Magellan Introductory course in Ocean Drilling (MICOD) – Urbino July 15-21, 2009.

To promote the integration of the various aspects related to the stratigraphy and the sedimentology of deep-sea sedimentary archives of paleoclimate records, the USSP Consortium has organized the Magellan Introductory Course in Ocean Drilling Sciences (**MICOD**) was held at the **University of Urbino** between **July 15-21, 2009**.

With the goal of training a new generation of ocean drilling Earth scientists also able to advantageously view field data in the light of models and *vice versa*, MICOD brought together 10 leading international experts in the Stratigraphy of Marine Sediments, Palaeoceanography, Palaeoclimatology, Geochemistry and (Paleo)climate modeling, all of them involved with ODP/IODP in the past, to lecture and mentor 29 typically first-year graduate students from 10 nations. The course has been organized in collaboration with the **Consortium for Ocean Leadership** "*School of Rock*", which allowed implementing modules mimicking the typical situation of incoming cores onboard the JOIDES *Resolution*, including initial lab studies.

The course included a 7-day-long intensive program covering e.g., an introduction on the deep-sea drilling techniques, followed by a series of lectures and exercises on the stratigraphy of marine sediments aimed at providing information, and analysis of, extant ocean drilling data including the various techniques used to construct age models. Exercises were focused on core description (core replicas and photographs) and the analysis of authentic shipboard data. Theoretical lectures and exercises on the stratigraphy of marine sediments has been complemented by a field component aimed at providing a comparison of the analysed oceanic sequences with the locally exposed Tethyan sedimentary sequence. Urbino's location within the Umbria-Marche Basin has provided exceptional field access to the regional stratigraphic records of the Cretaceous and Cenozoic paleoclimatic history and events focused upon by MICOD, which form an exceptional playground for stratigraphy field work. Several easily accessible outcrops has offered the opportunity for field view of records equivalent to those recovered by Ocean Drilling Science programmes (DSDP-ODP-IODP). Field and laboratory work has allowed students to produce original data across intervals marking the evolution of Cretaceous and Cenozoic climates. Produced data will be compared with the deep-sea records to evaluate them in a global context also using information obtained from lectures focused on the oceanographic and climate system and dynamics.

Background: Since 1968, scientific ocean drilling has contributed to obtaining a considerable archive of Earth history, which revealed much about the processes that drive our planet's dynamic character. Our understanding of the ancient ocean-climate system has greatly advanced because of the findings of deep-sea drilling. These advances have benefited from improved coring technologies, utilization of a wide variety of techniques for non-destructive characterization of cored material, creative scientific drilling proposals, generation of high resolution geochemical records (e.g., stable isotopes), and building upon earlier drilling results. The first part of the MICOD course has been developed along a description of the techniques involved in deep-sea drilling and their evolution, descritpion of cores and sediments and dating techniques, i.e. biostratigraphy, magnetostratigraphy, and cyclostratigraphy.

Following this introductory part, lectures and exercise have developed through the discussion of the main climatic and oceanographic event of the Cretaceous and the Cenozoic using the Paleocene Eocene Thermal Maximum as a main example of past global change.

One of the major outcomes of scientific ocean drilling is that the coupled ocean climate system has not always been characterized by slow, gradual, continuous processes. Rather, events of rapid changes are a consistent feature for many times in the past, some having being caused by unique events, such as the bolide impact that likely triggered the last great mass extinction event at the end of the Cretaceous Period (65.5 Ma), others by the complex action of different factors including orbital forcing and feedbacks in the climate system, opening and closing of oceanic gateways, growth of major mountain belts, and large-scale volcanism. At times, these varied influences have culminated in an abrupt change in the ocean-climate system caused by the crossing of some critical threshold thereby triggering a rapid disruption to the steady-state climate system. The analysis of these critical events in complete and well preserved sedimentary archives obtained with deep-sea drilling is crucial to shed lighhts on the linkages among these various variables. The deep-sea sedimentary record has provided spectacular examples of just how quickly the Earth's interconnected systems can be perturbed. The Cretaceous and Paleogene Periods contain several prominent examples of abrupt changes and orbital modulation in the ocean-climate system, including the Oceanic Anoxic Events (OAEs) Cretaceous/Paleogene (K/P) boundary, the Paleocene/Eocene Thermal Maximum (PETM), and the earliest Oligocene glaciation (Oi1 event) of Antarctica. The Neogene has witnessed the rapid Oligocene/Miocene glaciation (Mi1 event) of Antarctica, the mid-Miocene climatic optimum, the middle Miocene glaciation (Mi3-Mi4 event) of Antarctica, and the onset of Northern Hemisphere glaciation.

For theoretical lectures and class exercises the PETM has been used as a main case study with discussion of shipboard and shorebased real IODP data from different Legs. Discussion of data

from the PETM interval has been accompanied by frontal lectures on past climate variability and dynamics to allow their evaluation in a global perspective.

For field wok and laboratory exercises, four case studies have been selected to represent a wider spectrum of tempo and mode of past oceanographic and climatic changes, from the orbitally controlled deposition of organic-rich sediments (OAE1c) and dissolution intervals (Early Eocene hyperthermals) to the sudden changes induced by the impact of a bolide at the K/T boundary and, finally, the OAE2 which represent the climax of a long term interval of oceanographic and climatic changes. Field and laboratory work has allowed participants to produce original data across stratigraphic intervals containing events that mark the evolution of Cretaceous and Cenozoic climates.

MICOD provided an integrated student-centered program comprised of (1) integrated topical lectures by internationally recognized scientists; (2) student-centered data-rich exercises, investigations, and presentations on field data and modeling results; (3) Working goup sessions providing groups of participants with a more focused coverage of selected topics within paleoclimatology for selected intervals and events (4) a regional field excursion to classic Cretaceous and Cenozoic sections, and (5) intensive discussions of specific palaeoclimate topics in small student working groups facilitated by dedicated instructors. The program structure included IODP/JOI elements, by incorporating several modules of the '*School of Rock*' at the start of the program and an integration of student-centered investigations within the broader structure of a "virtual IODP leg".

Program of the meeting

	Wednesday July 15th	Thursday July 16th	Friday July 17th	Saturday July 18th
AM-0 (08.30-09.00)	Welcome and Introductions	Welcome and Introductions	Field Work	Welcome and Introductions
AM-1 (09.00-10.30)	Sediments & Core Description Leckie, Dickens	Paleomagnetism Leckie	Brief Excursion with lunch packest. 3 stops @ Furlo - short intro to the U-M series and panoramic view of the Jurassic	Past Climate Systems and Variability Von Der Heydt
AM-2 (11.00-12.30)	Lithostratigraphy Leckie, Dickens	Biomagnetostratigraphy Leckie	Contessa - panoramic view of the Cretaceous, Bonarelli, PETM , Lower Eocene @ Bottaccione - K/T boundary, Fucoid Marls	Climate Components 1 DeConto
	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK
PM-1 (13.30-15.00)	Time and Stratigraphy Leckie, Dickens	Cyclostratigraphy Lourens	Working groups : Field work Leckie, Lourens, Smit, Dickens Galeotti	Climate Components 2 Von Der Heydt
PM-2 (15.30-17.00)	Bio-stratigraphy Leckie, Brinkhuis	Cyclo-stratigraphy Lourens, Leckie		PETM - Shipboard Data Leckie, Dickens
Pre-Meal (18.00-19.00)	**Social at Tortorina Pool**	**Social at Tortorina Pool**	**Social at Tortorina Pool**	**Lecture: Jan Smit**

	Sunday July 19th	Monday July 20th	Tuesday July 21th
AM-0 (08.30-09.00)		Field Work : Paleogene	Laboratory
AM-1 (09.00-10.30)	PETM - Shorebased Data Leckie Dickens	Working groups : Lab work Leckie, Lourens, Smit, Dickens, Galeotti	Working groups : Lab work and/or and preparation of presentations Leckie, Lourens, Smit, Dickens, Galeotti
AM-2 (11.00-12.30)			
	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK
PM-1 (13.30-15.00)	Working groups : Lab and Field work depending on group assignements Leckie, Lourens, Smit, Dickens, Galeotti	Working groups : Lab work Leckie, Lourens, Smit, Dickens, Galeotti	Presentations by working groups
PM-2 (15.30-17.00)			
Pre-Meal (18.00-19.00)	**Social at Tortorina Pool**	**Social at Tortorina Pool**	**Social at Tortorina Pool**
Eveninig Lecture 20.00			