MANCHESTER 1824

The University of Manchester

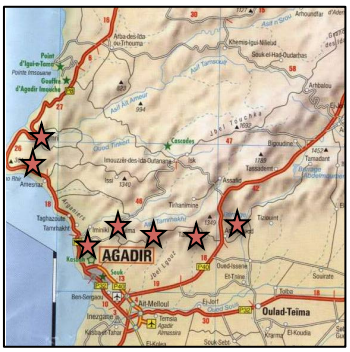
North Africa Research Group

Sponsors Field Course 2015
Atlantic Passive Margin Petroleum Systems, Morocco

Field Trip Leaders: Prof Jonathan Redfern [1], Giovanni Bertotti [2], Dr Stefan Schroeder [1]
with PhD students Tim Luber[1], Angel Arantegui[1] and Remi Charton[2].
([1]University of Manchester, [2] TuDelft)

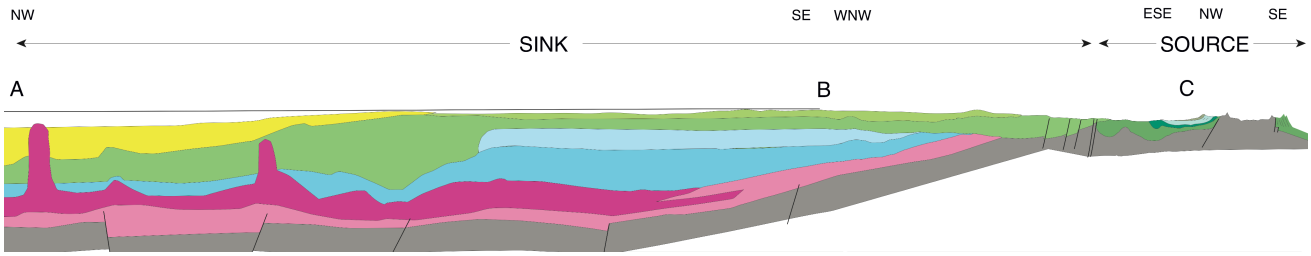
Summary

This field course for NARG Sponsors will examine key elements of the Atlantic Margin Petroleum System. Outcrops along the margin will be visited to examine the early Triassic rift sequences, Jurassic carbonate facies and diagenesis, and the Early Cretaceous stratigraphy and facies. In addition the course will address basin evolution and dynamics, examining evidence for subsidence, inversion and the issue of provenance of potential Early Cretaceous deepwater clastics. The field trip is based around completed and ongoing research in the area by NARG. The aim is to improve understanding of the depositional systems, facies modeling and basin evolution, highlighting the implications for petroleum systems and modeling and reservoir distribution.



Itinerary

Date:	*Itinerary*	*Accommodation*
Sunday 19th April:	Arrive Agadir pm, pick up from airport	Agadir
Monday 20th April:	Drive to Argana: Triassic Rift sequences of the Argana Basin	Argana
Tuesday 21st April:	Transect from Triassic to Early Cretaceous	Agadir
Wednesday 22nd April:	Jurassic carbonate facies	Agadir
Thursday 23rd April:	Early Cretaceous depositional systems	Agadir
Friday 24th April:	Basin evolution, structure and salt	Agadir
Saturday:	Depart Agadir	



Cost: The price is £2950 per participant (excl. VAT). Companies will be invoiced in advance for each registered participant. Companies may change the name of the participant up to 2 weeks before the trip date, but there will be no refunds for non-attendance. Each company is entitled to two places on the trip.

Participation: This is exclusive to NARG sponsors and collaborating Universities. In additon ONHYM will be invited to send up to 2 participants.

Transport: Transport in Morocco will be by 4x4 Landcruiser, 1 driver and 4 participants per car, fully fitted with safety equipment

Accommodation: Accommodation will mostly be in Agadir in a 3-4 star hotel. 1 night will be spent in the Argana Valley in typical simple Moroccan hotel, this will require sharing a twin room for some participants.

Meals: Cost includes all meals; breakfast, lunch in the field, and group evening meals in the hotel or selected restaurants. The fee does not include the costs of alcoholic beverages with meals, or incidentals in the hotels (telephone, drinks etc).

Travel: Travel to and from Agadir is at the participant's own cost. All travel in Morocco is included in the field trip costs.

Appendix 2: Field Course Leaders

Professor Jonathan Redfern
(jonathan.redfern@manchester.ac.uk)

Chair of Petroleum Geoscience
Basin Studies and Petroleum Geoscience Group

Jonathan Redfern is Chair of Petroleum Geoscience at the University of Manchester. He obtained a BSc in Geology from Chelsea College London and began his career in the oil industry in 1984, working for Fina UK in the North Sea. He left to complete a PhD at Bristol University, before returning to Fina in international new ventures based in Singapore, later managing regional studies in Libya and across North Africa. He subsequently joined Amerada Hess, as part of a specialist new ventures team, with a global remit, and latterly as Chief Geologist in Indonesia. Jonathan founded the North Africa Research Group in 2000, and heads the group based at the University of Manchester, which is supported by a consortium of leading oil companies and focuses on regional geological studies across the region. He has published extensively on the geology and petroleum systems of North Africa and regularly present at international conferences and oil and gas forums. He is a Fellow of the Geological Society and member of the AAPG and PESGB. He is also an associate editor of the AAPG Bulletin and the Journal of Petroleum Geology.

Recent Publications:

Fabuel-Perez, I., Hodgetts, D., & **Redfern, J.,** (2009), A new approach for outcrop characterization and geostatistical analysis of a low-sinuosity fluvial-dominated succession using digital outcrop models; Upper Triassic Oukaimeden Sandstone Formation, central High Atlas, Morocco *AAPG Bulletin*, 93, 6, pp. 795-827

Fabuel-Perez, I., Hodgetts, D. and **Redfern, J.** (2010). " Integration of digital outcrop models (DOMs) and high resolution sedimentology; workflow and implications for geological modelling; Oukaimeden Sandstone Formation, High Atlas (Morocco)." Petroleum Geoscience, 16, 133-154.133-154.

Lubeseder, S., **Redfern, J**., Boutib, L., (2009), Mixed siliciclastic-carbonate shelf sedimentation- Lower Devonian sequences of the SW Anti-Atlas, Morocco Source: *Sedimentary Geology*, 215, 1-4, pp. 13-32

Bodin S., E. Mattioli, S. Frohlich, J.D. Marshall, L. Boutib, S. Lahsini, **J.Redfern** (2010). "*Toarcian carbon isotope shifts and nutrient changes from the Northern margin of Gondwana (High Atlas, Morocco, Jurassic): Palaeoenvironmental implications.*" Palaeogeography, Palaeoclimatology, Palaeoecology, 297, pp 377-390.

Catterall, V., **Redfern, J.,** Gawthorpe, R.L., Hansen, D.M & Thomas, M.H.F (2010), Architectural Style and Quantification of a Submarine Channel-Levee Systems located in a structurally complex area: Offshore Nile Delta, *Journal of Sedimentary Research,* v. 80; no. 11; pp. 991-1017; DOI: 10.2110/jsr.2010.084

Bodin S., Fröhlich, S., Boutib, L., S Lahsini, S., and **Redfern J** (2011). Early Toarcian Source-Rock Potential in the Central High Atlas Basin (Central Morocco): Regional Distribution and Depositional Model. Journal of Petroleum Geology 34 (4), 345-363

Redfern, J., Shannon, P.M., Williams, B.P.J., Tyrell, S., Leleu, S., Fabuel Perez, I., Baudon, C., Stolfova, K., Hodgetts, D., Speksnijder, A., Haughton, P.D.W, Daly, J.S. , (2011) An integrated study of Permo-Triassic basins along the North Atlantic passive margin: implication for future exploration. *Geological Society, London, Petroleum Geology Conference series, v. 7, p. 921-936,* doi: 10.1144/0070921

Mader, N. K. and **Redfern, J.** (2011). A sedimentological model for the continental Upper Triassic Tadrart Ouadou Sandstone Member: recording an interplay of climate and tectonics (Argana Valley; South-west Morocco), Sedimentology, 1365-3091 DOI: 10.1111/j.1365-3091.2010.01204.x

Baudon, C., **Redfern, J** & Van Den Driessche P; J, (2012), Permo-Triassic structural evolution of the Argana Valley and implications on the kinematics and impact of the Atlantic rifting in the High Atlas, Journal of African Earth Sciences, 65, 91-104.

Jiménez Berrocoso, A., Bodin, S., Wood, J., Calvert, S.E., Mutterlose, J., Petrizzo, M.R., **Redfern, J.,** 2013. Dynamic sedimentary conditions during periods of enhanced sequestration of organic carbon in the central southern Tethys at the onset of the Cenozoic global cooling. Sedimentary Geology 290, 60-84

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Giovanni Bertotti (1958), is professor of Applied Geology at the Department of Geotechnology of the Delft University of Technology (TUD). GB was born in Italy where he did his studies until his "Laurea" in Earth Sciences obtained at the University of Pisa. He then spent one year at the University of Basel (CH) working on issues related to the tectonics of the Northern Apennines. In 1986, GB began then his PhD Thesis on the Mesozoic rifting evolution of the Lombardian sector of the Southern Alps. The Thesis, supervised by D. Bernoulli and S. Schmid, was based on a combination of structural and sedimentological field work and was awarded the silver medal of the ETH Zurich. In the frame of Postgraduate Studies on Developing Countries (NADEL), GB spent one year in Niger working on the hydrology of the region of Maradi and providing courses to technicians of local government agencies.

In 1991 Giovanni came to Amsterdam in the group of Sierd Cloetingh first as a post-doc, then as lecturer and, since 2001, as Associate Professor. During this period of time, GB worked at strengthening field geological research and pushing forward the integration with the numerical modelling techniques being developed at the VU. Gradually leaving the Southern Alps, GB was involved in projects, among others in the southern Apennines (Gargano promontory) and Romania. In recent years, GB has developed new research lines focussing on the tectonics of Morocco, Turkey and the Tyrrhenian margins. Increasingly interested in the quantitative aspects of geological fieldwork, GB, together with geoscientists from TUD, steered the development of DigiFract, an innovative acquisition and processing software aimed at the full description of fracture patterns affecting outcropping analogs of buried reservoirs. This has brought him in close cooperation with the Delft University of Technology. Attracted by the great know-how of this Institution, GB has applied for the position of Professor of Applied Geology and was appointed in March 2010. He started at Delft University of Technology on April 1, 2010.**!!**

Bertotti, G & Gouiza, M (2012). Post-rift vertical movements and horizontal deformations in the eastern margin of the Central Atlantic: Middle jurassic to early cretaceous evolution of Morocco. *International Journal of Earth Sciences, 101*(8), 2151-2165.**!! !**

Bertotti, G, Gouiza, M & Boro, H (2011). Tectonic evolution of Morocco and implications for North African fractured reservoirs. In s.n. (Ed.), *5th North African Mediterranean Petroleum and Geosciences Conference and Exhibition* (pp. 1-4). Manchester, UK: Univ. of Manchester.

Bertotti, G, Boro, H, Strijker, G. & Luthi, SM (2011). Predicting fracture patterns in North African buried reservoirs: breakthroughs from new regional ideas and new acquisition and processing tools. In s.n. (Ed.), *Naturally Fractured Hydrocarbon Reservoirs of North Africa - Outcrop Analogues, Subsurface Studies and Production Case Histories* (pp. 1-1). Manchester, UK: University of Manchester.

Bertotti, G & Gouiza, M (2011). Tectonics of anomalous vertical movements during the Jurassic to Cretaceous evolution of NW Africa. In s.n. (Ed.), *2nd International Conference and Exhibition of the Moroccan Association of Petroleum Geologists (MAPG-AAPG)* (pp. 1-1). Morocco: MAPG.

Dr Stefan Schröder
(stefan.schroeder@manchester.ac.uk)

Lecturer in Carbonate Geology
Basin Studies & Petroleum Geoscience Group

My particular research interests are in **microbial carbonates**, as well as the **sedimentological and diagenetic characterisation of carbonate reservoirs**. I have earned a PhD in geology from the University of Bern (Switzerland) in 2000, working on characterisation of microbial dolomite reservoirs in Oman. This was followed by postdoctoral research projects on Precambrian depositional systems at MIT and the University of Johannesburg. From 2007 to 2011, I worked as a carbonate and subsurface geologist for Total SA on reservoir studies, regional exploration studies and research applied to reservoir characterisation. Regional areas of expertise include southern Africa, the West African margin, Mauritania, the Mediterranean, the Middle East, and eastern Asia. I am teaching both undergraduate and postgraduate carbonate geology and field courses.

My research centres on the integration of regional, outcrop, subsurface, and laboratory data to understand **carbonate depositional systems** and **reservoir heterogeneities**. Past projects included digital outcrop studies applied to improving reservoir characterisation of microbial carbonates (Precambrian, Oman and Namibia), as well as the impact of fault-related dolomitisation on reservoir properties (Cretaceous, Spain). I have looked at diagenesis and subsurface characterisation of carbonate reservoirs in various settings and using data sets from outcrop, core, wireline logs, and seismic. Supervised student projects included diagenesis of Precambrian carbonates in the Congo and diagenesis associated with exposure surfaces in the Cretaceous of Oman. In the last few years I have gained **regional expertise in South Atlantic pre-salt and post-salt depositional and petroleum systems**, including a field trip to Angola. I have further supervised a recent BP-sponsored MSc thesis at Manchester on carbonate facies and diagenesis of Angolan pre-salt samples.

Recent publications relevant to consortium proposal:

López-Horgue, M.A., Iriarte, E., **Schröder, S.**, Fernández-Mendiola, P.A., Caline, B., Corneyllie, H., Frémont, Sudrie, M. & Zerti, S. 2010. Structurally controlled hydrothermal dolomites in Albian carbonates of the Asón valley, Basque Cantabrian Basin, Northern Spain. Marine and Petroleum Geology, 27, 1069-1092.

Schröder, S., Grotzinger, J.P., Amthor, J.E. & Matter, A. 2005. Carbonate deposition and hydrocarbon reservoir development at the Precambrian–Cambrian boundary: the Ara Group in South Oman. Sedimentary Geology, 180, 1-28.

Adams, E.W., **Schröder, S.**, Grotzinger, J.P. & McCormick, D.S. 2004. Digital reconstruction and stratigraphic evolution of a microbial-dominated isolated carbonate platform (terminal Proterozoic, Nama Group, Namibia). Journal of Sedimentary Research, 74, 479-497.