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Earthtime-UE final reporting

The solicitation of a "short visit grant" within the framework of the ESF activity entitled "EARTHTIME – The European Contribution" has been made to attend the Urbino Summer School in Paleoclimatology (Italia). During the twenty days of the summer school (2013, August, 10-30th), I thoroughly improved my knowledge on the past-global change reconstructions. This grant offered me the opportunity to actively participate to this event.

1. Purpose of the Urbino Summer School of Paleoclimatology (USSP)

The Urbino Summer School of Paleoclimatology (USSP) focuses on past climate dynamics with special emphasis on the analysis of the long-term carbon cycling and its implications in the understanding of present and future climates. The USSP hold participants (MSc and PhD students, Post-Graduate) from different backgrounds and working on disparate projects.

Paleoclimatology covers various aspects of earth science. It aims to reconstruct climate variability at different time scales based on sedimentary archives in the oceans and on the continents. Consequently, it covers various and numerous scientific specialties. Because of this multidisciplinarity and in order to be able to reconstruct reliably past climate dynamics, it is essential to be familiar with the different approaches used in paleoclimate studies. In this context, the USSP proposes refreshing and up to date courses covering most of the paleoclimatology fields; the goal being mainly to provide participants with an advanced working knowledge on the paleobiological and geochemical proxy data and their use in reconstructing and modeling of past climates.

Another aim of the USSP is to procure new ideas, discussions and interpretations about on-going student projects. The high quality of the teaching courses and the presence of

international scientists at the forefront of global oceanographic and paleoclimate research give the opportunity to discuss our research and ideas as well as future projects.

2. Description of the USSP courses

USSP 2013 will integrate lectures, symposia, fieldtrips, and exercises on the many different areas of paleoclimatology including biogeochemical cycling, paleoceanography, continental systems, and all aspects of deep time climate modeling. These techniques and systems were explored through interactive discussions of Cretaceous anoxic crises, Paleocene/Eocene hyperthermals, the Greenhouse-Icehouse transition, Neogene and Quaternary climate dynamics.

2.1. Amphitheatre Lectures

The different lectures were taught by 22 scientists leading senior scientists from around the world (see details of the teaching program in appendix). The summer school was composed of four themes:

- Biogeochemical cycles: corresponds to the long and short term circulation of chemical elements (e.g., carbon, oxygen, nitrate, phosphorus, calcium, silicon) within the different earth reservoirs (ocean, biosphere, rocks and atmosphere). The good understanding of these cycles is essential to study climate and ecosystems changes through time and in the future. One of the most frequent methods to study these cycles in the past is to measure the isotopic signature of the different chemical elements in the sediment and in the fossilizing carbonates. These isotopic measurements are used to reconstruct the past-climate variability (e.g. sea-surface temperature, sea-surface salinity, ice-sheet volume and weathering). During the USSP, several biogeochemical cycles have been detailed as well as their interpretations in terms of climate change, with concrete examples.

- Paleoceanography: the oceanic circulation within the atmospheric circulation is responsible for the distribution of the heat on the surface of the earth and therefore the climate. Indeed, the ocean dynamic is mainly driven by the atmospheric circulation and the differential global warming. The study of past-oceanic circulation is possible

from fossil (nannoplankton, calcareous and siliceous micro-organisms) and sediment records from the ocean. Moreover, isotopes from different chemical element (like oxygen and carbon) can be used to trace the water masses, the oxygenation of the water column, primary productivity, temperatures, salinity, etc... Lecturers of this topic argued about the use of the various fossil records (chemical, physical, biological properties), isotopes and the use of sediment record.

- Continental systems: Various archives from the continent (e.g., speleothem data, lake sediments) are very useful to reconstruct mean annual and seasonal range of temperatures, moisture level, atmosphere chemistry, paleoaltitude, ecology. The lectures focused on recently new continental proxies (leaf, clump isotopes, paleosol carbonate chemistry).

- Deep-time climate modeling: this corresponds to the use of quantitative methods to simulate the interactions of the atmosphere, oceans, land surface, and ice on a global earth scale. In this aim, different parameters can be modeled such as sea-surface temperature and salinity, oceanic currents, and atmospheric carbon concentration. Climate model can be applied for the study of the dynamics of the past climate system as well as the projections of future climate. Lectures lined up the validity of the model hypothesis and the criticism needed to interpret a model. To do that, several practical exercises have been provided.

Each of these themes has been taught by leading specialists in this field.

2.2. Field trips and workshops

During the USSP, we benefited from one day field-trip around Urbino. In fact, the geological area of Urbino is characterized by stunning sedimentary outcrops presenting a very clear climatic cyclicity (see pictures 1 and 2). Student groups were organized and allocated to different places and outcrops in order to collect data about the cyclicity of the sedimentary deposits. After, the data were integrated into a software, that we manipulated, and correlated to insolation parameters in order to quantify the climatic cyclicity and to interpret the forcing parameters.

Picture 1: The Vispi Quary in the Contessa Valley, near Gubbio. Outcrop of pelagic Cretaceous sediments in the Umbria-Marche Basin (UMB) of Italy.

Picture 2: Studied outcrop of pelagic Cretaceous sediments in the Umbria-Marche Basin (UMB) of Italy

Finally, during the Cioppino workshop, instructors and visiting scientists presented their latest research results, often unpublished and provocative data. Students presented a poster on their on-going research.

3. Application of the USSP to my PhD research

My PhD project requires a good knowledge about paleoclimatology. Indeed, the main objective of my thesis is to construct and calibrate a paleo-oxygenation proxy for the Arabian Sea. This proxy will be constrained from living and dead micro-organisms (benthic foraminifera). The USSP offered me the opportunity to obtain a better understanding of

proxies and climate modeling and improve my knowledge of past-global change reconstruction.

It was a great opportunity for me to attend lectures led by international scientists at the forefront of global oceanographic and paleoclimate research. In addition, the USSP 2013, by holding 55 students, permits an easier contact with lecturers and professors. The poster session also incited discussion on my project research. This interaction with different scientists and with students from different field works gave me new ideas about interpretations of my data and also for further application of my project. This was especially useful before starting the calibration of the paleo-oxygenation proxy which I intend to perform this ongoing year.

4. USSP: springboard for the future

I think that the USSP is a perfect place to meet professors for discussing future scientific projects as post-doctoral projects.

Discussions with the other participants were also very useful and interesting. New scientific ideas were initiated and the future collaborations look very promising.

Concluding remarks

The Urbino Summer School of Paleoclimatology was a real success in terms of knowledge, skills development, scientific interaction and social relations. The USSP allows me to consider new interpretations on my PhD subject, but also to envisage collaborations and projects for the future.

Appendix 1: Courses schedule

	Wed	Thu	Fri	Sat	Sun	Mon	Tue
	10-Jul	*11-Jul*	*12-Jul*	*13-Jul*	*14-Jul*	*15-Jul*	*16-Jul*
9:00 - 10:30	Systems and Archives I: Overview of Climate System (Raymo)	Age Models I: Time and Stratigraphy (Schellenberg)	Carbon Cycle I: (Ridgwell)	FREE DAY (Optional Carbon Cycle Investigation in AM)	Field Excursion (All on-site instructors present)	Age Models V: Climate Variability and Orbital Forcing (Lourens/Raymo)	Stable Isotopes I: Theory and Systematics (Spero, Zachos)
11:00 - 12:30	Systems and Archives II: Sedimentary and Biotic Archives (Schellenberg)	Age Models II: Biomagnetostratigraphy of PETM (Schellenberg)	Carbon Cycle II: (Ridgwell)			Age Models VI: Cyclostratigraphic Analysis (Lourens, Raymo)	Stable Isotopes II: Theory and Systematics (Spero, Zachos)
13:30 - 15:00	Systems and Archives III: Sedimentary and Biotic Archives (Schellenberg)	Age Models III: Cyclostratigraphy Theory (Palike/Raymo)	Carbon Cycle III: (Ridgwell)			Age Models VII: Cyclostratigraphy of PETM (Lourens, Raymo)	Stable Isotopes III: Problem Set and Data from Field Sections (Spero, Zachos)
15:30 - 17:00	Systems and Archives IV: Primer Stable Isotopes (TBD)	Age Models IV: Cyclostratigraphy Theory (Palike/Raymo)	Carbon Cycle IV: (Ridgwell)			Age Models VIII: Age Model of PETM (Lourens, Raymo, Schellenberg)	Stable Isotopes IV: Problem Set and Data from Field Sections (Spero, Zachos)
Night							Discussion and Integration: Age Models, Isotopes, Carbon Cycle, and Earth History

	Wed	Thu	Fri	Sat	Sun	Mon	Tue
	17-Jul	*18-Jul*	*19-Jul*	*20-Jul*	*21-Jul*	*22-Jul*	*23-Jul*
9:00 - 10:30	Biogeochemical Cycles I (Paytan)	Understanding and Issues III: The Quaternary (Raymo)	Proxies II: Marine Inorganic (Rosenthal/Relchart)	Proxies VI: Terrestrial (Snell)	Cloppino Conference	FREE DAY	Discussion and Integration: Proxiesa and Cloppino
11:00 - 12:30	Biogeochemical Cycle II (Paytan)	Understanding and Issues IV: The Holocene (Rosenthal)	Proxies III: Marine Biota (Hendrerlks/Thomas)	Proxies VII: Terrestrial (Snell)			Geochemical Modeling I: (TBD)
13:30 - 15:00	Understanding and Issues I: Mesozoic Greenhouse World (Jenkyns)	Proxies I: Marine Inorganic (Rosenthal/Relchart)	Proxies IV: Marine Biota (Hendrerlks/Thomas)	Proxies VIII: Organic Chemistry Principles (Pagani)			Geochemical Modeling II: (TBD)
15:30 - 17:00	Understanding and Issues IV: The Paleogene Greenhouse World (Sluijs)	Proxies II: Marine Inorganic (Rosenthal/Relchart)	Proxies V: Marine Biota (Hendrerlks/Thomas)	Proxies VII: Organic Chemistry Proxies (Pagani)			Geochemical Modeling III: Calculations and Simulations (TBD)
Night	Understanding and Issues II: Greenhouse-Icehouse Transition and the Icehouse State (Zachos)			Discussion and Integration: Proxies	Cloppino Banquet		

	Wed	Thu	Fri	Sat	Sun	Mon	Tue
	24-Jul	*25-Jul*	*26-Jul*	*27-Jul*	*28-Jul*	*29-Jul*	*30-Jul*
9:00 - 10:30	Climate Models I: Principles and Practices (Deconto, Huber, Valdes, Von Der Heydt)	Climate Models III: Cretaceous (Deconto, Huber, Valdes, Von Der Heydt)	Climate Models VII: Cryosphere Dynamics and Sea Level (Vermeerse/Stocchi)	Tipping Points in Climate (Skinner)	FREE DAY	Past to Future I: Monsoons and African climate and culture during the Holocene (DeMenocal)	Past to Future V: TBD
11:00 - 12:30		Climate Models IV: Paleogene (Deconto, Huber, Valdes, V. Der Heydt)	Climate Models VIII: Cryosphere Dynamics and Sea Level (Vermeersen/Stocchi)	Ocean Acidification (TBD)		Past to Future II: Global Warming (Huber)	Past to Future VI: Biotic Responses TDB
13:30 - 15:00	Climate Models II: Calculations and Simulations (Deconto, Huber, Valdes, Von Der Heydt)	Climate Models V: Miocene-Pliocene (Deconto, Huber, Valdes, V. Der Heydt)	Climate Models IX: Quaternary/Holocene Climate Models (Deconto, Huber, Valdes, V. Der Heydt)	Pliocene Dyamics (TBD)		Past to Future III: Sea Level Rise (Vermeersen)	Past to Future VII: Paleoclimatology, Politics, Policy (Deconto/DeMenocal)
15:30 - 17:00		Climate Models VI: Biosphere Dynamics (Beerling)	Discussion and Integration: Geochemical and Climate Modeling	Past Climate Sensitivity		Past to Future IV: Panel and Discussion	Past to Future VIII: Panel and Discussion
Night							

Lectures	Investigations	Field Work and Analyses	Integration and Discussion	Cloppino Conference	Evening Activities