INTERNATIONAL ASSOCIATION OF SEDIMENTOLOGISTS

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Contents

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SUPER SEDIMENTOLOGICAL EXPOSURES

The extensional Corinth-Patras basin evolution from Pliocene to present and the different coarse-grained fan-delta types along Corinth sub-basin

Introduction

The Corinth–Patras basin is a late Pliocene to Quaternary WNW trending extensional basin that extends for 130km across the Greek mainland. It formed by late Cenozoic back-arc extension behind the Hellenic trench (Fig. 1A; Zelilidis, 2000). During the Pliocene, extension formed the Corinth–Patras basin, and the resulting WNW-directed basin was relatively uniform in width and depth along its axis (Fig. 1B).

The Corinth–Patras basin was separated into two WNW-trending sub-basins (Corinth and Patras sub-basins, 90 km and 30 km long and up to 30 km and 20 km wide, respectively) due to a NE-trending rifted sub-basin (Rion sub-basin, 15 km long and up to 3 km wide; Fig. 1B). Both sub-basins (Corinth and Patras) show high rates of subsidence along the southern, more active margins. Changes in predominant stress directions at this time led to the Rion sub-basin acting as a transfer zone between the extending Patras and Corinth sub-basins. Due to the above-mentioned different fault trends in the area of the Rion sub-basin, the Corinth–Patras basin locally became very narrow and shallow, forming the Rion Strait which influences sedimentological evolution of the whole basin (Figs 2 and 3).

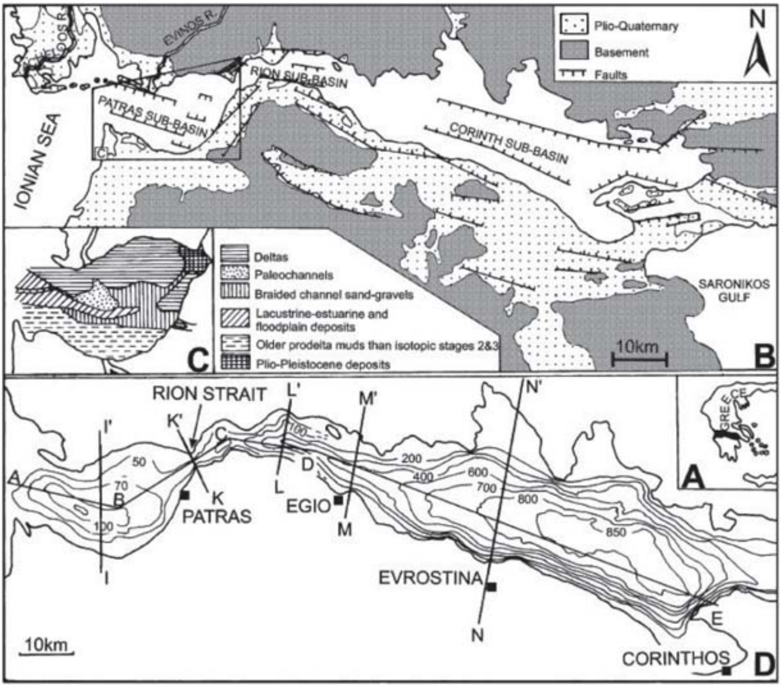

Figure 1. (A) Sketch map of Greece: black area indicates the studied area (shown in B and C). (B) Geological map of the Corinth–Patras graben,showing the Post-Miocene sediment distribution, the principal extensional faults, and the three sub-basins (Corinth, Patras and Rion). (C) Sediment facies distribution in the Patras sub-basin during isotopic stages 2 and 3.). (D) Recent Corinth– Patras basin configuration showing the present basin bathymetry.

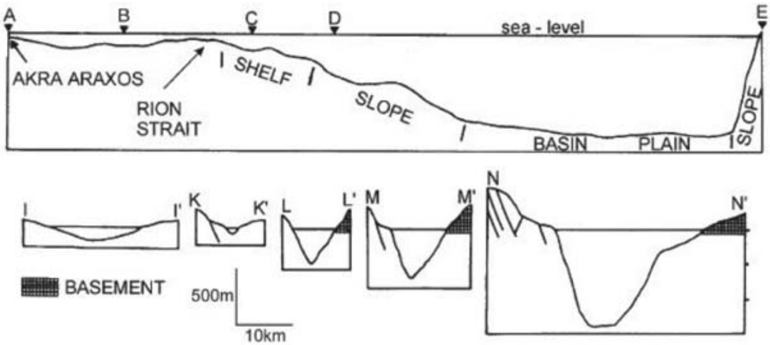

Figure 2. Cross-sections along (A–E) and across (I–I0, K–K0, L–L0, M–M0, N–N0) the Corinth–Patras graben showing the basin geometry. For locations see Figure 1D.

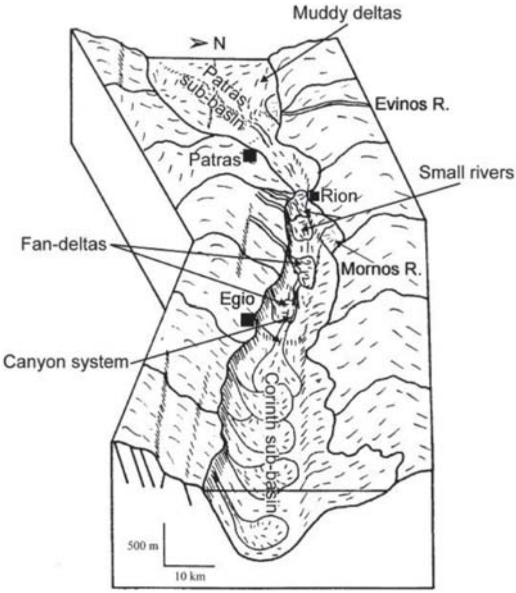

Figure 3. Morphological sketch showing the distribution of depositional environments in the present Corinth–Patras graben. Note also the narrow shelves on the southern margins of the Corinth sub-basin

Pliocene muddy deltaic, shelfal and marginal marine deposits are exposed on the uplifted southern margins of the basin. During the Quaternary the basin was deeper, forming at times a lake, at times a marine seaway, connected both at Akra Araxos and Corinthos (Fig. 1). Fan-delta deposits fed by small rivers pass basinwards into turbidites in the deep areas. Large rivers produce mixed sand-mud deltas. At present the basin is open only at the western end, in Akra Araxos, and is subdivided into two sub-basins (Corinth and Patras) connected by the Rion Strait (Fig. 1D). The Corinth sub-basin is characterized by an asymmetric bathymetry, deepening southwards (Fig. 3). The slopes in the south are 30–40^{o} and in the north 10–20^{o}. Narrow shelves and slopes characterize the margins, dissected by canyon systems. The gentler slopes in the Patras sub-basin compared with the Corinth subbasin, have resulted in much of the sand load of the rivers being trapped on subaerial deltas or in the coastal zone while fine-grained sediments have accumulated in the central part of the sub-basin at a rate of about 0.5 mm/yr (Fig. 1C).

Fan-delta sedimentation in the Corinth sub-basin

Tectonic and stratigraphic background

The Corinth sub-basin is separated into two WNW-trending rifted segments and consists of a series of asymmetrical grabens, which are separated by NNE-trending transfer faults and basement highs developed on WNW-trending listric extensional faults (Fig. 4b,c). The southern segment, which occupies the coastal areas of the northern Peloponnesus, has been elevated about 1000 m above the present sea-level (Doutsos & Piper, 1990). In this uplifted segment, exposed sediments consist of late Pliocene to early Pleistocene fluvial and lacustrine–lagoonal deposits up to 600 m thick; these are unconformably overlain by up to 500 m of alluvial-fan and fan-delta deposits and marine terraces up to 30 m thick. Fan-delta sedimentary processes and architecture from the Egio (Poulimenos *et al.*, 1993) and Evrostina sub-basins (Zelilidis & Kontopoulos, 1996) have been studied.

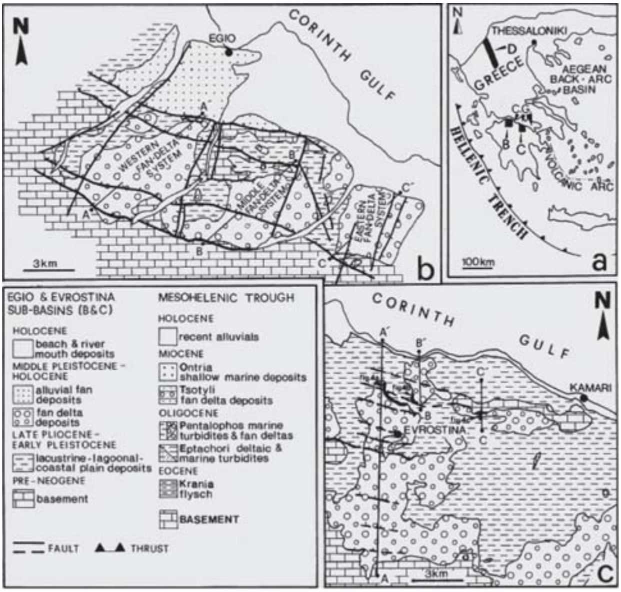

Figure 4. (a) Sketch map of Greece showing the studied areas (black boxes), and the Corinth graben (C.G.). (b,c) Geological maps of the Egio and Evrostina rifted sub-basins, respectively, showing the Quaternary sediment facies distribution and the principal WNW extentional faults and NNE transfer faults (modified from Poulimenos et al., 1993; Doutsos et al., 1988).

Fault geometry in the Egio and Evrostina sub-basins

WNW-trending normal faults with up to 800 m of vertical displacement divide the southern part of the Corinth graben in a series of tilted blocks. Many of these faults have listric geometry, dip towards the north at 50–85o and show an antithetic rotation sense in the downthrown beds, and although homoclinally rotated sags have been also observed. Each of these faults is accompanied by closely spaced minor faults with the same kinematic sense and by one antithetic fault (Fig. 4b,c). The major extensional faults vary along strike, with changes in vertical throw and the sense of rotation in the downthrown beds. Such changes are accomplished by NNE-trending transfer faults. These transfer faults are at a high angle, with a vertical displacement of up to 450m and subdivide the grabens into discrete blocks with different subsidence histories. They dip either to the east or to the west and show both a synthetic and an antithetic sense in the downthrown beds.

Sedimentation processes in the Evrostina and Egio sub-basins

Sedimentation in the Egio sub-basin (Fig. 4b) was described by Poulimenos *et al*. (1993), who showed a complex development of fan-delta foresets on the hangingwalls of major faults, with erosional contacts between successive sequences (Fig. 5a, sections A-A' and B-B').

The fan deltas are characterized by a lack of toe-sets and were termed trapezoidal deltas by Poulimenos *et al*. (1993). In the Evrostina sub-basin we recognize (Fig. 4c) one main fan-delta system that prograded northwards and one minor fan-delta system that prograded southwards, each with different depositional processes (Fig. 5b, sections A–A' and C–C', respectively). Fan deltas are coarse grained and lie unconformably over the pre-Neogene basement in the most proximal parts and over Pliocene–Pleistocene lacustrine–lagoonal basement in the rest of the basin. These deltaic systems developed at the margins of the Corinth graben and in a basin which basinwards is restricted by an intrabasinal basement high with horst morphology, so that a protected basin was formed. This intrabasinal basement high formed due to uplift caused by activity of minor synthetic and antithetic faults (Fig. 5b).

The main fan-delta system consists of two superposed deltaic sequences (A and B) (Fig. 5). Both of these sequences prograded from the southern margins northwards; they are composed of subaerial (alluvial fans) and subaqueous (foresets) sectors. Alluvial fans are developed on the footwall of a major fault and between the major fault and a minor fault having the same kinematic sense (Fig. 6).

Alluvial fans consist of coarsening-upwards cycles. Each cycle consists of poorly sorted, clast- or matrix-supported, pebbly–cobbly conglomerates. No grading or stratification is present. Imbrication is poor and rarely observed.

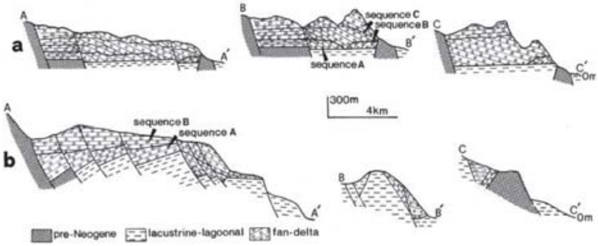

Figure 5. Cross-sections illustrating development of the fan deltas in the two studied rifted sub-basins. (a) Egio sub-basin. Section A–A' refers to the western deltaic system, B–B' to the middle deltaic system and C–C' to the eastern deltaic system. (b) Evrostina sub-basin. Section A–A' refers to the major deltaic system, B–B' to the fan-delta evolution, in front of the intrabasinal basement high, of the major fan-delta system, and C–C' to the minor deltaic system. For locations see Figure 4(b,c), respectively.

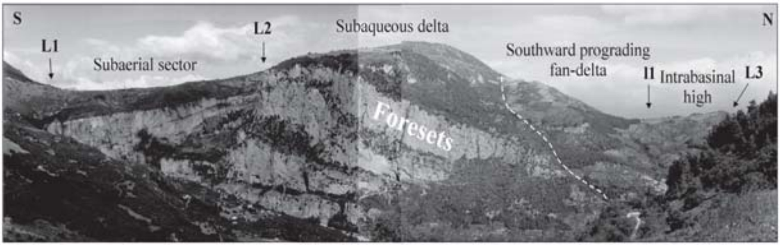

Figure 6: Photograph from Egion sub-basin which corresponds to the section B-B' of figure 5a. For details about faults see figure 4b.

Alluvial fans of sequence B (up to 350 m thick) rest with angular unconformity over alluvial fans of sequence A (up to 250 m thick) (Fig. 5b, A–A'). Alluvial fans of sequence A pass basinwards to foresets (Fig. 7) up to 450 m thick in the dip direction, that terminate in an intrabasinal basement high. Bottomsets are absent. Alluvial fans of sequence B pass laterally to foresets of sequence B, up to 200 m thick in the dip direction. The latter developed over foresets of sequence A. Foresets consist of fining-upwards conglomeratic cycles dipping 35° basinwards. Each cycle consists at the base of clast- or matrix supported, unstratified cobbly conglomerates that pass upwards and upslope into thin to medium interbedded normally graded, well-sorted, gravely sand and gravel beds, characterized by massive and rare cross-stratification. The pebble *a*-axis is parallel to palaeoflow. Foresets adjacent to the major fault scarp formed vertically stacked micro-fan-delta subsequences with oblique and sigmoidal clinoform geometries (Fig. 5a, B–B'), which reflect episodes of slip and no slip, respectively.

Basinwards sequence B overstepped the intrabasinal basement high, forming fine-grained bottomset deposits up to 50 m thick over the intrabasinal basement high, laterally to the foresets.

Thus, sequence A terminated in the intrabasinal basement high and is

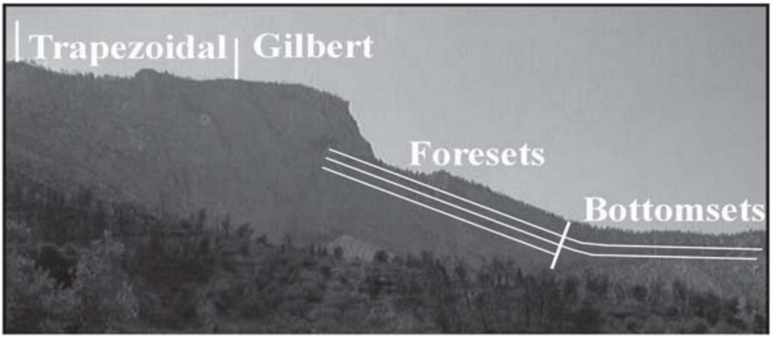

Figure 7: Photograph showing how trapezoidal-type fan-deltas pass gradually to Gilbert – type fan-deltas when sedimentation overstepped the intrabasinal basement high. This photograph corresponds to the section A-A' of figure 5b.

characterized by the absence of toe-sets; in contrast, sequence B overstepping the intrabasinal basement high is characterized by the presence of toe-sets. Transfer fault activity formed NNE-trending narrow zones of subsidence where large channels, in a NNE direction, and fan deltas were formed. Large channels (300–500 m wide and 50–100 m deep) developed on the hangingwall of the major fault, cross-cutting the foresets of sequence B. Fan deltas (Fig. 5b, B–B') prograded in a northward direction on the hangingwall of a minor fault in front of the intrabasinal basement high; these consist of foreset and bottomset deposits with much more finegrained sediments than those of sequences A and B.

The southward prograding minor fan-delta system, which originated from an intrabasinal basement high, is coarse grained and consists of foreset deposits up to 100 m thick in the dip direction (Fig. 5b, C–C,). Foreset deposits of this fan delta system are covered by fine-grained sediments that developed to the north of the southern margins and rest unconformably over lacustrine–lagoonal deposits.

Discussion

Sedimentary basin infill into rift basins

The Egio and Evrostina sub-basins, developed at the southern margins of the Corinth graben, are protected WNW-trending rift basins that are confined basinwards by an intrabasinal basement high with horst morphology. Transport of sediment was perpendicular to sub-basin elongation and from the southern margin or from the intrabasinal basement highs, and formed fan-delta deposits.

Fan-delta deposits were generated along WNW-trending major faults; NNE-trending transfer faults contributed to their lateral development and to the basin-fill configuration. These fan-delta deposits are coarse grained, and sediment fluxes were dominated by mass flows. All outcrops consist of foreset deposits that formed on the hangingwall of steep, fault-controlled nearshore slopes. In some places, alluvial fans, topsets and marine terrace deposits are present. On rare occasions, where fan deltas overstepped intrabasinal basement highs, bottomsets were formed over them.

Four different fan-delta frameworks have been recognized in these protected sub-basins: (a) only with foresets (e.g. sequence B in the Egio subbasin, Fig. 5a and sequence A in the eastern deltaic system of the Egio sub-basin, Fig. 5a, C–C'); (ii) with alluvial fans and foresets (sequence A in the western deltaic system of the Egio sub-basin, Fig. 5a, A–A'); (iii) with alluvial fans, foresets and topsets or marine terraces (e.g. sequence C in the middle deltaic system of the Egio sub-basin, Fig. 5a, B–B,); and (iv) with alluvial fans, foresets and bottomsets (sequence B in the major deltaic system of the Evrostina subbasin). The depositional pattern in cases (i)–(iii), where bottomsets are absent, produce trapezoidal-type fan deltas.

Powerful underflows that probably developed between synthetic and antithetic faults at the bottom of the protected basins affected the entire area and transported the fine-grained sediments outside the protected basin to the Corinth graben (Poulimenos *et al.*, 1993). In places, channellized bodies cross-cut the foresets as a result of the above mentioned powerful underflows, whose location was controlled by transfer fault activity. The presence of topsets and sandy marine terraces indicate periods of sea-level still-stand.

Relationship between trapezoidal- and Gilbert-type fan deltas

In some cases there is lateral transition, in the progradation direction, from trapezoidal-type fan deltas to Gilbert-type fan deltas, where intrabasinal basement highs were overstepped in rifted basins.

In particular, when sedimentary infill with fan-delta deposits is unable to overstep an extensive intrabasinal high, then only trapezoidal-type fan deltas can be formed (Egio sub-basin). Where the intrabasinal high is small, it can be progressively overstepped by fan-delta deposits, which pass from trapezoidal-type to Gilbert-type fan deltas (Evrostina sub-basin).

Selected references

Doutsos T., Piper DJW., 1990. Listric faulting, sedimentation and morphological evolution of the Quaternary eastern Corinth graben: first stages in continental rifting. Bulletin of the Geological Society of America, 102: 812–829.

Poulimenos G., Zelilidis A., Kontopoulos N., Doutsos T., 1993. Geometry of trapezoidal fan deltas and their relationship to extensional faulting along the south-western active margins of the Corinth rift. Basin Research, 5: 179–192.

Zelilidis A., 2000. Drainage evolution in a rifted basin, Corinth graben, Greece. Geomorphology, 35: 69–85.

Zelilidis A., Kontopoulos N., 1996. Significance of fan deltas without toe-sets within rift and piggy-back basins: examples from the Corinth graben and the Mesohellenic trough, Central Greece. Sedimentology, 43: 253–262.

Accomodation

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Web-site: www.greekhotel.com/peloponnese/patra/astir

Hotel Tzaki

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Patras (Greece)
Tel.: +30 2610453960
Web-site: www.hoteltzaki.gr

Restaurant

Blue Danube
Kastelokampos beach
Patras (Greece)
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REPORT ON

FOURTEENTH MEETING OF SWISS SEDIMENTOLOGISTS

On Saturday, 28 January 2006, 62 sedimentologists congregated in Fribourg, Switzerland, for the 14th SwissSed Meeting. Most came from Swiss universities but also people from the Swiss Geological Survey, from Holland, France, and the U.K. were present. The ages ranged from master students to retired professors, with a clear predominance of the young generation.

It was a small meeting with only 9 oral presentations and 14 posters, all by master or PhD students. Topics ranged from Carboniferous mudmounds in Spain to a Holocene lake fill in southern Argentina, from high-resolution facies analysis revealing orbital forcing to experiments that reproduce microbial dolomite formation, from the palaeoecology of nerineid gastropods to the mineralogy of Bermudan palaeosols, from biostratigraphic calibration of carbonate platform facies to multi-proxy analyses unravelling palaeoenvironmental changes. Talks and posters were of excellent quality and on the level of any big international congress.

In his keynote lecture, Jan Smit from Amsterdam presented results from the bore-hole in the Chicxulub impact crater and triggered an animated debate about the K/T boundary. It was helpful for the MSc and PhD students to see that there are still hot topics in Earth Sciences and that, despite of year-long research by hordes of scientists, there are still open questions that call for even more research.

At the end of the meeting, a discussion was launched on the value of «Sedimentology» as a science and of its perception in the scientific community.

Geochemistry, geomicrobiology, palaeoceanography, palaeoclimatology, or modelling denudation rates in relation to tectonic uplift and climate are fascinating topics and attract more and more researchers. Has Sedimentology merely become a methodology that serves these other disciplines? The answer clearly is NO: Sedimentology is the science that analyses the archives of Earth history, and we still need extensive expertise to read and understand these archives. Old-fashioned stratigraphic logging and old-fashioned facies analysis are indispensable if we want to interpret correctly our geochemical proxies and reconstruct palaeoceanographic and palaeoclimatic changes. Nevertheless, there is a trend that Sedimentology is considered «boring» and not «cutting-edge». If we want to publish high-impact journals, we better avoid mentioning facies analysis. If we write a research proposal or postulate for an academic position, we better say that we need a LA-ICP mass spectrometer and not just a good optical microscope. It is therefore up to us sedimentologists who are in editorial boards, funding agencies, and nomination committees to constantly underline the importance of Sedimentology as a basic science on which the other disciplines can build.

The discussion continued informally with wine and snacks. The participants then left with the firm determination to come back to Fribourg in January 2007.

André Strasser
Fribourg, Switzerland

NEWS FROM

The Hellenic Sedimentological Association

Maurice Tucker Lecture Tour – University of Athens, Greece

The Hellenic Sedimentological Association (HSA) was founded in November 2003 with principal aim the promotion of the discipline of Sedimentology, both as a research specialty, as well as an applied sector in the industry. In its first two years the HSA has reached a membership of more than 100 and we expect that in the future our Society will continue to grow in number and quality.

Recognizing the significant service that the International Association of Sedimentologists (IAS) has provided to the Greek sedimentological community, the members of the Hellenic Sedimentological Association have decided to develop strong links with it and foster enhanced cooperation and participation with its members.

Among other priorities, the most prominent is the organization of the 25th IAS regional congress in Greece (Patras, Greece, September 4-7, 2007) and we ask your support for the realization of this task. The Hellenic Sedimentological Association has already its Newsletter named «***Ion***» (meaning coast, Flavius Arrianus: The Ascent of Alexander, Ch. XXVI) and you may download the first two issues from our website (ias-hellas.geol.uoa.gr). Members of IAS are welcome to join us and send their contribution to our Newsletter.

We also decided to organize a series of short seminars / lectures and we have invited outstanding personalities from the international sedimentological community to visit us. Professor Maurice Tucker from Durham University, Department of Geology, made the symbolic start and delivered a lecture for the members of the HAS and the staff of the Geological Department of Athens.

Professor Maurice Tucker was recently in Greece, as a member of the Organizing Committee of IAS, regarding the forthcoming 25th IAS Meeting of

Sedimentology. Despite his busy schedule he kindly agreed to give a lecture in the University of Athens, Department of Geology, with the title «*Carbonate cycles: sea-level, sediment and sunshine*». This was a fascinating and inspiring lecture.

The lecture took place at the I. Drakopoulos Amphitheater and was attended by faculty members and delegates from the University of Athens, Aristotle University of Thessaloniki, National Technical University of Athens, Agricultural School of Athens, the Institute of Geological and Mineralogical Research, the National Centre for Marine Research, the Hellenic Petroleum Corporation, as well as many graduate and postgraduate students.

Professor Maurice Tucker has a wealth of experience and his research, that includes carbonate platforms and carbonate hydrocarbon reservoirs, is well known to all of us, especially through his excellent books and his outstanding papers. As suggested from the subject of his lecture, he is particularly interested in the study of cyclicity in high-frequency carbonate and clastic sequences, a phenomenon that from a long time ago drew the attention of researchers, but in recent years is considered a *fundamental* issue of sedimentology evidently because it is connected to astronomical cycles.

In his lecture Professor Tucker spoke about the reflection of the cyclical differentiation of the orbital parameters of the Earth in the stratigraphic sequences and phases. This is not a simple matter since the differentiation of many other factors enters into consideration, such as for example, solar radiation, sea level and climate. Professor Tucker delivered this lecture with elegance and inspiring humour and the appreciative audience participated in lively discussion at the end of his talk.

We warmly thank all the colleagues who responded to the Hellenic Sedimentological Association's invitation to attend the lecture of such a distinguished scientist.

Dr Fotini Pomoni
Associate Professor of the University of Athens
Department of Geology and Geoenvironment
President of the HSA & IAS National Correspondent
fpomoni@geol.uoa.gr

IAS Postgraduate Grant Scheme

IAS has established a grant scheme designed to help PhD students with their studies. We are offering to support postgraduates in their fieldwork, data acquisition and analysis, visits to other institutes to use specialised facilities, or participation in field excursions.

About 10 grants, each of up a maximum of 1000 Euros, are awarded twice a year.

These grants are available for IAS members only, and only for postgraduates. Students enrolled in MSc programs are not eligible for grants. The application must include a short CV and a budget. A letter from the supervisor supporting the application must be sent directly to the Treasurer of the IAS.

An application form is on our website (http://www.iasnet.org). Moreover, the application form can be requested from the Treasurer's Office (IAS, Office of the Treasurer, Ghent University, Department of Geology and Soil Science, Krijgslaan 281/S8, B-9000 Gent, Belgium; E-mail: *Patric.Jacobs@UGent.be*)

Application deadlines:	1st session:	March 31
	2nd session:	**September 31**
Recipient notification:	1st session:	before June 30
	2nd session:	**before December 31**

CALENDAR

SEDIMENT2006
4th Annual Conference of the Central European Section of SEPM

7-9 June, 2006
University og Göttingen, Germany

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E-mail: info@sediment2006.de
Web-page: http://www.sediment2006.de

Climate and Biota of the Early Paleogene

June 12-16, 2006
Bilbao, Spain

Dr. Victoriano Pujalte
Departamento de Estratigrafía y Paleontología
Facultad de Ciencia y Tecnología Universidad del País Vasco
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Fax: +34 601 3500
E-mail: cbep2006@lg.ehu.es
Web site: www.ehu.es/cbep2006

Polish Sedimentological Conference
Sedimentation in Foreland Basins

June 22-23, 2006
(including field-trips June 21-26)
Zwierzyniec, Poland
(field trips also in Ukraine)

Contact: Anna Wysocka
Faculty of Geology
Warsaw University
Zwirki i Wigory Str. 93, 02-089 Warszawa, Poland
E-mail: pokos2@uw.edu.pl
Web-page: http://www.geo.uw.edu.pl/IGP/POKOS2/1.htm

17TH INTERNATIONAL SEDIMENTOLOGICAL CONGRESS*

August 27 –
September 1, 2006
Fukuoka
Japan

Ryo Matsumoto
Department of Earth & Planetary Sciences
University of Tokyo
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Web-page: http://sediment.jp/

CARBONIFEROUS CONFERENCE COLOGNE 2006
FROM PLATFORM TO BASIN. A RESEARCH FIELD CONFERENCE SPONSORED BY SEPM-CES

September 4-10, 2006
Cologne,
Germany

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Institut für Geologie und Mineralogie
Universitaet Koeln
Zuelpicher Str., 49a 50674 Koeln, Germany
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E-mail: markus.aretz@uni-koeln.de
Web site: http://www.ccc2006.uni-koeln.de

3RD MID-EUROPEAN CLAY CONFERENCE MECC'06

September 18-22, 2006
Opatija,
Croatia

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HR-10000 Zagreb, Croatia
Phone: +385 1 4605 999 Fax: +385 1 4605 998
E-mail: mecc06@gfz.hr
Web site: http://mecc06.gfz.hr

SEA LEVEL CHANGES: RECORDS AND MODELING * (SEALAIX'06)

Convenors : G.Camoin (CNRS, Aix-en-Provence, France), A. Droxler (Rice University, Houston, USA), C. Fulthorpe (Univ. of Texas, USA), K. Miller (Rutgers University, USA)

September 25-29, 2006
Aix-en-Provence
and Giens,
France

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ALLUVIAL FANS 2007

18-22 June, 2007
Banff, Alberta,
Canada

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Saint Mary.s University
Halifax, Nova Scotia, Canada
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Web-page: http://husky1.smu.ca/~pgiles/AF2007/
AlluvialFans2007.htm

4TH INTERNATIONAL LIMNOGEOLOGICAL CONGRESS *

July 11-14, 2007
Barcelona
Spain

Contact: Dr. Lluis Cabrera
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25TH MEETING OF SEDIMENTOLOGY (SEDIMENTOLOGY AND ENVIRONMENT)*

September 4-7, 2007
Patras,
Greece

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