

**SASEG**  
**SWISS ASSOCIATION OF ENERGY GEOSCIENTISTS**

Is pleased to announce a lecture from the

**AAPG Distinguished Lecture Tour Europe**

**Prof. Colin Reeves**

Earthworks BV, Delft, The Netherlands

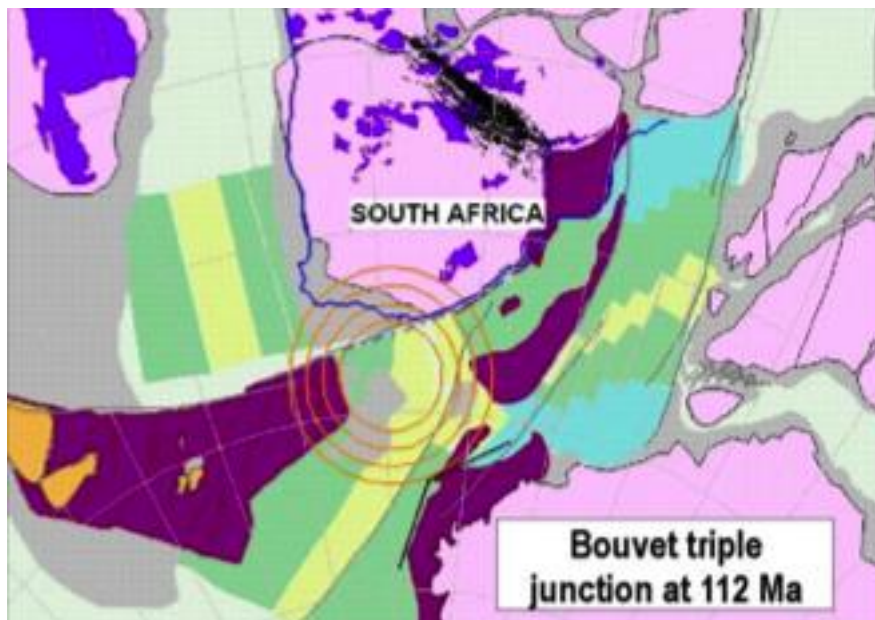
**Some plate-tectonic thoughts on the early  
opening of the South Atlantic Ocean  
(and implications for Hydrocarbon Exploration)**

**Wednesday, November 30th, 17h00**

University of Geneva, Department of Geology, Auditorium 1  
13, Rue des Maraichers  
1205 Genève

You are cordially invited to attend (non-SASEG guests welcome)

Peter Burri  
President SASEG



## **Some plate-tectonic thoughts on the early opening of the South Atlantic Ocean**

Colin Reeves

*Earthworks BV, Delft, The Netherlands (reeves.earth@planet.nl)*

Plate tectonics starts with the realization that the earth's lithosphere today is divided into a small number of large plates with seismicity mostly confined to their common margins. Uniformitarianism, the foundation of geology, says that things were always like this. But active plate boundaries change position over time and even minor intra-plate exceptions (e.g. the North Sea graben) are not negligible from an economic standpoint.

As a result of many years of work in Africa and elsewhere, the former (super-) continent of Gondwana has been divided into about 50 lithospheric fragments that have each individually remained rigid since Gondwana became a single, stable continent with the ending of collisional tectonics very early in the Phanerozoic. Over much of Gondwana, this stability persisted for 350 million years. Relative movements between these constituent Precambrian pieces since Gondwana started disruption about 180 Ma provide a measure of crustal extension, not only at the passive margins of the continents that were formed but at internal rifts within Africa, for example.

The record of Gondwana dispersal is in the sea floor topography and the magnetic anomalies ('stripes') that help constrain the timing of continental movements. Good, worldwide data on the former have only been available for the last 15 years. Carefully retracing the process of ocean growth with time leads to a model of the dispersal process and puts limits on the original relative configuration of the constituent fragments in a rigid, stable Gondwana. Within the South Atlantic Ocean, the earliest phases of rifting between what is now Africa and South America, the transition of rifting in to drifting and eventually to passive margin development are the most important to understanding the petroleum potential along the formerly conjugate coasts.

A reliable starting point for pre-drift rifting would eliminate some important sources of uncertainty in these earlier phases of ocean development. An important unknown is the width of the strip of Precambrian crust that has been lost from outcrop through extension and subsidence during the pre-drift rifting process. An accurate 'fit' depends on reliable detail in the present-day outcropping geology having large, mappable features such as major vertical faults that may be correlated reliably from one continent to the other, across the missing strip. In the process of modeling, the opening of the South Atlantic Ocean has been reduced to its barest essentials, consistent with the latest available fracture zone data, in an attempt to understand better the precise original fit of South America and Africa and the Euler geometry of the earliest phases of rifting. The first scissor-like wedging apart of the two continents, presumably under the influence of the Tristan mantle plume, must have changed into a more coast-normal relative movement once the full length of mid-ocean ridge was established and the Equatorial Atlantic propagated westward towards the Central Atlantic. This would amount to a change in spreading direction of about 30 degrees at about 125 Ma (early Aptian) in the southernmost part of the ocean.

A prototype animation of the whole process based on the 2010 Geological Map of the World is to be found at <http://www.reeves.nl/upload/SouthAtlantic1.gif>

## Colin Reeves Short curriculum vitae

**Colin Reeves** has been involved for 40 years with the use of (airborne) geophysical mapping in support of geological reconnaissance and resource exploration in the developing countries. He holds degrees from Cambridge, Birmingham and Leeds universities in England and started his professional career with the Geological Survey of Botswana in 1970 where he planned and executed the first national gravity survey coverage over a five-year period. From 1976 to 1983 he lived in Canada, working first for Geoterrex Limited in Ottawa and then Paterson, Grant and Watson Limited in Toronto. He interpreted the initial CIDA aeromagnetic coverage of the Kalahari in Botswana before spending time on similar projects in Brazil, Ivory Coast, the South China Sea, Tanzania, Kenya and Burundi. He became a director of PGW and - with Ian MacLeod - co-founded Geosoft® in this period.

In 1983 he moved to Delft, The Netherlands, becoming Professor in Exploration Geophysics at the International Institute for Aerial Survey and Earth Sciences (ITC). Here he took charge of postgraduate and MSc courses in exploration geophysics for students almost exclusively from Africa, Asia and Latin America. Some 250 students, including over 50 research MScs, passed through his division over 20 years, many now holding senior positions in their own countries.

He continued with consulting work, mainly in Africa and India, as part of his ITC duties and then, in 1991, accepted an invitation from the Government of Australia to head the geophysical mapping programme of the Australian Geological Survey Organisation (now Geoscience Australia) during a two-year leave of absence, 1991-3. In Canberra he supervised, *inter alia*, the production of the first magnetic and gravity anomaly images of all Australia. He also initiated the digital compilation of all aeromagnetic data for the whole of Africa (AMMP), Arabia, India and the Middle East (AAIME) from his ITC base, 1989-1999.

After returning to the Netherlands in 1993 he was elected as head of the Delft Location of ITC and then, in 1996, to the chairmanship of the Department of Earth Resources Surveys. He served internationally as chairman of Division V (Instruments, Observatories, Surveys and Analyses) for the International Association for Geomagnetism and Aeronomy (IAGA) from 1995 to 1999. He was for many years an active member (including chairman, 1991 to 1995) of IAGA's working group *Magnetic Anomalies, Land and Sea*, culminating in the first edition of the Magnetic Anomaly Map of the World in 2007. He has published widely on geophysical mapping and its contribution to understanding geology and regional tectonics. He has hands-on experience of most countries in sub-Saharan Africa through visits or student projects and has retained active contacts with leading geoscientists in India through visits and international projects there since 1985. He took early retirement from ITC in 2004 after the institute left Delft.

He set up Earthworks BV in 2001 and through it has undertaken advisory work on many projects where the combination of geology, paleo-geographic reconstruction, regional geophysical interpretation and digital cartography can deliver new insight. Ongoing research to understand better the geology and tectonics of the southern continents has focused on the detailed sequence of fragmentation of Gondwana. This has included a long association with Cambridge Paleomap Services in Cambridge, UK and early exploitation of new tectonic information coming from ocean-floor topographic data released in 1997. While initially inspired by a wish to achieve a more convincing assembly of Gondwana's Precambrian elements, the consequences of refined Mesozoic fragmentation models in the development of sedimentary basins along the new passive margins and within internal rifts have generated commercial interest.

He has also taken active part in large, aid-sponsored geophysical mapping programmes to support new mineral exploration initiatives in Mozambique, Madagascar, Uganda and Nigeria since 2000. New local knowledge feeds the global model – and *vice versa*. He sees the development of such holistic, GIS-based approaches to geology and tectonics in a plate-tectonic framework as an important concept for advancement in the earth sciences in the years ahead. He follows closely the emergence of initiatives such as *OneGeology*, *Dapple* and the *GIRAF* initiative for Africa. He contributes to *AfricaArray* through an honorary professorship at the University of the Witwatersrand and is an associate of *AEON* (the Africa Earth Observatory Network) at the University of Cape Town.

In 2009 he delivered one of the two Association Lectures at IAGA's 11th Scientific Assembly in Sopron, Hungary in August. He chose as his topic *Geomagnetism and Exploration of Global Geology*. (The video may be watched at <http://media.iaga.ggki.hu/a11.html>). He also gave the opening presentation at the 'Africa' meeting of the Geological Society of Houston/PESGB in London in September 2009. He has encapsulated lessons from his Gondwana studies into a two-day workshop that has been given at various locations in Africa, Europe and North America since 2005. (<http://www.reeves.nl/upload/AfricanGeodynamicsBrochure.pdf>).

Colin still lives in the old centre of Delft and works from an independent office nearby.

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