Somaliland
Untested Plays Revealed by TGS Data

Felicia Winter, Africa and Middle East
Roberta Masotti, Geological Products and Services
Finding Petroleum, Finding Oil and Gas in Sub Saharan Africa, 25 June 2018
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Study Area

Is Yemen's Conjugate Ready?
Somaliland. Untested Plays Revealed by TGS Data - Content

1. Where are we?

2. Why re-enter Somaliland?


5. Offshore - What does that mean for the Prospectivity?
   → Insights based on TGS 2D regional Seismic

6. Onshore Airborne Magnetics - Implications for the onshore Potential.

7. Summary.
Where are we? (1/7)
Geological And Structural Map Of The Gulf Of Aden

Onshore Geology

Ali and Watts, 2016
Onshore Geology – Offshore Gravity

Bouguer Anomaly offshore compared to Geology onshore (EFA project, Ed Purdy)

+ Grid map blurred for Confidentiality reasons+
Why re-enter Somaliland? (2/7)
Under-Explored

Several exploration plays with world class potential remain to be tested.

Exploration History

Zeila-2 Dry
Zeila-1 Dry
Zeila-3 Dry
Heemaal-1 Tight
Dagah Shabel-1 Technical Discovery
Dagah Shabel-2 Oil shows
Dagah Shabel-3 Oil shows
Las Dureh-1 Dry
Bur Dab-1 Dry
Yaguri-1 Dry
Las Anod-1 Dry
Biyo Dader-1 Oil shows
Offshore Seismic GECO

Bandar Harshau-1 Oil and Gas shows
Dab Qua-1 Oil and Gas shows
Faro Hills-1 Dry
Buran-1 Conorada - Spudded 1958 TD 312m - Basement Dry
Hedad-1 Conorada - Spudded 1957 TD 2437m - Basement Dry

Nagal-1 Oil and Gas shows
Kalis-1 Oil and Gas shows
Shabeel-1 Oil and Gas shows
Darin-1 Gas shows

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Shows In Somaliland And Conjugate Yemen

- Bandar Harshau-1 Oil shows in Upper Jurassic Wanderer Lst., Cretaceous Jesomma Sst.
- Dab Qua-1 Oil and Gas shows in Cretaceous/Paleocene Limestones
- Shuhayr Oil Field, Sayhut Basin Oil in Eocene Carbonates
- Sharmah Oil Field Discovered 1982 Oil in Eocene Carbonates
- Biyo Dader-1 Oil shows
- Dagah Shabel-3 Oil shows in Upper Jurassic Wanderer Lst., Cretaceous Jesomma Sst.
Why Somaliland?

1) Yemen, the conjugate margin, is producing hydrocarbons

2) Evidence for hydrocarbons on- and offshore Somaliland
   • Seeps onshore
   • Shows in wells onshore and offshore (gas and oil)
   • Coastal basin structures
   • Structural traps throughout Jurassic, Cretaceous and Tertiary
     (in place for maturation and migration)

3) Let’s piece the story together and target more confidently
Recent Activity

New government → kick start exploration activity offshore

Genel / BGP acquiring the Seismic

RakGas / BGP planned seismic acquisition (blocks 9 and 12)

Drilling planned (2019) by Genel (Oodweyne block, west)
Structural Framework (3/7)
TGS Data Used For Structural And Prospectivity Interpretation

- 5,323km 2D seismic (6-10km spacing, coverage: 21,500km², 6km streamer, 10s record length)
- 2 offshore wells (1 control well: Bandar Harshau-1)

2.5km line spacing
- small scale structures <1.5km width
- depths <0.5km resolvable

25km line spacing
- basement >5km well resolved

Min. 100km offset (NW)
- maximum depth 17km resolved
Sub-basins and highs, regional NW-SE trend

Central plateau, older basement structures.

NW-SE trend, Nogal Basin. suggested rift arm dashed lines.
Petroleum System (4/7)
Petroleum Systems

**Tertiary Petroleum System:**
- Eocene
- Miocene
- Miocene Bandar Harshau Group: clastics, carbonates
- Eocene Taleh anhydrite
- Interbedded shales and mudstones

**Mesozoic Petroleum System:**
- Jurassic Bihen, Gahodleh, Daghani Group
- Cretaceous Jesomma shale
- Jurassic Adigrat
- Cretaceous Jesomma/Tisje
- Paleocene Aurado Formations
- Miocene Bandar Harshau Group: clastics, carbonates
- Eocene Taleh anhydrite
- Interbedded shales and mudstones

Modified from Ali and Watts (2016)
Trap Types Related To Late Jurassic and Oligo-Miocene Rifting

Structural Traps:

- tilted fault blocks and drag folds
- flower structures (strike-slip movements)
- horsts and grabens

Stratigraphic Traps:

- syn-rift infill clastics with updip-pinchoout
- ponded turbidites
- post-rift slope and basin floor fan
- carbonates buildups

Combination traps:

- Syn- & post-transform transpressional anticlines
Petroleum System Events Chart

Critical Moment
(everything falls into place)
Structural And Play Summary Offshore

Sub basins delineated and controlled by converging fault systems (on Basement map, TWT)

- Cretaceous rotated fault blocks (500-750m Water)
- Transpressive en echelon (200-700m Water)

Neogene stratigraphic plays (<750m Water)

- Pull apart Tertiary basins
- Cretaceous/Eocene horsts (<500m Water)

Basement Map in TWT

+ Grid map blurred for Confidentiality reasons+
Potential Plays (Gravity Syn-rift Model For Underlying Crust)

- Tertiary slope fans
- Cretaceous rotated fault blocks

Transitional crust and sediment fill
Play Example Roll Over Anticline

Transpressive structures
Source Rock Evaluation (Near Rollover Anticline Trap) – Pseudowell Offshore

Good temperature calibration with the crustal stretching model ( Calibration well Bandar Harshau-1). Vitrinite calibration done with Dab Qua-1.

Modelled Source Rocks (Upr. Cretaceous, Lwr. Tertiary) are currently in the Oil window, and started expelling Mid Miocene.

Maximum heat at present day (for Basement/Syn-rift levels), reaching 270°C.
Play Example Oblique Strike - AVO Anomaly

Slope fan class II/III AVO in Oligo-Miocene syn-rift (up to ~200km²)
Bandar Harshau Basin (Eastern) Example

Oligo-Miocene pull-apart basin

Oligo-Miocene syn-rift

Cretaceous Pre-rift
Onshore – Potential (6/7)
Aeromagnetics Onshore – Geological Domains Of Interest

1. High amplitude, high frequency pattern.  
W-E trending densely clustered small scale features, most likely shallow.  
→ Possibly Miocene Volcanism over Rift Basins

2. Low amplitude, low frequency pattern.  
NW-SE trending continuous regional features.  
→ Possible Halfgraben as offshore E and NE

3. Variable amplitude, high and medium frequencies  
W-E trending superimposed small and large scale features.  
→ Possibly Basins with intra-basinal fault related structures and traps  
  Nogal Rifting WNW-ESE trends (E of survey)
Aeromagnetics Onshore – Domain #1

High amplitude, high frequency pattern.

W-E trending densely clustered small scale features, most likely shallow

→ Possibly related to Miocene Volcanism

→ Possibly Rift Related Basins
Aeromagnetics Onshore – Domain #2

Low amplitude, low frequency pattern. NW-SE trending features.

→ Likely onshore set of halfgraben as in continuation offshore N and NE
Aeromagnetics Onshore – Domain #3

Variable amplitude, high and medium frequencies.
W-E trending superimposed small scale and large scale features.

- Deep regional structures, possible Jurassic rift basins (Nogal)
- Offsets by NW-SE strike-slip faulting (Nogal Rifting trend)

→ Intra-basinal fault related traps

Modified from Okoli (2016)

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Variable amplitude, high and medium frequencies.

W-E trending superimposed small scale and large scale features.

- Deep regional structures, possible Jurassic rift basins (Nogal)
- Offsets by NW-SE strike-slip faulting (Nogal Rifting trend)
- Intra-basinal fault related traps

**Note:** The deep basin structures onshore seem to follow the same trend as the pull-apart en echelon basins (oblique rifting offshore).

En echelon structures in Water Depths of 200-700m
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7. Summary.
1. Conjugate to Yemen (producing fields)

2. Hydrocarbon evidence
- onshore seeps
- oil/gas shows onshore
- oil/gas shows offshore

3. Rift basin regimes
- Mesozoic rift onshore
- Tertiary rift offshore

4. Tested source rocks
- Jurassic
- Cretaceous
- Eocene/Miocene

5. Prospectivity offshore showcased
- Rotated fault blocks (A)
- Transgressive structures (B)
- Stratigraphic plays
- Seal and overburden in place
- AVO brightening of slope fans
- Traps in place for expulsion

6. Onshore potential is promising
a) Halfgraben structures
b) Basins with fault related traps

+ Grid map blurred for Confidentiality reasons+
Thank you

NOTE
To see the high resolution seismic, gravity and magnetic data or for any further enquiries please contact us directly at:
(Email)  AMEsales@tgs.com
(Tel.)    +44208 339 4200