2010-2022 : a « decade » of O&G Exploration
ASPO : June the 14, 2022

Marc Blaizot
marc.blaizot@gmail.com
Global O&G Discoveries From Drake times

F. Alabert (Géologues n° 192, March 2017)

Since the 90’s not enough Oil discoveries so replacement not reached even with DO and Unconventional plays. **Supply crunch in short-mid term**

- Gas is OK and could/will substitute part of the oil uses (petrochems-transport)
2010-2021 Decade: E&P investments
The golden age followed by two terrible recessions
2012-2021: E&A exploration drilling: 2 big dives
2012-2021: a close-up to E&P results

Very bad years because of shrinking investments but above all because of smaller and scarce discoveries.

Mean discoveries
10 Gb of oil/year
58 Tcf (10 Gboe) of gas/year

Not enough to compensate consumption even for gas
35 Gboe/y
140 Tcf gas/y

IHS updating January 2022

Figure 2 – Global discovered resources vs oil price

Note: Arrows indicate recorded recoverable resources at year-end.
Source: Data taken from IHS Markit upstream E&P content (EDIN) © 2022 IHS Markit
2010-2022 Conventional EXPLORATION SYNTHESIS
Gas to the East and Oil to the West!

OIL and GAS Discoveries

Oil discoveries: Argentina, Brazil, Guyana, Suriname, US, Mexico, Ghana, Ivory Coast, Namibia, Uganda, Norway,

Gas discoveries: Mauritania, Senegal, South Africa, Mozambique, Tanzania, Malaysia, UAE, Australia, Turkey, Azerbaijan, and Russia

Beyond Middle East O&G and US LNG: How to compensate Russia supplies? Gas from Africa and Oil from Americas?
Oil prone Basins: Guyana-Orange (Namibia)-Santos (Brasil)-Ghana-Ivory Coast- Lacustrine period: SR type 1

Gas prone Basins: East Med (Egypt, Cyprus, Israel)? Black Sea (Turkey), Senegal-Mauritania, Rovuma (Mozambique/Tanzania), Kara and Ob delta (Russia): Big delta: SR type 2,

Gas and oil Basins: Outenica (South Africa), Russia (West Siberia)
Global exploration Plays and associated discoveries (2005-2016) from F. Alabert (Géologues n° 192, March 2017)

1) Large Deltas (DO comprised)
2) Foothills
3) Rifts and grabens
4) Pre-salt Carbonates
5) Abrupt Margins
6) Unconventionnel

Yet To Find not including unconventional

<table>
<thead>
<tr>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivie</td>
</tr>
<tr>
<td>Iran</td>
</tr>
<tr>
<td>Irak</td>
</tr>
<tr>
<td>PNG</td>
</tr>
<tr>
<td>USA</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>Argentina</td>
</tr>
<tr>
<td>Uganda</td>
</tr>
<tr>
<td>Norvég</td>
</tr>
<tr>
<td>Mozambique</td>
</tr>
<tr>
<td>Brésil</td>
</tr>
<tr>
<td>Turkmenistan</td>
</tr>
<tr>
<td>Egypte</td>
</tr>
<tr>
<td>Ghana</td>
</tr>
<tr>
<td>Guyana</td>
</tr>
<tr>
<td>UK</td>
</tr>
<tr>
<td>Sénégal/Mauritanie</td>
</tr>
<tr>
<td>Nigeria</td>
</tr>
</tbody>
</table>
Russia: impressive arctic Gas discoveries 2019-2021

Marshall Zhukov-Kara sea - Rosneft-2020- 28 Tcf?
Dinkov-Kara Sea-2019- Gazprom-13 Tcf
Nyarmeyskoya-Kara Sea- Gazprom-2019-4Tcf
Zinicheva-Taymir-2021- Rosneft-BP- 13 Tcf-
Zinicheva gas discovery in Taymir peninsula

Drilled in Yermak Neftegaz area north east of Payakha (Vostok) cluster
Gas and Condensate in Lower Cretaceous sandstones
13 Tcf?

Vostok from Vankor to Payakha could have more than 4 Gbo of reserves-
Develop with,,6500 wells,
Turkey Black Sea: TPAO-Major Gas discoveries

1- Sakarya 1 WD of 2,115m; TD 4,525m
More than 100m of the natural gas-bearing reservoir in Pliocene and Miocene sandstones, gas reserves of 320 Gm3 of lean gas, which is the largest gas reserves discovered in the Turkish Exclusive Economic Zone as well as in the Black Sea.

2- TPAO made a second discovery Amasra, deeper at a depth of 4,775m in 2,117m WD. Additional 30m of gas play in sandstones of the early-Pliocene to late-Miocene, 3-the drilling of the exploratory well Amasra-1 in the northern Sakarya gas field discovered 135 Gm3 gas,
4-the cumulative natural gas reserves of the field to 450 Gm3 of gas
Probable biogenic gas/ Reservoirs quality?
TPAO-Major Gas discovery in Turkey Black Sea

Sakarya Gas Discovery

- Turkish energy minister quoting contingent resources of 405 Bcm (14.3 Tcf) of gas.
- Western Black Sea, 170km from the Turkish coast. 4km from the TurkStream pipeline.
- Discovered in Oct. 2020 with Tuna-1
- 2014m water depth.
- Pliocene to Miocene reservoirs at three levels between 3000 and 4775m.
- 2000km² 3D acquired in Q4 2019 by Shearwater Geoservices.
- Assumed to be structural trap but could be stratigraphic.
- No information on reservoir thickness, quality, extent or gas composition.
- Türkali-1 appraisal well started drilling in Nov. 2020, 4km to the NW of Tuna-1

*Based on atena Figure 2 Alaphaca case in Exploration Playe in the Turkish Black Sea, Mentor et al, Leading Edge, Sept. 2009 Edge*
Huge discoveries: 80 Tcf
Egypt: Zohr
Israel: Leviathan, Tamar, Karish, etc.,
Cyprus: Glaucus, Aphrodite

Very rapid appraisal and start-up
Production in Israel started in 2013: Tamar - 1 bcf/d then Leviathan in 2016 at 1,2 bcf/d
Production in Egypt started in 2017
Zohr reached: 2,7 bcf/d since 2019

Complicated stories to unlock production and export to Europe
Turkey/Cyprus and Israel/Libanon disputes/
Many partners /Long route for East Med pipe to Europe
Easiest LNG way?
Egypt recovered 7 Mt/y export in 2021
Guyana-Surinam bassin : multi-sources
Cretaceous sandy turbidites

- Guyana and Surinam réservoirs seem to be different from the few published maps
- Youger and shallower in Guyana
- Large deep sea fans in Guyana like Lizza
- Restricted feeders in Surinam
- Multi source points : large ranges of poro-perm values ?

- Higher GOR in Surinam

- 11 Gbo in Guyana ; 2 Gboe in Surinam ?
GUYANA-Exxon- Stabroek block update (May 2022)

**Exploration**: ExxonMobil: 45%; Hess 30% and CNOOC 25%. ExxonMobil made another 5 oil discoveries in 2021/2022 and increased its estimate of the discovered recoverable resource to approximately 10 billion oil-equivalent barrels with other multibillions additional exploration stakes. The total significant discoveries is 25 for a 26800 km² block.

**Production**: to date, the Liza Destiny FPSO in production, since December 2019 (4y and ½ after discovery!), at around 120,000 bopd. Liza Unity FPSO will become Guyana’s 2nd offshore production unit, moored in January 2022 at WD of 1,600 meters, and should produce 220,000 bopd, with a gas treatment capacity of 400 million cftpd and water injection capacity of 250,000 bwpd. The FPSO will be able to store approximately 2 million barrels of crude oil.

Singapore's Keppel started work on the third FPSO unit, the Prosperity FPSO destined for the Payara development. At least six FPSOs are expected to be online in the Stabroek block by 2027 with the potential for up to 10 FPSOs on the block to develop the discovered reserves. Towards a 1 000 000 BOPD production in 2030!

**Gas-to-Shore project**, the conceptual studies for a construction of a 50 MMscf/td pipeline from the Liza Phase 1 and Liza Phase 2 FPSO vessels to an onshore natural gas liquid (NGL) and natural gas processing (NGP) plant for domestic needs,
Suriname –TOTAL Apache- Block 58-Exploration

Maka-Kwaskwasi-Sapakara-Keskesi and Krabdagu discoveries in 2020/2021/2022 confirm excellent oil trend SE of Starbroek block in Guyana

Bonboni-1 water-bearing Campanian (main objective) reservoir. Maastrichtian objective: 16 meters of net oil pay with ow-GOR, 25-degree API black oil.

Sapakara South-1 appraisal 4 km from the discovery well. SPS-1 encountered 30 meters of net oil pay in of high-quality (1-2 Darcies) Campano-Maastrichtian reservoir, "A restricted flow test averaged 4,800 bopd of 34-degree API with GOR 1100 scf/bbl, According to Apache, a single reservoir in SPS-1 proved connected resource of 350 Mbo IOIP. "Seismic imaging of this Sapakara reservoir supports substantially more potential resource.
Ivory Coast - Major O&G discovery - CI 101 block by ENI

Baleine 1 well ENI 90 %; Petroci 10 %
TD : 3445 m
light oil-bearing intervals (40° API) of Santonian and Cenomanian-Albian age. Cenomanian-Albian level shows discrete to good reservoir and has been successfully tested to production. Very probable extension in block CI-802 (ENI op)

IOIP 1.5 to 2 Gbo
IGIP 1.8 to 2.5 Tcf
Namibia : Orange Basin : a new oil province in deep offshore Africa

Two discoveries announced 1st Quarter 2022
- **Graff 1 by Shell** : WD 2000 m ; TD : 5375 m Mixed Cenomanan-turonian Cretaceous Turbidites plays –
  - 300 Mbo Reserves ? Appraisal in progress
- **Venus 1 by TotalEnergies  40 % (QP 30 %/Impact 20 %, Namcor 10 %)** : Wd : 3000 m ; TD : 6300 m Albian basin floor fan with 84 m of oil net pay
  - Huge reservoir extension with AVO and DDC : 600 Km2 !
  - **Reserves 3 Gbo** ? But not tested : Permeability ?
Namibia: Orange Basin: a new oil province in deep offshore Africa
South Africa, Outeniqua basin: Brulpadda and Luiperd Discoveries by TotalEnergies

Operator: TotalEnergies, 45% with Qatar Petroleum 25%, CNR 20% and Africa Energy 10%

1-Brulpadda WD: 1400 m; TD: 3600 m,
- 57 m, gas and condensate, LK reservoirs
- 550 Mboe to 1 Gboe

2- Luiperd 1: WD: 1800 m; TD: 3400 m
73 meters good HC net sandstones
DST 1: 33 Mcf/d and 4300 bopd

Development! Gas To Shore,
Phase one: subsea wells feeding production to a shallow-water platform, with gas piped to a GTL facility and power plant
South Africa, Outeniqua : Brulpadda and Luiperd Discoveries

Sources: Africa Energy Corp
2010-2020 Rovuma Basin: Mozambique giant gas discoveries (100 Tcf+)

MOZAMBIQUE MAKES PROGRESS ON LNG PROJECTS

Mozambique LNG
Operator: Total
Capacity (million mt/yr): 12.9
FID: Jun-19
Expected first LNG: 2024

Coral FLNG
Operator: Eni
Capacity (million mt/yr): 3.4
FID: Jun-17
Expected first LNG: 2022

Rovuma LNG
Operator: Exxon/Eni-CNPC
Capacity (million mt/yr): 15.2
FID: Dec-18
Expected first LNG: 2025

Source: S&P Global Platts
2010-2021 Three main exploration success process

• **Old** ideas on **New** domains (analogies):
  • Large deltas: Senegal/Mauritania, Israel/Cyprus, Russia (Ob delta)
    • Key drivers: thick deltaic series, total isopach maps, new geophysical methods (FTG, massive 3D, DHI)

• **New** ideas on **Old** domains (breakthroughs):
  • Pre Salt Carbonates (Bresil, Egypt)
  • Basement reservoir or basement migration (Norway/Johann Sverdrup)
  • Hydrodynamics traps in HP centrifugal Basins (Azerbaidjan)
  • Unconventional Resources: SG/LTO: worldwide mature provinces / USA/Canada/Argentina/Russia
    • Key drivers: revisiting masses of old data with an « out of the box » thinking

• **New** ideas in **New** domains (genius):
  • Abrupt margins (Ghana-Ivory Coast- Guyana/Suriname)
  • Outer Front Deltas (Mozambique, Namibia?)
    • Key drivers: geological concepts and weak signals (satellites)