Mesozoic Salt Diapirism in Southeastern Bahamas as Evidenced by Geophysics*

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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

Hansen, A.D., 2014, A surprising asymmetric paleothermal anomaly around El Gordo diapir, La Popa Basin, Mexico: AAPG Bulletin, v. 98/2, p. 213-226.

Epstein, S.A., and D. Clark, 2009, Hydrocarbon Potential of Mesozoic Carbonates of the Bahamas: Carbonates and Evaporites, v. 24/2, p. 97-138.

Talwani, M.K., 1960, Gravity anomalies in the Bahamas and their interpretation: Unpublished Ph.D. Thesis, Columbia University.

Mesozoic Salt Diapirism in SE Bahamas
as Evidenced by Geophysics

The Columbus Pillow Project

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Samuel Epstein, Geovalve Consulting LLC. New York

David Schieck, Seismic Solutions, Cochrane, Alberta

AAPG Paper 9/4/2014

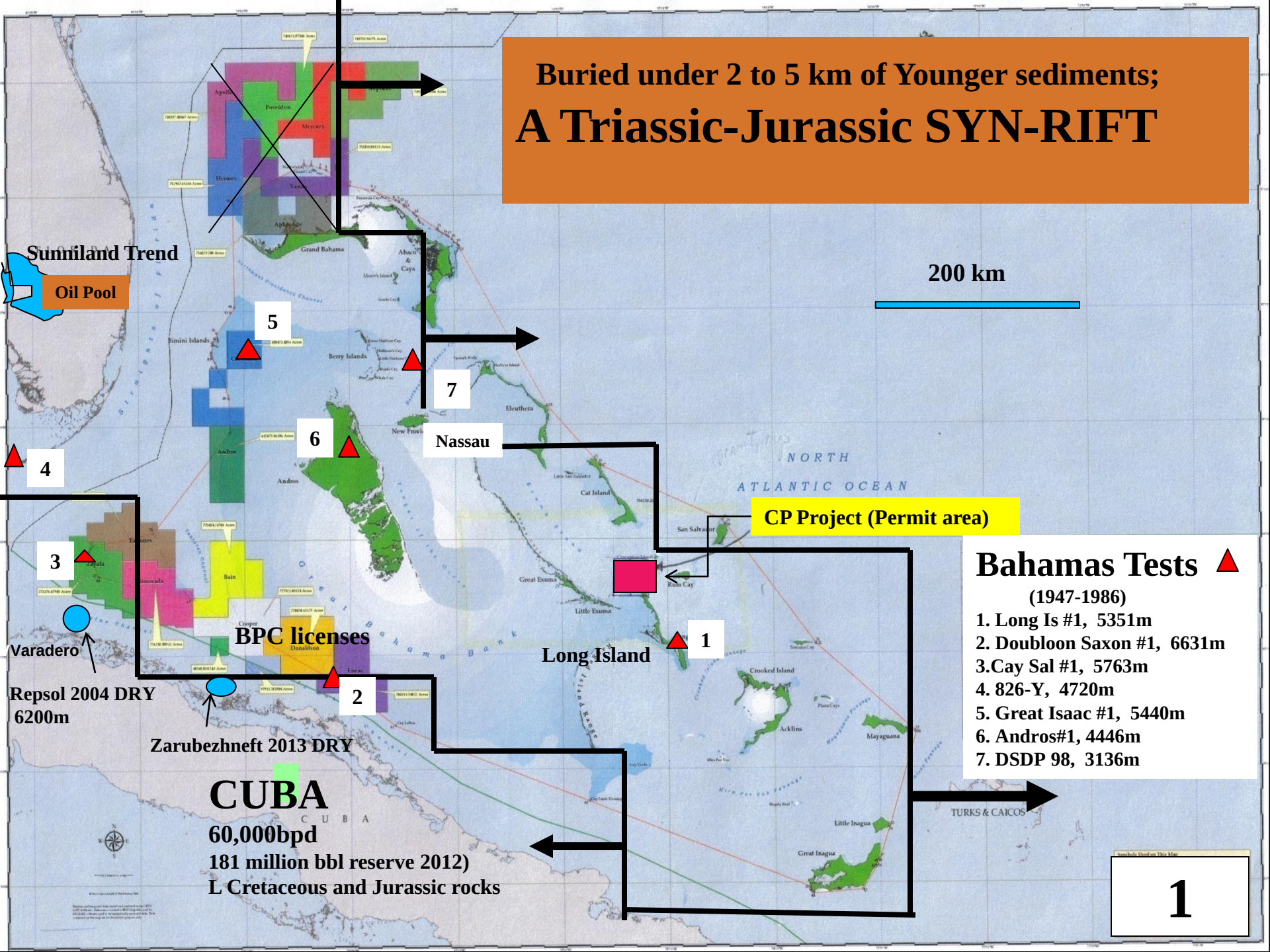
Principal Geological Reference;

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

Hydrocarbon Potential of Mesozoic Carbonates of the Bahamas

in

CARBONATES and EVAPORITES V24, No2, p97-138


Buried under 2 to 5 km of Younger sediments;
A Triassic-Jurassic SYN-RIFT
Sunniland Trend
Oil Pool
200 km
5
7
6
4
Nassau
CP Project (Permit area)
3
BPC licenses
Varadero
Repsol 2004 DRY
6200m
2
Zarubezhneft 2013 DRY
Long Island
1
CUBA
60,000bpd
181 million bbl reserve 2012)
L Cretaceous and Jurassic rocks
Bahamas Tests
(1947-1986)
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
NORTH ATLANTIC OCEAN
TURKS & CAICOS
1

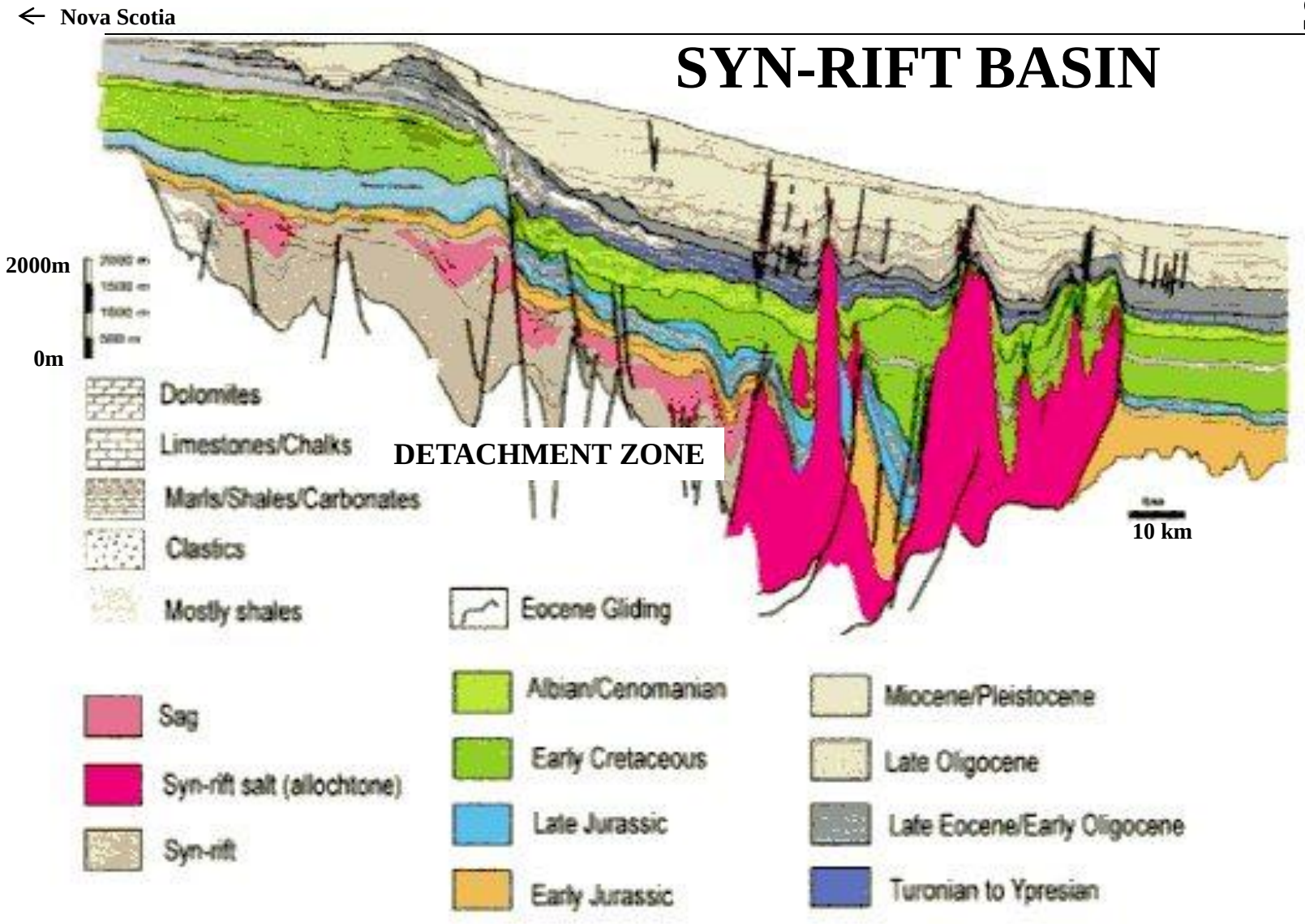
Significance of a Syn-Rift Basin*

- 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)

1a

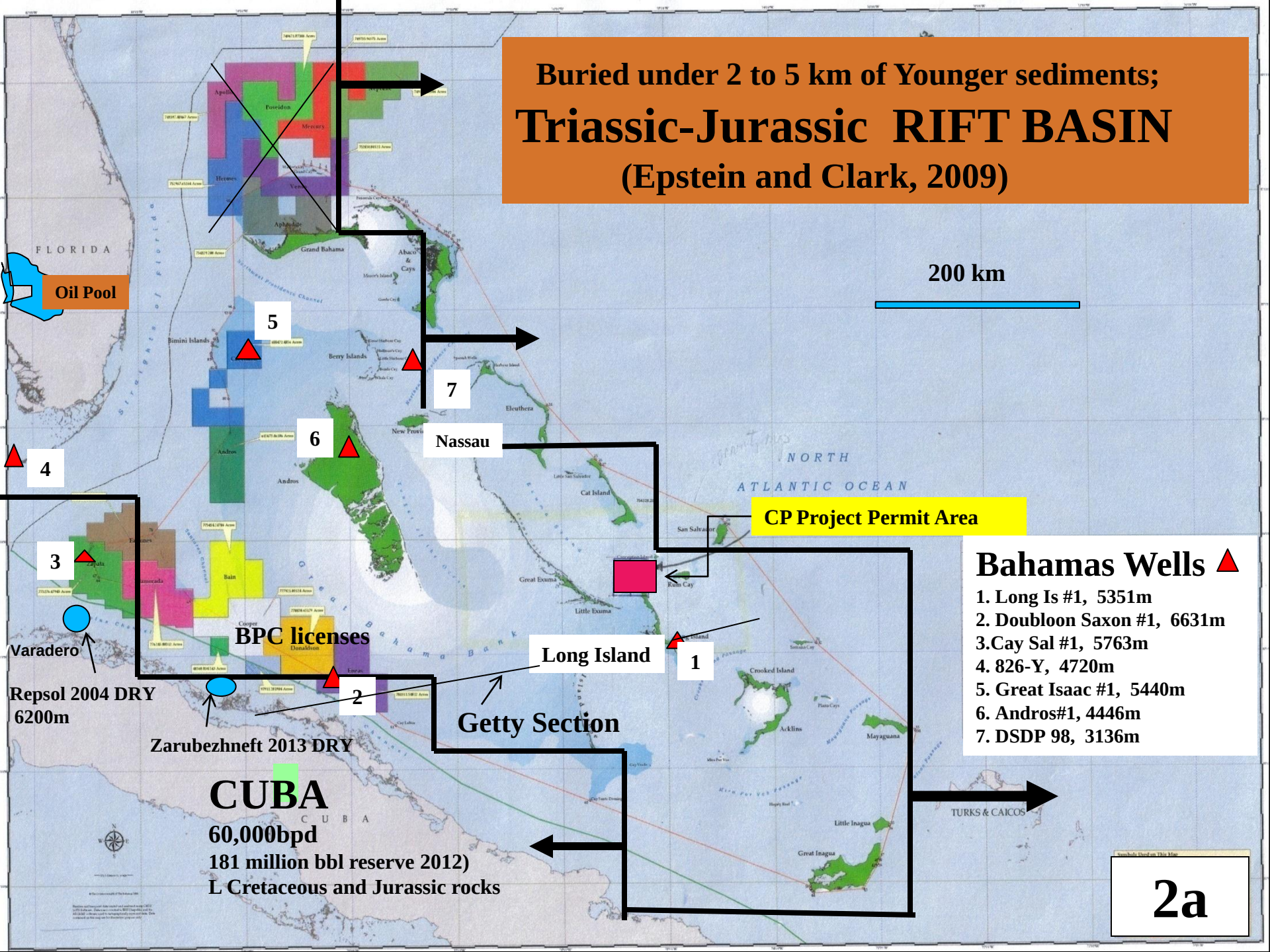
*Hansen (2014) AAPG Bull.v98,No2 pp213-226

Jurassic Salt Diapirism; Offshore Nova Scotia*, GoM



* Monnier, Colletta &Mcbarek (2010)

1b


Buried under 2 to 5 km of Younger sediments;
Triassic-Jurassic RIFT BASIN
(Epstein and Clark, 2009)
200 km
FLORIDA
Oil Pool
5
7
6
4
3
2
1
Nassau
CP Project Permit Area
BPC licenses
Long Island
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60,000bpd
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NORTH ATLANTIC OCEAN
Bahamas Wells
1. Long Is #1, 5351m
2. Doubloon Saxon #1, 6631m
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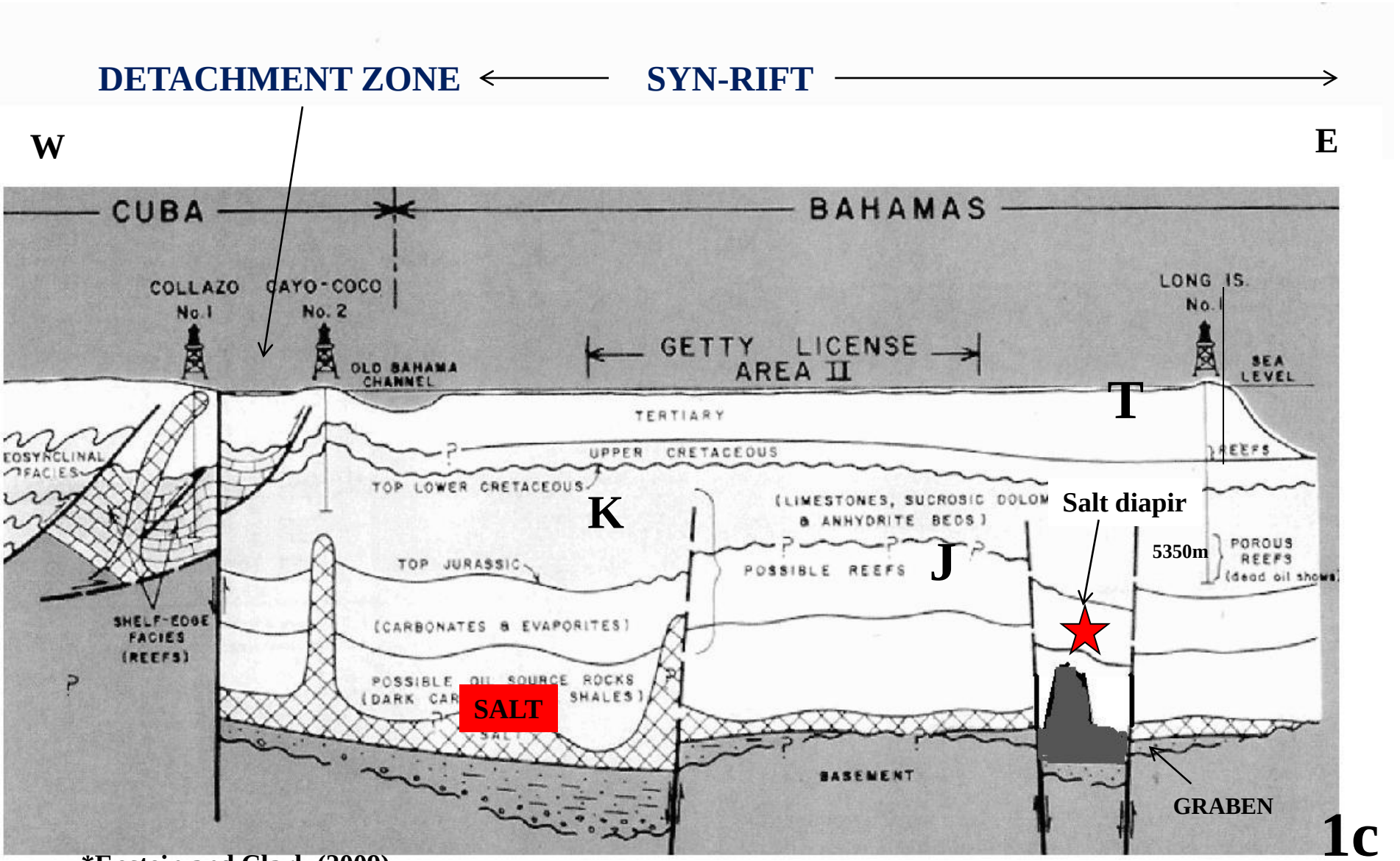
4. 826-Y, 4720m
5. Great Isaac #1, 5440m
6. Andros#1, 4446m
7. DSDP 98, 3136m
TURKS & CAICOS
2a

GETTY(1980) CONCEPTUAL CROSS-SECTION*



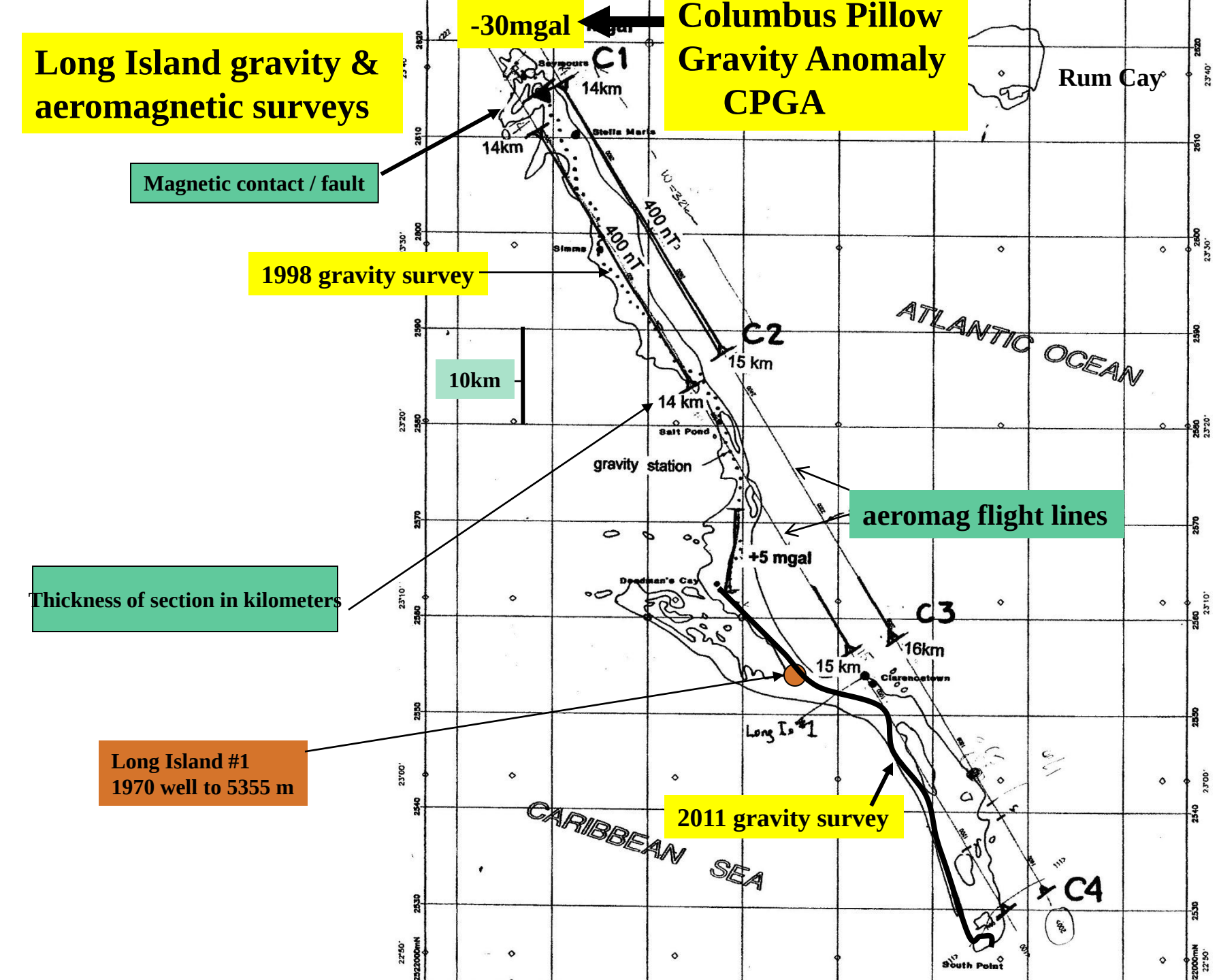
1c

*Epstein and Clark (2009)

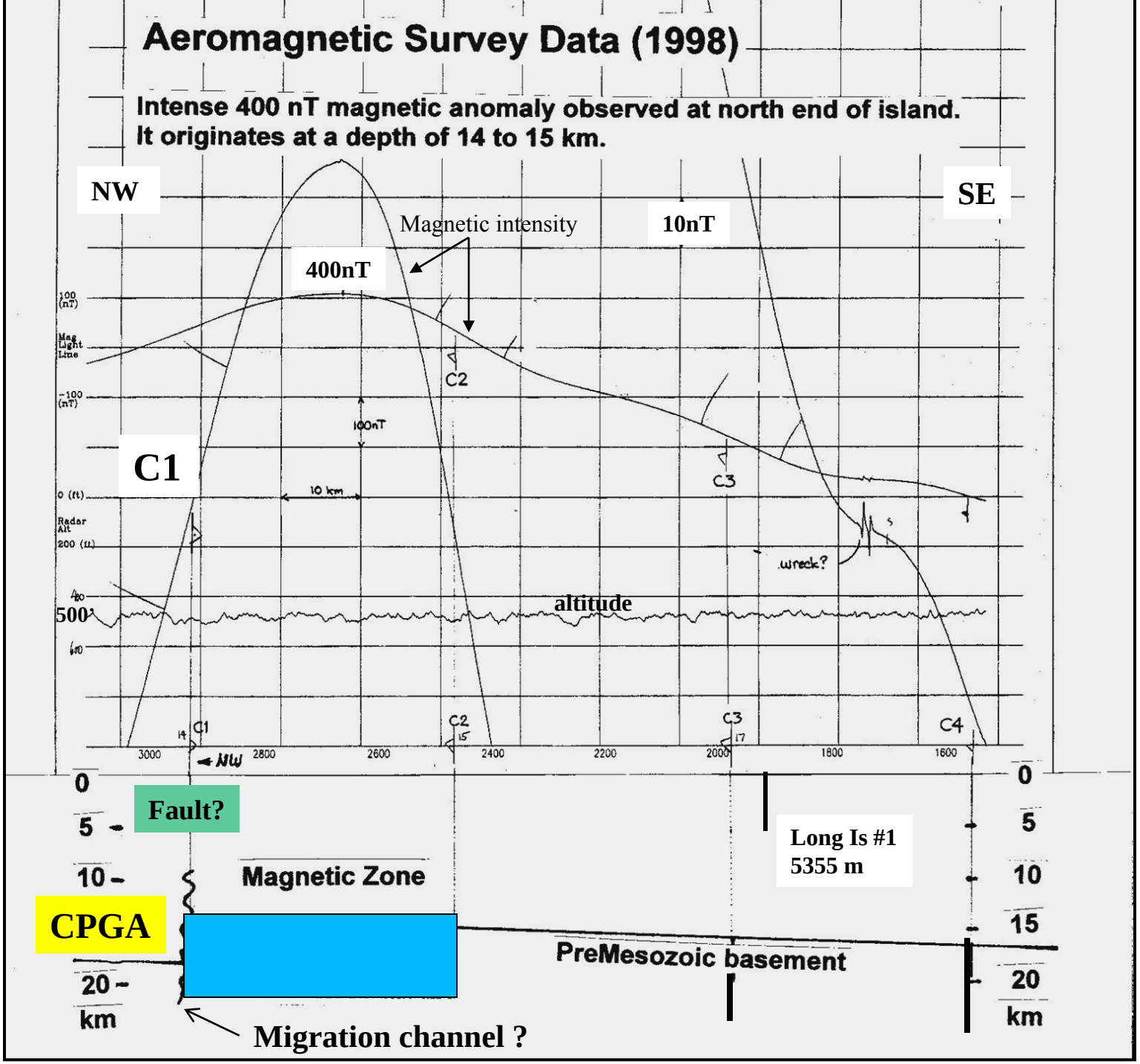
Compilation of Geophysical Data for Columbus Pillow Project

1. Pre-1960 marine gravity data (Talwani PhD Thesis, 1960) of Bahamas
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

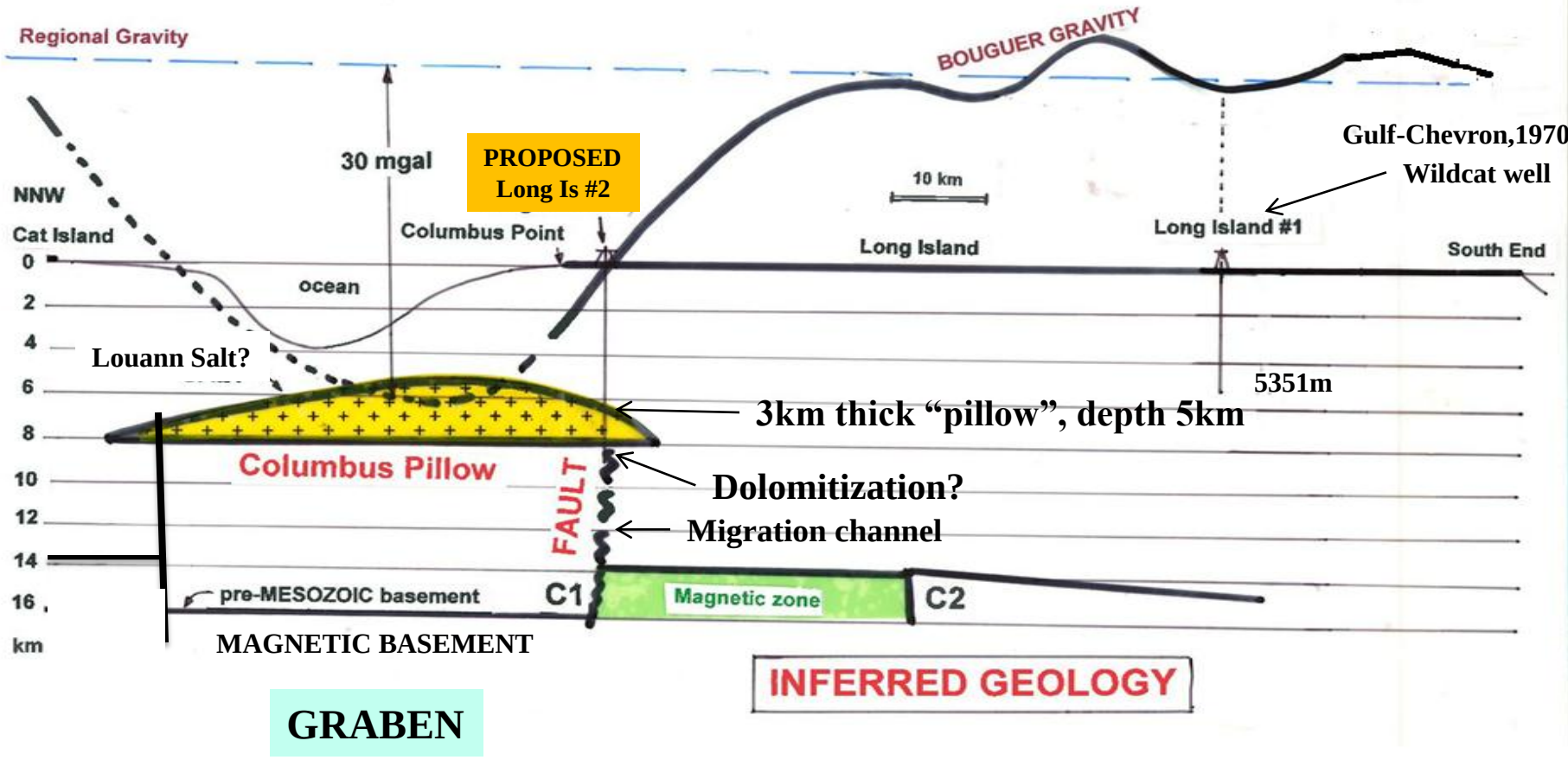


2c


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.
NW
SE
Magnetic intensity
10nT
400nT
C1
C2
C3
C4
100nT
10 km
wreck?
altitude
500
Fault?
Magnetic Zone
CPGA
Long Is #1
5355 m
PreMesozoic basement
Migration channel ?
km

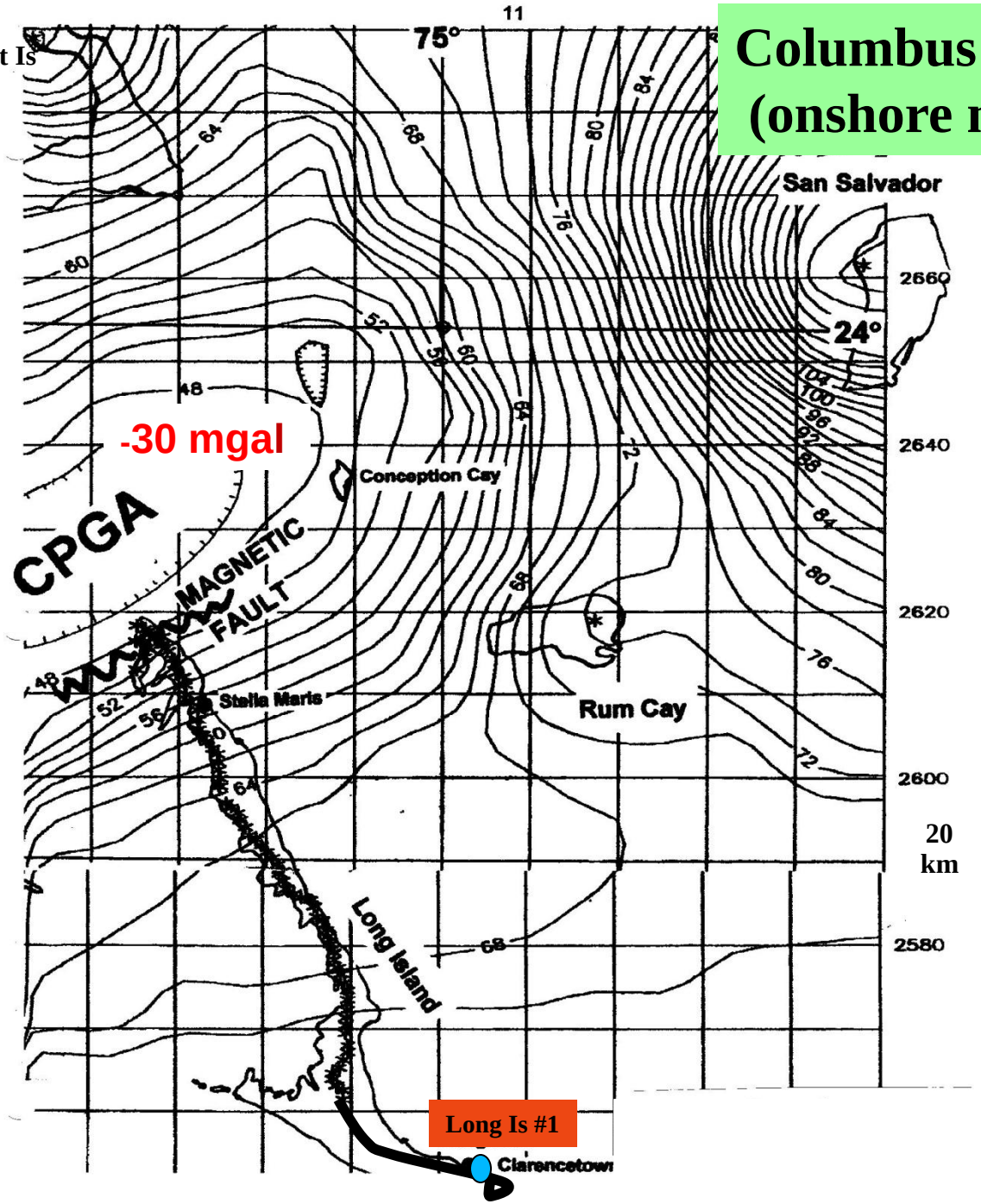
2d

COLUMBUS PILLOW GRAVITY ANOMALY

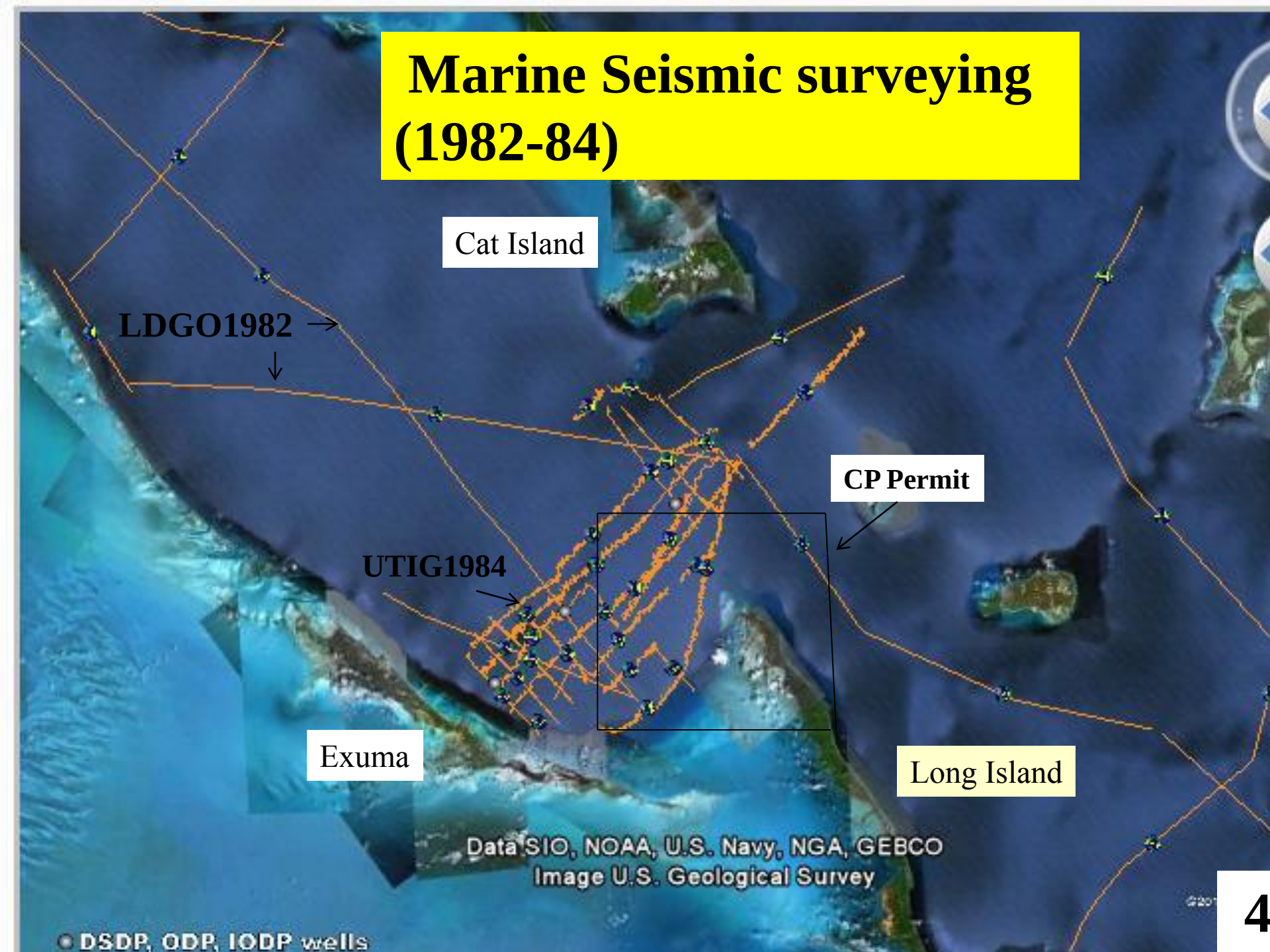


2e

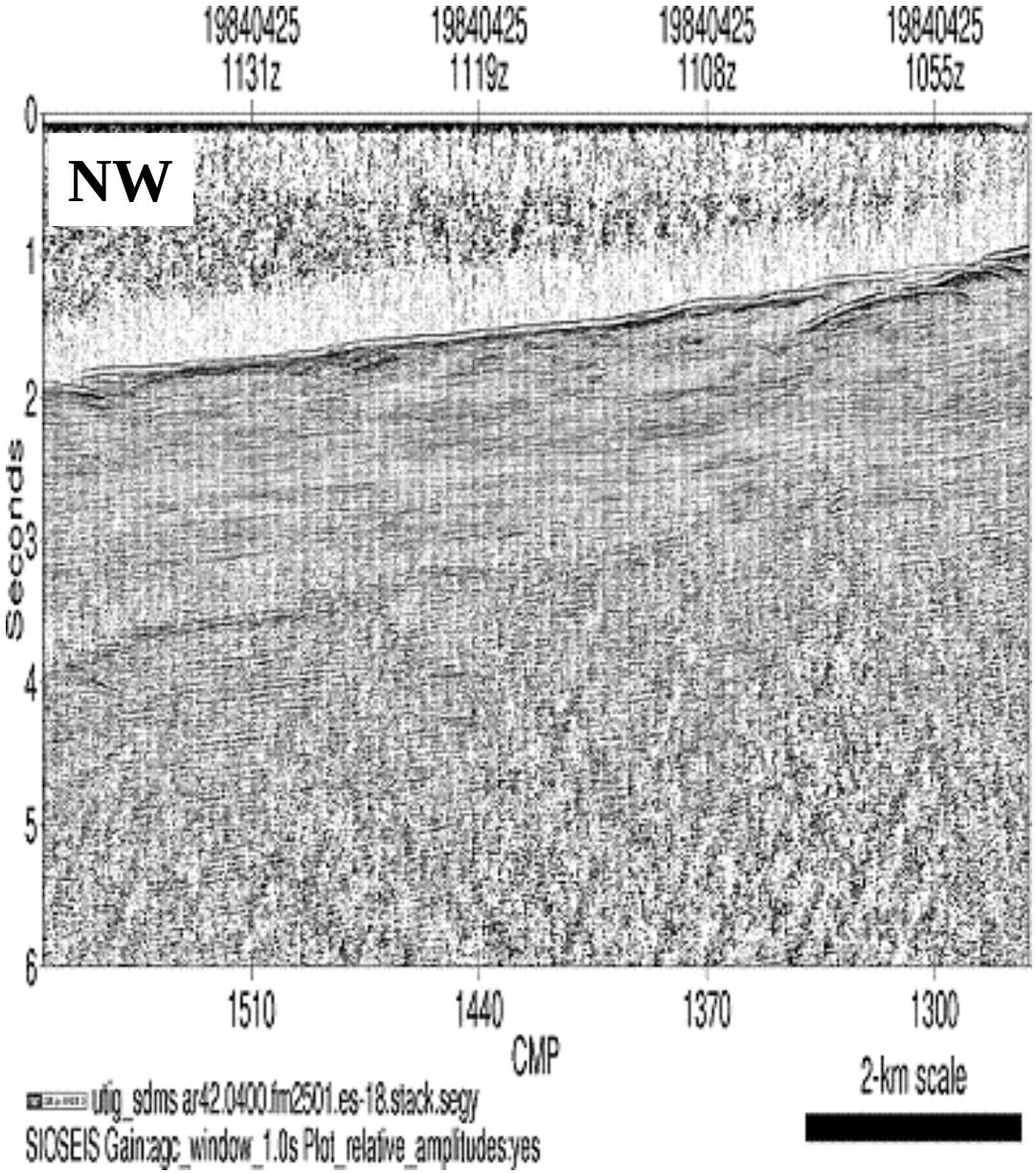
Columbus Pillow Gravity Anomaly (onshore measurements;1998-2011



Contour interval; 2mgal


Marine Seismic surveying (1982-84)
Cat Island
LDGO1982
CP Permit
UTIG1984
Exuma
Long Island
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey
DSDP, ODP, IODP wells
4

UTIG Seismic line es-18

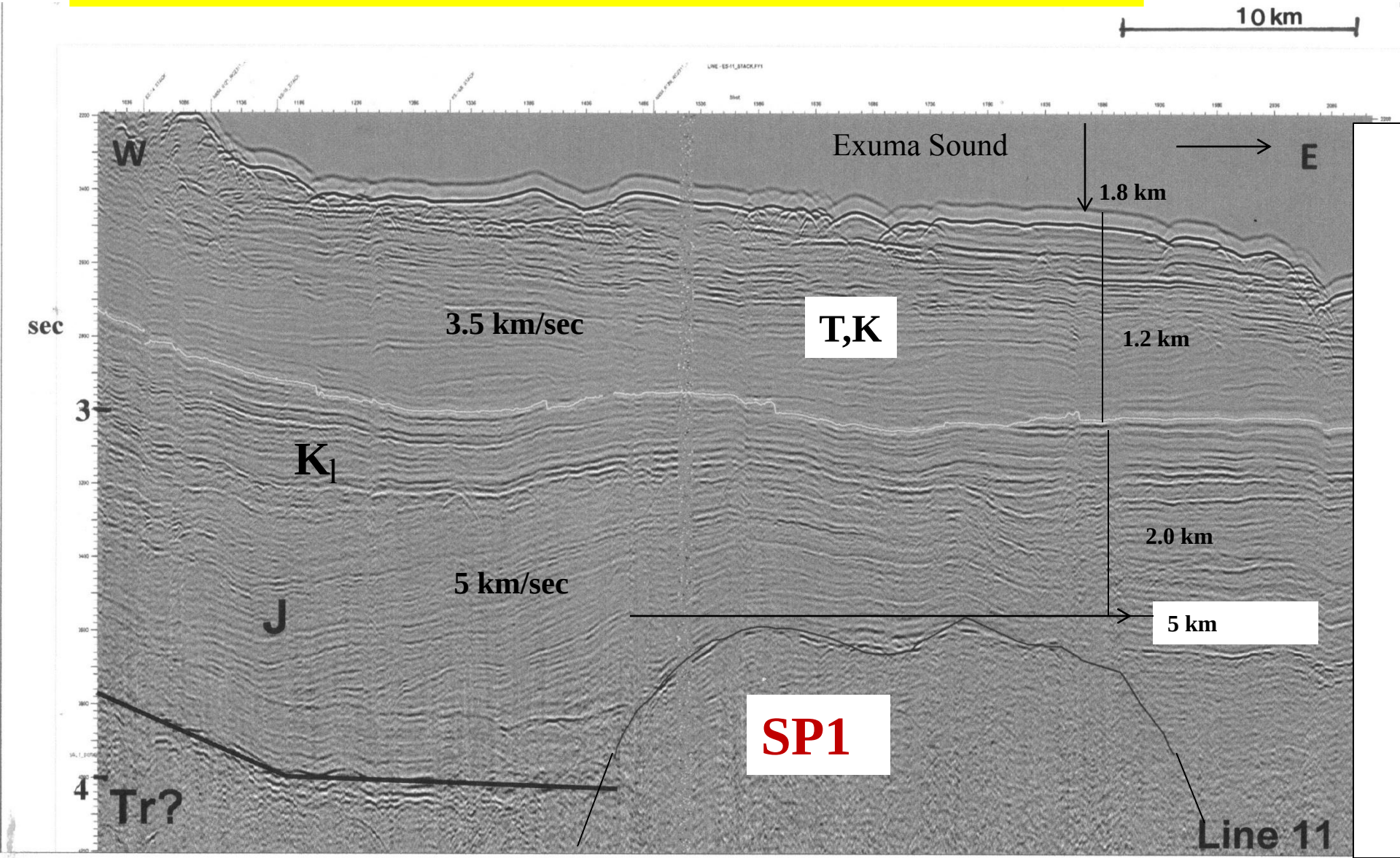


4a

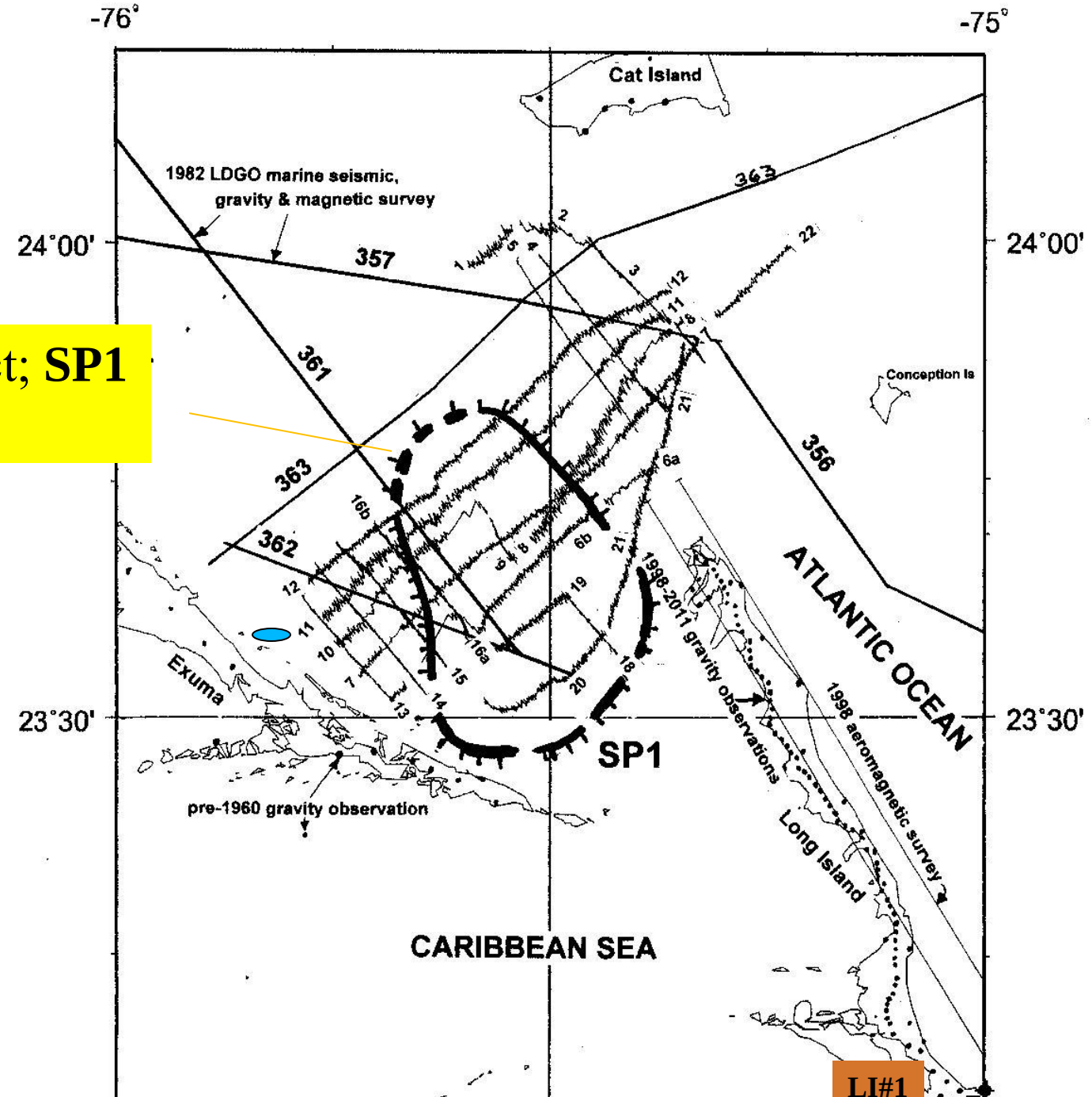
Processed* UTIG seismic data

4b

* D. Schieck (2012) using DISCO software

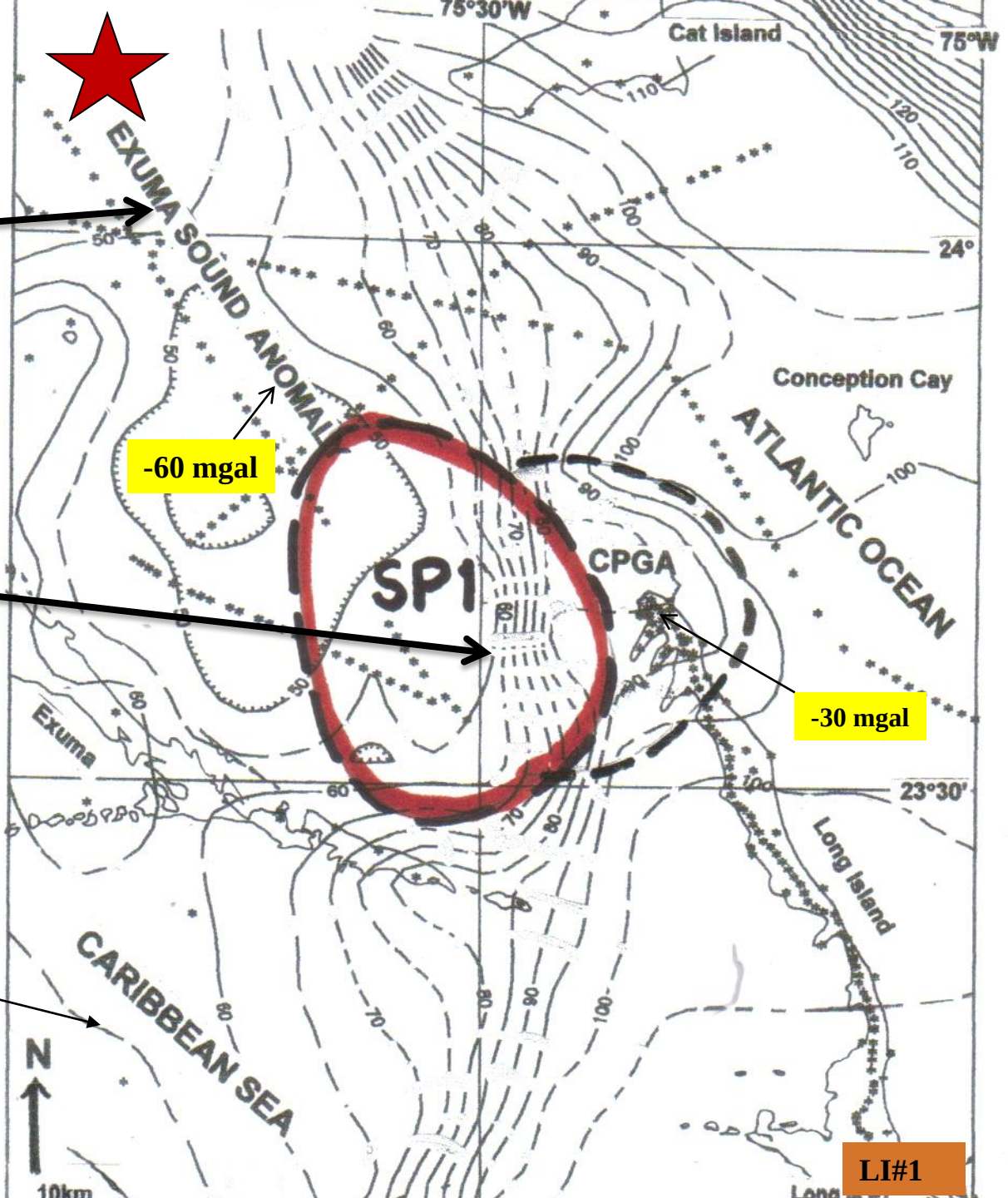


Seismic prospect; **SP1**



EXUMA SOUND RIFT
"DEPO ZONE"

SP1 & CPGA;
A SALT DIAPIR



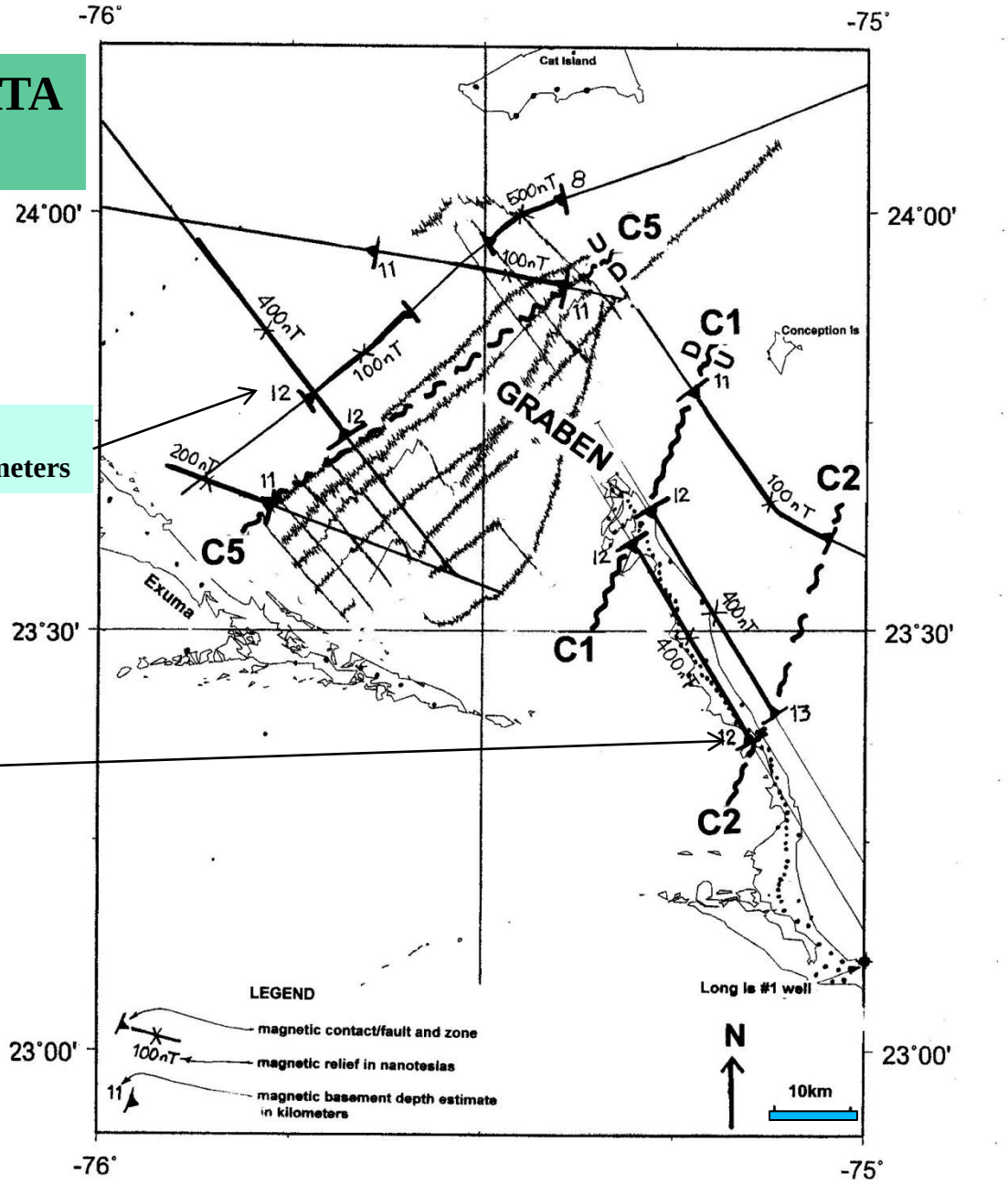
5 mgal contours

5b

MAGNETIC DATA ANALYSIS

Magnetic basement depth determination in kilometers

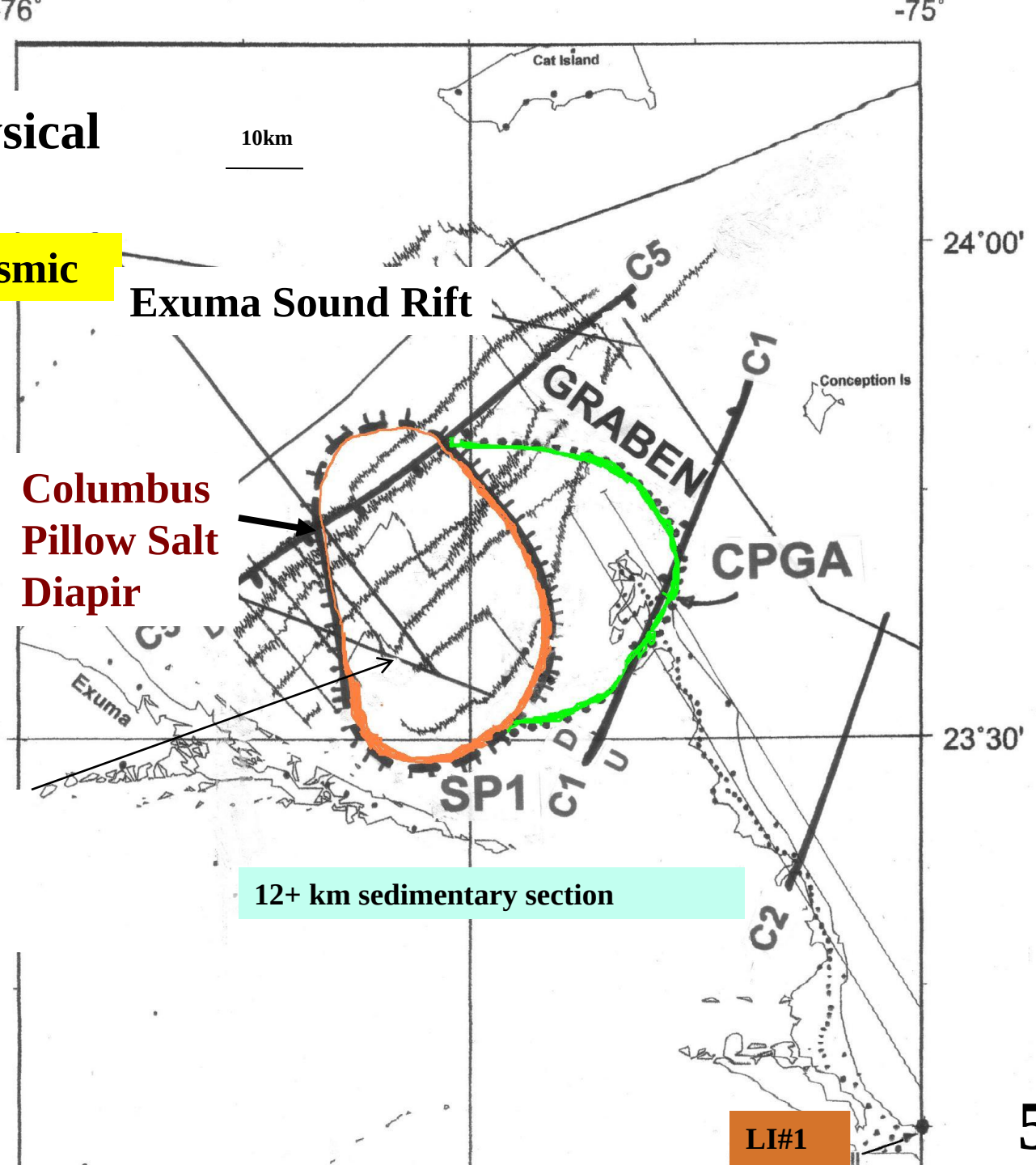
Magnetic contact



5c

Composite Geophysical Interpretation;

gravity+magnetic+seismic



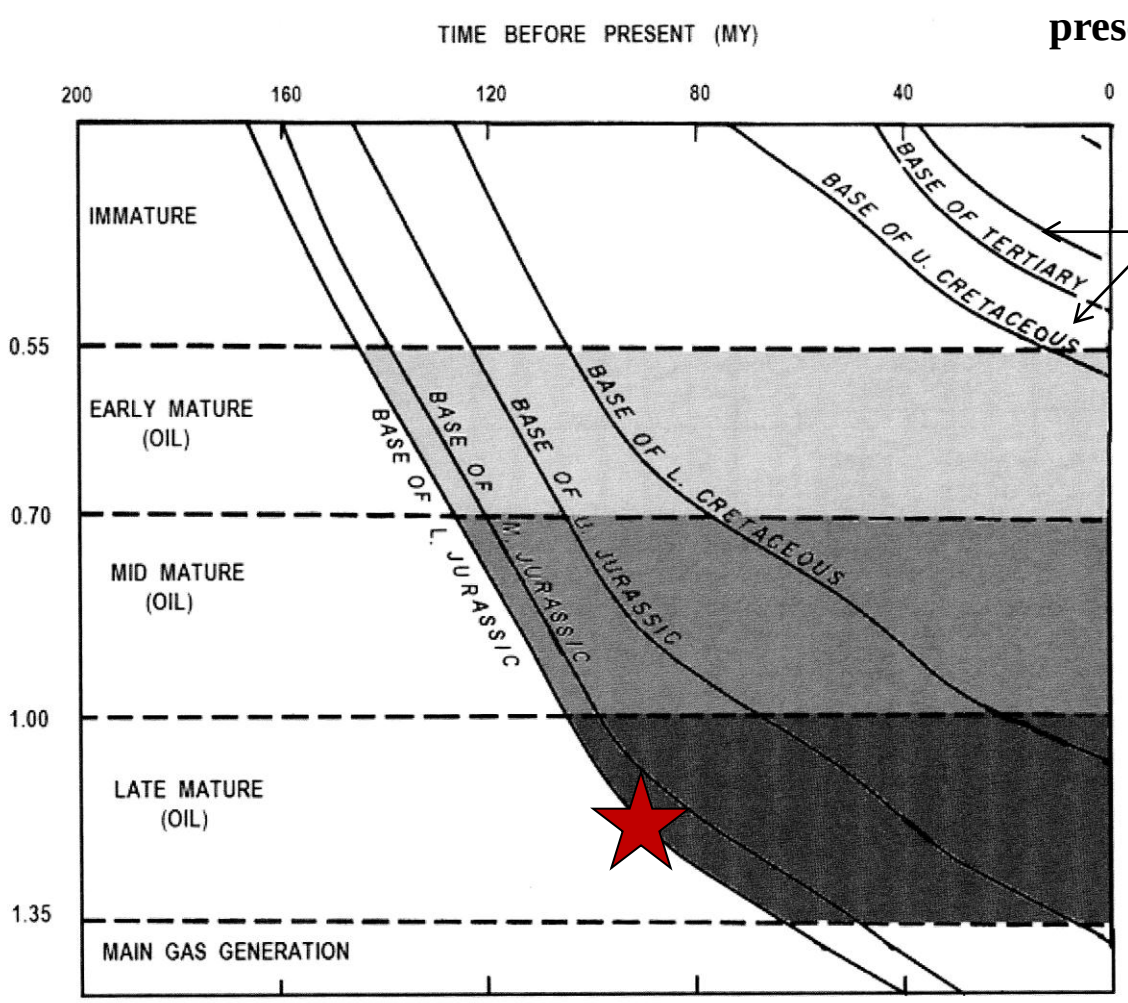
- **Prospective traps above and adjacent to the diapir**
- **Salt makes for excellent trap SEALS!**

5d

THERMAL MATURITY in LONG IS #1 WELL

Lopatin Diagram

Vitrinite Reflectance (%Ro)



Barren rocks

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)**

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