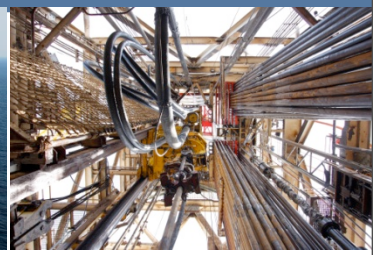
EXPLORATION & PRODUCTION

RHCI/COM

Deep offshore







TOTAL

Kit E&P - September 2010
JM MASSET TOTAL SA-ASPO FRANCE
ASPO conference-BRUXELLES- april 27,2011

EXPLORATION & PRODUCTION

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1. Overall view

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The deep offshore in the history of the petroleum industry

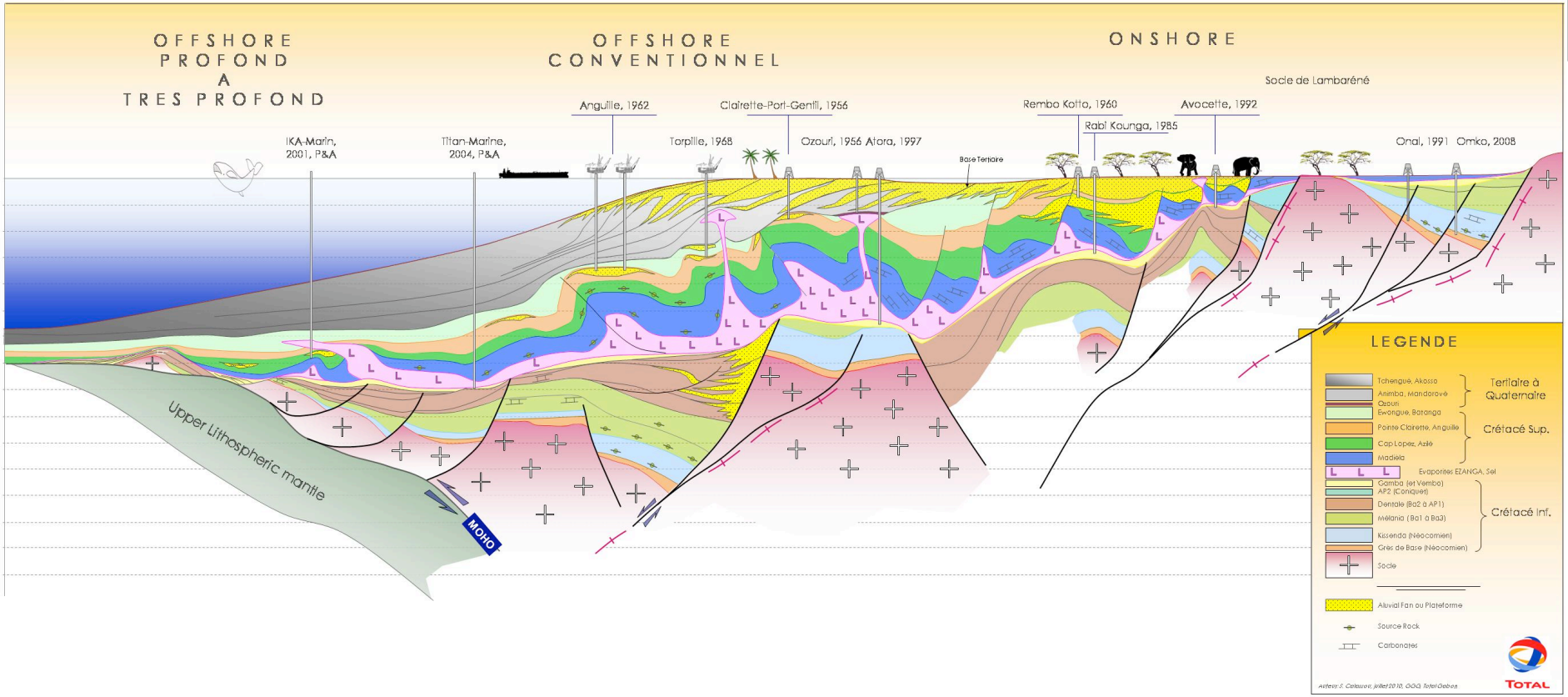
- **Exploration began onshore before being developed offshore, but remained confined for many years to the continental shelf (maximum water depths of 400 meters)**

- **The quest for new resources gave rise to the deep offshore: exploration in water depths greater than 500 meters**
  - Hydrocarbons discovered in the turbidite rocks of the deep offshore => the majors adapted to these new technological challenges
  - For the last 10-15 years, operations have been conducted in water depths of around 2,500 meters (drilling record of 2,900 metres set in 2004). Most developments are between 1,000 and 1,500 meters

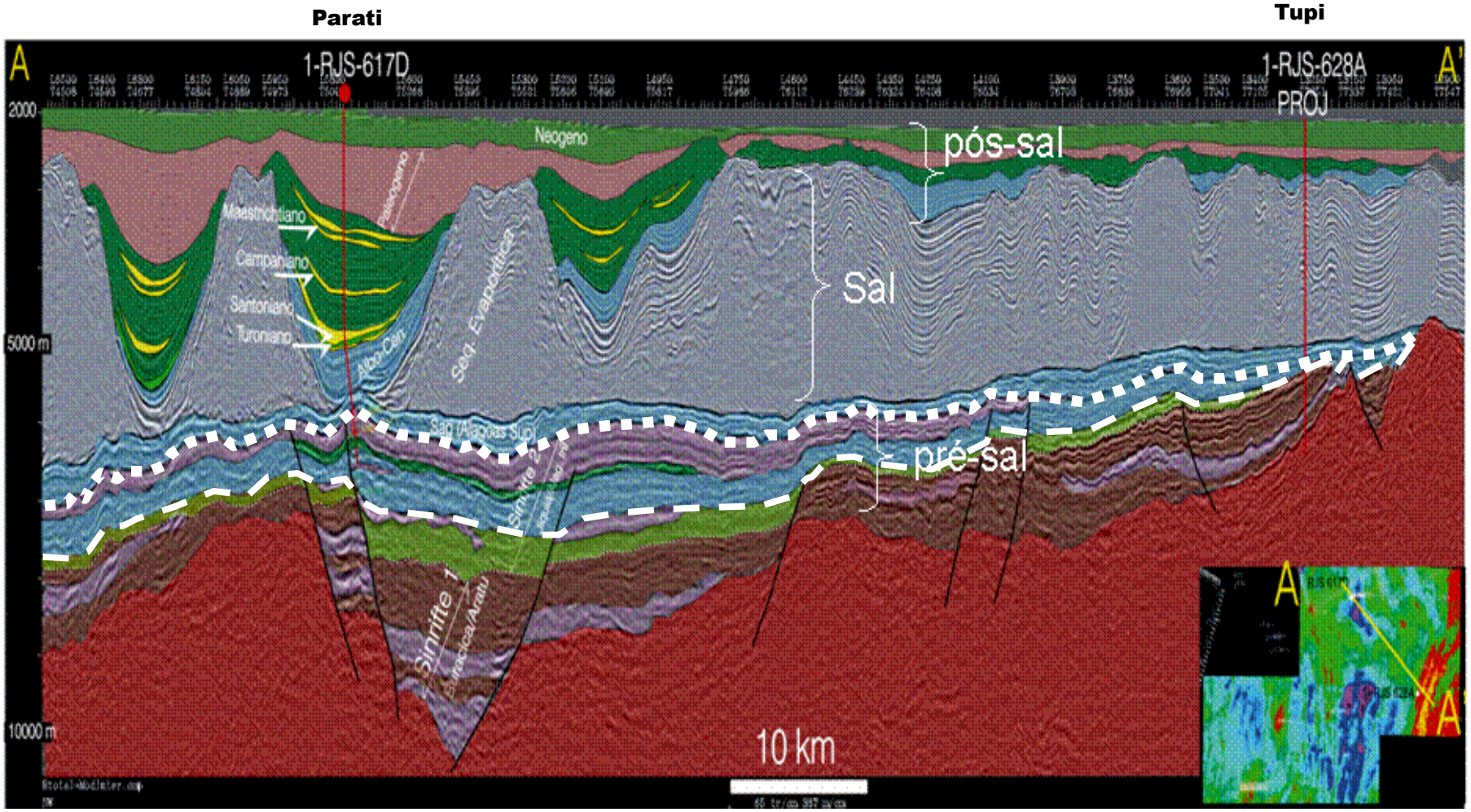
Total: extensive deep offshore expertise

TOTAL

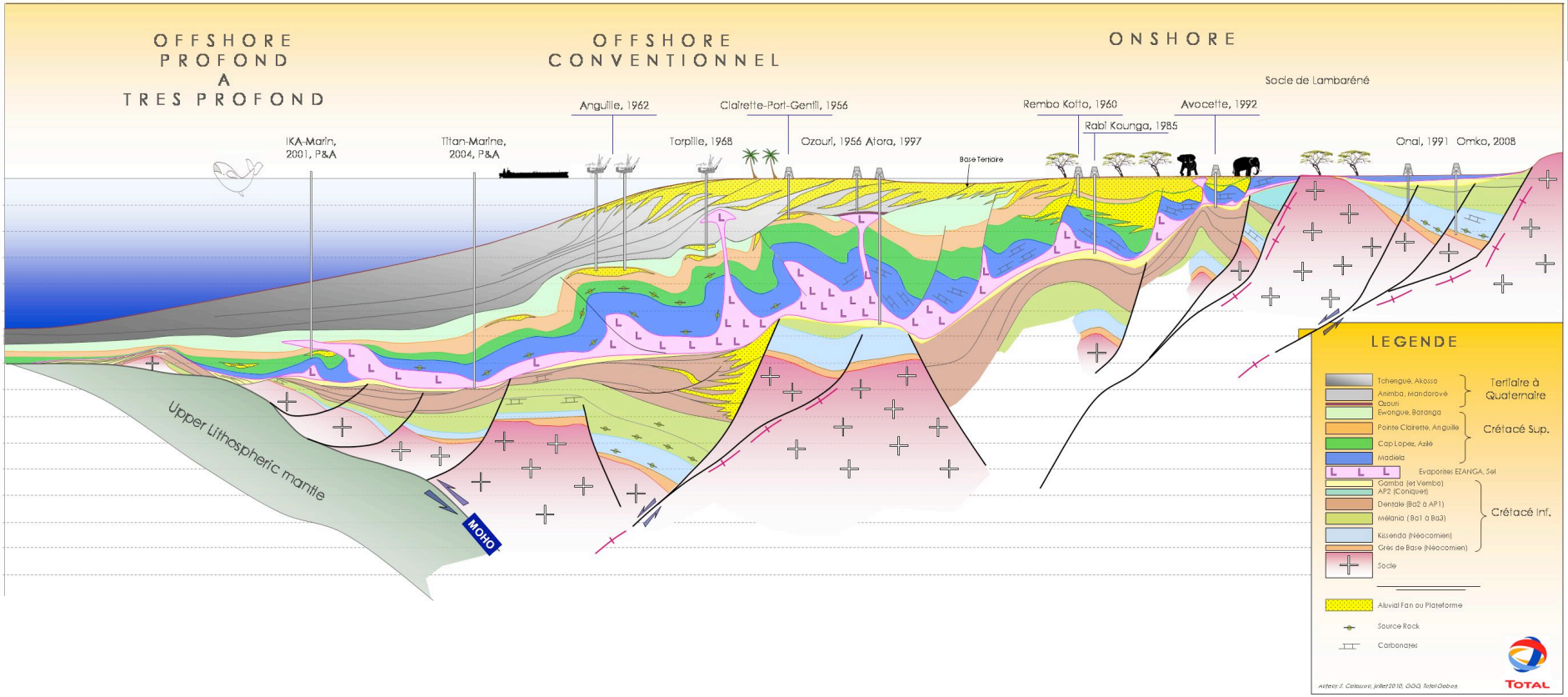
Gabon main exploration domains



from PETROBRAS publication



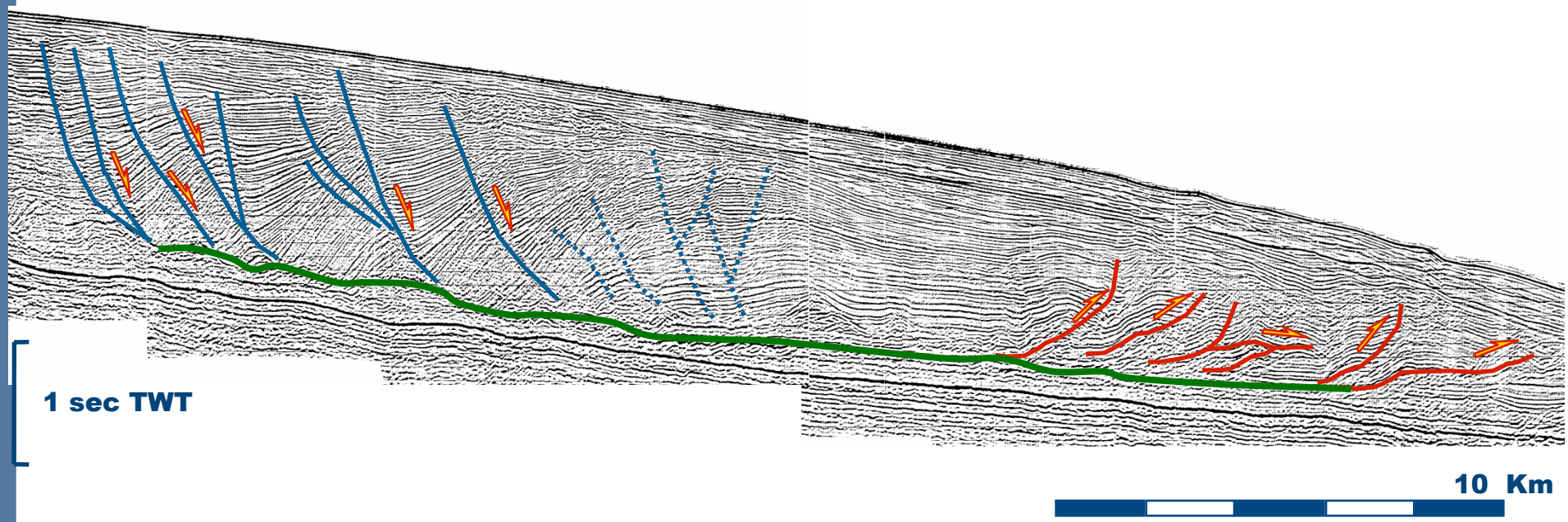
Gabon main exploration domains



Basic concepts in gravity tectonics

Main parameters that control gravity tectonics:

- Mechanical Properties of the Detachment
- Weight of the Sediments above it
- Its Topography



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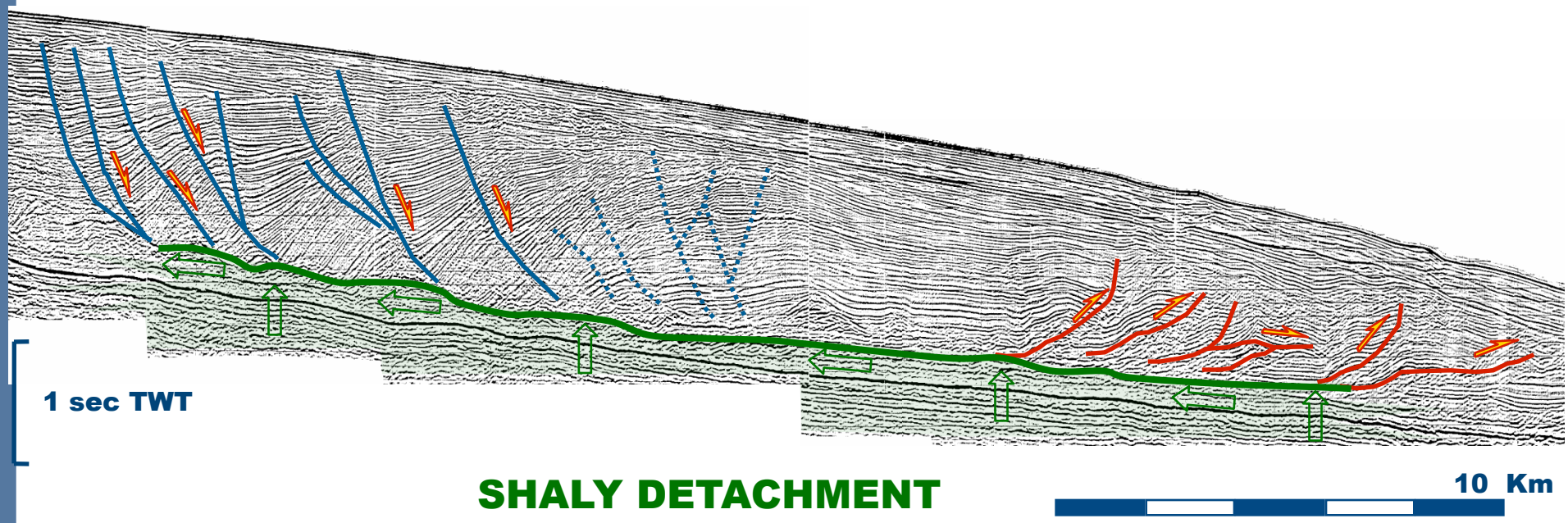

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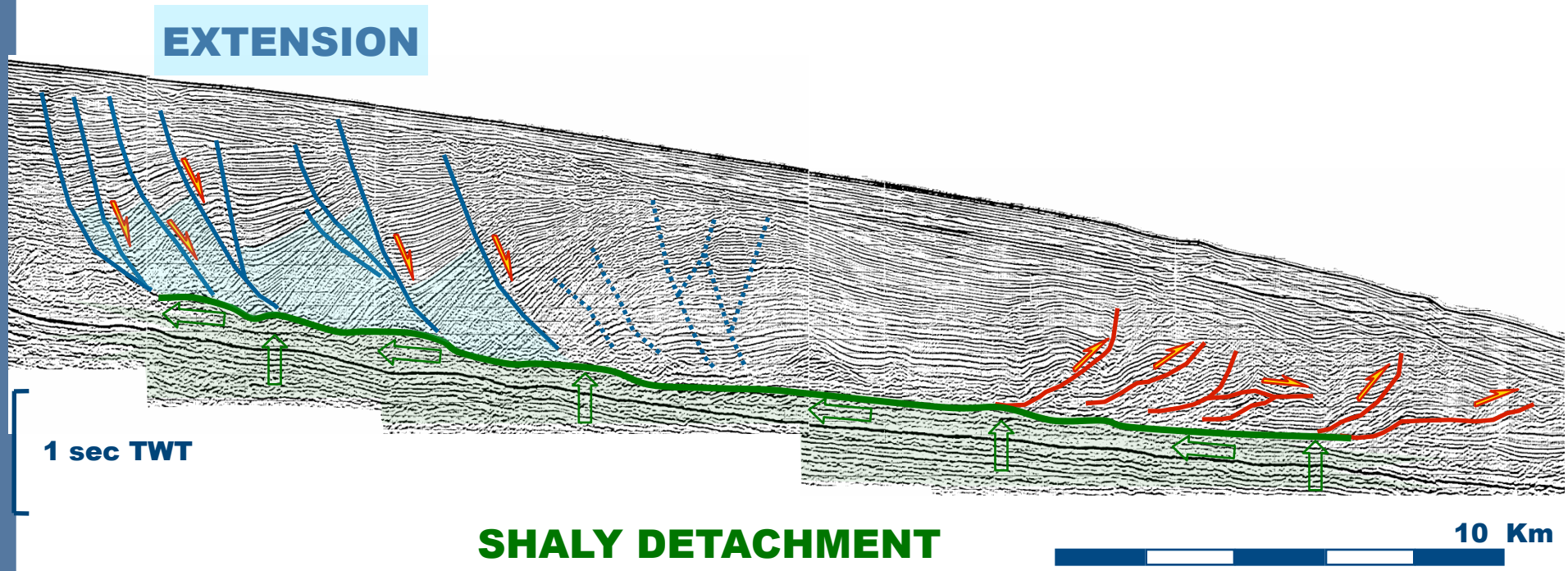

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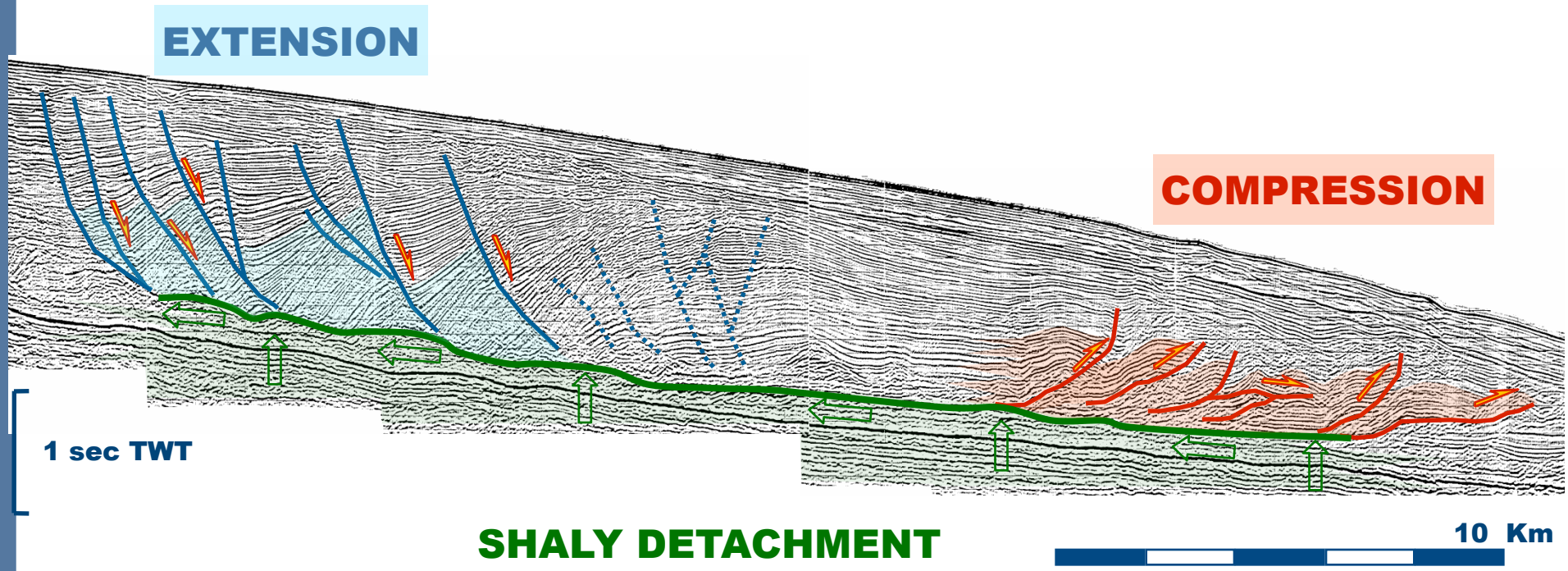

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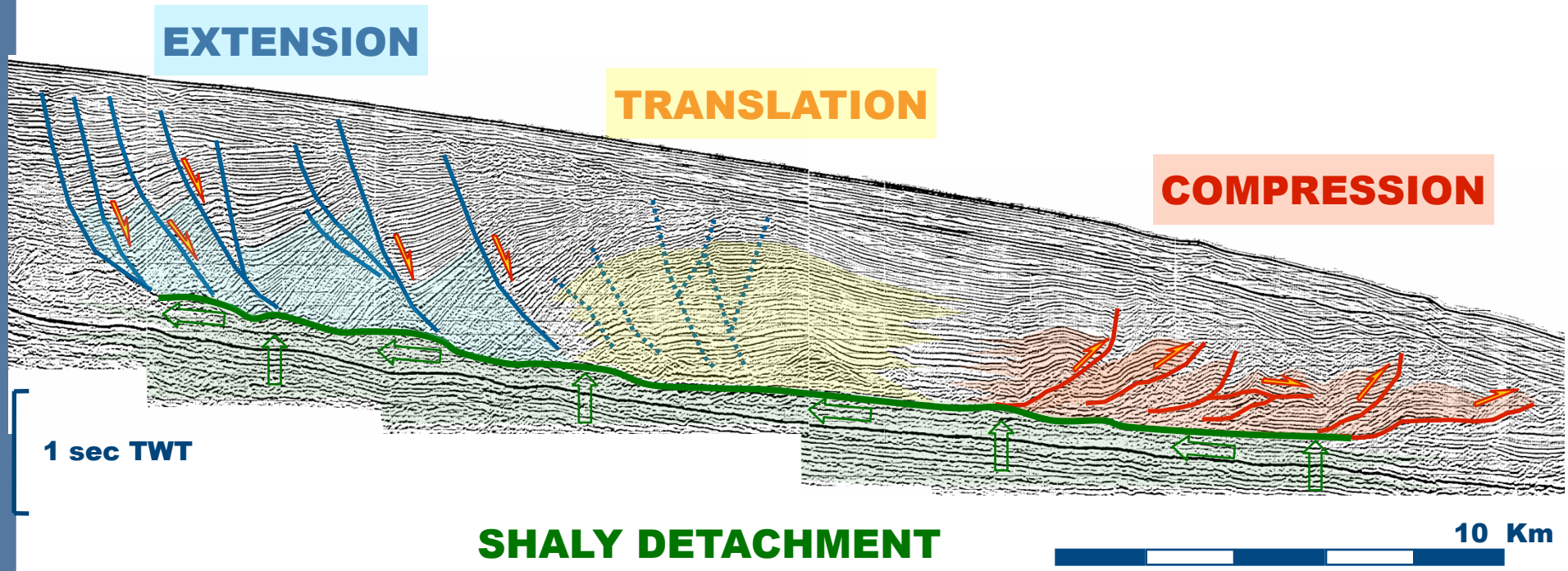

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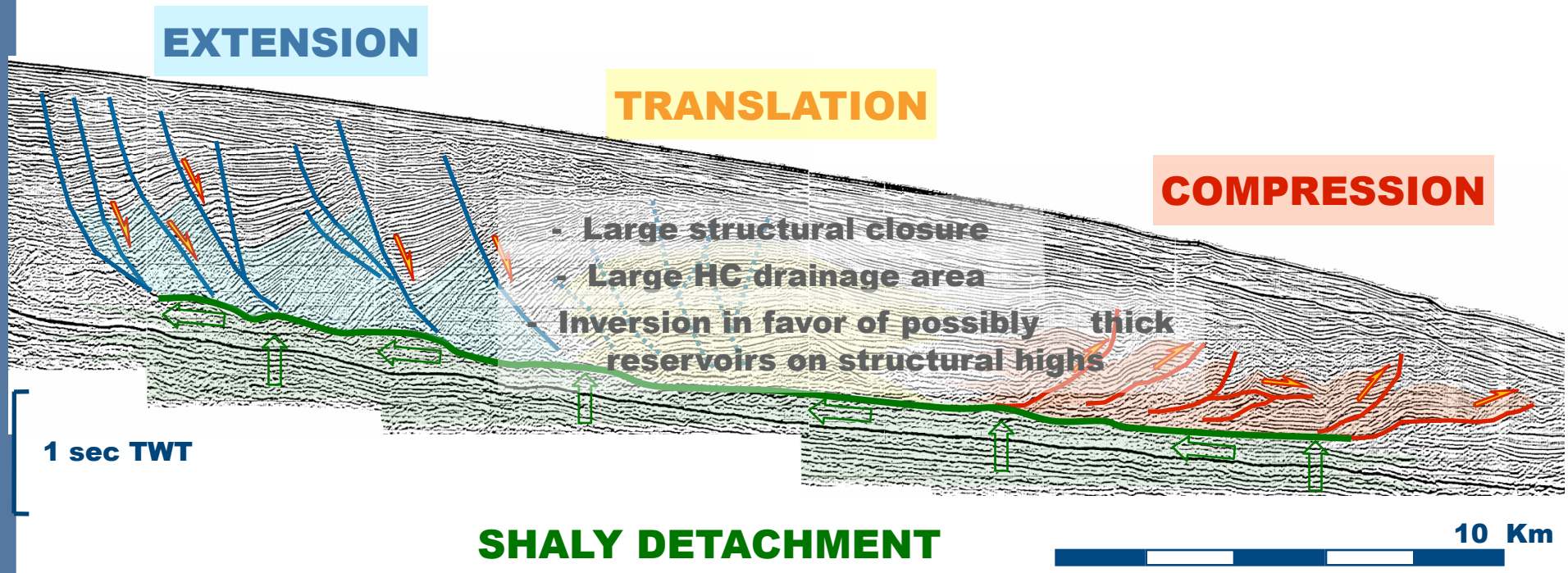
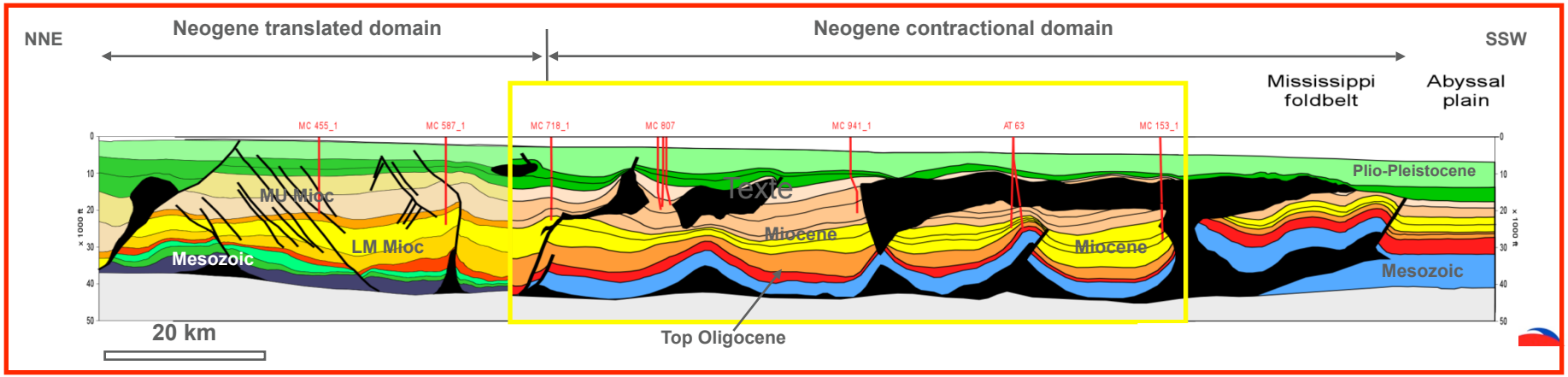


TOTAL

Eastern GoM: exemple of subsalt turtle-back anticlines in a contractional domain



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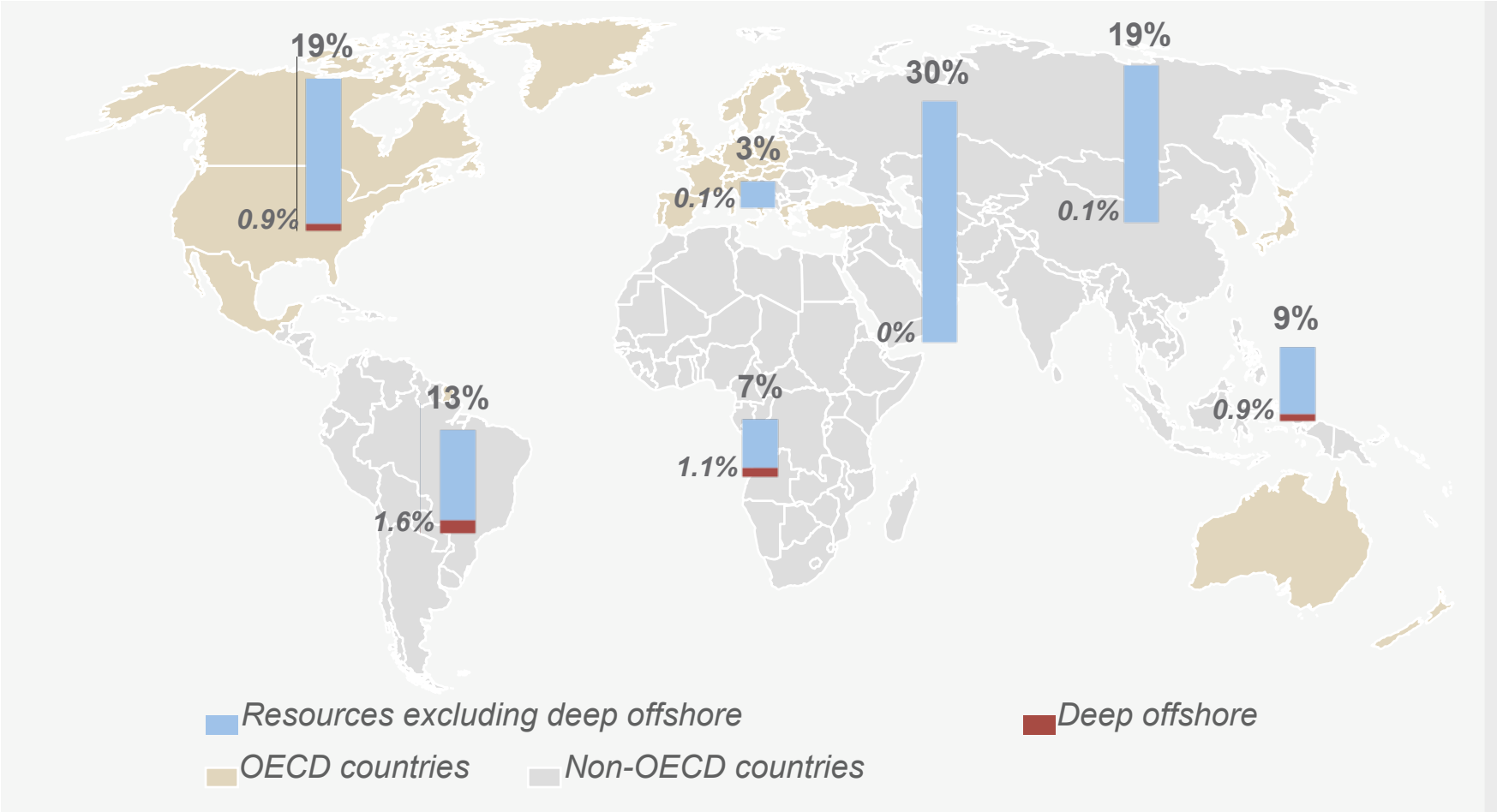
Global oil & gas remaining resources (4000 Gboe)

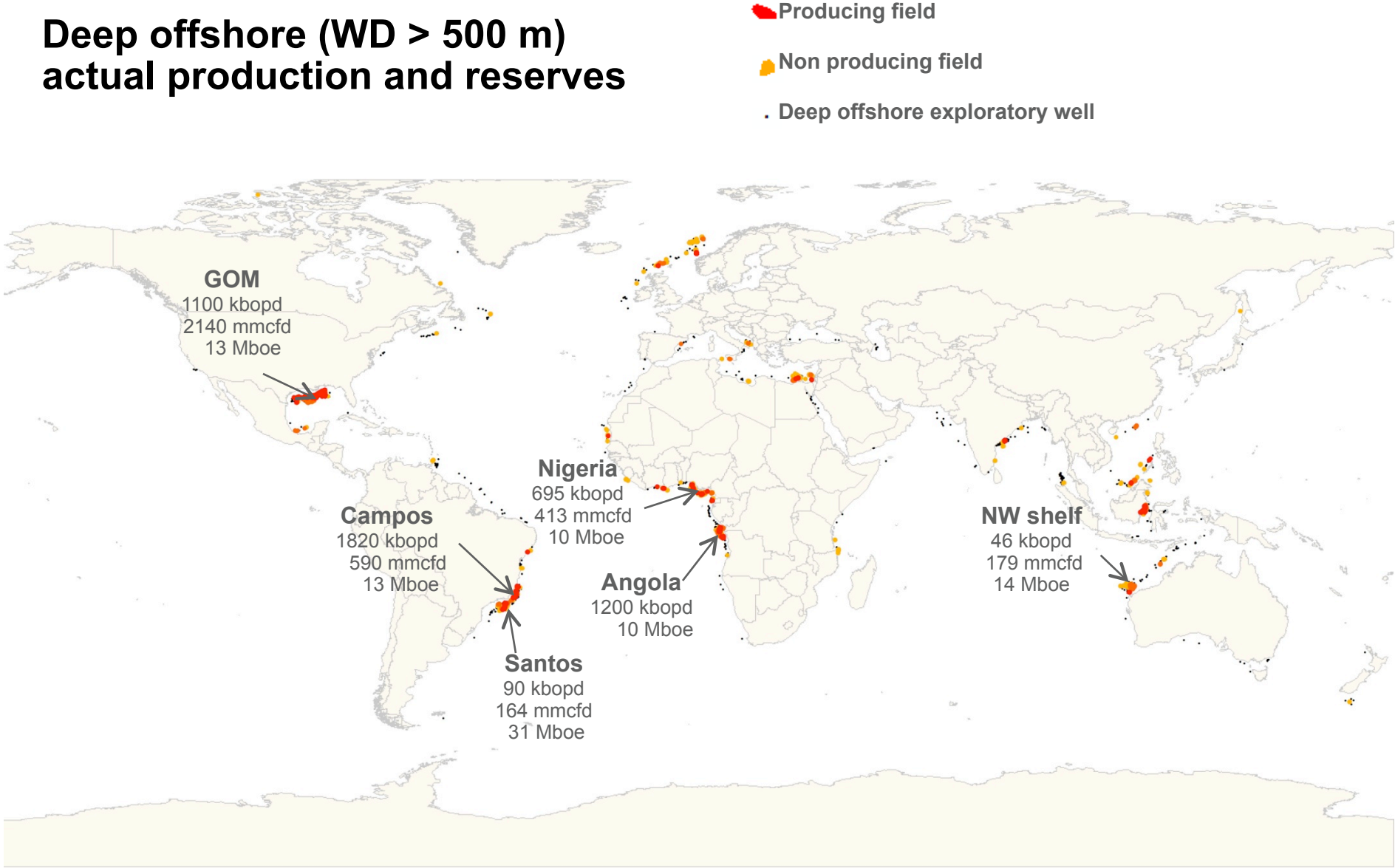
Deep offshore: 5% of global resources*



* excluding oil shale
deep offshore resources : 20% of oil Yet- to-find

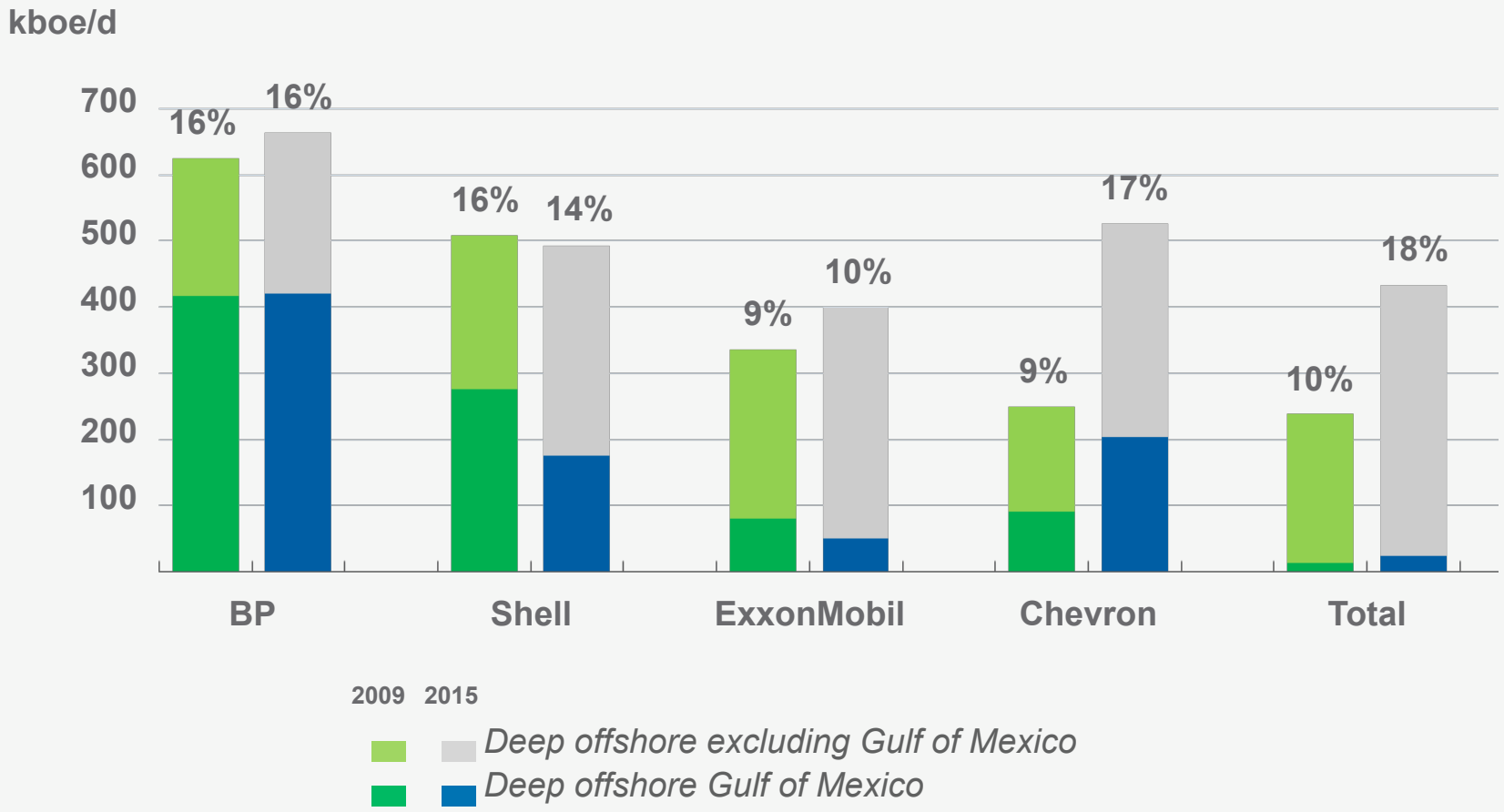
TOTAL

Deep offshore (WD > 500 m) actual production and reserves



Deep offshore production of the majors 2009 & 2015(e)

Share of production in deep offshore

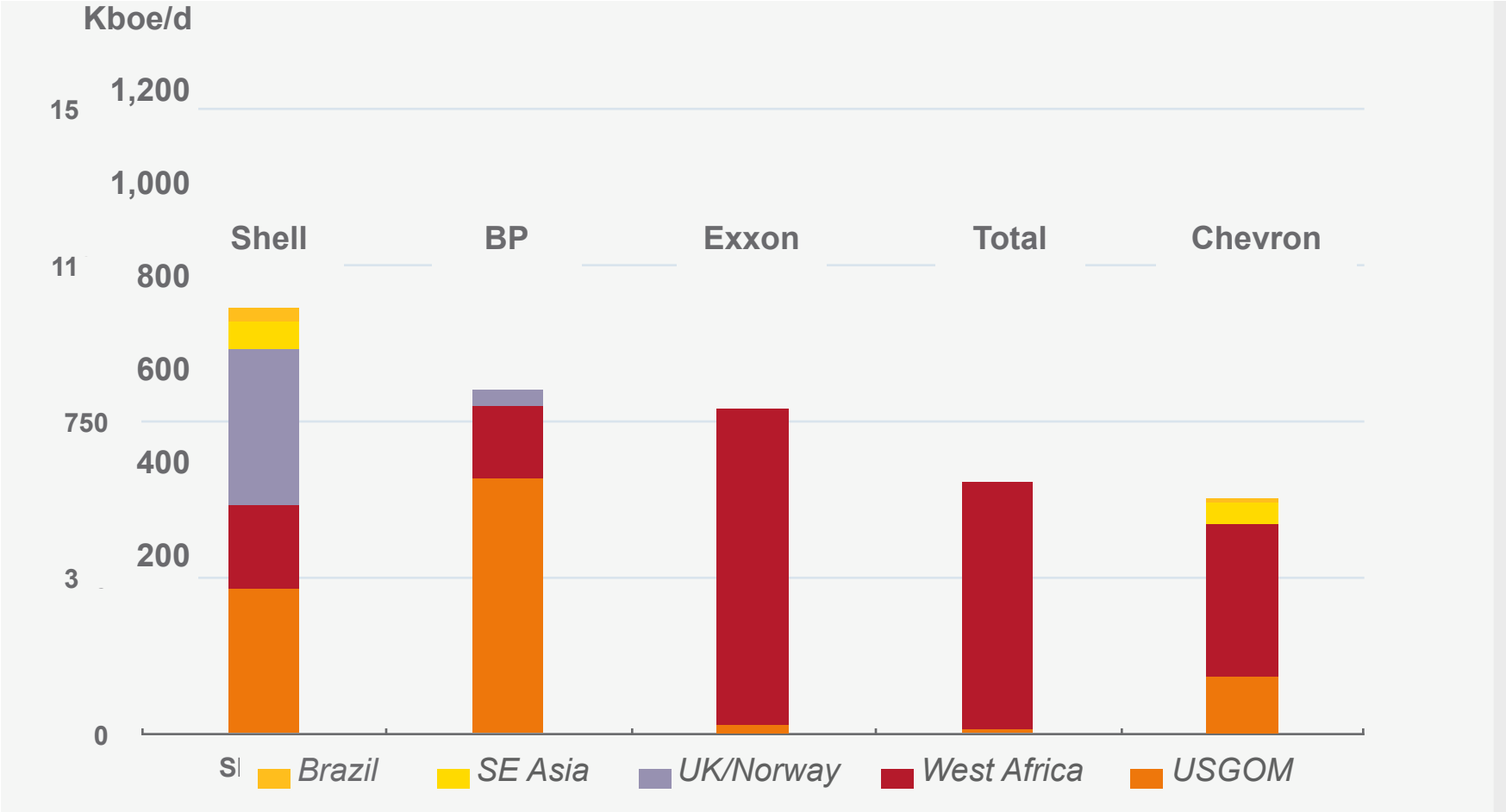


Sources: Total, Wood Mackenzie
KIT E&P septembre 2010

TOTAL

Deep offshore production of the majors 2009

Operated production per company



sources: Total, Wood Mackenzie
- Kit E&P - September 2010

2. Tried and tested expertise to respond to tomorrow's challenges

Deep offshore challenges

Deep offshore challenges

Girassol FPSO during Rosa heavy lifts

Reduce development costs

TOTAL

Deep offshore challenges

Girassol FPSO during Rosa heavy lifts

Reduce development costs

Produce remote / small fields

All Electrical Systems, K5F, North Sea (all-electrical Xmas tree installation)

Pazflor Gas/Liquid separator

TOTAL

Deep offshore challenges

Girassol FPSO during Rosa heavy lifts

Reduce development costs

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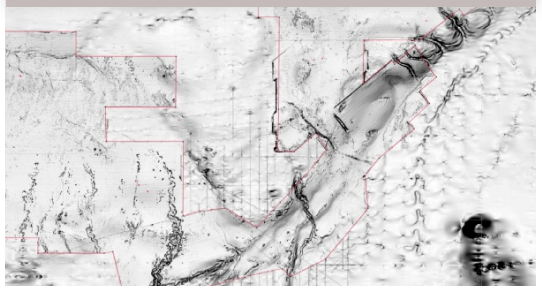
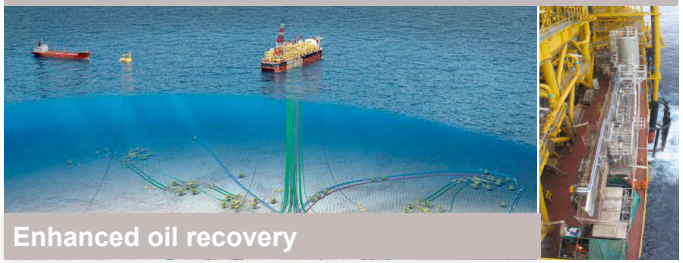
Prepare maturity of assets

Knowledge and monitoring of geohazards, ERIG 3D



Dalia polymer injection skid, Deep offshore, Angola



Enhanced oil recovery

TOTAL

Deep offshore challenges

Girassol FPSO during Rosa heavy lifts

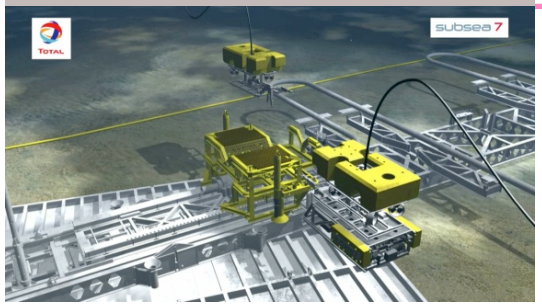
All Electrical Systems, K5F, North Sea (all-electrical Xmas tree installation)

Reduce development costs

Produce remote / small fields

Pazflor Gas/Liquid separator

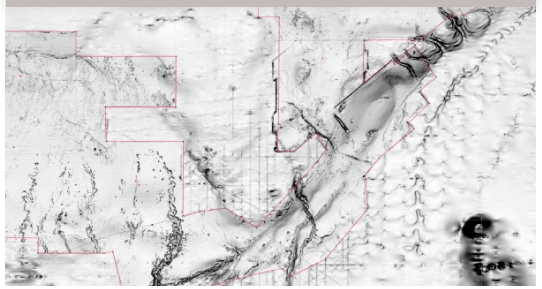
Success of Water Injection line I15 repair – Girassol



Ensure reliability, operability & maintenance of producing assets

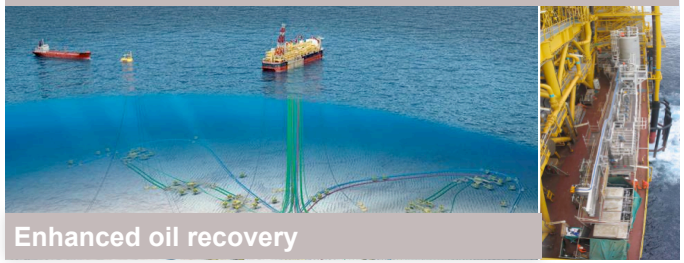
Prepare maturity of assets

Knowledge and monitoring of geohazards, ERIG 3D



AUV Swimmer

Dalia polymer injection skid, Deep offshore, Angola



Enhanced oil recovery

TOTAL

Deep offshore HSE: a paramount priority

- **HSE awareness on FPSOs**
  - Daily “Safety talks” attended by all teams
  - Regular campaigns to inform
  - Targeted training programs

- **Energy efficiency: from Girassol to CLOV a series of improvements have been made in the energy efficiency of equipment installed on the FPSO**
  - Aeroderivative turbines
  - All-electric energy architecture
  - Speed variators
  - Waste-heat recovery units (WHRU) on gas turbine exhaust outlets
  - Vented gas recovery units (VGRU) on wash tanks and boilers
  - Flared gas recovery units (FGRU)

TOTAL

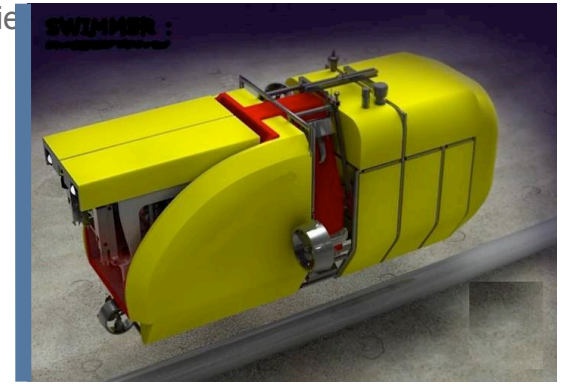
Technological know-how: Production

- **From bottomhole to surface**
  - One of the most critical challenges of the deep offshore: assuring the smooth flow of the fluids from the reservoir to the floating support vessel
- **Continuous optimisation of hydrate prevention**
  - Innovate to contend with the challenge of long-distance subsea tie-ins
- **Subsea processing: initiating a daring strategy with Pazflor**
  - Subsea gas/liquid separation, a decisive step for the future
  - For artificially lifting heavy oils: new-generation pumps, coupling multi-phase and centrifugal technologies
- **Gigantic production units: FPSO**
  - Perfecting the design of these floating behemoths that ensure four functions: production, treatment, storage and export

TOTAL

Tomorrow's challenges: Overcoming the barriers of long distances

- **Going further with multi-phase transport or subsea separation**
  - At present: production loop, 20 km
  - Tomorrow: alternative (solutions, up to 50 km) development schemes capable of connecting satellite fields more than 50 km away from production hub
  - Further in the future: subsea to shore scheme for vey long tie-backs in harsh environment
- **Innovative development schemes**
  - Hybrid loop, electrical heating, gas/liquids separation, cold export
- **Subsea processing: moving towards the "all-electric"**
  - Compared with hydraulic systems: reliable, environmental impact better controlled, faster and more accurate steering, real-time monitoring, lower development costs for long subsea tie
  - E.g. K5F
- **Managing the facilities' maturity**
  - Swimmer: a new Hybrid AUV/ROV for Inspection, Maintenance and Repair
  - RACS: "Riser annulus condition surveillance system" field test on the FPU Alima. RACS is an innovative tool for monitoring the annuli of flexibles (real-time detection of damage to a flexible's annulus), but also for monitoring the liquid level in the annulus of the flexible in production.



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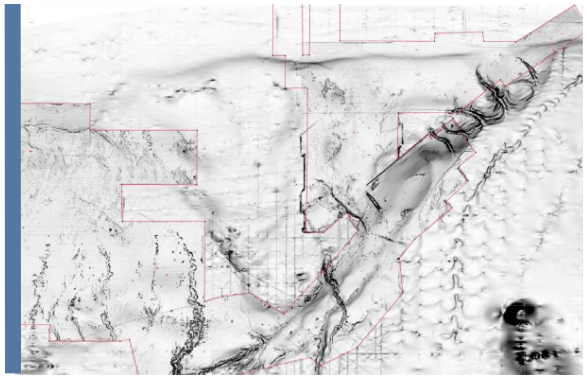
3. Commitments and responsibility

Environment and safety

- **Preserving the biodiversity of the deep offshore**
  - Preliminary studies: environmental base-line study including an inventory of subsea fauna
  - Total-Ifremer partnership ongoing since 1999
    - 1999 - 2005: Biozaire (Angola-Congo-Gabon)
    - 2008: oceanographic reconnaissance campaign offshore Nigeria
    - Congo: monitoring of marine mammal movements

- **Managing the risks of the deep offshore**
  - Identify the geohazards to guarantee the safety of our installations
    - 1998: Zaiango with Ifremer (Angola-Congo-Gabon)
    - 2003-2004: Neiris campaign (Nigeria)
    - 2008: ERIG 3D (Nigeria)



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Environment and safety

- **R&D works on**
  - The ageing of installations: monitoring, calculation models for hulls, anchoring devices and risers
  - Gas hydrocarbon propagation models via the use of analogues in the natural environment
  - Dropped objects module
  - Identification of the specific risks of a blowout in the deep offshore

Backing the sustainable economic growth of the host states

- **Sharing technological know-how**
  - Local recruitment and training
    - Akpo: stepping up the "Nigerian content"
    - Usan: accelerating technology transfers
    - Egina: involving local companies in basic engineering
- **Supporting the growth of the local industrial structures**
  - Building lasting infrastructures
    - Angola: construction of the Dande industrial base in 2005
- **Helping local communities**
  - Improving access to health services in rural areas
    - Angola: developing access to healthcare and training local personnel (midwives, nurses)
- **Opening doors to new business opportunities for the NOC**

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