Mesozoic Salt Diapirism in Southeastern Bahamas as Evidenced by Geophysics*

Allan Spector¹, Samuel A. Epstein², and David Schieck³

Search and Discovery Article #30352 (2014)**
Posted August 18, 2014

*Adapted from oral presentation given at 2014 AAPG Annual Convention and Exhibition, Houston, Texas, April 6-9, 2014
**AAPG©2014 Serial rights given by author. For all other rights contact author directly.

¹Columbus Pillow Exploration Company (Bahamas) Ltd, Long Island, Bahamas (24aspector@gmail.com)
²Geoval Consulting LLC, Queens, New York, US
³Seismic Solutions, Cochrane, Alberta, Canada

Abstract

For several decades, Bahamas has intermittently attracted interest for hydrocarbon exploration. Only 6 test wells had been drilled, encountering thick upper Mesozoic and Cenozoic carbonates which, for the most part, are almost barren in hydrocarbon content. Because of the great depth to the older rocks; 3 to 4 km, these rocks were hardly drill tested. To the west, in Cuba, Jurassic and older strata have produced over 60,000 barrels of oil per day. Cuba currently has proven reserves of 181 million barrels of oil. Analyses of gravity, magnetic, and processed seismic data in southeastern Bahamas provide independently clear evidence for the presence of Jurassic salt diapirism. The interpreted diapir is adjacent to a deep rift basin that may be a principal source of hydrocarbon generation. That basin has a drainage area of over 9000 sq km and a thickness of over 12 km. It appears to be part of a Triassic-Jurassic rift that extends southeast from Florida. In the vicinity of the interpreted diapir, calculations of thermal maturity from well log analysis validate the possibility of hydrocarbon generation and expulsion from the Middle Jurassic to the present.

Selected References


Mesozoic Salt Diapirism in SE Bahamas as Evidenced by Geophysics

The Columbus Pillow Project

Allan Spector, Columbus Pillow Exploration Company (Bahamas) Ltd
Samuel Epstein, Geovalve Consulting LLC. New York
David Schieck, Seismic Solutions, Cochrane, Alberta

AAPG Paper 9/4/2014
Principal Geological Reference;

S.A. Epstein and D. Clark (2009)

Hydrocarbon Potential of Mesozoic Carbonates of the Bahamas

in

CARBONATES and EVAPORITES V24, No2, p97-138
Nassau

Varadero

CP Project (Permit area)

Buried under 2 to 5 km of Younger sediments; A Triassic-Jurassic SYN-RIFT

Sunniland Trend

Oil Pool

Repsol 2004 DRY 6200m

Zarubezhneft 2013 DRY

1. Long Is #1, 5351m
2. Doubloon Saxon #1, 6631m
3. Cay Sal #1, 5763m
4. 826-Y, 4720m
5. Great Isaac #1, 5440m
6. Andros#1, 4446m
7. DSDP 98, 3136m

Bahamas Tests (1947-1986)

CUBA

60,000bpd

181 million bbl reserve 2012)

L Cretaceous and Jurassic rocks

CUBA

60,000bpd

181 million bbl reserve 2012)

L Cretaceous and Jurassic rocks

CUBA

60,000bpd

181 million bbl reserve 2012)

L Cretaceous and Jurassic rocks

CUBA

60,000bpd

181 million bbl reserve 2012)

L Cretaceous and Jurassic rocks
Significance of a Syn-Rift Basin*

- can contain organic-rich sediments (hydrocarbon source rocks)
- Major salt deposits and structures; Gulf of Mexico, Brazil, etc
- high heat flow, contributing to higher source rock maturation
- Excellent reservoir rocks in sands (erosion of basin flanks)

Jurassic Salt Diapirism; Offshore Nova Scotiα*, GoM

* Monnier, Colletta & McBarek (2010)
Buried under 2 to 5 km of Younger sediments; Triassic-Jurassic RIFT BASIN (Epstein and Clark, 2009)

**Bahamas Wells**
1. Long Is #1, 5351m
2. Doubloon Saxon #1, 6631m
3. Cay Sal #1, 5763m
4. 826-Y, 4720m
5. Great Isaac #1, 5440m
6. Andros#1, 4446m
7. DSDP 98, 3136m

**CUBA**
- 60,000 bpd
- 181 million bbl reserve 2012
- L Cretaceous and Jurassic rocks

**Repsol 2004 DRY 6200m**
**Zarubezhneft 2013 DRY**
GETTY(1980) CONCEPTUAL CROSS-SECTION*

DETACHMENT ZONE ← SYN-RIFT

CUBA ← BAHAMAS

COLLAZO No. 1 GAYO-COCO No. 2

OLD BAHAMA CHANNEL

GETTY LICENSE AREA II

TERTIARY

TOP LOWER CRETACEOUS

UPLSSTONES, SUCROUS DOLOM & ANHYDRITE BEDS)

POSSIBLE OIL SOURCE ROCKS (DARK CAR SHALES)

SALT

SALT diapir

5350m

EAST

LONG IS. No. 1

SEA LEVEL

GRABEN

*Epstein and Clark (2009)
Compilation of Geophysical Data for Columbus Pillow Project

2. 1982 LD marine survey gravity data NW of Long Island
3. 1984 UTIG marine survey magnetic data in Exuma Channel
4. 1998-2011 land gravity measurements by Spector in the Bahamas
5. 1998 Terraquest aeromagnetic survey of Long Island
6. 2012 re-processing of 1982-84 UTIG & LD marine seismic data
Long Island gravity & aeromagnetic surveys

Long Island #1 1970 well to 5355 m

-30mgal Columbus Pillow Gravity Anomaly CPGA

1998 gravity survey

10km

Magnetic contact / fault

2011 gravity survey

Aeromag flight lines

Thickness of section in kilometers
Aeromagnetic Survey Data (1998)

Intense 400 nT magnetic anomaly observed at north end of island. It originates at a depth of 14 to 15 km.

Magnetic intensity

400nT

10nT

NW

SE

Fault?

Magnetic Zone

CPGA

PreMesozoic basement

Migration channel?

Long Is #1
5355 m

C1
PROPOSED Long Is #2

COLUMBUS PILLOW GRAVITY ANOMALY

MAGNETIC BASEMENT

Louann Salt?

3km thick “pillow”, depth 5km

Dolomitization?

Migration channel

Gulf-Chevron, 1970 Wildcat well

5351m

GRABEN

INFERRED GEOLOGY

PRE-MESOZOIC basement

C1

Magnetic zone

C2

Regional Gravity

BoGUEUR GRAVITY

30 mgal

NNW Cat Island

ocean

Columbus Point

Long Island

Long Island #1

South End

Columbus Pillow

FAULT

PROPOSED Long Is #2
Columbus Pillow Gravity Anomaly
(onshore measurements; 1998-2011)

Contour interval; 2mgal

-30 mgal
Marine Seismic surveying (1982-84)

Cat Island

LDGO1982

UTIG1984

CP Permit

Exuma

Long Island
UTIG Seismic line es-18

NW
Processed* UTIG seismic data

* D. Schieck (2012) using DISCO software

Exuma Sound

3.5 km/sec

5 km/sec

1.8 km

1.2 km

2.0 km

5 km

SP1

K₁

J

T, K

Tr?
Seismic prospect; SP1
EXUMA SOUND RIFT
“DEPO ZONE”

SP1 & CPGA; A SALT DIAPIR

-60 mgal

-30 mgal

5 mgal contours
MAGNETIC DATA ANALYSIS

Magnetic basement depth determination in kilometers

Magnetic contact
Composite Geophysical Interpretation;
gridacy+magnetic+seismic

Exuma Sound Rift

- Prospective traps above and adjacent to the diapir
- Salt makes for excellent trap SEALs!

12+ km sedimentary section
THERMAL MATURITY in LONG IS #1 WELL

Lopatin Diagram

**Vitrinite Reflectance (%Ro)**

- IMMATURE
- EARLY MATURE (OIL)
- MID MATURE (OIL)
- LATE MATURE (OIL)
- MAIN GAS GENERATION

**Jurassic oil**
Production starts
100 to 120 my ago

**Barren rocks**

Present

Jurassic oil Production starts
100 to 120 my ago
SUMMARY of FINDINGS

1. **Diapiric salt structure** (Columbus Pillow = -30mgal gravity) revealed in gravity and seismic data, at depth of 5 km, localized by magnetic graben structure

2. Favorable **hydrocarbon generation** conditions. in Lower Cretaceous and Jurassic rocks from vitrinite analysis

3. Indication of the Exuma Basin Depo Center a 12 km thick sedimentary section, NW trending, 100 km long Contains **thick salt interval** (-60 mgal gravity)

Allan Spector; 24aspector@gmail.com