST and 1039 for productivity. The reconstructed SST range from 10 to 21,7 °C and the summer export productivity from 31,5 to 95,2 gC/m²/y. The Holocene is marked by relative warm summer SST of more than 20 °C but can be divided into 3 phase with slightly colder SST before and after a warm period between 7,7 and 3,7 ky BP. This warm period coincided with the lowest export productivity values. Between 13,3 and 12 ky BP a colder period occurred (min. 10 °C) with increase of export productivity values (max. 89,9 gC/m²/y). Trends observed in core MD01-2446 are in general conform with the lower resolution record of D11957P, also located on the Tore Seamount (39°03'N, 12°35'W, Lebreiro, 1997, Paleo.). For the Holocene climatic evolution offshore site MD01-2446 is more similar to the core sites off Sines (37°47.99N, 10°9.99'W, Salgueiro et al., 2010, QSR), but the site recorded much stronger cooling during the Younger Dryas than the nearshore cores along the Portuguese margin, while Heinrich stadial 1 was warmer.

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Project

06-EuroMARC-FP-011 / Ultraslow
 spreading and hydrogen based deep
 biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Mineralogy and Geochemistry in the Arctic crust near Loki's Castle, 74 degrees N (South Knipovich Ridge)

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The Loki's Castle hydrothermal vent field is composed of several active, over 10 m tall chimneys, producing up to 320°C fluid. The main sulfides in chimneys are sphalerite, pyrite and pyrrothite, with generally lesser chalcopyrite. Alteration products collected adjacent to chimneys contain much anhydrite, gypsum and talc. Quartz, anhydrite, gypsum and barite are also present, and locally abundant. Rhythmically zoned sphalerites suggest pulsating hydrothermal activity.

Here we report the preliminary results of a detailed study (in progress) of sequential extraction and analyses of metals from sediments in the vicinity of Loki's Castle, in order to detect correlations with microbial populations and/or subseafloor mineralized intervals. The results expose numerous anomalies. Some consist of isolated high values of metals such as Cu or Zn, whereas others contain clusters of high values of several metals in the same interval. The former correspond to bedded fallout, from nearby hydrothermal activity (in a not too distant past), but the latter may correspond to intersections of hydrothermal plumes ascending through (variably) porous sediment. This may an effect on the microbial population (deep biosphere).

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Project

06-EuroMARC-FP-004 /
 Multidisciplinary study of
 continental/ocean climate dynamics
 using high-resolution records from the
 eastern Mediterranean (MOCCHA)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Organic walled dinoflagellate cyst based paleoclimate reconstruction during “Roman Classical Period” in Southern Adriatic area and its potential forcing mechanisms

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The current abrupt rise in global temperature within the last century has resulted in major concern about future climate change, and there is a strong debate about the question if the current rise in global temperature is in range of the normal climatic “noise” or if it is a significant positive anomaly. One way to obtain more insight into this question is by studying past time intervals where potential analogue conditions existed. One of these time intervals is the “Roman Classical Period” (RCP: ~200 BC – 600 AD). Although it is generally thought to be a time interval where global temperatures were relatively high, reconstructions vary remarkably in different regions. Even within a region, reconstructions are not always uniform. In order to obtain more insight into the climatic variability during this time, there is an urgent need for highly detailed climatic reconstructions.

Paleoclimate variability in Mediterranean area has been reconstructed by various proxy records during past decades. However, little work covering “Roman Classical Period” on decadal or higher temporal resolution exists. In this study we present the results of a high resolution study on the climatic and paleoceanographic changes during the “Roman Classical Period” in the Southern Adriatic region. Detailed information about the variability in the organic dinoflagellate cyst associations of piston core DP30PC (39°50.07'N, 17°48.05'E, water depth 270 m) allows the reconstruct of short term climatic steered cyclic changes in sea surface temperature, upper water nutrient availability as well as of Italian local river discharge/precipitation signals. Possible mechanisms behind the observed dinocyst records are discussed to have a better understanding of the climate forcing mechanisms in Mediterranean area.

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Project

06-EuroMARC-FP-004 /
 Multidisciplinary study of
 continental/ocean climate dynamics
 using high-resolution records from the
 eastern Mediterranean (MOCCHA)

Topic: High resolution climate records and climate changes

Multidisciplinary study Of Continental/ocean Climate dynamics using High-resolution records from the eastern mediterranean (MOCCHA)

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continuous marine records with sufficient time resolution are essential for studies on high-resolution paleoclimate and high-frequency variations. Such records are rare but vital for our understanding of causes and consequences of climate and environmental change at decadal to millennial time scales. Our initial studies at a near-coastal and a deep Mediterranean anoxic basin site seem to provide a continuous marine paleo-climate record that permits such high-resolution and well dated climate reconstructions for at least the last few kyr. Cores for the MOCCHA project have been collected during the pre-Moccha ESPRESSO cruise with RV Universitatis and CAPUCCINO cruise with RV Poseidon, followed by the DOPPIO cruise and the MACCHIATO-cruise with RV Pelagia. The cores recovered and studied thusfar appear to contain largely laminated sediments (submillimetric) down to 10 kyr.

We will introduce the sites with existing and recently published evidence and supplement these with preliminary results for both sites obtained during these cruises. All of these are illustrating their suitability for high-resolution studies of paleoclimate that we hope to extend to > 35 kyr, i.e. for future IODP drilling.

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Project

06-EuroMARC-FP-011 / Ultraslow
 spreading and hydrogen based deep
 biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Trollveggen Vent Field: Mineralogy and geochemistry of chimneys and deposits, and evidence of hydrothermal activity in far-field cores.

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The Jan Mayen vent fields were discovered in the Mohns Ridge during an expedition with the Norwegian research vessel "G.O. Sars" in July 2005. They comprise two main active areas: (1) Soria Moria and (2) Gallionella Garden & Trollveggen. The Trollveggen vent field is located at depths of 700-750 m. Venting takes place mainly through white smoker chimneys with fluid temperatures reaching up to 260-270°C. Here we present mineralogical and geochemical data from vent chimneys and near vent deposits collected at the Trollveggen vent field with an ROV. Cross-sections of chimneys present evident mineralogical zonation, showing acicular barite crystals in the outer parts and sulphide enrichments in the interior (Sph + Cpy +/- Py - Po). The near vent deposits are mainly formed by vent fragments, showing a mineral assemblage similar to that of chimneys. Total geochemical analyses both from vents and near vent deposits showed higher concentrations in Ba, Co, Zn, Fe, but also slight enrichments in Au and Ag. REE patterns from chimneys and near vent deposits suggest that REE have been deposited from hot (> 250°C) hydrothermal fluids. Sediment cores collected in the vicinity of the Jan Mayen hydrothermal field suggests that hydrothermal activity is not restricted to the known vent areas. Two of the collected gravity cores registered geochemical signatures related with hydrothermal activity, showing metal enrichment and a slightly positive Eu anomaly.

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Project

06-EuroMARC-FP-011 / Ultraslow spreading and hydrogen based deep biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

On the origin of barite chimneys in two hydrothermal sites along the slow-spreading Arctic Mid-Ocean Ridge

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Two hydrothermal sites along the slow-spreading Arctic Mid-Ocean Ridge (AMOR), the Jan Mayen Vent Fields (JMVFs) and the recently discovered Loki's Castle Hydrothermal Field (LCHF) contain numerous low-temperature barite chimneys, partially covered by white microbial mats. The JMVFs are located at 71°N on the south-western Mohns Ridge, approximately 50 km north of the Jan Mayen fracture zone. The LCHF is located at 73.5°N on an axial volcanic ridge where the Mohns Ridge transitions into the Knipovich Ridge and consists of two high-temperature venting areas. Active hydrothermal venting at both sites is confirmed by elevated hydrogen sulfide concentrations and discharge of high-temperature fluids, reaching 270°C in the JMVFs and 317°C in the LCHF.

Barite chimneys from the JMVFs are composed of barite, silica and abundant pyrite-dominated sulfide minerals that display a conspicuous concentric morphology. Raman spectroscopic analysis of the central regions of these concentric sulfide minerals points to the existence of mackinawite (FeS). Furthermore, the existence of greigite (Fe₃S₄) surrounding the mackinawite is suggested. This observation confirms the general conclusion of earlier experimental studies that these phases act as the metastable precursors of pyrite. In contrast, the barite chimneys of the LCHF consist mainly of pure barite with lesser amounts of sulfide minerals.

The difference in the mineralogical composition between the two sites is also expressed in its sulfur and oxygen isotopic composition. δ³⁴S_{sulfate} and δ¹⁸O_{sulfate} values of barite chimneys from the JMVFs are lower than δ³⁴S of seawater sulfate (δ³⁴S = +21‰) and δ³⁴S_{sulphide} values point to a magmatic sulfur source (δ³⁴S = 0‰). This implies that the JMHFs barite chimneys have been formed by a mixture of seawater and hydrothermal fluids, similar to the origin of black smokers. In contrast to the JMVFs, both the δ³⁴S_{sulfate} and δ¹⁸O_{sulfate} values from the LCHF barite chimneys are higher than δ³⁴S values for seawater sulfate, and show remarkable differences between the surface of the chimneys and the interior. The highest δ³⁴S_{sulfate} values have been found in the chimney interior, reaching δ³⁴S_{sulfate} values up to +34.9‰. Negative δ³³S_{sulfate} values in combination with positive δ³⁴S_{sulfate} and δ¹⁸O_{sulfate} values strongly point to biological sulfate reduction processes, most likely in the sub surface of the LCHF. The presence of filaments within the

	<p>chimneys (revealed by SEM) supports the view that biologic processes caused the observed sulfur and oxygen isotope fractionation. Further mineralogical and isotope studies will provide more detailed insights on the formation of barite chimneys found in these hydrothermal sites along the slow-spreading AMOR.</p>
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Project

06-EuroMARC-FP-011 / Ultraslow
spreading and hydrogen based deep
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Topic: Geodynamic, hydrothermal and biogeochemical processes

**Loki's Castle Arctic Vents and Host Sediments:
Mineralogy and Geochemistry**

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Loki's Castle hydrothermal field is located in the Arctic Ocean, in the bend between the South Knipovich Ridge and the Mohns Ridge, at 76°49'N. The results presented here are from samples collected with the ROV Bathysaurus XL and consist of chimney fragments and seafloor sediments from the vicinities.

The studies consist of a petrographic description, X- ray diffraction analysis, chemical analyses under the electron microprobe and bulk chemical analyses of major and trace elements.

The sulphide assemblage most commonly present in the samples consists of sphalerite, pyrite and pyrrhotite, with minor amounts of chalcopyrite. Sulphide-poor selected samples collected at the base of chimneys are mostly composed of anhydrite, gypsum and talc. Association of quartz, anhydrite, gypsum and barite were also found in some of the sediment samples. The observed sulphide assemblage is consistent with the temperature of 320°C measured in Loki's Castle vents. The interior of chimneys are enriched in Zn, Cu and Fe while the exterior are enriched in Ba and Sr.

REE patterns for the recovered seafloor sediments show a perfect match with NASC.

The sulphide-poor samples collected at the base of the chimneys denotes sea water interaction with the hydrothermal fluid and consequent decrease in the temperature, precipitating sulphates.

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Project

06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 – Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

The Tahitian freshwater system at present and in the LGM

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As part of IP7, in one project we focused on the study of the Tahiti freshwater systems to determine the key factors are for the chemical evolution of the natural waters. We analyzed recent water samples, including freshwater, seawater and brackish water samples and related it to the geochemistry of the volcanic rocks on Tahiti. Despite the tropical climate and the generally high weathering potential of volcanic rocks, the overall mineralization of the freshwater samples is very low (between 10-460 μ S), which is due to the high precipitation amount (up to 8500 $\text{mm}\cdot\text{a}^{-1}$) and the low residence times in the freshwater system. All freshwater samples are undersaturated in respect to aragonite/calcite and therefore could potentially dissolve the reef carbonates offshore Tahiti.

Taking into account the present water balance on Tahiti and the location of Tahiti in the tropics, today and in the Last Glacial maximum (LGM), we can reconstruct a water balance for the LGM. Coupling this with a geochemical modeling approach we can show differences in the total freshwater flux and its solutes between today and in the LGM.

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Project

06-EuroMARC-FP-008 / Atlantic
 Meridional Overturning Circulation
 During Interglacials (AMOCINT)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Abrupt Changes in North Atlantic Climate and Hydrography and Their Relationship to Deep Ocean Ventilation During the Penultimate Interglacial (MIS 5e)

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Quantifying climate and surface ocean conditions at times in the past that resemble our projected future is essential for resolving key issues concerning the future likelihood of, and mechanisms for, ocean variability and its related environmental impacts. At the peak of the previous interglacial period, North Atlantic and sub-arctic climate shared many features in common with projections of our future climate; including warmer than present conditions and a reduced Greenland ice sheet. Here we use the Eirik Drift Calypso core MD03-2664 (57°26.56N, 48°36.60W), recovered on the IMAGES P.I.C.A.S.S.O cruise of the R/V Marion Dufresne of the French Polar Institute, to reconstruct (sub)centennial changes in North Atlantic climate, surface ocean hydrography, and deep water properties during the Marine Isotope Stage (MIS) 5e. The Eirik Drift is formed under the influence of the Nordic Seas overflows contributing to North Atlantic Deep Water (NADW). The study site lies at 3440 m just below the main axis of the sediment laden Western Boundary Undercurrent (WBUC), and is ideal for studying past changes in the circulation and properties of newly formed water masses in the lower branch of the Atlantic Meridional Overturning Circulation (AMOC). High-resolution stable isotopic analysis ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$) of planktonic foraminifera (*G. bulloides* and *N. pachyderma* (sin)) and benthic foraminifera (*C. wuellerstorfi*), planktonic foraminiferal counts and temperature reconstructions from Mg/Ca analysis of the planktonic foraminifera *N. pachyderma* (sin) were performed to characterize surface ocean properties and hydrography in a key region for monitoring water mass formation and freshwater transports. Preliminary results from the foraminiferal assemblages, the ratio of left- and right-coiling *N. pachyderma*, and Mg/Ca analysis suggest that surface waters started warming during early MIS 5e. Towards the peak of MIS 5e, the coiling ratio of *N. pachyderma* (dex), reaches up to 82%, suggesting a period of warmer surface water conditions off southern Greenland than today. The warm surface water conditions prevailed until the peak of MIS 5e when it abruptly cooled. This sharp cooling occurs in ~340 years, and is followed by a gradual warming. The $\delta^{18}\text{O}$ minima observed in $\delta^{18}\text{O}$ records of *G. bulloides* and *N. pachyderma* (sin) is coeval with the cooling observed in foraminiferal assemblage and Mg/Ca data, and suggests marked freshening in the surface waters during this period.

	<p>The source of these hydrographic changes and their relationship to freshwater transport, Greenland Ice Sheet melting, and changes in North Atlantic Deep water properties (benthic $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$) are discussed.</p>
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Project

06-EuroMARC-FP-011 / Ultraslow spreading and hydrogen based deep biosphere (H2DEEP)

Topic: Geodynamic, hydrothermal and biogeochemical processes

High resolution community profiling of stratified sediments associated with Loki's Castle vent field at the Knipovich ridge.

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The taxonomic composition of the microbial communities harbouring deep-sea sediments appears to be relatively uniform on a global scale, with a handful of different phyla dominating. However, the proportional incidents of the various groups differ significantly between different locations. It is often stated that geochemical and physical factors are likely to control the distribution of the dominating taxa, but a clear correlation is often not apparent. The reason for this may be limited data, low spatial resolution, as well as inadequate depth of the taxonomic profiling. Further, geochemical data obtained from pore water can be difficult to interpret due to recycling of elements. Finally, the fact that microorganisms within the same taxa, even within organisms of the same species, can have extremely versatile metabolic probabilities blurs the picture.

Several gravity cores (3-4 metres deep) retrieved from the area surrounding the Loki's Castle hydrothermal vent field during the H2DEEP cruise in 2008 have been analysed. Due to the vicinity to the vent field the sediment cores are highly stratified with distinct layers of hydrothermal and/or volcanic origin containing components like sulphide minerals and basalt debris. The cores were analysed by a XRF core scanner for geochemical composition. In addition, total inorganic and organic carbon contents (TIC and TOC) of the sediment and the pore water chemistry (e.g. ammonium, sulphide, sulphate, major elements) in distinct layers in each core have been analysed. In order to relate these data to microbial abundance, function and community composition, cell numbers (Archaea, Bacteria, Crenarchaeota and the Crenarchaeota amoA gene) have been estimated by real time qPCR. Further, the taxonomic profiling in each layer has been analysed using massive parallel sequencing of the 16S rDNA gene, a newly developed sequencing technique that enables an unprecedented high resolution on the microbial community structure.

By enhancing the spatial resolution and amount of geochemical data and the depth of DNA sequencing from highly stratified deep-sea sediments, we have identified correlations between community composition and geochemical properties that otherwise would not be apparent. Based on this we predict possible roles for some of the dominating taxa within the sediments.

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Project

06-EuroMARC-FP-008 / Atlantic Meridional Overturning Circulation During Interglacials (AMOCINT)

Topic: High resolution climate records and climate changes

Deep-sea counterpart of Holocene Bond cycles

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Here we challenge the importance of relatively little isotopic changes in the long-term Holocene stability of Atlantic deep waters. Tore seamount' subtropical site MD01-2446 provides evidence of synchronicity in the wiggling patterns of the deep and surface ocean circulation with Antarctica and Greenland along the Holocene, with periodicities of 600-1200 years.

Periodic light delta13C of benthic foraminifera Cibicidoides wuellerstorfi confirms widespread, episodic SOW incursions into the North Atlantic, which emerge as the deep-sea counterpart of subpolar Bond's ice-rafting events (correlation with delta18O isotope ratios of planktic foraminifera Orbulina universa and Globorotalia inflata).

Gradients of delta18O isotope ratios between planktic and benthic foraminifera (G. inflata - C. wuellerstorfi) indicate a change in regime before and after 8.5 ka to a more stratified and warm water column. The 8.2 kyr polar north Atlantic-event is well recorded at the Tore subtropical latitude and a peculiar surface warming dominates the NA eastern basin during 6-3.5 ka.

We propose the AMOC as the integrative forcing mechanism synchronizing the various frequencies of climate proxies (different oscillators).

This science is supported by the AMOCINT project (ESF-EUROCORES programme, 06-EuroMARC-FP-008; through FCT EUROMARC/0002/2007) and INGMAR program (LNEG-Research Unit of Marine Geology, Portugal); core collection was done by IPEV and the Pole-Ocean-Pole project (EU 5thFP, Contract No. EVK2-2000-00089); and British Ocean Sediment Core Repository (BOSCOR) supplied sediment samples.

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Project

06-EuroMARC-FP-003 / The last deglacial sea-level and climatic changes. Coral reef records in the south Pacific: Tahiti (French Polynesia) - IODP Expedition #310 – Australian Great Barrier Reef – IODP Proposal #519. (CHECREEF)

Topic: High resolution climate records and climate changes

Calcium isotope fractionation (d44/40Ca) in tropical corals: Applicability for environmental reconstruction.

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This poster discusses the parameters that control the calcium isotope fractionation in tropical coral skeleton using a multi-proxy dataset. The aim of the study is to 1) test the applicability of calcium isotope ratio in aragonitic coral skeleton for the reconstruction of environmental factors and 2) constrain the biological parameters that may affect the isotope fractionation.

Our dataset includes fossil and modern coral samples. The last deglacial fossil coral samples were cored during the IODP Expedition 310 in Tahiti in 2007. For an accurate record, the specimens were sampled by micro-drilling at high resolution. The modern corals were collected in Maghoodhoo Island, Republic of Maldives, in February 2010, along a transect from the lagoon to the open ocean. Ca and O isotopic composition as well as Sr/Ca ratio were measured on the same sample. Ca isotopes were measured using a TIMS Finnigan Triton T1, following the method described in Heuser et al. (2002).

The preliminary results show that the Ca-isotope fractionation is species dependent, with values ranging between ~0.65 and ~0.98 ‰. No relationship between precipitation rate and fossil coral d44/40Ca is recognized. Subseasonal temperature variations reconstructed by d18O and Sr/Ca ratio are not mirrored in coral d44/40Ca. Thus, the weak temperature dependence reported in Böhm et al. (2006) is possibly not the only parameter that is responsible for the fractionation. The Ca isotope values for modern corals across the platform vary between ~0.75 and ~0.98 ‰ but remain constant for each species. This excludes the bathymetric gradient as a factor that affects calcium fractionation in coral skeleton.

The weak influence of temperature does not allow the use of calcium isotope fractionation in coral skeleton as a confident paleothermometer. However, removing sea-surface temperature from the d18O signal (d18Osw) results in a fossil coral d44/40Ca curve that closely matches d18Osw, pointing to salinity as a potential factor that affects coral d44/40Ca. This relationship will be further constrained in our ongoing investigation, using modern corals cultured at various salinities. Because fractionation seems species-dependent, we further focus on inter-colony and inter-species variability to better constrain calcium isotope fractionation processes.

	This includes a better understanding and evaluation of biocalcification in corals.
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Project

06-EuroMARC-FP-002 / Mid latitude
 carbonate systems: complete
 sequences from cold-water coral
 carbonate mounds in the northeast
 Atlantic (CARBONATE)

Topic: Geodynamic, hydrothermal and biogeochemical processes

Early diagenetic processes in carbonate mounds and their influence on palaeo-environmental records

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Early diagenetic processes in carbonate mounds and their influence on palaeo-environmental records

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Within the ESF-project CARBONATE (06-EuroMARC-FP-002) K.U. Leuven has been studying cold-water carbonate mounds along the eastern North Atlantic margin with a focus on the Porcupine Seabight and the Gulf of Cádiz (e.g., Foubert et al., 2008). On gravity cores taken from carbonate mounds in the Gulf of Cádiz, several geochemical, geophysical and petrographical methods have been performed to quantify the influence of early diagenesis on the palaeo-environmental record registered in cold-water carbonate mounds. Two different sedimentary fraction types (biogenic carbonate-rich and terrigenous silicate-rich fraction) are coupled to interglacial/glacial palaeo-environmental conditions indicating that the environmental conditions for coral growth were better during glacial periods in the Gulf of Cádiz. Early diagenesis has obviously influenced the palaeo-environmental record in the mound sediments. The cold-water corals and other bioclasts are dissolved and attacked by bio-erosion and both framboidal and euhedral pyrite are present. Furthermore, diagenesis has also an impact on the petrophysical behaviour of carbonate bodies with porosity, permeability and connectivity (pore water fluid dynamics) being crucial to understand biogeochemical reactions in these mounds. Several mounds were influenced by upward diffusing hydrocarbons leading to the installation of a shallow sulphate-methane transition zone (SMTZ) having a major impact on the early diagenetic processes within the mound sequence (e.g., Pirlet et al., *subm.*). Moreover, the SMTZ seems to be dynamic and fluctuate through space and time. In order to assess the local effects of active gas and fluid seepage on early diagenetic processes and the

	<p>petrophysical characteristics in carbonate mounds, there is a strong need in the future to study individual mounds located in seep-related areas.</p> <p>On Challenger mound (IODP Exp. 307 Hole U1317E) in the Porcupine Seabight, elemental ICP-OES analyses were performed in order to calibrate the available XRF-logging measurements, and so to quantify the amount of dissolution and possible early precipitation in this carbonate mound (i.e. the quantification of early diagenesis). Early diagenetic processes overprint the primary environmental cyclic record in particular in the Ca-rich layers. Extensive coral dissolution and the genesis of small-scaled semi-lithified layers are the main diagenetic features observed in Challenger Mound. An open system diagenetic model explains low cementation rates compared to extensive aragonite dissolution Foubert and Henriet, 2009). Currently, the impact of early diagenesis on paleoceanographic proxies is tested by the comparison of geochemical signals (e.g., temperature – $\delta^{18}O$, $\delta^{13}C$, Mg/Ca, Sr/Ca, Li/Mg) between foraminifera and corals through the complete Challenger Mound succession. For future studies on carbonate mound sediment records it will be crucial to take early diagenetic processes into account when interpreting paleoceanographic parameters as implemented in Pirlet et al. (2010) and already recognised for mound base sediments by Raddatz et al. (in press).</p> <p>References</p> <p>Foubert, A., Depreiter, D., Beck, T., Maignien, L., Pannemans, B., Frank, N., Blamart, D., Henriet, J.P. (2008) Carbonate mounds in a mud volcano province off northwest Morocco: key to processes and controls. <i>Marine Geology</i>, 248, 74-96.</p> <p>Foubert, A. and Henriet, J.P. (2009) Nature and Significance of the Recent Carbonate Mound Record: The Mound Challenger Code. <i>Lecture Notes in Earth Sciences</i>, Vol. 126, Springer, 350 pp.</p> <p>Pirlet, H., Wehrmann, L., Foubert, A., Brunner, B., Blamart, D., De Mol, L., Van Rooij, D., Dewanckele, J., Cnudde, V., Swennen, R. and Henriet, J.P. (submitted) Unique authigenic mineral assemblages reveal different diagenetic histories in two neighbouring cold-water coral mounds on Pen Duick Escarpment, Gulf of Cadiz. <i>Sedimentology</i>.</p> <p>Raddatz, J., Rüggeberg, A., Margreth, S., Dullo, W.-Chr., and IODP Expedition 307 Scientific Party (in press) Paleoenvironmental reconstruction of deep-water carbonate mound initiation in the Porcupine Seabight, NE Atlantic. <i>Marine Geology</i>.</p>
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Project

06-EuroMARC-FP-008 / Atlantic
Meridional Overturning Circulation
During Interglacials (AMOCINT)

Topic: Land, ocean and climate records: interaction and forcing mechanisms

Reconstructing holocene inflow-overflow dynamics in the nordic seas using sediment parameters and model results

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AMOCINT is an ESF EuroMARC project led by Professor Eystein Jansen. It aims to reconstruct changes in Atlantic Meridional Overturning Circulation (AMOC) during interglacials using high-resolution marine records.

The large heat transport of the meridional overturning circulation makes it important for climate (Rahmstorf 2006). How it might respond to changes in external forcing, including a possible destabilisation of ice sheets on Greenland and Antarctica, is one of the key uncertainties of future climate change (AMOCINT project proposal).

The AMOC is driven partially by surface winds, partially by convective mechanisms. How much heat the AMOC can transport to high northern latitudes and how far north it can reach depend in part on the vigour of convection in the Nordic Seas.

The vigour of convection can be captured through reconstructing past changes in the physical and chemical properties of the inflows into the Nordic Seas, namely the Norwegian Current, and of the overflows originating in the region and moving south across the Greenland-Scotland Ridge.

In the first phase of the project a preliminary sortable silt record has been produced for the eastern branch of the Norwegian Current over the Vøring plateau using IMAGES piston core MD95-2011 and box core JM97-948/2A (66°58.19'N, 07°38.36'E, 1,048m). These cores have been dated and thoroughly studied, thus a large number of proxy data are already available. The sortable silt record will be used to deduce changes in the strength of the inflow along the Norwegian continental margin. Thus a kinematic tracer will be added to previous studies, which have focussed on temperature and salinity. Comparison of the preliminary sortable

	<p>silt record with the already existing climate related proxy data across key intervals with known significant changes in climate during the Holocene suggests that the sortable silt record does show a potential climate signal with prominent multi-decadal to century-scale variability.</p> <p>As a next step an in-depth analysis will follow producing high-resolution sortable silt records for at least two sites along the flow path of the eastern branch of the Norwegian Current for the last 1,200 years, and will be compared/correlated with other relevant proxy data and output from transient experiments with climate models over the same period.</p>
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