History of Petroleum Exploration in Trinidad and Tobago*

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Abstract

Petroleum exploration in Trinidad and Tobago began in 1857 and was based on seeps, but currently uses sophisticated techniques like integrated basin analyses, petroleum systems concepts and 3D seismic. Initial prospecting based on seeps commenced in the 1850's, and continued until 1905. During this phase, prospectors drilled on the basis of proximity to the pitch lake or oil seeps and found two fields which were never developed.

Prospecting on the basis of seeps gave way to a more scientific approach as geologists began to be employed. They did mapping to look for anticlines, armed only with the traditional geological tools of a hammer and compass/clinometer. On this basis, all the major land fields in Trinidad had been discovered by 1920. They have produced more than 1.5 billion barrels of oil to date.

The second oil province was discovered in 1954 by geologists who postulated extensions of land trends into the offshore. Together these offshore fields have produced over one billion barrels of oil. Exploration started off the East Coast of Trinidad in the late 1950's. This resulted in the discovery of three giant oil fields and a series of large gas and condensate fields. 2D seismic was run in the late 1960's followed by exploration drilling along the "Patao High" which resulted in the discovery of over 10 TCG.

Exploration entered a new phase in 1979 with the recognition of the Cretaceous age of the source, concepts of the plate tectonic history and geochemical studies which allowed integrated basin histories and the identification of eleven "petroleum systems". Research from 1989 onwards resulted in the concept of evaporative fractionation of oil which successfully predicted deep residual oil. BPTT's recent (2013) 3D ocean bottom cable seismic revealed deep structures (below the shallow gas), which may hold deep black oil.

BHP Billiton discovered a major oil and gas field within the Central Range Transpressive Zone Lower Oligocene sands. The field has produced over 60 million barrels of oil to end of 2015. The exploration focus has turned recently to the ultra-deep waters off the East coast where BHP Billiton and BGTT ran the world's largest single 3D seismic survey in 2015.

Selected References

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HISTORY OF PETROLEUM EXPLORATION IN TRINIDAD AND TOBAGO

By

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&
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AAPG ICE
Cancun Mexico
September 6-9 2016

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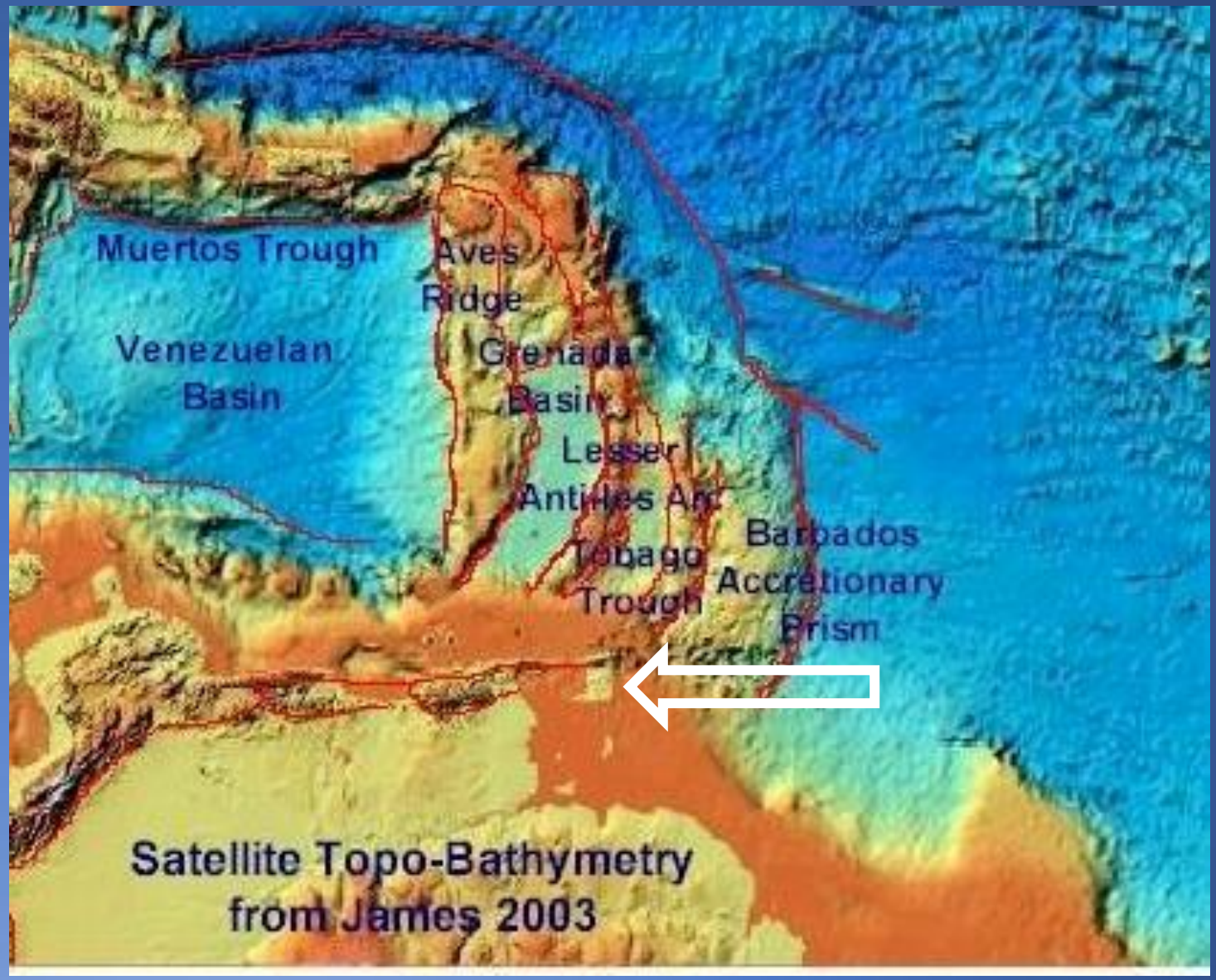
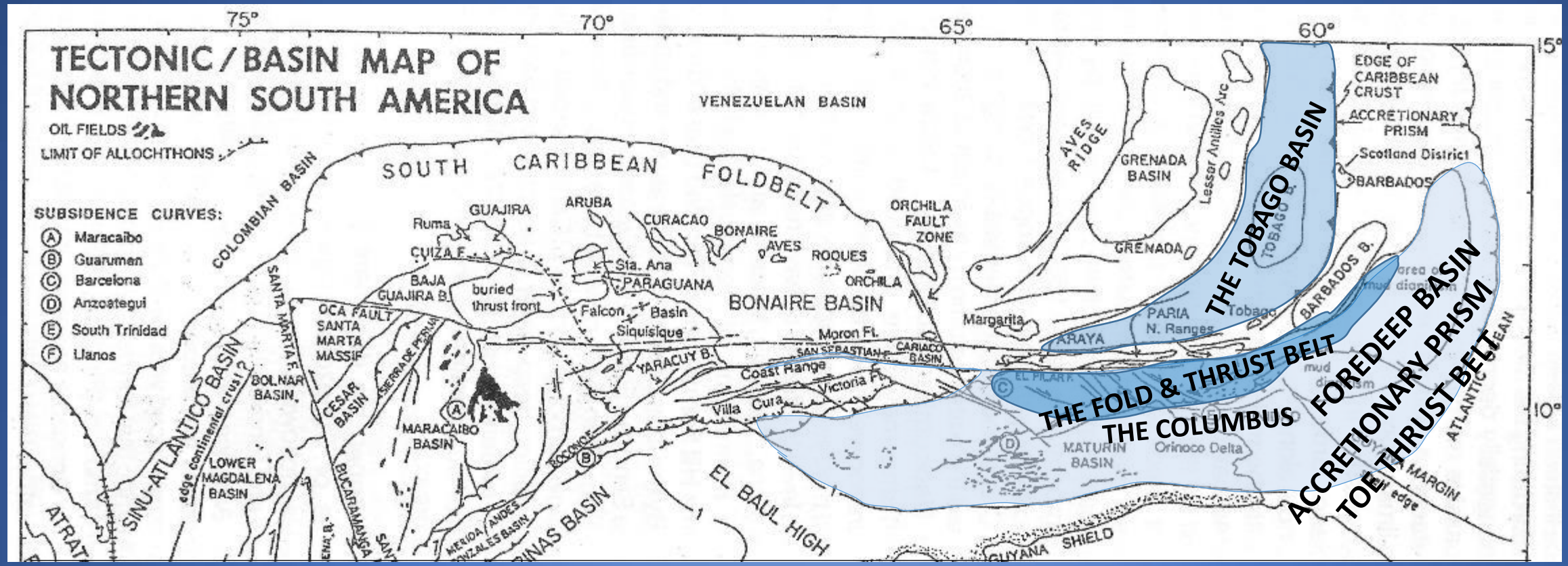
INTRODUCTION

TRINIDAD AND TOBAGO IS LOCATED IN THE S.E. CORNER OF THE CARIBBEAN PLATE



Map altered from James 2003

INTRODUCTION



Map altered from Pindell 1991

THE MAJOR BASINS ARE:

- **THE TOBAGO FOREARC BASIN**
- **THE COLUMBUS FOREDEEP BASIN AND**
- **THE LOWER TERTIARY FOLD AND THUST BELT OVERLAIN BY**
- **THE GULF OF PARIA (PULL APART) BASIN AND THE SOUTHERN (PIGGY-BACK) BASIN AND**
- **THE ACCRETIONARY PRISM WITH A TOE-THRUST BELT TO THE EAST**

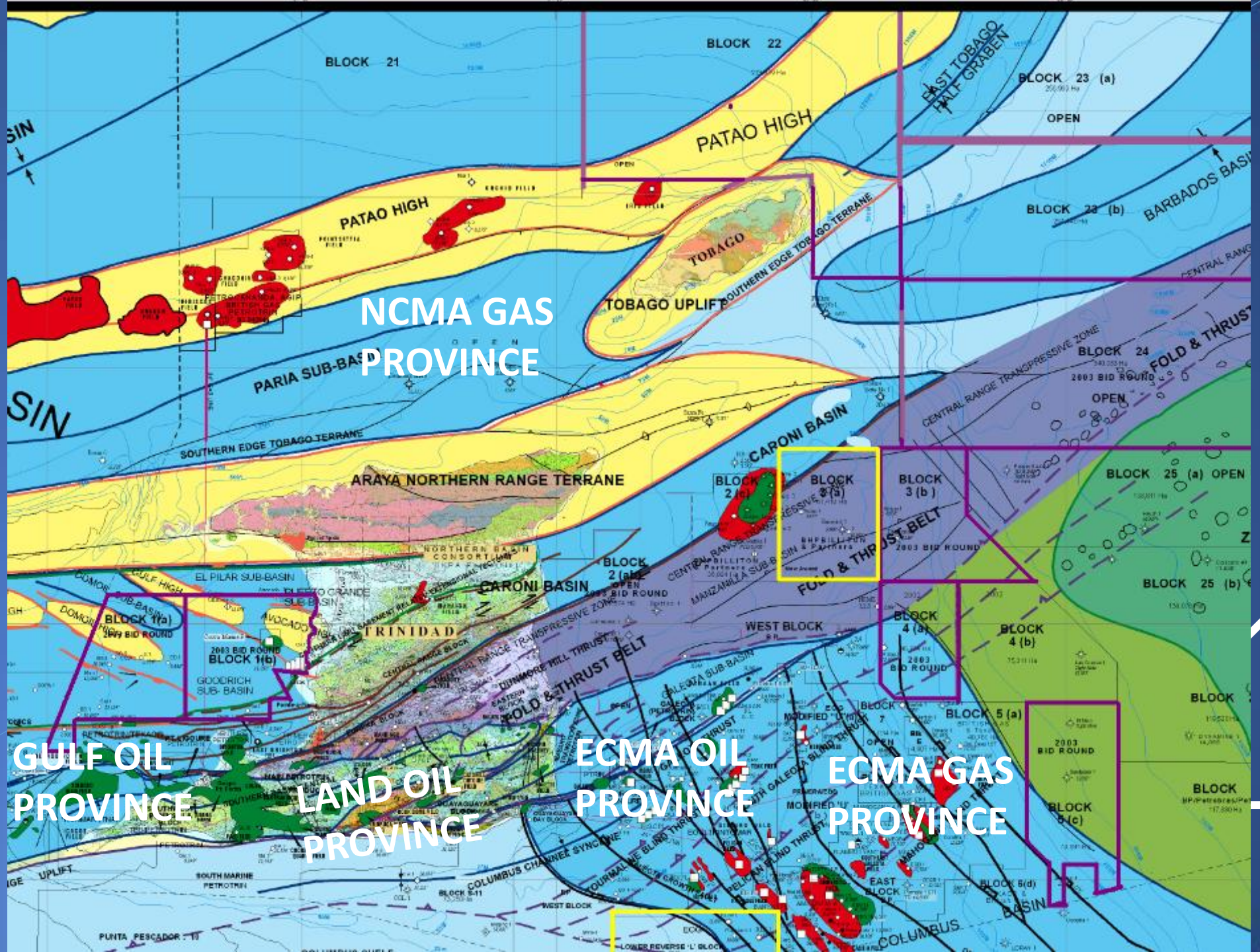
INTRODUCTION

PETROLEUM EXPLORATION STARTED IN 1857
AND CONTINUINES TODAY

TO DATE THERE HAVE BEEN EIGHT EXPLORATION PHASES RESULTING IN THE DISCOVERY OF THREE OIL PROVINCES AND TWO GAS PROVINCES WITH CUMULATIVE OIL PRODUCTION OF OVER 3.5 BILLION BARRELS OIL AND OVER 12 TCF GAS

A NINTH EXPLORATION PHASE WITH HUGE POTENTIAL IS JUST STARTING IN ULTRA-DEEP WATERS

OIL & GAS PROVINCES

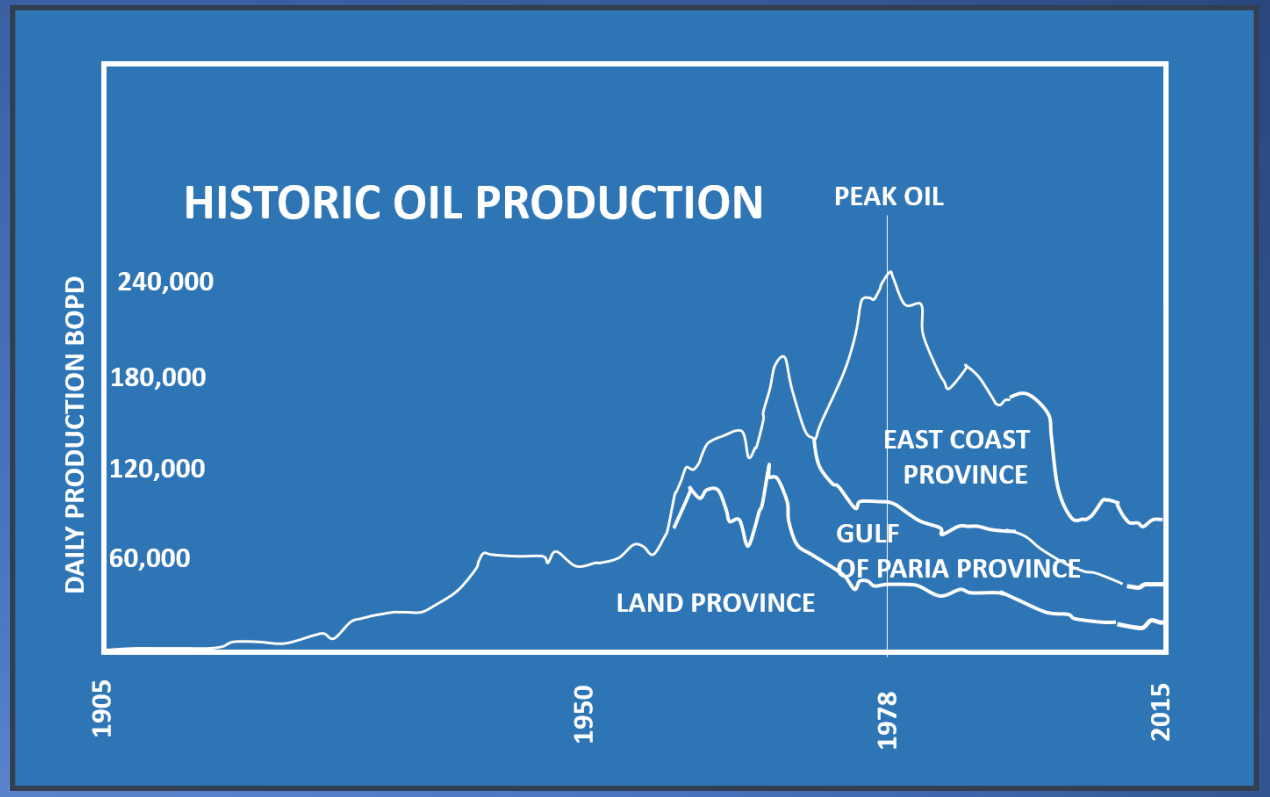


Map altered from Persad 2003

INTRODUCTION

THREE OIL PROVINCES:

- LAND
- GULF OF PARIA
- EAST COAST MARINE AREA



- PEAK OIL (1978): 228,000 BOPD
- CURRENT (Q1 2016): 74,700 BOPD
- CUMULATIVE OIL PRODUCTION OVER 3.5 BILLION BARRELS

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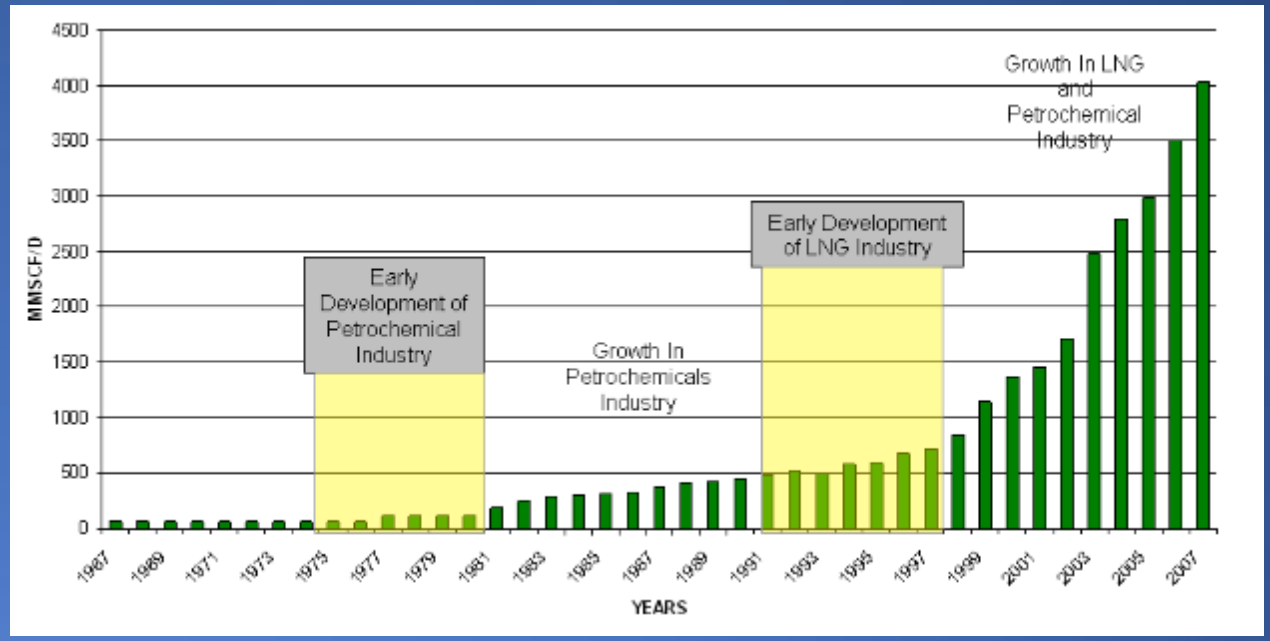
TWO GAS PROVINCES:

- EAST COAST MARINE AREA
- NORTH COAST MARINE AREA



- GAS PRODUCTION PEAKED 2009 at 4.564 BCFGD
- Q1 2016 PRODUCTION IS 3.6 BCFD, WITH 435 MMCFGD FROM THE NCMA
- CUMULATIVE GAS PRODUCTION OVER 12 TCF GAS

EXPLORATION PHILOSOPHY PHASE ONE

This phase of exploration commenced in the 1850s and continued until 1905.

During this phase, prospectors with no formal training, drilled on the basis of proximity to the Pitch Lake or oil seeps.

The concept was simple…. Look for oil where you know it to exist.

The tools were equally simple… follow the seeps.

The early drilling included a well in 1857 at the Pitch Lake by Merrimac, and wells by Walter Darwent at Aripero in 1867.

All found oil

Darwent's death soon after resulted in a 35 year hiatus

Darwent and his Aripero Well (Besson 2014)

EXPLORATION PHILOSOPHY PHASE ONE

Randolf Rust and John Lee Lum started exploring for oil also on the basis of seeps in 1898.
By 1905 they had discovered what is now called Beach Field in Guayaguayare (cumulative to date over 90 MMBO) , rehabilitated Darwent's original Aripero wells
and drilled new wells

The Aripero Well in 1987 (Besson 2014)

In Guayaguayare circa 2010 (Besson 2014)

EXPLORATION PHILOSOPHY PHASE TWO

Geological Mapping looking for Anticlines

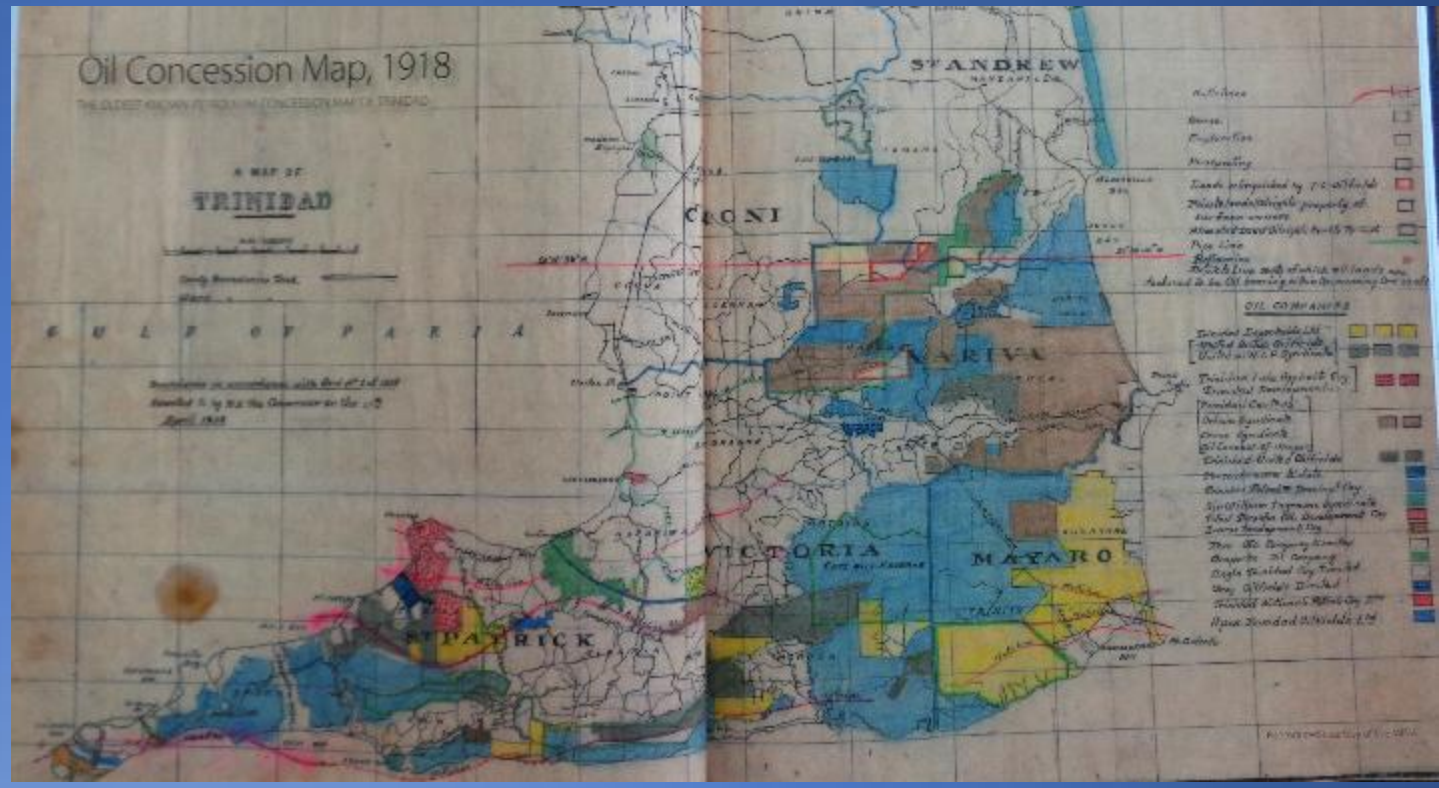
Prospecting on the basis of seeps gave way to a more scientific approach as geologists entered the picture.

They did field mapping to look for anticlines, armed only with the traditional geological tools of a hammer and compass/clinometer. Due to the thick vegetation outcrops were scarce, as such 9’ deep trenches were dug to create exposures also holes were augured and the cuttings examined.

EXPLORATION PHILOSOPHY PHASE TWO

DISCOVERY OF THE LAND PROVINCE

Between 1905-1907 Cunningham-Craig, a Government geologist mapped the entire southern Trinidad and identified a number of prospective areas on the basis of anticlines and oil seeps. Using this data the Government leased a swath of land acreage to a number of mainly start-up companies



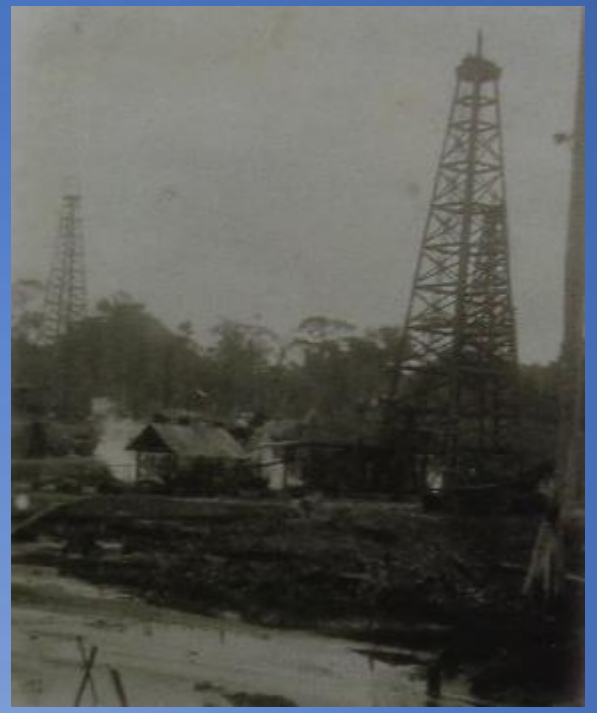
Oil Concession Map 1918
(Besson 2014)

EXPLORATION PHILOSOPHY PHASE TWO

DISCOVERY OF THE LAND PROVINCE

Within 10 years virtually all the major land fields in Trinidad had been discovered. The land fields of this first petroleum province have produced over 1.5 billion barrels of oil by the end of 2015. Most of this came from these early discoveries or deeper pools found later.
Current LAND production (Q1 2016) is 21,074 bopd

FIELD NAME	YEAR OF DISCOVERY
Point Fortin	1908
Parrylands	1908
Brighton	1910
Barrackpore	1911
Beach	1911
Tabaquite	1911
Palo Seco-Erin	1912
Guapo	1912
Forest Reserve	1914
Fyzabad	1918



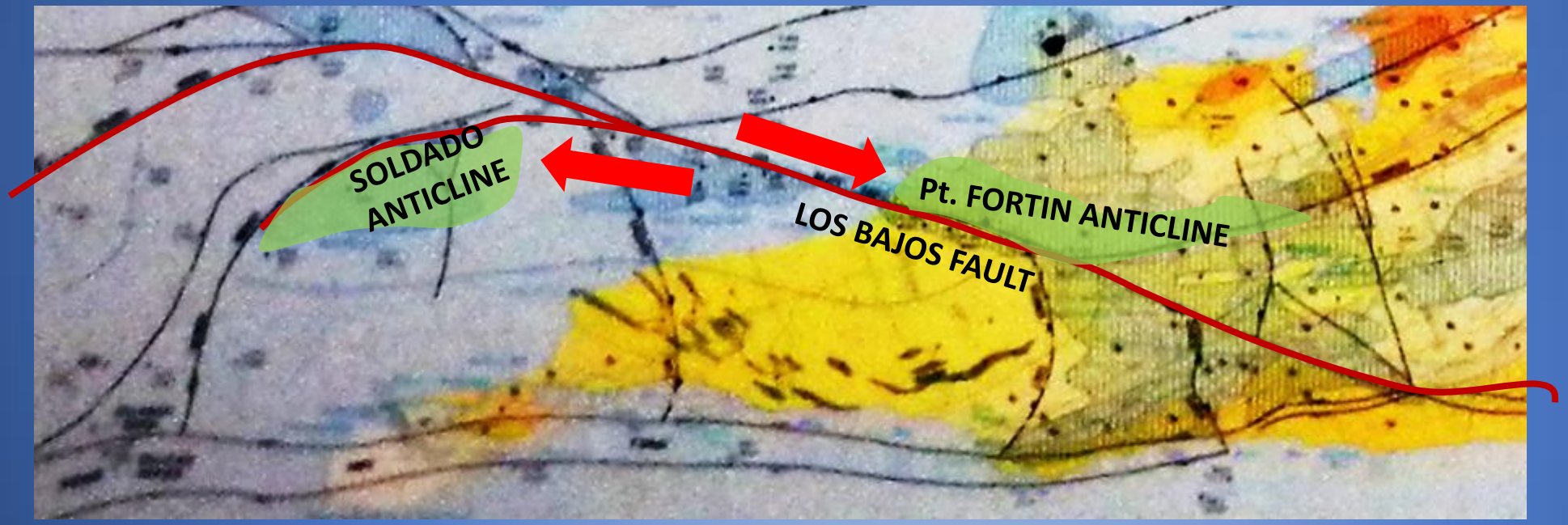
Fyzabad Exploration well 1918 (Besson 2014)

EXPLORATION PHILOSOPHY PHASE THREE
Conceptual Thinking (Trendology) and Technology (Seismic)…I

DISCOVERY OF THE GULF OF PARIA PROVINCE

The second oil province was discovered in 1954 by astute geological thinking by the geologists of the day like C.C. Wilson, who using 2D seismic, extrapolated the Los Bajos Fault off-shore and correlated the Soldado Anticline offshore as the unmoved portion of the prolific Pt. Fortin Anticline onshore

Modified from Robertson Research 1984

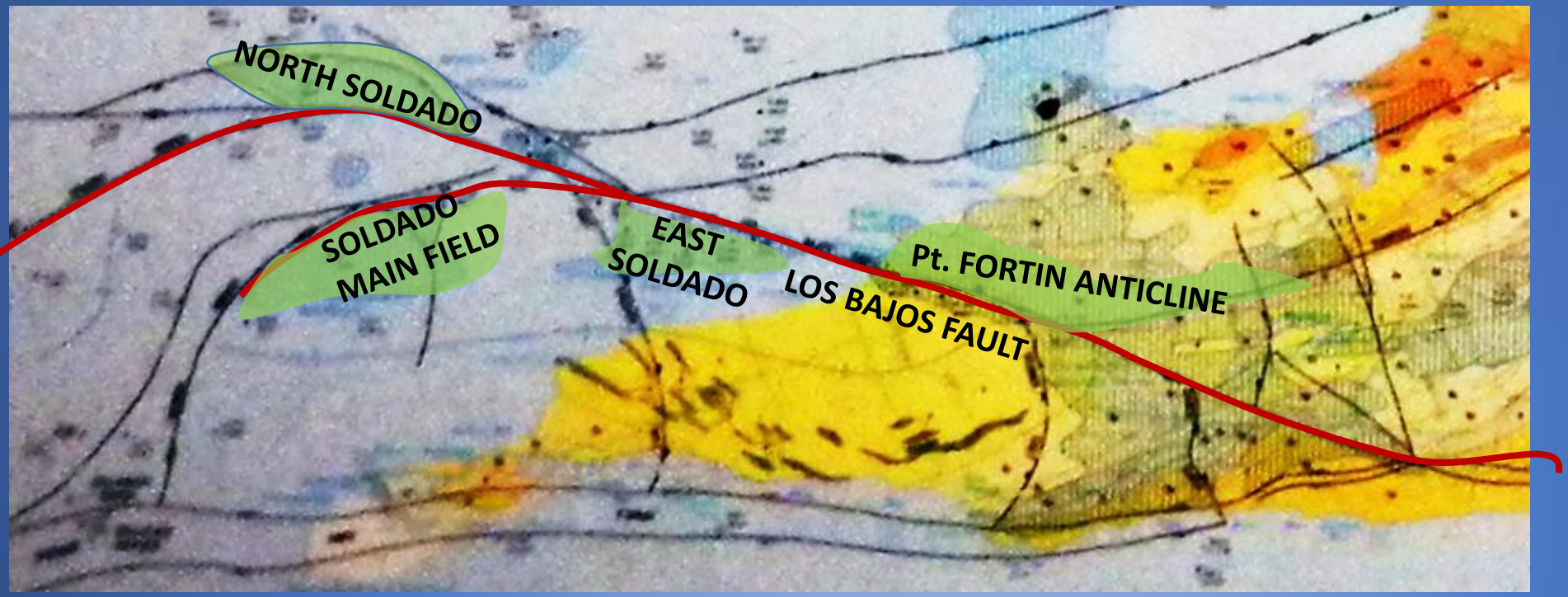


DISCOVERY OF THE GULF OF PARIA PROVINCE

The first well High Seas One was the discovery well of the Soldado Main Field.
Within five years two other large fields were discovered… East Soldado and North Soldado
Other fields have found since then

To the present the Gulf of Paria fields have produced over one billion barrels of oil and current production (Q1 2016) is 21,335 bopd

Modified from Robertson Research 1984

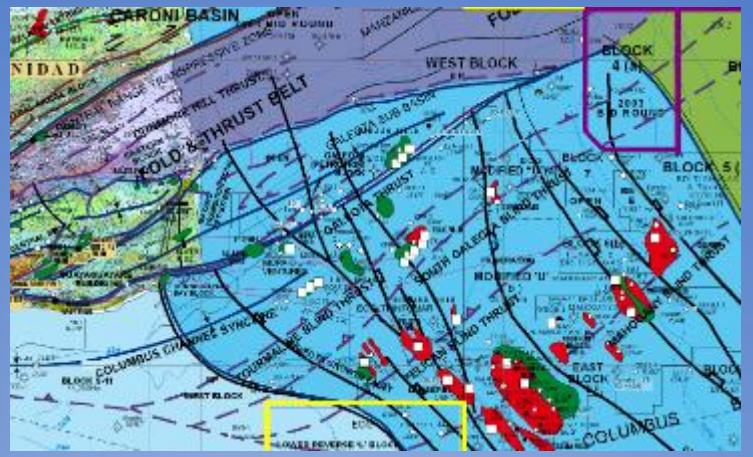


EXPLORATION PHILOSOPHY PHASE FOUR Conceptual Thinking Trendology) and Technology (Seismic)…II

DISCOVERY OF THE EAST COAST OIL AND GAS PROVINCES

The third oil province was discovered using the same exploration philosophy as was used in Phase Three

Dominion Oil and then PanAmerican (Amoco) drilled a series of wells starting in 1961, on anticlines along trend with those onshore where major discoveries had been made.

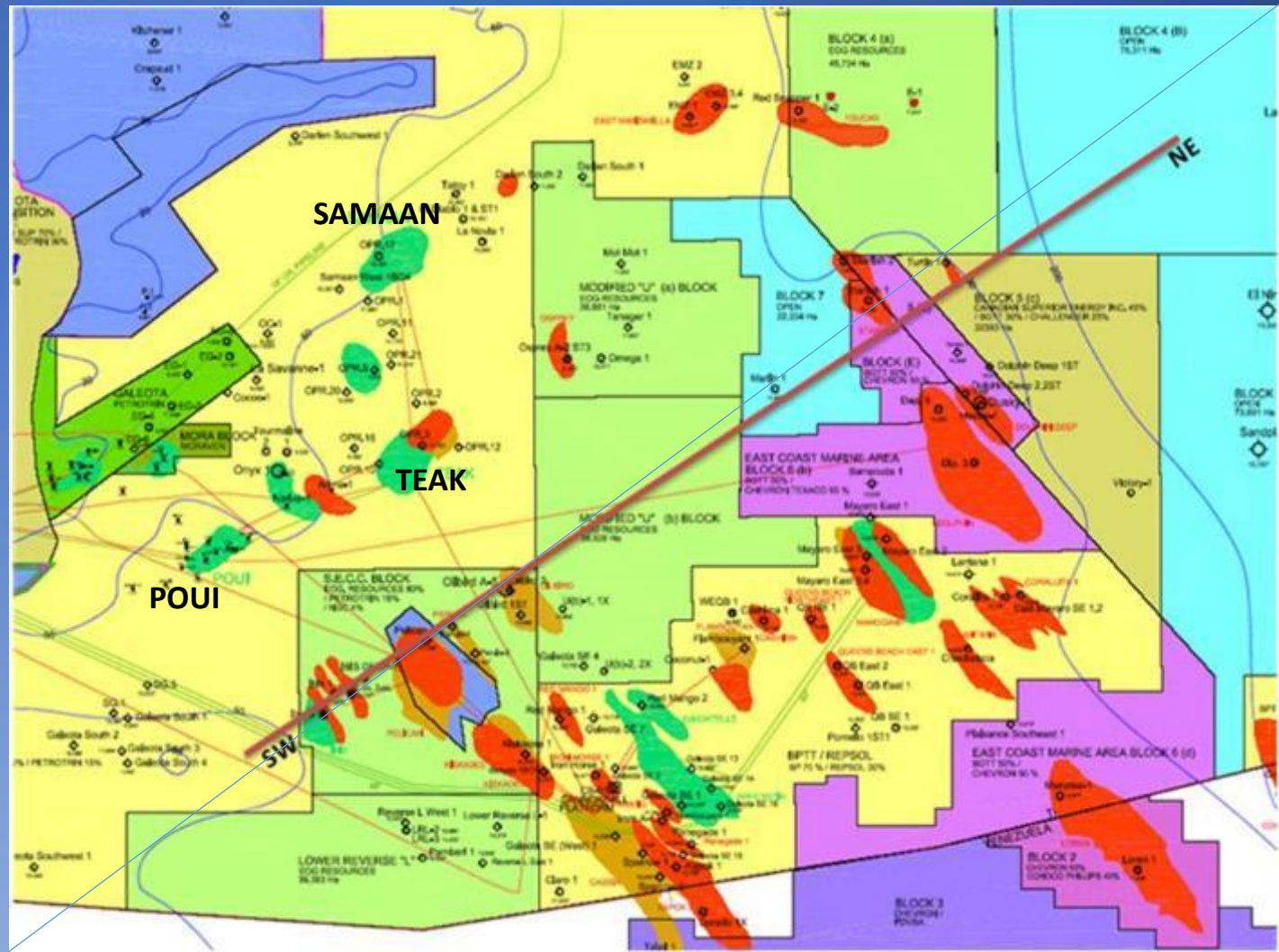


DISCOVERY OF THE EAST COAST OIL AND GAS PROVINCES

Modified from GSTT

Within 10 years (by 1971) three giant oilfields, Teak, Samaan and Poui and several giant gas fields were discovered.

Together these and later discoveries have produced over one billion barrels of oil and condensate and over ten trillion cubic feet of gas Q1 2016 ECMA production is 32,291 bpd of oil and condensate and 3.6 bcfgd.



EXPLORATION PHILOSOPHY PHASE FIVE
Offshore 2D seismic

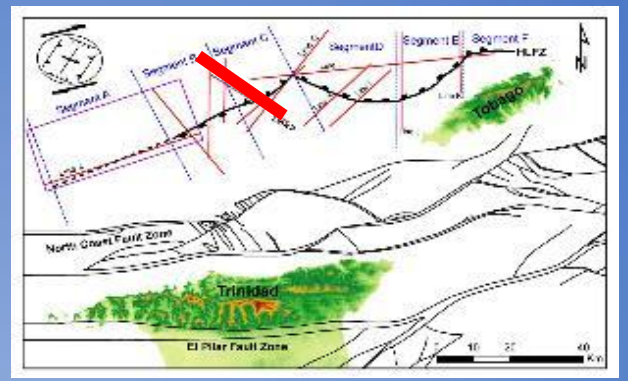
DISCOVERY OF THE NORTH COAST MARINE AREA (NCMA) GAS PROVINCE

The second gas province was discovered using for the first time direct hydrocarbon detection.

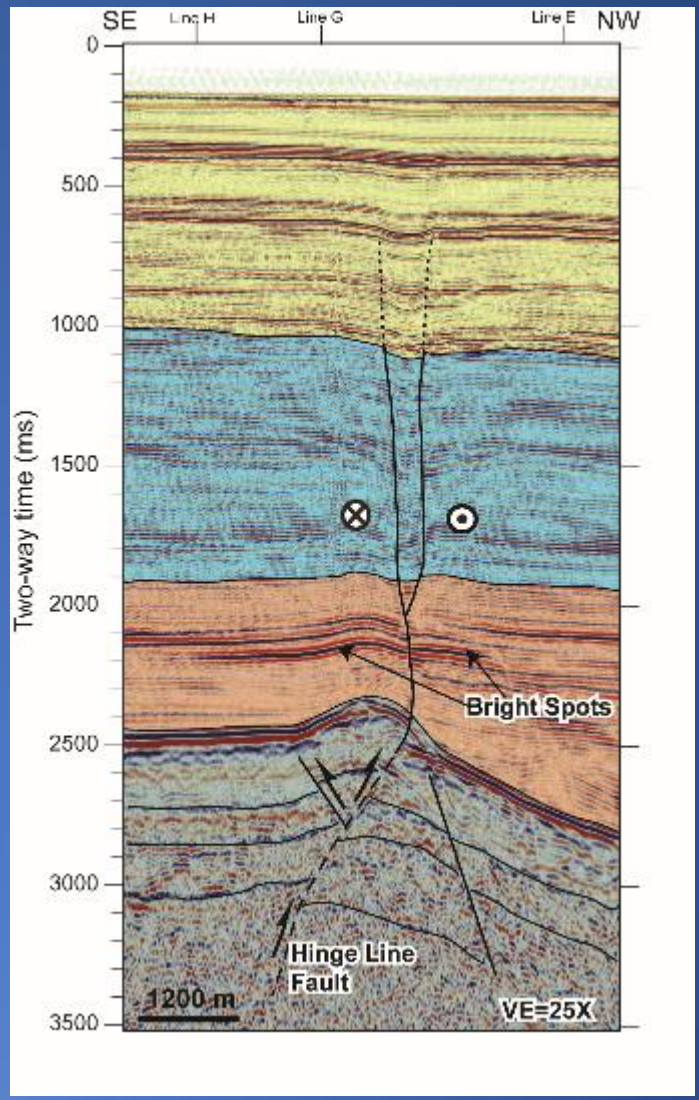
2D lines run in the NCMA in 1968 with United Nations funding showed distinct bright spots on structures along the Patao High

Within 5 years the Hibiscus, Pointsettia, Chaconia Orchid and Iris fields had been discovered along the crest of the Patao High

Other fields have found further east along trend since then using 3D seismic.



Source Punette 2011



Seismic Line F
Source Punette 2011

EXPLORATION PHILOSOPHY PHASE FIVE

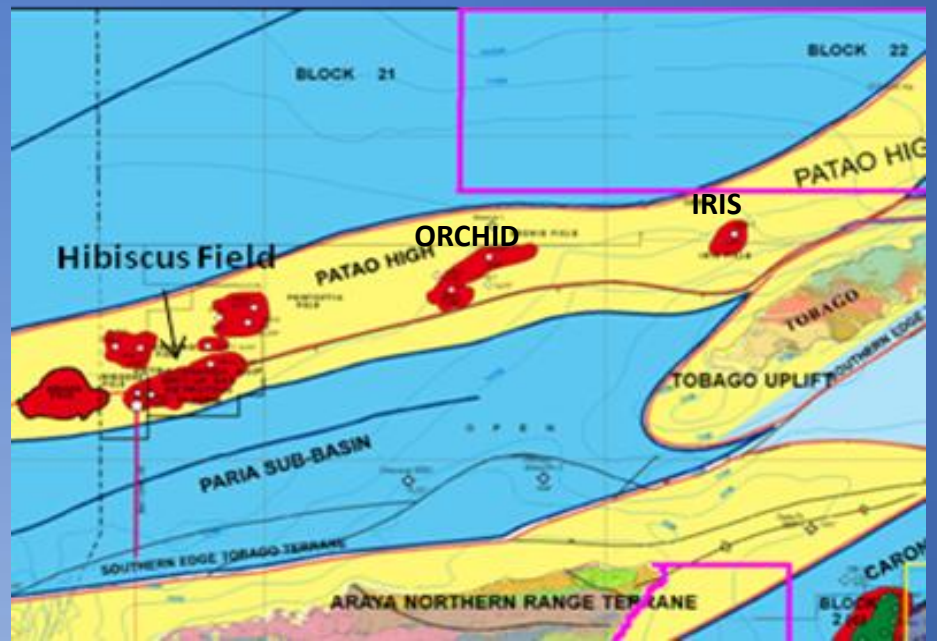
Direct Hydrocarbon Detection

DISCOVERY OF THE NORTH COAST MARINE AREA (NCMA) GAS PROVINCE

The Hibiscus Complex (comprising Hibiscus, Ixora, Pointsettia and Chaconia) came on production in 2004 at 450 MMCFGD and 50 BCD.

Current production is 435 MMCFD and 50 BCD

Map altered from Persad 2003

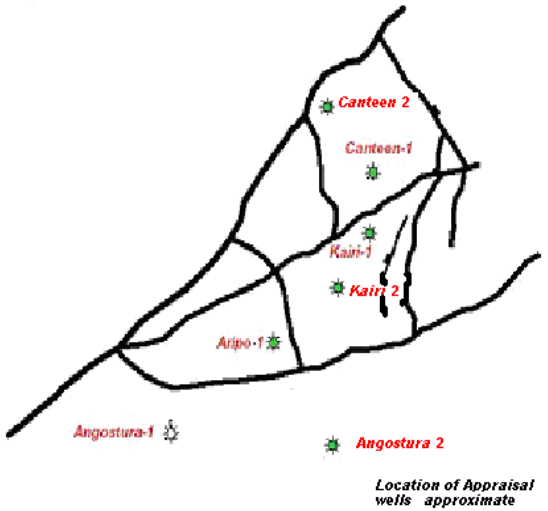


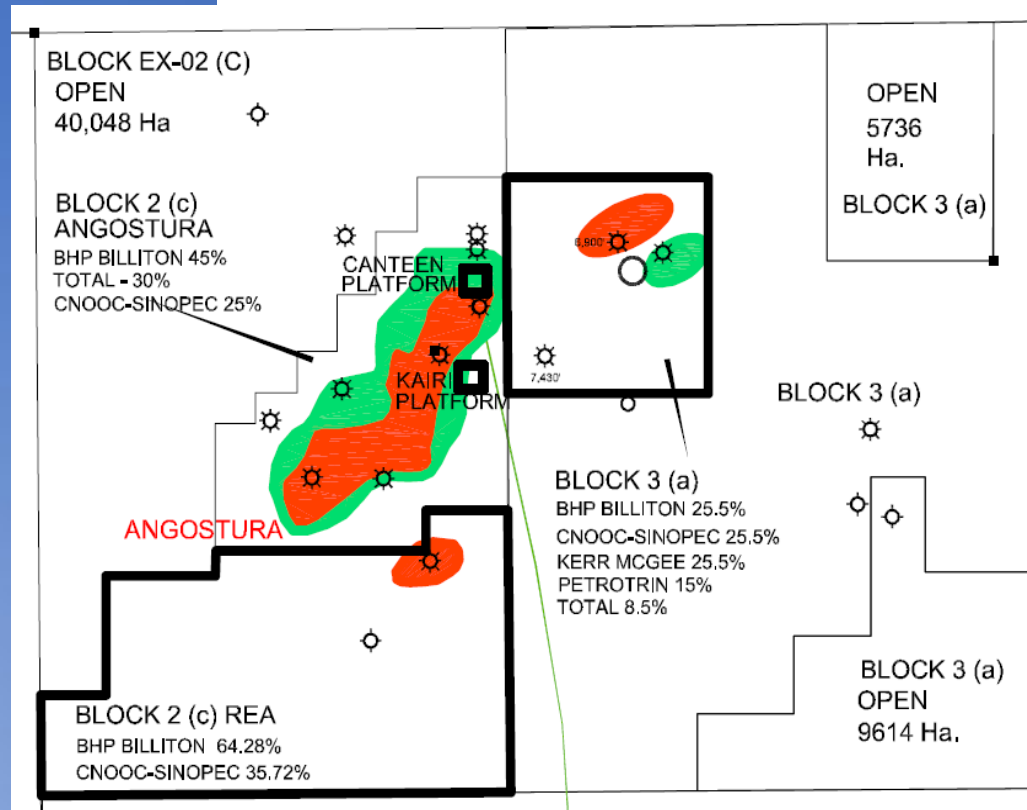
EXPLORATION PHILOSOPHY PHASE SIX
EARLY OBC SEISMIC

DISCOVERY OF THE ANGOSTURA COMPLEX IN THE ECMA

IN THE MID 1990's BHP BILLITON (OPERATOR) AND PARTNERS ACQUIRED OBC SEISMIC AND DISCOVERED THE LARGE ANGOSTURA FIELD COMPLEX IN AN OFFSHORE EXTENSION OF THE FOLD AND THRUST BELT …GAS WITH AN OIL LEG

The Angostura field came on production in 2005 and has since produced about 60 million barrels of oil to end 2015 and in Q1 2016 still producing 6,500 bopd and 379 MMCFGD, of which sales are about 252 MMCFGD.





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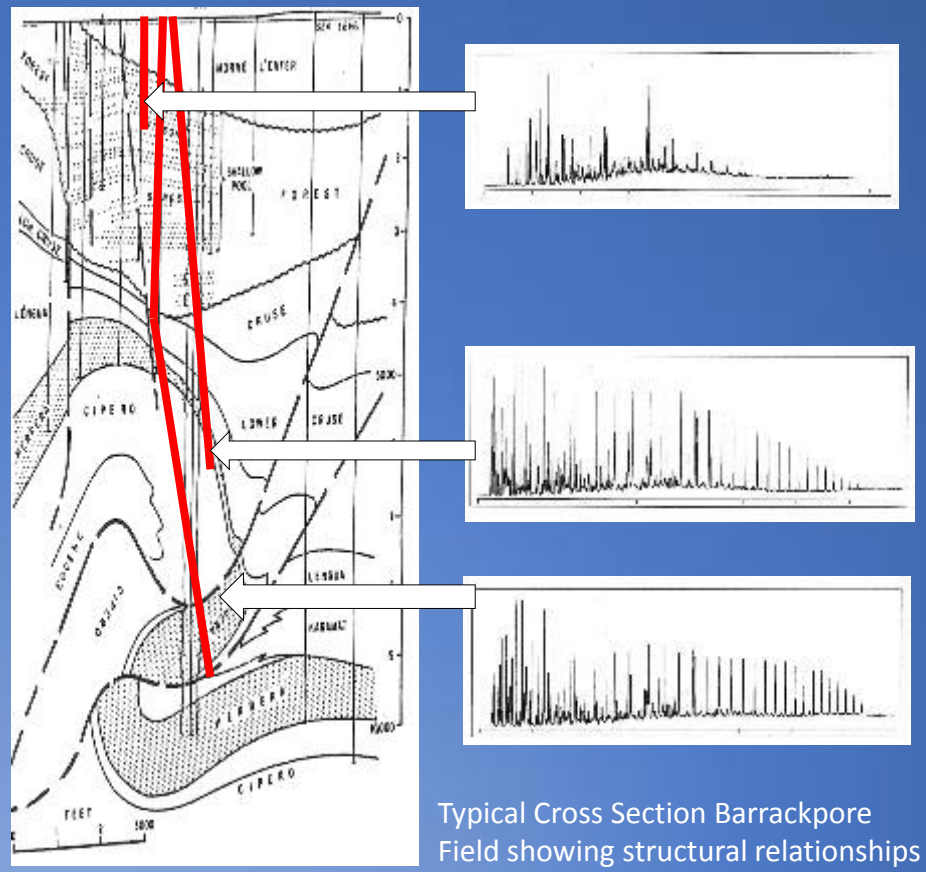
EXPLORATION PHILOSOPHY PHASE SEVEN
EVAPORATIVE FRACTIONATION

DISCOVERY OF DEEPER POOLS PERSAD & TALUKDAR (1989 & 1995) USED THE CONCEPT OF EVAPORATIVE FRACTIONATION TO PREDICT RESIDUAL OIL BELOW THE ECMA GAS/CONDENSATE FIELDS AND BELOW THE SHALLOW HEAVY OIL FIELDS ONSHORE AND IN THE GULF OF PARIA AS WAS FOUND IN BARRACKPORE



HRGC Bk 2
Wilson Sands
API Gravity 16.0
Strongly biodegraded

HRGC Bk 3
Overthrust Herrera
API Gravity 42.8
Strongly fractionated light oil

HRGC Bk 1X
Intermediate Herrera
API Gravity 25.0
Residual waxy oil significant loss of light hydrocarbons

Typical Cross Section Barrackpore Field showing structural relationships of Wilson and Herrera Formations and relative locations of KPAL's Bk 1X, Bk2 and Bk3 wells.

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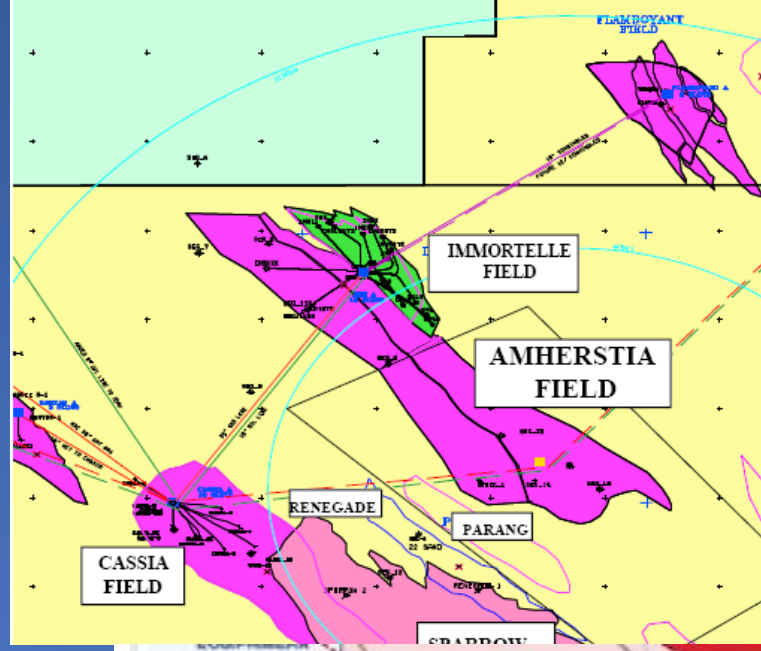
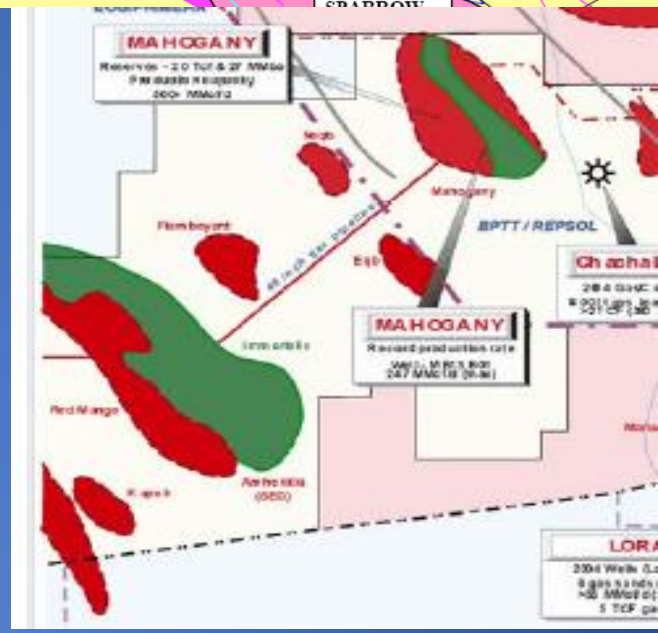
EXPLORATION PHILOSOPHY PHASE SEVEN
EVAPORATIVE FRACTIONATION

DISCOVERY OF DEEPER POOLS

PERSAD & TALUKDAR (1989 & 1995) USED THE CONCEPT OF **EVAPORATIVE FRACTIONATION** TO PREDICT RESIDUAL OIL BELOW THE ECMA GAS/CONDENSATE FIELDS AND BELOW THE SHALLOW HEAVY OIL FIELDS ONSHORE AND IN THE GULF OF PARIA

DEEPER THIN OIL LEGS HAVE SINCE BEEN DISCOVERED IN MAHOGANY AND AMHERSTIA/IMMORTELLE FIELDS IN THE ECMA AND DEEP (CRUSE) OIL HAS BEEN DISCOVERED IN THE SOUTHWEST PENINSULA ONSHORE





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EXPLORATION PHILOSOPHY PHASE EIGHT
OBC SEISMIC

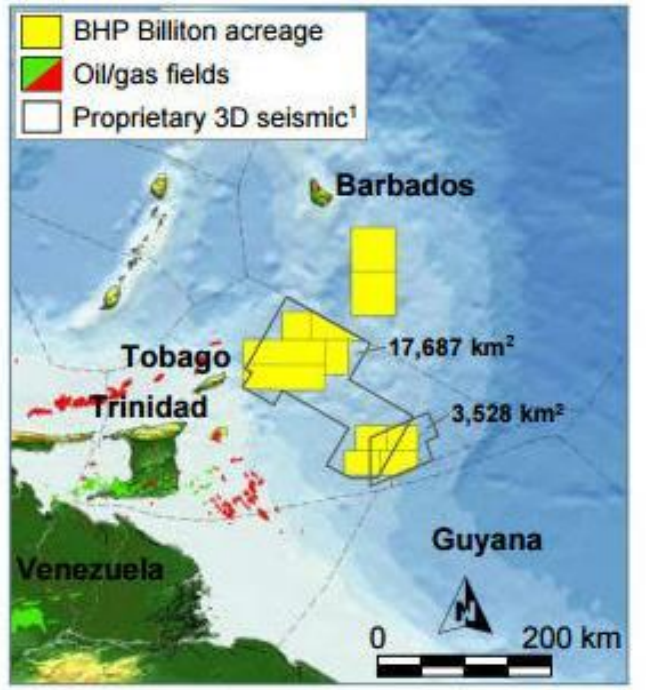
DISCOVERY OF DEEPER POOLS IN THE ECMA

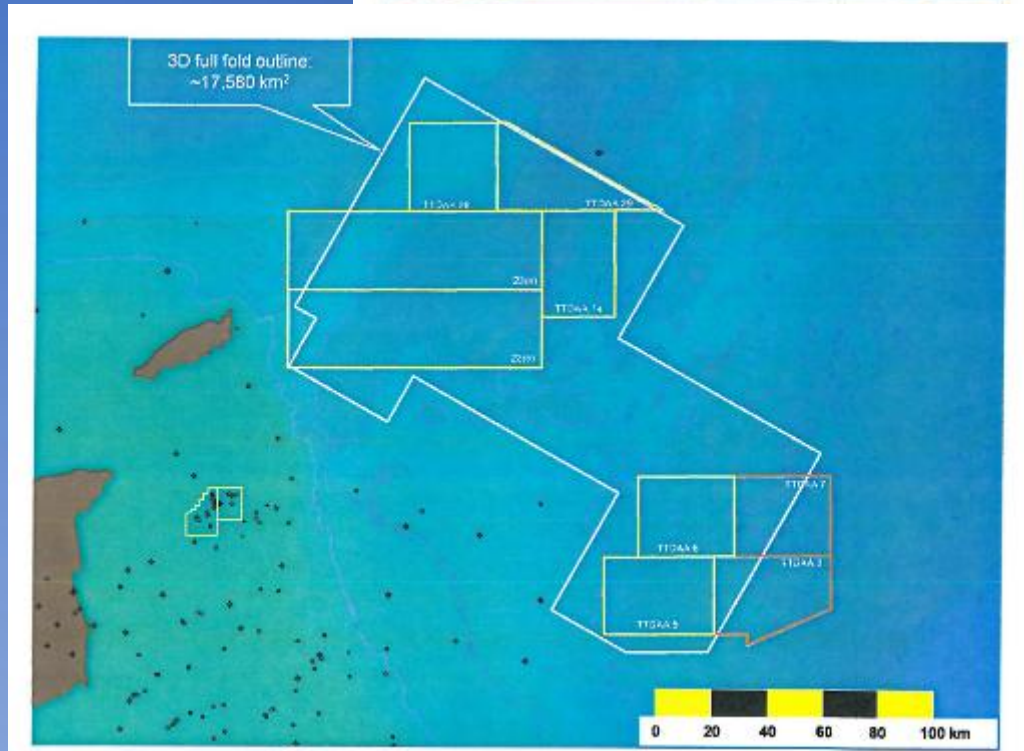
BP USED NEW GENERATION OBC SEISMIC IN 2013 TO SEE BELOW THE SHALLOW GAS IN THEIR ECMA FIELDS AND HAVE DISCOVERED DEEPER GAS AND CONDENSATE IN THE SAVONETTE FIELD AND PLAN TO DEVELOP THE ANGELIN FIELD

EXPLORATION PHILOSOPHY PHASE NINE
DEEP WATER EXPLORATION

EXPORATION IN THE DEEP AND ULTRA-DEEP WATER AREAS HAS STARTED

BHP BILLITON RECENTLY RAN THE LARGEST 3D SEISMIC PROGRAMME IN THE WORLD…+/- 24,000 sq. kms.





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EXPLORATION PHILOSOPHY DEEP WATER EXPLORATION

PHASE NINE

EXPLORATION IN THE DEEP AND ULTRA-DEEP WATER AREAS HAS STARTED

BHP BILLITON HAS NOW STARTED EXPLORATION DRILLNG LE CLERC 1 (completed drilling) AND BURROKEET 1

HUGE POTENTIAL…OIL AND GAS