The Banda Arc, "Spice Islands"
Banda Arc

- Horseshoe-shaped double “arc”
  - Outer Arc, larger islands (largest Timor and Seram), continental, NO ophiolites
  - Inner, active volcanic arc (Banda or Spice Islands)
  - Weber Deep between Inner and Outer arcs, at area of greatest curvature

- Over 10km relief from deepest Weber Deep to highest mountains in Outer Arc

- 16,209 line km 2D broadband data
  - Indonesia
    - BandaSeis Phases I, II & III
    - BandaSeis Phase V
  - Timor Leste
    - BandaSeis Phase IV

- The interpretation of this dataset advances our understanding of the tectonic mechanisms that shaped the region and highlights potential implications this may have on petroleum systems
Water Depths
Geological Evolution
Tectonic Setting

- At least since Jurassic, close to relatively magma-poor continental margin
- Jurassic crust of the Argo Abyssal Plain currently being subducted beneath the Java Trench
- Present complex geology results from two opposing tectonic forces: N movement of Australian Plate (MOR far to the S) and sinistral shear on Greater Sorong Fault System (plate boundary)
- Timor at leading edge of collision with Indonesian island arc; GPS measurements confirm part of Australian Plate
Primary petroleum systems are:

- Jurassic
- Triassic
- Permian
  - “Find the Plover” – the principal exploration target is the deltaic and marginal marine Lower to Middle Jurassic Plover Formation
- Triassic offers new and potentially important target for the area
- The existence of several adjacent multi TCF gas fields and the abundant deep-water seeps attest to active petroleum systems across the study area
Proterozoic sutures are the fundamental control for later structural features

The Covalima Sub-basin (newly recognised offshore Timor Leste) genetically related with Flamingo Trough and Vulcan Sub-basin

These basins opened during the Triassic in a sinistral transtensional environment

Regional shear zone NNE-SSW extending from the North West Shelf to the Timor area

This complex shear zone was active during the Late Triassic and later, inducing sinistral transtension in the whole region, initiating opening of most of the Jurassic basins
Tectonic Setting
(Robert Hall)

- Banda embayment became aligned with Java trench at ~17 Ma; subduction zone propagated rapidly E
- Progressive rollback of the Banda subduction zone into embayment
- System jams
Timor Deformation

- Normal subduction to 10 Ma
- Contraction 10–5.5 Ma
  - includes metamorphism
- 1 m.y. aseismic hiatus
- 4.5 Ma and ongoing
  - Doming (rebound)

UWA published and ongoing work
Timor Uplift

Nguyen et al. 2012
Timor Fold and Thrust Belt
Constraints from Seismic 1
Constraints from Seismic 2
Timor Trough: strike slip faults (ongoing)
Timor Orogen

- Normal subduction to 10 Ma
- Contraction 10–5.5 Ma
  - Includes metamorphism
- 1 m.y. aseismic hiatus
- 4.5 Ma and ongoing (onshore):
  - Strike slip deformation
  - Doming (isostatic rebound)
- 4.5 Ma and ongoing (offshore):
  - Gravitational fold-and-thrust belt
  - Strike slip deformation
(Offshore) Timor Fold and Thrust Belt

Poynter et al., 2013 WABS
Petroleum Systems
Abundant seeps attest to the presence of an active petroleum system with onshore seeps in Timor Leste tied to Jurassic and Triassic sources.

**Source**
- Jurassic restricted marine oil source with mixed kerogen (Wai Luli shale)
  - Lower-Middle Jurassic gas-prone fluvio-deltaics (~Plover)
- Upper Triassic to Lower Jurassic sequence (Aitutu and Babulu)

**Reservoir**
- Late Triassic and Early–Middle Jurassic shallow marine siliciclastics (Babulu, Wai Luli sandstones, and equivalents of the Malita and Plover in the Bonaparte Basin)
Petroleum Systems 2

- **Seal**
  - Intraformational seals at several levels

- **Trap**
  - Structural - horst blocks, tilted fault blocks, fault-propagation folds

- **Plays**
  - Inversion anticlines, roll-over anticlines, fault blocks
  - Closures below the Timor Orogenic wedge
    - Adjacent Jurassic source rocks would not be buried deep enough to be over-mature
    - Reactivated normal faults terminate near the décollement surface (~top seal)
Maturity Considerations

Belalang-1

Napoleon-1
Raksasa Mud Volcano

P. Baillie, 2008 – presentation at AAPG International Conference, Cape Town, RSA

Noble et al., 2009
Raksasa Regional Context
South Banda Prospectivity
Jurassic Thickness
Example Lead

Play Elements
Trap: Rotated Fault Block
Reservoir: Middle Jurassic (Plover Fm) sandstones
Seal: Middle Cretaceous claystones
Source: Middle Jurassic (Plover Fm) shales
Water Depth: 2,450 m
Area and Depth: 166 km² and 1,635 mBML

Risk Considerations
Trap: 0.65
Reservoir: 0.70
Seal: 0.70
Source: 0.60
POS: 19%
Key Issues: Source maturity and trap
Summary
South Banda Summary

- Banda Arc geology complicated – contraction resulting from ongoing arc/continent collision
- Strong indications of working petroleum system(s)
  - Onshore and deep-water oil seeps, satellite slicks
- Past exploration (in part) hampered by imaging problems resulting from geological complexity
- Broadband acquisition and modern processing techniques have revealed much of the previously-hidden geology
- Onshore field-based studies helped unravel details of the Neogene collision
- Significant exploration opportunities, similar to Bonaparte Basin
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Rappart, 1885 – Bandanaira
Thank you