Living Africa

Oceans - Resources - Climate

Goals

- linking ocean and continent processes from sedimentation histories
- linking sedimentation to tectonic uplift and subsidence
- changes in climate: upwelling dynamics and continental aridity
- ocean current dynamics: Agulhas rings and Benguela upwelling
- hydrocarbon generation and migration: methane seeps
Marine Cenozoic Record

Precambrian - Jurassic

Thin Cenozoic cover on the margin

Orange Basin

SA Petroleum Agency
Project 3.1  Generation and migration of natural gas

Gesa Kuhlmann
Rolando di Primio
Douglas Paton
Dave van der Spuy
Brian Horsfield

GFZ – UWC - UCT
PASA
Petro SA
De Beers marine

Data Set: 6,000 km 2D seismic profiles, 12 oil wells in shelf area (<500m water depth)

Isopach Map modified from Seranne & Anka (2005) after Emery et al. (1975)
Evidence of gas-seepage and mud-volcanoes (Ben-Avraham et al., 2002)

Methane flux – gas hydrates – energy resource - climate
Seismic profile showing seepage of gas from the subsurface into the Atlantic Ocean

Active kitchen area generating HC

Migration pathway along stratigraphic horizons

3D petroleum systems model
Gas flux over geologic timescales – climate
100 Mt methane flux since Jurassic in southernmost part of the Orange Basin
High-amplitude reflections may correlate to black shales of Ocean Anoxic Event 3 (80-90 Ma)
Gas leakage – Seismic expression

Crater-like gas escape structure within Tertiary sediments
HC generation & migration at present day
Living Africa – Capacity building

3-DAY SHORT COURSE
Basin Modelling and Petroleum Systems evolution

By Dr. G. Kuhlmann and Dipl.-Geophys. K. Hirsch,
GeoForschungsZentrum Potsdam, Germany

COURSE OUTLINE:

Part I (Day 1, October 17th)
A) Lecture:
   - Basin classification
   - Basic concepts and definitions
   - Geodynamic rift models
   - Subsidence analysis controlling factors: crustal structure
     faulting, temperature, deposition, compaction,
     - Internal deformation
   - Backstripping: geohistory analysis, implications for heat flow
B) Exercise
   - Backstripping

Part II (Day 2 and 3, October 18th-19th)
A) Lecture:
   - Principles of basin modelling
   - The Conceptual Model
   - Boundary conditions
   - Calculation of compaction, heat flow, fluid flow
   - Model calibration
B) Exercise
   - PC exercise on 1D and 2D Modelling
     a) Setting up a 1D/2D Model
     b) Simulation, calibration
     c) Interpretation: Burial history, Thermal history, Maturation history
Project 3.2  Seismic stratigraphy of the South African margin
Gabriele Uenzelmann-Neben and Philip Schlüter - AWI

Agulhas Passage - Antarctic Bottom Water
Ocean circulation - Climate

Uenzelmann-Neben et al., Fig.1
Evolution of ocean currents since the Cretaceous

Schlüter and Uenzelmann-Neben (2007)
High-resolution palaeo-record since Pliocene climate transition – Int. Ocean Drilling Program proposal
Project 3.3  Neogene palaeoceanography
John Compton, Caren Herbert, James Wiltshire, Rochelle Wigley, Livuhwani Maake - UCT

Marine – terrestrial connections

- aridification
- Orange River discharge
- upwelling
- wind
- Agulhas Rings - heat transfer
- Cenozoic climate: Wet and warm to Cool and dry
- Continental Uplift & Erosion
- Changes in sea level
- Heat transfer
- Orange River discharge
- Wind
- Agulhas Rings - heat transfer
Late Cenozoic evolution of the margin

Compton and Wigley (2004; 2006)
Western Margin

Interglacial (Holocene) highstand records

Shelf storage of terrigenous mud and organic carbon
Orange River Terrigenous Mud Flux

Pre-dam flux (1930-1969) = 49 million tons/yr (comparable to Cretaceous/Paleogene flux)

1980-1990 flux = 17 million tons/yr (trapping of sand and coarse silt by dams)

Mean Holocene flux = 6 million tons/yr

Indicates an approximate 8 fold increase in sediment flux to the western margin (Bremner et al., 1990)
Soil Erosion

Dongas (gullies) – weathered bedrock + colluvium (Pleistocene valley fill) erosion

Agriculture – loss of top soils

Rain + relief = sediment factory

Drakensberg escarpment
Caren Herbert PhD – Holocene mudbelt
Sub Tropical Convergence
Deep Water circulation
Sub Tropical Convergence
upwelling
Southern Ocean Productivity

Nutrient (P, Fe) supply from continental sources

Dust and lateral (deep water) advection
Project 3.4  Past precipitation patterns in South Africa
Hedi Oberhansli, Heinz Wilkes, Tim Partridge  GFZ - WITS

Tswaing Lake
Coring site

25°24′ S, 28°04′ E

crater diameter: 1130 m
lake diameter:  ~ 300 m
depth:  < 3 m

Sea surface temperatures – monsoon – orbital cycles
Terrestrial records - speleothems – dune activity
BioArchive Tswaing Crater

Biomarker study of the modern and fossil ecosystem and the influence of climate change

Cyanobacteria

Lake Productivity

- Bacteria
- Dinofl.
- Algae

C17-Alkane
17-Alkene
17-Alka-diene
IS


