A Snapshot of Deltaic and Basement Tectonics at a Former Accretionary Margin, NW Borneo

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Deltaic and Basement Tectonics, NW Borneo

- tectonic setting
- horizontal stress orientations
- vertical stress magnitudes
- prograding deltaic tectonics
NW Borneo Tectonic Setting

Metcalfe (1996)
NW Borneo Tectonic Setting

- Late K-early TT subduction of oceanic crust of proto-South China Sea: Crocker Rajang accreted
Brunei Cross-Section

Sandal (1996)
Brunei Cross-Section

Sandal (1996)
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Australian Earth Sciences Convention July 2006, Melbourne
Maximum Horizontal Stress Orientation

(a) Breakout

(b) DITF

$\sigma_{hmax}$

$\sigma_{hmin}$

$0.5 \text{ m}$

$0.25 \text{ m}$
Applications of Present-Day Stress Data

- seal integrity
- naturally fractured reservoirs
- wellbore stability
- sand production
- reservoir drainage
- fracture stimulation
- EOR/flooding

Risk of Breakout

$\frac{C_o}{\sigma_v}$
BUT in Brunei present-day stress orientations are not consistent with the observed structures.
Champion Field Blowout, 1979, Inner Margin

CP-141 Blowout Schematic

Seabed blowout

NW-SE Fracture Created

Initially Normally Pressured Reservoirs

Open Borehole

Overpressured Reservoirs
1979 blowout crater

NW-SE blowout fractures

1974 surface eruption and crater under platform

1974 surface eruption

NW-SE blowout fractures

1974 line of craters

1000 m
Shale Dykes in Jerudong Anticline Confirm Miocene-Pliocene Stress Rotation in Inner Shelf

Miocene: $S_{Hmax}$ margin-parallel

Pliocene: $S_{Hmax}$ margin-normal
Brunei Stress Evolution

Outer Margin
Sparker Seismic

Champion
Blowout

Jerudong
Shale Dykes

Breakouts
Drilling-induced
tensile fracs
Quality:
A
B
C
D

0 km 25

Brunei
Active Normal Faulting, Outer Margin

15m high fault scarp on sea floor

Hiscott (2001)
Brunei Stress Evolution

- $S_{Hmax}$
- margin-parallel
- margin-normal

Legend:
- Breakouts
- Drilling-induced tensile fracs
- Quality: A, B, C, D

Scale: 0 km 25 km

Brunei
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Vertical Stress Magnitude

- vertical stress exerted by overburden load
- evaluated from density and checkshot sonic log data
- commonly assumed to be 1.0 psi/ft in Tertiary deltas (22.63 MPa/km or average density of 2.3 g/cm³)
- Brunei shows greatest recorded lateral variation in vertical stress
Sv Gradients at 1500m Depth

Sv Low
0.8 psi/ft
ρave 2.07 g/cm³

Sv High
1.1 psi/ft
ρave 2.48 g/cm³

Cross-section
Sandal (1996)
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- Miocene-Recent inner shelf: deltaic growth faulting-related, margin-parallel stress rotated to basement-controlled margin-normal stress
- Miocene-Recent outer shelf: deltaic toe-thrusting, margin-normal stress rotated to deltaic growth faulting-related, margin-parallel stress
- Progradning deltaic tectonics driven by basement-controlled uplift in a collisional margin
- Vertical stress increases proximally due to basement-controlled uplift
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