

Scientific Report

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1) Summary

The 19th edition of the International Sedimentological Congress, “Sedimentology at the crossroads of new frontier”, was held in Geneva (Switzerland) from the 18th to the 22nd of August 2014. The Technical Sessions and Special Symposia ran on 18, 19, 21 and 22 August 2014 (a.m./p.m.) and Mid-Congress excursions were organized on 20 of August.

Two symposia focused on topics relevant for COCARDE:

In symposium S12 (*Carbonate mounds in shallow and deep time*) processes, growth dynamics and driving factors of modern and fossil carbonate mound systems were compared and contrasted. Most of recipients of COCARDE grants (**8 PhD students and post-doctoral researchers**) presented their work in this session including both posters and oral presentations.

The symposium S6 (*Scientific Drilling for unraveling the sedimentary records of past tectonic, climatic and environmental processes*) started with a general presentation by **Gilbert Camoin** focusing on new opportunities in scientific drilling. The subsequent oral presentations, along with posters, covered a wide range of topics including results from IOPD and ICDP drilling campaigns.

Apart from these two sessions with COCARDE funding, related topics were handled in various sessions of the congress, in particular ‘Carbonate platforms’, ‘Diagenesis of carbonate sediments’, ‘Hot vents, cold seeps, terrestrial and marine crusts: the challenge of non-classic carbonates’, ‘Geomicrobiology’, ‘Tufas, speleothems, evaporites, travertines, calcretes and sinters’. Two out of the four plenary talks, by Carlota Escutia (Spain) and Anny Cazenave (France), included data resulting from, or related to, scientific drilling.

2) Description of the scientific content of and discussion at the event

Most of the recipients of COCARDE grants (**8 students and post-doctoral researchers**) presented their work in the dedicated session (both posters or an oral presentations).

Franchi et al. presented new data on rare earth element geochemistry of the Early Devonian Kess Kess carbonate mounds (Eastern Anti-Atlas, Morocco) that seem to support the hypothesis of hydrothermal influence on mound growth.

Al Kateb et al. presented a poster titled “Phosphate pollution in the Gulf of Gabes (Tunisia): the problem of the phosphogypsum discharge”. High phosphorous concentration occurring at Gabes is interpreted as the result of industry discharge of phosphogypsum causing an eutrophication of the nearby marine environment.

Feenstra et al. presented results from the first author’s MSc thesis and future PhD project on understanding the temporal and spatial variability of early diagenesis in carbonate mounds, including in vitro experiments for a better understanding of the

coral skeleton climate archives of cold- and warm-water corals.

Hamaekers et al. presented their “3D visualization and characterisation of microbial dolomite through X-ray microtomography: results from an in-vitro lab experiment”. The authors pointed out that “the combination of XRD, SEM, TEM and μ -CT has the possibility to become a powerful tool to study microbial precipitates during laboratory experiments”, although one should be aware that good standards will still be to delineate and refine the density threshold for microbial dolomite in future investigations.

Resentini et al.'s presentation focuses on “Targeting the right grain size in detrital-geochronology studies” in symposium S28: “Provenance signatures in modern and ancient sediment dispersal systems”. The tool presented is versatile and can be used in most of detrital-geochronology research.

Larmagnat et al. presented data from a systematic approach of Silurian to modern carbonate mounds. Results illustrate how mud rich carbonate mounds with similar geometries, macro and micro fabrics can evolve due to variable inputs from the three main accretionary processes, namely biomineralisation, organomineralisation and marine cementation.

Titschack et al. presented carbonate budget of cold-water coral mounds along a latitudinal transect in a talk and an additional poster. The talk concentrated on high-resolution cold-water coral (CWC) reef aggradation and carbonate accumulation rates of Norwegian CWC reefs from various settings. According to the authors, the observed aggradation rates exhibit the highest documented rates from CWC reefs so far and the obtained mean carbonate accumulation rates exceed previous estimates of CWC reefs by a factor of 2-3 and are in the range of tropical reef environments. The poster focuses on results from medical CT-scans of 3-dimensional macrofossil clast segmentation performed and combined with a macrofossil clast size and orientation analyses.

Delivet et al. presentation “Seismic geomorphological reconstructions at Goban Spur: implications for Plio-Pleistocene MOW bottom current variability” deals with high-resolution single channel sparker seismic data revealing the presence of large-scale sediment waves nearby DSDP site 548. Downhole geophysical data of DSDP site 548 and the seismic stratigraphic analysis allowed to suggest a Time/Depth correlation chart. Based upon the seismic geomorphological characteristics of the observed seabed and the buried sediment waves, the authors proposed that the relative bottom current variability might be assessed throughout time.

The symposium S6 (Scientific Drilling for unravelling the sedimentary records of past tectonic, climatic and environmental processes) started with a general presentation by **Gilbert Camoin** focusing on new opportunities in scientific drilling). The subsequent oral presentations, along with poster presentations, covered a wide range of topics including results from IOPD and ICDP.

Four plenary talks were given by top scientists in their field including a wide range of timely subjects and new frontiers of research in sedimentology.

- Sedimentary Records of the Ice Sheet Behavior During Past Warm Intervals: An Ocean Drilling Strategy by Carlota Escutia (Spain)

Polar ice is an important component of the Earth Climate System, affecting global sea level, ocean circulation/heat transport, albedo, and marine productivity, among others. Despite of their relevance, polar areas are largely unsampled and as a result the correlations between: 1) the records of temperature, CO₂ and ice sheet volume (and equivalent sea level), and 2) the mechanisms responsible for glacial-interglacial cycles (i.e., role of atmospheric CO₂) have not been yet fully elucidated.

The study of ice cores retrieved from the polar ice cap has afforded major breakthroughs in understanding natural climate variability over the last 800,000 years. However, at no time during the last 1 million years (m.y.), CO₂ concentrations in the atmosphere reached the 400ppm we experience at present. In fact, the lower values of atmospheric CO₂ and temperatures forecasted for the end of this century (IPCC, 2013) have not been experienced on our Planet for over 4 m.y. (i.e. before the Arctic ice sheets formed), and the higher forecasted values since before the ice sheets in Antarctica formed. Antarctica and its margins are therefore key locations from where to retrieve the long-term sediment records needed for a detailed understanding of how ice sheets responded to past climate forcings.

During the last decades ocean drilling in Antarctica (e.g., DSDP, ODP Legs 178, 188, IODP Expedition 318, ANDRILL and SHALDRIL) has revealed regional information about sea ice and ice sheets development and evolution. Although these records are still sparse and incomplete, they are complimentary and allow for a preliminary assessment of the variations between different ice sheet sectors. Additional records are needed if we are to address key knowledge gaps about the role of polar ice in climate change, targeting questions such as: how do ice sheets respond to warmer than present conditions (elevated CO₂ and temperatures); ice-ocean interactions (and equivalent sea level rise); timing of events; rates of change; tipping points; regional variations; and northern vs. southern hemispheres (in phase or out-of-phase) variability. This data is critical to provide constrains to sea-ice and ice sheet models, which are the basis for forecasting the future of the cryosphere in a warming world.

A multiplatform, multinational strategy has been developed within the SCAR PAIS (Scientific Committee for Antarctic Research-Past Antarctic Ice Sheet Dynamics) Program to collect sediment records from ice-to-abyss transects in vulnerable areas of the Antarctic ice sheets. With this strategy, PAIS aims to improve our understanding of the sensitivity of the Antarctic Ice Sheets to a broad range of past climatic and oceanic warm conditions (i.e., “greenhouse” climates, times of more recent warming and ice sheet retreat during glacial terminations). Ocean Drilling is key to this strategy. The ECORD Mission Specific Platforms will allow access to coastal and ice-covered areas, and will allow for higher recovery of glacial sediments. Ship-based drilling (i.e., JOIDES *Resolution*-type) is required for obtaining long-term high-quality paleoclimate and paleocenanographic records in deeper, ice-free areas of the margin. These records will be linked with ice core and continental records of past ice sheet behavior and sea level, yielding an unprecedented view of past changes in ice sheet geometry, volume, and ice sheet-ocean interactions.

- Earth's Deep-Time Insight into Our Climate Future by Isabel Montañez (USA)

Earth has two fundamentally different climate states—a cool ‘icehouse’ state characterized by the waxing and waning of continental-based ice sheets at high

latitudes, and a 'greenhouse' state characterized by much warmer temperatures globally and only small—or no—ice sheets. Although Earth has been in an icehouse for the past 34 million years, warmer greenhouse conditions have been the 'typical' climate state of the past half billion years. At the current rate of global C emissions, atmospheric CO₂ is projected to increase within this or the following century to levels last experienced on Earth prior to the onset of our current glacial state. Insight into how the Earth system will function in such an evolving and high CO₂ environment uniquely resides in the deep-time geologic record — the only integrated archive of the full spectrum of climate-related processes, feedbacks, and complex climate-ecosystem interactions in the earth system.

The paleoclimate record of the recent past unquestionably provides a critical baseline against which future climate change can be assessed given its resolution and precision. However, it captures only part of the known range of climate phenomena as it has been derived from a time dominated by low (30% lower than today) and relatively stable atmospheric CO₂ and bi-polar glaciations. Study of the deep-time geologic record reveals climate change in the past that was at times far more dynamic than suggested by reconstructions of the past few hundred thousand years and further elucidates feedbacks in the climate system that have operated differently in the past. Data-climate model comparisons of past warm periods further suggest that the magnitude and duration of climate change and the CO₂ levels at which critical climate and ecological thresholds could be crossed may well be underestimated by current climate projections. This presentation will place current and projected levels of atmospheric CO₂ into a deep-time context and use three examples of past major transitions to document the dynamic nature of past global warmings during both ice- and green-houses, evidence for atmospheric CO₂-climate coupling throughout Earth history, and to illustrate climate and ecological thresholds of greenhouse-gas forced climate change.

- Sedimentology Frontiers from Earth to Mars: Dunes, Deformation, and Diagenesis by Marjorie Chan (USA)

An enticing challenge of sedimentology is applying our knowledge to new exploration settings, using clues and proxies to deduce the processes of sedimentation. Mars has held our interest since ancient times, but now through new technologies and instrumentation advances we have the ability to scientifically explore the Red Planet at unprecedented scales. Studies of sedimentary environments on Earth are critical, as terrestrial analogs help us interpret depositional and diagenetic processes, as well as determine where habitable environments for life might exist.

Three comparative sedimentary examples of Earth settings show remarkable similarities to recent satellite and rover imagery from Mars:

1. Ergs on Earth are globally important reservoir units for both hydrocarbons and water. Mars has spectacular dune forms and dust devil tracks, reflecting the ubiquitous nature of eolian processes shaping the surface of Mars. Porous dune sediments record the interactions of the atmosphere and the surface, and have the potential to hold fluid volumes or cement mineralogies in the subsurface.
2. Soft-sediment deformation with varying expressions (e.g., contorted cross bed sets, massive sandstone layers, and clastic injectites) occur in eolian units. These can

provide clues to past water table conditions and the susceptibility of the sediments to strong ground motion. Weathering patterns in these sandstones can reflect differences in the massive versus cross-bedded host rock textures.

3. Finally, Earth sandstones commonly show different colors of iron oxide cementation reflecting the mobility of iron in the Earth's crust. These diagenetic records of past fluid flow histories provide clues about reservoir properties for aquifers and hydrocarbons. Is diagenesis a biogenic as well as a physical process? Many diagenetic relationships suggest a very strong link.

Mars is an exciting frontier for sedimentology, offering opportunities for serendipitous discoveries of what might exist within its sedimentary layers and surface landforms.

- Climate change, ocean warming, land ice melt and sea level rise by Anny Cazenave (France)

It is now well established that the Earth's climate is warming and that the main reason is the accumulation inside the atmosphere of green house gases produced by anthropogenic fossil fuel combustion and change in land use (IPCC AR5, 2013). Global warming has already several visible consequences, in particular increase of the Earth's mean temperature and of ocean heat content, melting of glaciers, and ice mass loss from the Greenland and Antarctica ice sheets. Ocean warming causes thermal expansion of sea waters, hence sea level rise. Similarly, land ice melt that ultimately reaches the oceans, also causes sea level to rise. Sea level rise induced by global warming and its impacts in coastal zones has become a question of growing interest for in the scientific community, and the media and public. In this presentation, we summarize the most up-to-date knowledge about climate change and associated impacts on ocean warming, land ice melt and sea level rise. We also present sea level projections for the 21st century under different warming scenarios, highlighting the regional variability that superimposes the global mean rise. Finally, we address the question of the sea level rise impacts. We discuss the many factors (due to natural phenomena and direct anthropogenic forcing) causing adverse effects in coastal zones and show that climate-related sea level rise will generally amplify the vulnerability of these regions.

All these very well attended lectures provided the opportunity to show delegates' cutting edge science as well as new research directions in diverse and contrasting fields dealing with sedimentology.

The meeting registration included three mid congress fieldtrips in order to accommodate the interests of the different delegates. A great trip on the Neptune, the oldest sailing boat still navigating Lake Geneva, brought to participants information dealing with the Quaternary processes that have lead to the formation of the lake along with anthropological data about the early inhabitants of the region. A second mid congress fieldtrip gathered delegates interested in geo-resources. Since the late 60's through the 80's Western Switzerland and surrounding France regions have been intensely investigated for hydrocarbons. Several exploration wells were drilled but without commercial success.

The largest mid congress field trip allowed participants to examine, in a magnificent

mountainous environment, the Cretaceous to Paleogene stratigraphic succession of the Platé Massif, northern Subalpine Chains (Haute-Savoie, France). This well exposed succession, is very diverse including a drowned carbonate platform of Early Cretaceous age, a condensed interval with glauconitic sandstones and phosphate crusts, Late Cretaceous pelagic limestones, and an Eocene carbonate platform exhibiting a variety of facies, from terrestrial to reefal. Participants reached the top of the stratigraphic succession by cable car and discovered breath-taking views of the Mont Blanc and other Alpine mountains! They further examined the rocks while walking back down to the station along an easy path.

As at every ISC edition several awards were delivered to outstanding colleagues. They were given during the General Assembly following the past president speech by Poppe de Boer. The prestigious Sorby Medal, the association highest distinction, was delivered to Noel P. James from Canada, in recognition for his outstanding contribution to carbonate sedimentology. Noel's talk was preceded by a citation by Peir Pufahl. This year it was delivered by the second time the Walther Medal. This mid career award was given to Thierry Mulder from France for his exceptional contributions to the knowledge of mud wasting events. The award was present by the president of the association. Dirk Hebbeln presented the Young Scientist Award to Michael Strasser from Switzerland. Peter Swart delivered the Association Honorary Membership to Judith A. McKenzie for her long lasting efforts and collaboration with IAS.

3) Assessment of the results and impact of the event on the future direction of the field

Overall, all sessions were well attended and provided a platform for discussion on challenging topics for future discussion. Specifically, the topic raised can be linked to the objectives of the Science Plan for the International Ocean Discovery Program (IODP): "Illuminating the Earth's Past, Present and Future", designed to guide multidisciplinary, international collaboration in scientific ocean drilling during the period 2013 to 2023. All four main themes highlighted in the Science Plan were relevant for the discussions at the ISC 2014:

- *"Climate and Ocean Change, Reading the Past and Informing the Future" which targets one of the most pressing questions about the climate, ocean and ice-sheet response to on-going increase in greenhouse gases.*

Apart from S6 and S12, several sessions, including T2, T3, T4, T9, S4, S5, S16, S19, S20, S23, S34 and S35, discussed issues linked to this topic. Overall, quantitative and high-resolution datasets seem to be of prime importance, along with a better understanding of the processes in the northern and southern hemisphere for a better link between these.

- *"Biosphere Frontiers" that includes exploration of deep life within the sub-seafloor and the study of ecosystem response to environmental forcing and ocean events.*

This research field was probably the one with the most-attended sessions. Cutting-edge research on-going in various settings around the world was presented and

discussed, including reports by teams working in the so-called Pre-Salt (particularly Angola and Brasilia). The sessions are T1_S4, T1_S5, T3_S3, T5_S1, T5_S2, S12, S13, S21, S25 and S32.

- *Earth Connections will concentrate on the links between surface, lithospheric and deep Earth processes.*

This field was mirrored in presentations of the sessions S1, S6, S15 and S31.

- *Earth in Motion addresses dynamic processes that occur on human time scales, including those leading to and resulting from earthquakes, landslides, and tsunamis.*

Two sessions focused on this research field, namely S6 and S7. First results of drilling of the Nankai accretionary prism, e.g., as presented by Strasser M. showed that continental margins might be “natural seismographs for reconstructing the earthquake history towards better characterizing the seismotectonic setting and better understanding long-term recurrence patterns”.

4) Final programme of the meeting

Programme of the COCARDE-sponsored session see Annexes on pages 8-11.

5) List of participants

Submitted online.

Appendixes

MONDAY 18

	7:45	8:15	9:15-10:00	10:15	10:45-12:15	12:15	13:30	14:30-15:30	15:30	16:30-18:00	18:00
R380		Opening Ceremony					Keynote Lecture				
R080			T2_S1 Carbonate platforms	T2_S1 Carbonate platforms	T5_S1 Diagenesis of carbonate sediments	T5_S1 Diagenesis of carbonate sediments					
R280			T1_S4 Lacustrine and palustrine environments	T1_S4 Lacustrine and palustrine environments	S25 Hot vents, cold seeps, terrestrial and marine crusts: the challenge of non-classic carbonates	S25 Hot vents, cold seeps, terrestrial and marine crusts: the challenge of non-classic carbonates					
R290				S22 Sedimentary dynamics and depositional controls in mudrocks	S31 Triassic to Jurassic basin analysis in the Tethyan realm	S30 Tectonic controls on carbonate platform architecture					
R060	POSTER SET UP		S1 Subaquatic paleoseismology: records of large Holocene earthquakes in marine and lacustrine sediments	S1 Subaquatic paleoseismology: records of large Holocene earthquakes in marine and lacustrine sediments	S1 Subaquatic paleoseismology: records of large Holocene earthquakes in marine and lacustrine sediments	S1 Subaquatic paleoseismology: records of large Holocene earthquakes in marine and lacustrine sediments					
R070				S28 + T3_S4 Provenance signatures in modern and ancient sediment dispersal systems	S28 + T3_S4 Provenance signatures in modern and ancient sediment dispersal systems	S28 + T3_S4 Provenance signatures in modern and ancient sediment dispersal systems					
R030				S33 Sed. + strat. + geochem. archives of the late Paleozoic ice age	S33 Sed. + strat. + geochem. archives of the late Paleozoic ice age		T2_S4 Siliciclastic platforms				
				S15 Sedimentary hosted mineralization and placer deposits	S15 Sedimentary hosted mineralization and placer deposits	S8 Modern and ancient drainage networks in tectonically active settings	T1_S3 Impact of glacial processes on sedimentation				
R040				S17 Phosphorus, phosphorites and marine authigenesis: sedimentology, geochemistry and environments of formation	S17 Phosphorus, phosphorites and marine authigenesis: sedimentology, geochemistry and environments of formation						
				POSTERS AND COFFEE		LUNCH		POSTERS AND BEER			POSTER REMOVAL

TUESDAY 19

	8:00	8:30-10:00	10:00	10:45-12:15	12:15	13:30	14:30-15:30	15:30	16:30-18:00	18:00	19:00
R380	POSTER SETUP	T6_S2 Hydrocarbon reservoirs and water resources	POSTERS AND COFFEE	T6_S2 Hydrocarbon reservoirs and water resources	LUNCH	Keynote Lecture	T10_S1 Sedimentary organic matter	POSTERS AND BEER	T10_S1 Sedimentary organic matter	POSTER REMOVAL	PUBLIC LECTURE MICHEL MEYER (R380)
R080		T5_S1 Diagenesis of carbonate sediments		T5_S1 Diagenesis of carbonate sediments			T2_S1 Carbonate platforms		T2_S1 Carbonate platforms		
R280		S32 + T3_S3 + T5_S3 Geomicrobiology		S32 + T3_S3 + T5_S3 Geomicrobiology		T1_S5 Tufas, speleothems, evaporites, travertines, calcretes and sinters	T1_S5 Tufas, speleothems, evaporites, travertines, calcretes and sinters				
R290		T1_S1 Aeolian environments		T1_S2 Alluvial fan and fluvial environments		T1_S2 Alluvial fan and fluvial environments					
R060		S34 Palaeogeography, palaeoecology and resource geology in the geological past		S34 Palaeogeography, palaeoecology and resource geology in the geological past		T9 Climate and Earth surface environments in deep time	T9 Climate and Earth surface environments in deep time				
R070		T2_S3 Deep-sea environments		T2_S3 Deep-sea environments		T2_S3 Deep-sea environments	S12 – COCARDE Carbonate mounds in shallow and deep time				
R030		S5 Sedimentology of extreme events		S5 Sedimentology of extreme events		T3_S1 + S27 Events in sedimentation	T3_S1 + S27 Events in sedimentation				
R040		T8 + T6_S1 + S11 Volcano-sedimentology		T8 + T6_S1 + S11 Volcano-sedimentology		T7 Predicting and visualizing sedimentary processes and systems through modeling	T7 Predicting and visualizing sedimentary processes and systems through modeling				

THURSDAY 21

	8:00	8:30-10:00	10:00	10:45-12:15	12:15	13:30	14:30	15:15-19:00	19:00
R380	POSTER SETUP	T4_S3 Sequence stratigraphy and cyclostratigraphy	POSTERS AND COFFEE	T4_S3 Sequence stratigraphy and cyclostratigraphy	LUNCH	Keynote Lecture	POSTERS AND COFFEE	Presidential address IAS General Assembly (R380)	POSTER REMOVAL
R080		T4_S2 Sedimentation and tectonics		T4_S2 Sedimentation and tectonics					
R280		S13 Recent developments in geomicrobiology of hypersaline systems		S13 Recent developments in geomicrobiology of hypersaline systems					
R290		S7 Turbidity current, subaqueous mass flow and mass movement processes – recent insights and future research directions		S7 Turbidity current, subaqueous mass flow and mass movement processes – recent insights and future research directions					
R060		S21 Non-marine carbonates and basin hydrology		S21 Non-marine carbonates and basin hydrology					
R070		T6_S2 Hydrocarbon reservoirs and water resources		T6_S2 Hydrocarbon reservoirs and water resources					
R030		T4_S1 Climatic signatures in sedimentation							
R040		T5_S2 Diagenesis of non-carbonate sediments		T5_S2 Diagenesis of non-carbonate sediments					

FRIDAY 22

	8:00	8:30-10:00	10:00	10:45-12:15	12:15	13:30	14:30-15:30	15:30	16:30-18:00	18:00	
R380	POSTER SETUP	T4_S2 Sedimentation and tectonics	POSTERS AND COFFEE	T4_S2 Sedimentation and tectonics	LUNCH	Keynote Lecture	T2_S1 Carbonate platforms	POSTERS AND BEER		POSTER REMOVAL	
R080		T2_S2 Coastal environments		T2_S2 Coastal environments			T2_S2 Coastal environments				T2_S2 Coastal environments
R280		S6 Scientific Drilling for unraveling the sedimentary records of past tectonic, climatic and environmental processes		S6 Scientific Drilling for unraveling the sedimentary records of past tectonic, climatic and environmental processes		S6 Scientific Drilling for unraveling the sedimentary records of past tectonic, climatic and environmental processes	S34 Palaeogeography, palaeoecology and resource geology in the geological past				T3_S2 Ichnology and taphonomic processes applied to sedimentology
R290		T6_S2 Hydrocarbon reservoirs and water resources		S26 Role of benthic microfossils in shallow-water carbonate sedimentation		S26 Role of benthic microfossils in shallow-water carbonate sedimentation					
R060		S4 Rapid climate / environmental changes in Mesozoic greenhouse world		S35 Sediments, archives of global environmental change during deep time		S35 Sediments, archives of global environmental change during deep time					
R070		S19 + S20 Measuring times and rates					S14 What's up with varves ?				S16 High-resolution terrestrial archives of climate change across the Mediterranean
R030		S37 Applications of X-ray computed tomography in sedimentology									