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# Oil & Gas

**Energy at Birmingham**

**July 8th 2011**

# Primary Stages of Oil Production

- Desk study to identify favourable geology
- Exploration seismic survey
- Exploratory drilling
- Appraisal for economic feasibility
- Facility development and production
- Crude oil and gas processing
- Distribution to pipeline

Hydrocarbon Exploration (Petroleum Geology)

Materials for Deep Water Production

Oil & Gas Energy Initiative

Advanced Oil Recovery Technology

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# Hydrocarbon Exploration (Petroleum Geology)

T Reston / S Jones
Geography, Earth and Environmental Sciences

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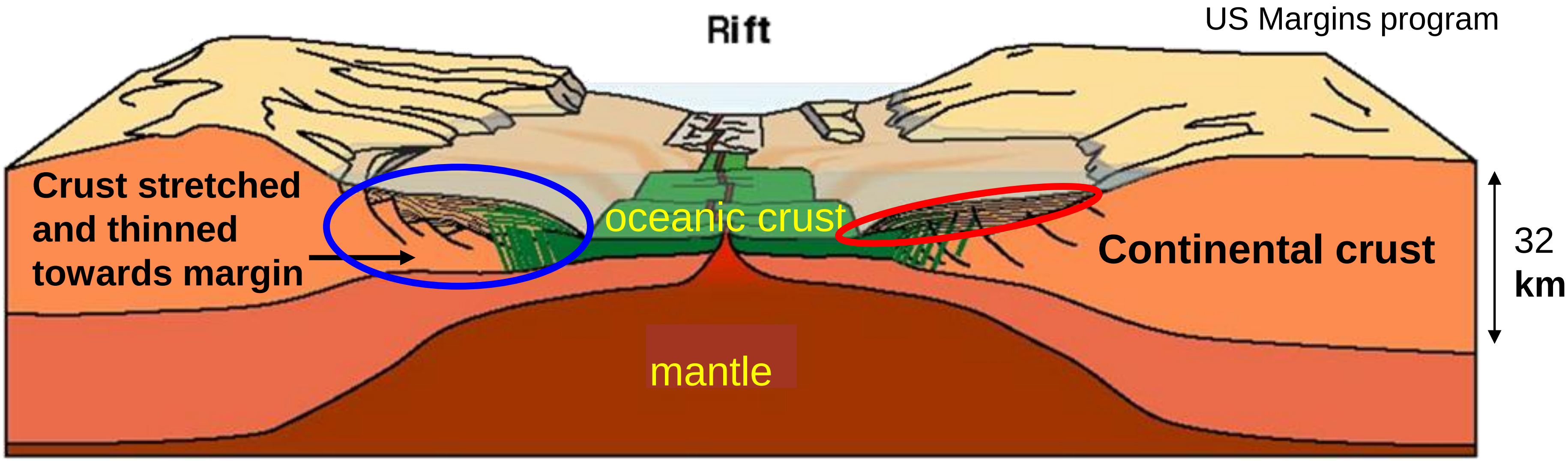
# Continental breakup to form an ocean



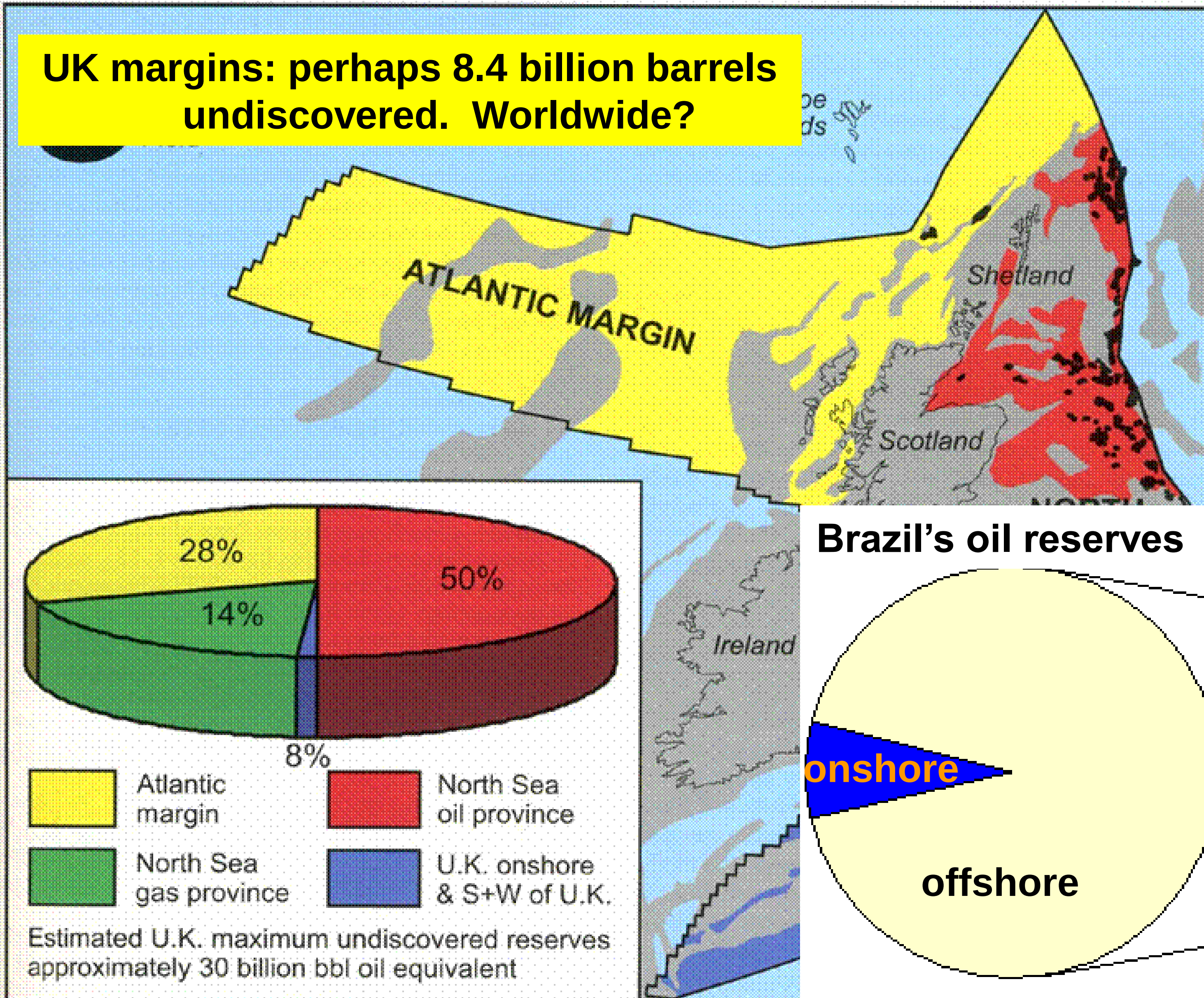

- Stretching causing crustal thinning and separation and eventual formation of oceanic crust by melting of underlying mantle
- rifted margins are trailing edge of broken, stretched continental crust
- are sites of deposition of thick sediments where oil can form and accumulate
- The final frontier in hydrocarbon exploration

Tim Reston (t.j.reston@bham.ac.uk), Steve Jones, GEES

# Reserves at margins

Source: DTI website 2007

**UK margins: perhaps 8.4 billion barrels undiscovered. Worldwide?**




## Brazil's oil reserves

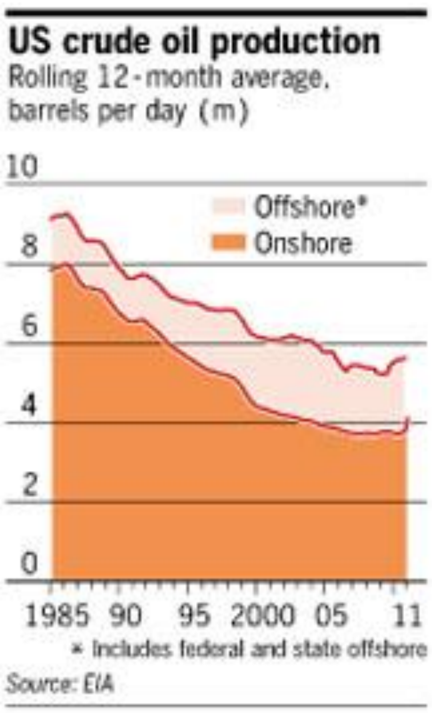
onshore

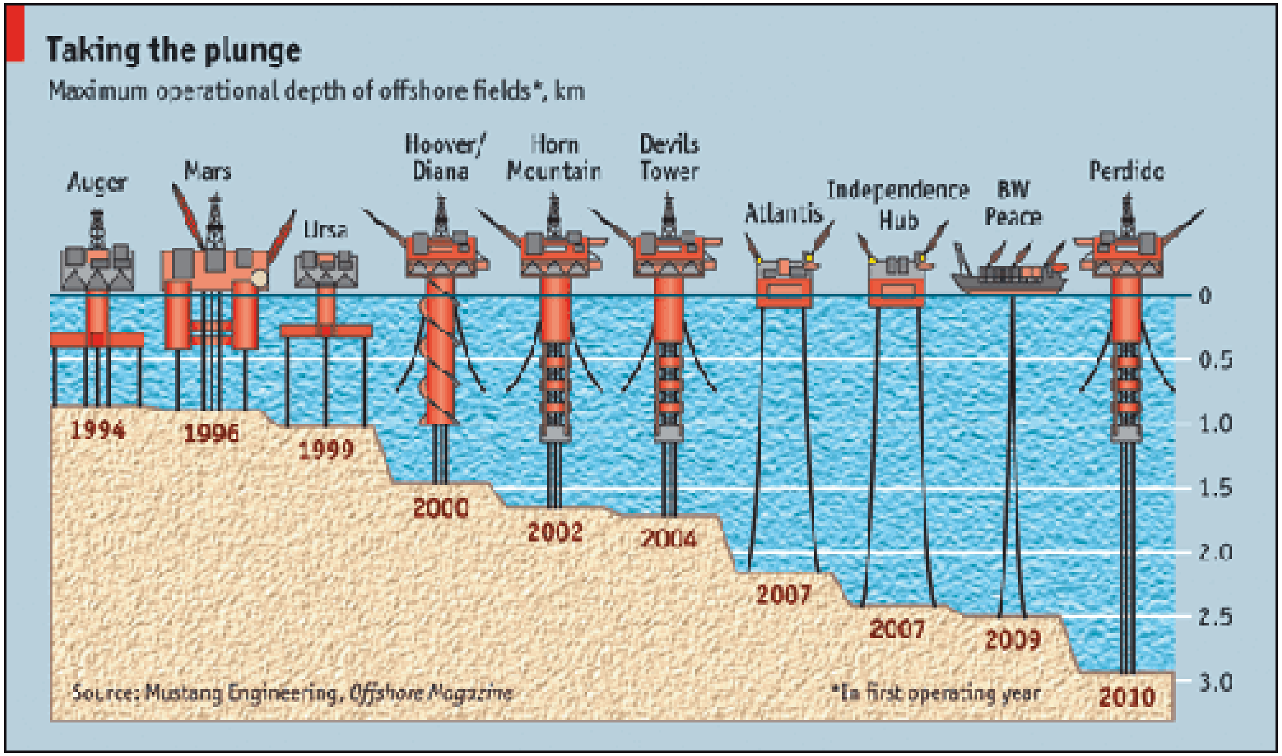
offshore

Currently estimated at 123 billion barrels mostly offshore – was 10 billion barrels in 2005.

Tim Reston (t.j.reston@bham.ac.uk), Steve Jones, GEES

# Oil exploration moving offshore into deep water



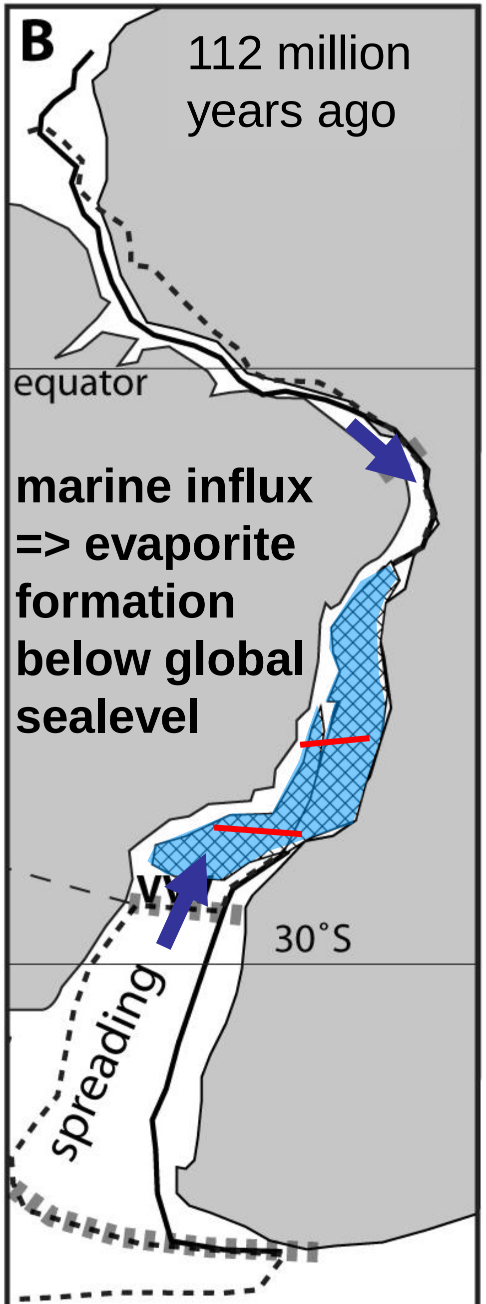

US production onshore decreasing steadily

but offshore (margins) increasing to 2 million barrels a day despite Deepwater Horizon disaster.

**Important to understand formation of rifted margins to minimise risk**

**Tim Reston (t.j.reston@bham.ac.uk), Steve Jones, GEES**

# Geological puzzles at rifted margins

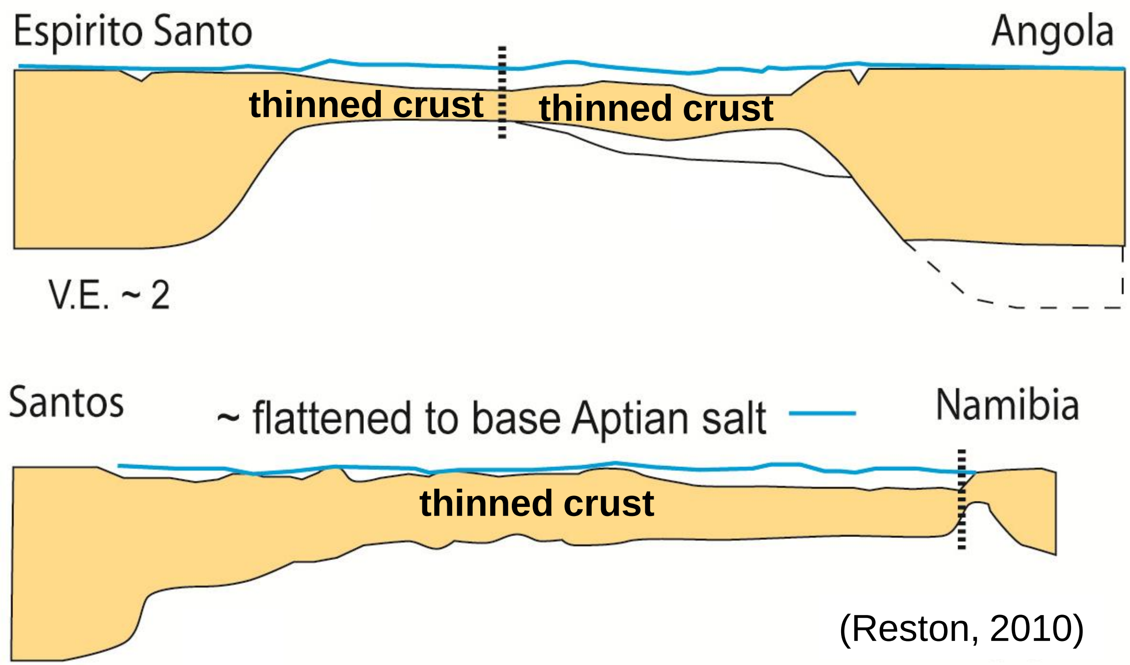



**How is the crust thinned so much?**

- massively stretched along many faults?
- or deep crust somehow removed / displaced elsewhere?
- implications for distribution of oil source rocks and of reservoir rocks

**Can deep rift form separated from global ocean?**

- allows accumulation of **thick salt deposits** to trap oil




(Reston, 2010)

**We address these fundamental questions about the opening of the S Atlantic and other margins.**

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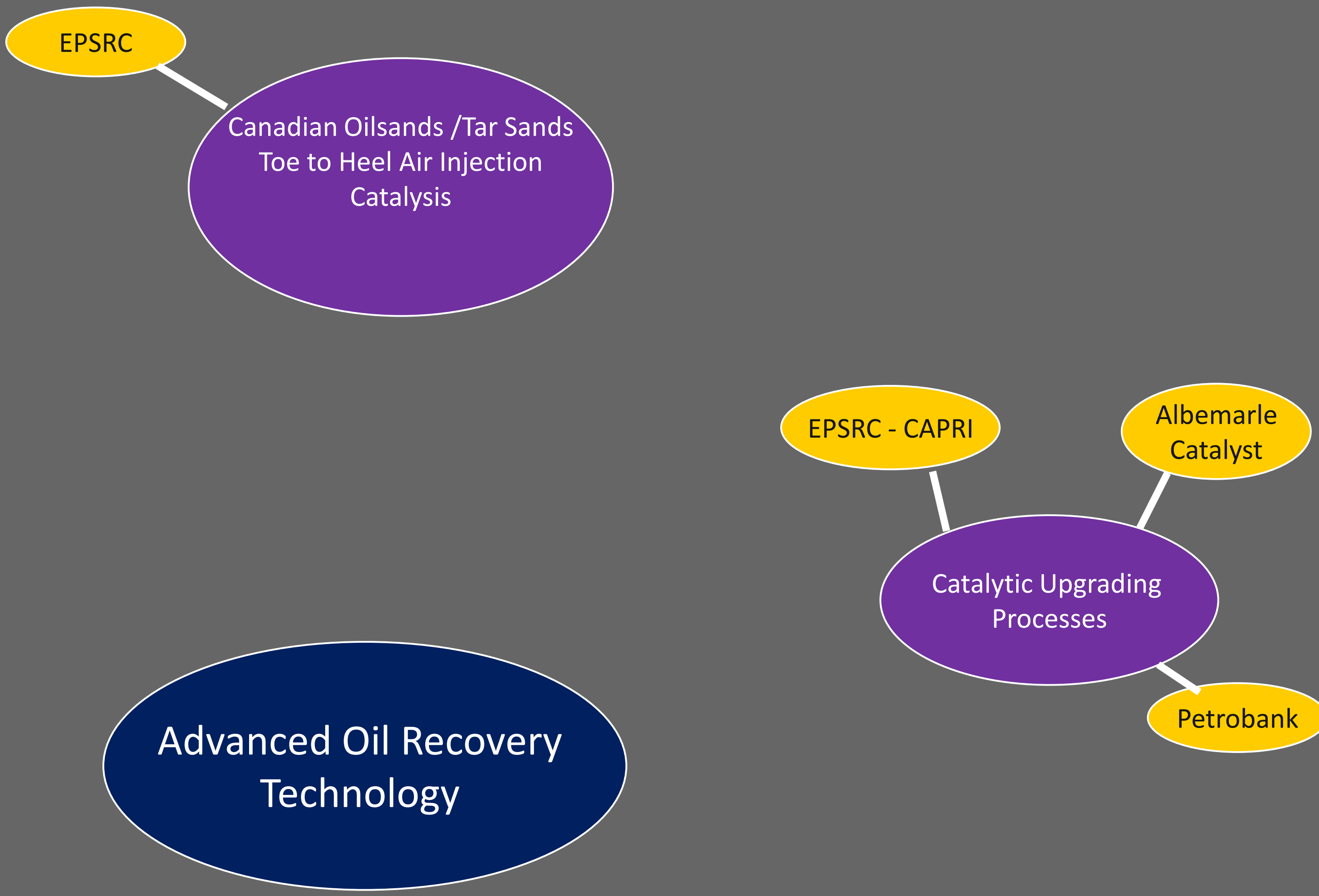


J Wood
Chemical Engineering

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# Major Heavy Oil and Bitumen Sources

Heavy oil and bitumen is dense and viscous, but could be used as a transport fuel if considerably upgraded

Extraction by surface mining is environmentally damaging

| **Heavy Oil** | | |
|---|---|---|
| **Rank** | **Region** | **Total BBO in place** |
| 1 | Arabian | 842 |
| 2 | Eastern Venezuela | 593 |
| 3 | Maracaibo | 322 |
| 4 | Compeche | 293 |
| 5 | Bohai Gulf | 141 |

| **Bitumen** | | |
|---|---|---|
| **Rank** | **Region** | **Total BBO in place** |
| 1 | Western Canada Sed. | 2330 |
| 2 | Eastern Venezuela | 2090 |
| 3 | North Caspian | 421 |
| 4 | Volga-Ural | 263 |
| 5 | Maracaibo | 169 |

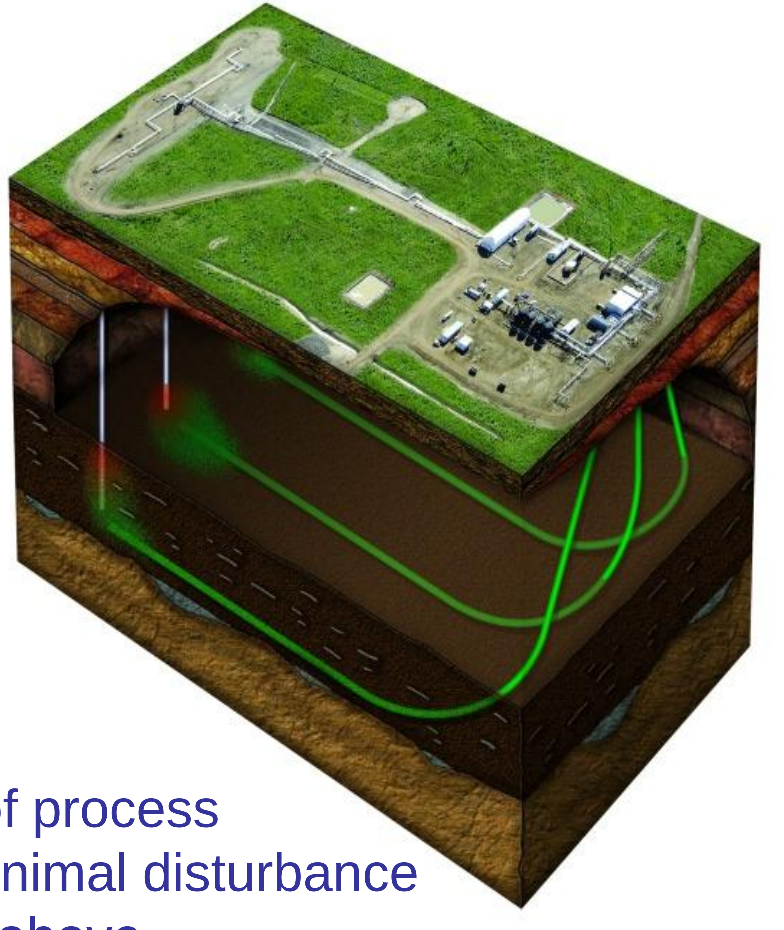
Source: U.S. Geological Survey, 2007

**Joe Wood (j.wood@bham.ac.uk), EPS – Chemical Eng**

# Toe to Heel Air Injection (THAI) Catalytic Process *In-situ* (CAPRI)

## *In-situ* Techniques for Heavy Oil Recovery*

- Simple technology with ease of control
- Very high recoveries of up to 85% oil in place
- Uses less energy than steam-based techniques
- In-situ upgraded oil with virtual elimination of heavy metals
- Suitable for almost all of the reservoirs previously ruled out to be unrecoverable
- Field trials Petrobank - Whitesands Project

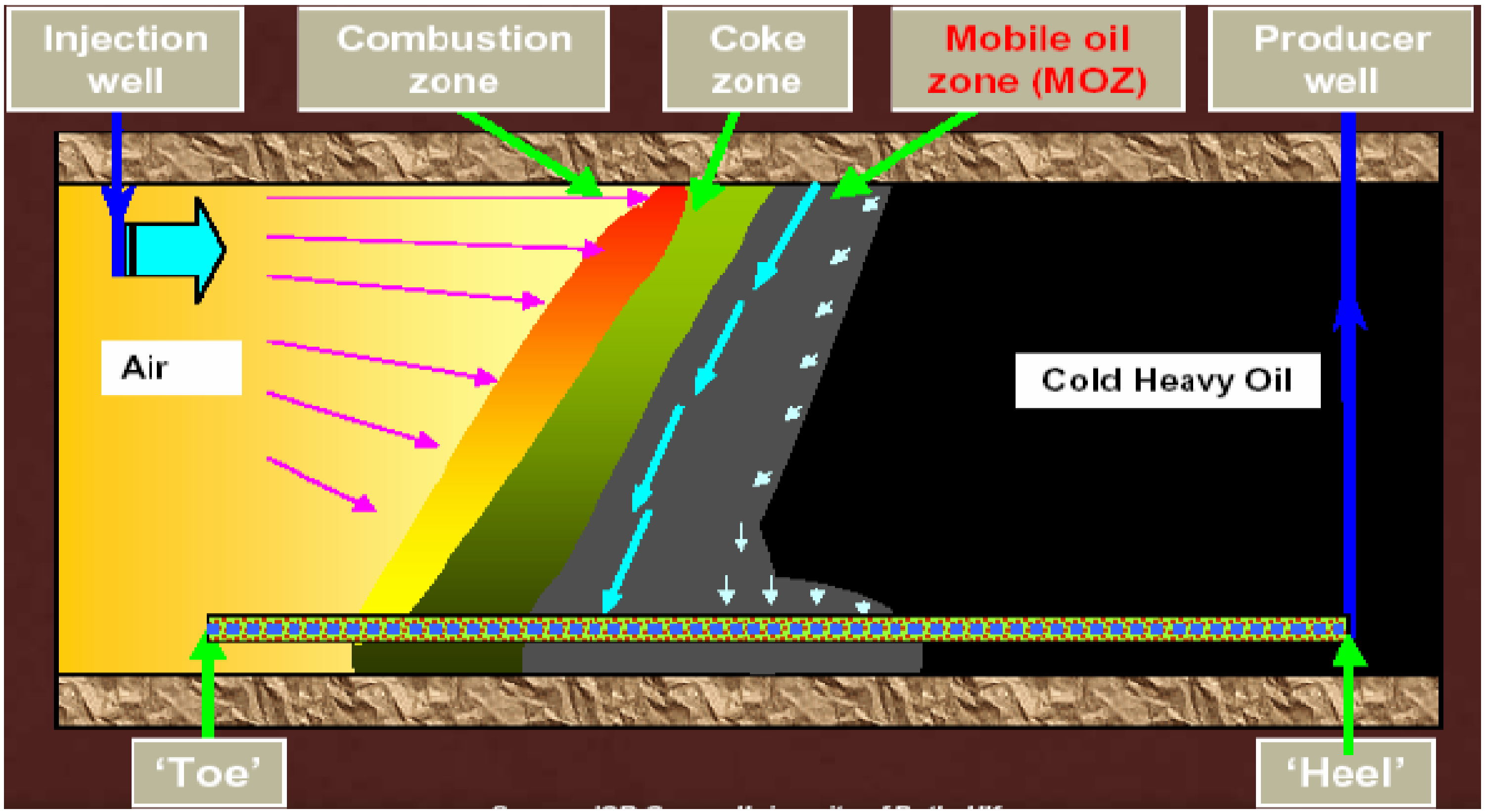


Cut-away of process showing minimal disturbance of the land above

*M. Greaves and T. Xia, 2001 collaborator, Univ. of Bath

# THAI/CAPRI in action (Canada)

A catalyst is packed into the well to achieve upgrading of oil *in-situ*
Typical catalysts include refinery CoMo and NiMo with alumina support

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# Objectives of Experimental Work

- Optimise the catalyst design: Pore structure, pellet size, surface properties
- Investigating catalyst deactivation
- Understanding the overall mechanism of upgrading of heavy oil/bitumen
- Effect of crude oil containing metals
- Effect of water (water gas shift reaction)

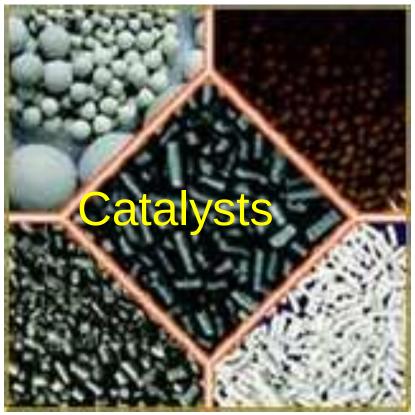
Experimental Upgrading rig in Chemical Engineering

Joe Wood (j.wood@bham.ac.uk), EPS – Chemical Eng

# Preventing carbon deposition and coking

Optimising catalyst acidity to minimize coking

Operate under conditions that minimize coking





Optimising catalyst design

Regeneration

Purifying the feed

not practical with THAI

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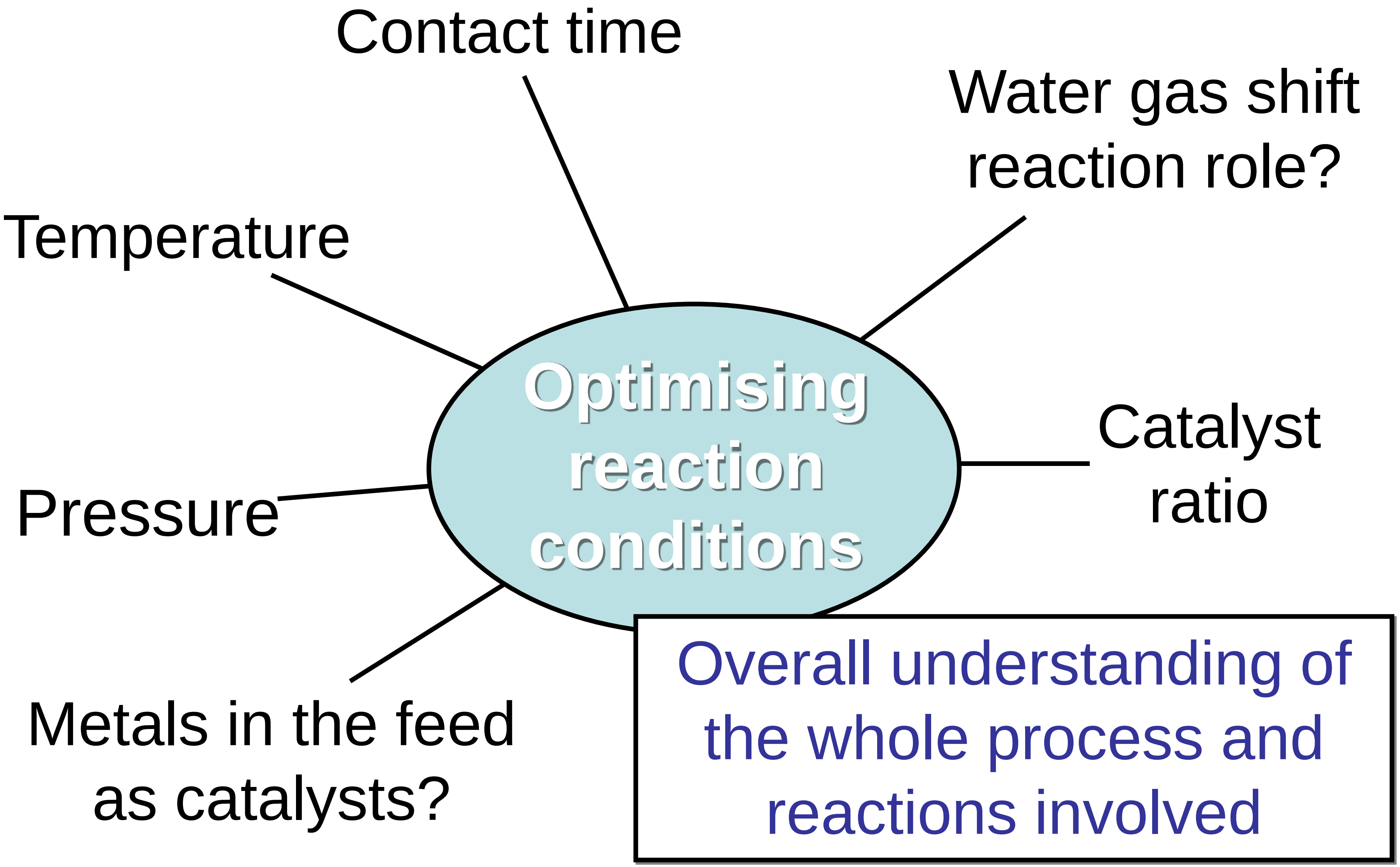
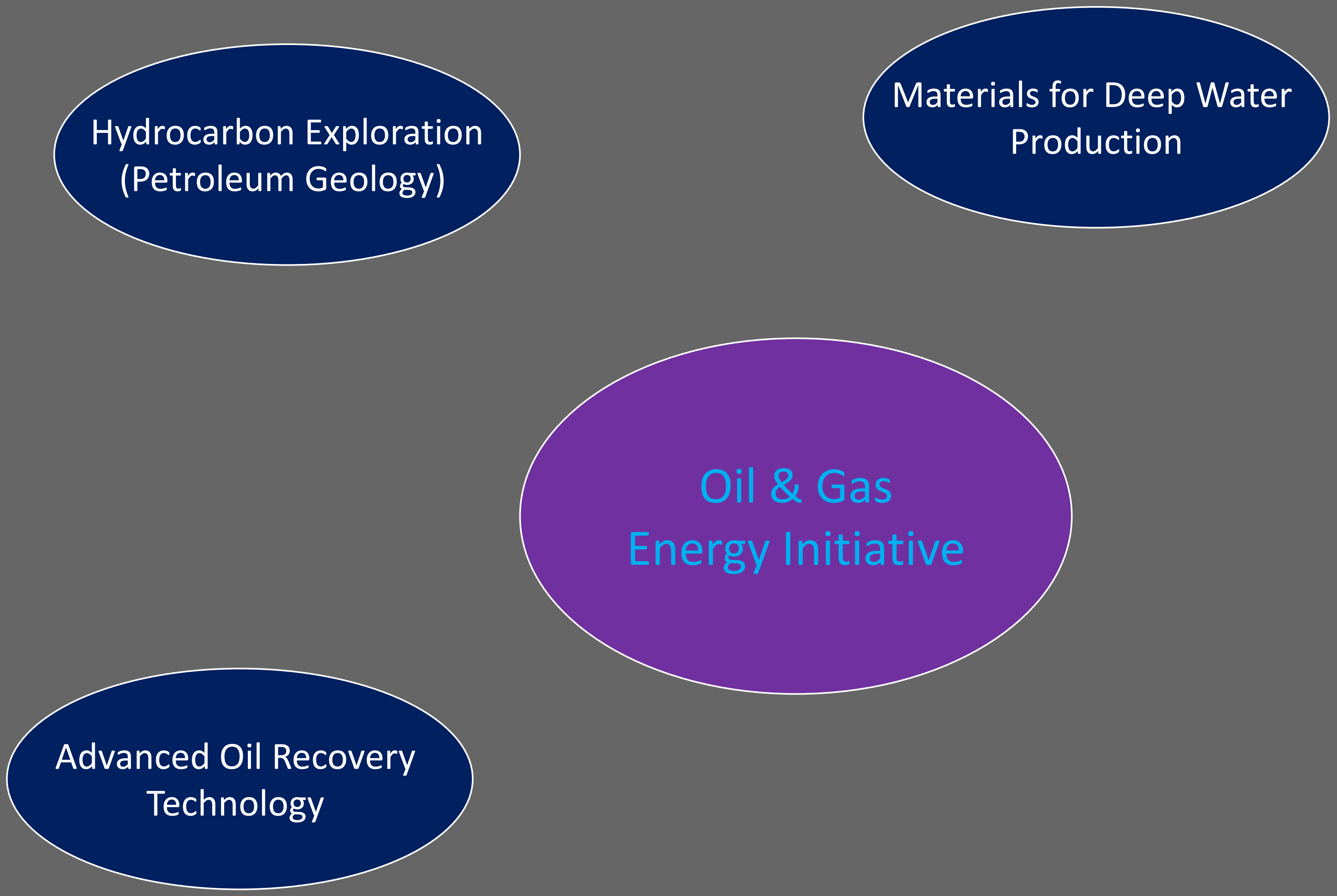

Contact time
Water gas shift reaction role?
Temperature
Optimising reaction conditions
Catalyst ratio
Pressure
Metals in the feed as catalysts?
Overall understanding of the whole process and reactions involved

# Examples of Upgrading Achieved

- Canadian Crude Oil Viscosity 1 – 5 Pa.s
- Viscosity after THAI process 0.58 Pa.s
- Viscosity after CAPRI process may be as low as 0.039 Pa.s
- →Upgraded oil requires less processing in the refinery
- →Easier to transport, requires less diluent
- →Less environmental impact than surface mining.

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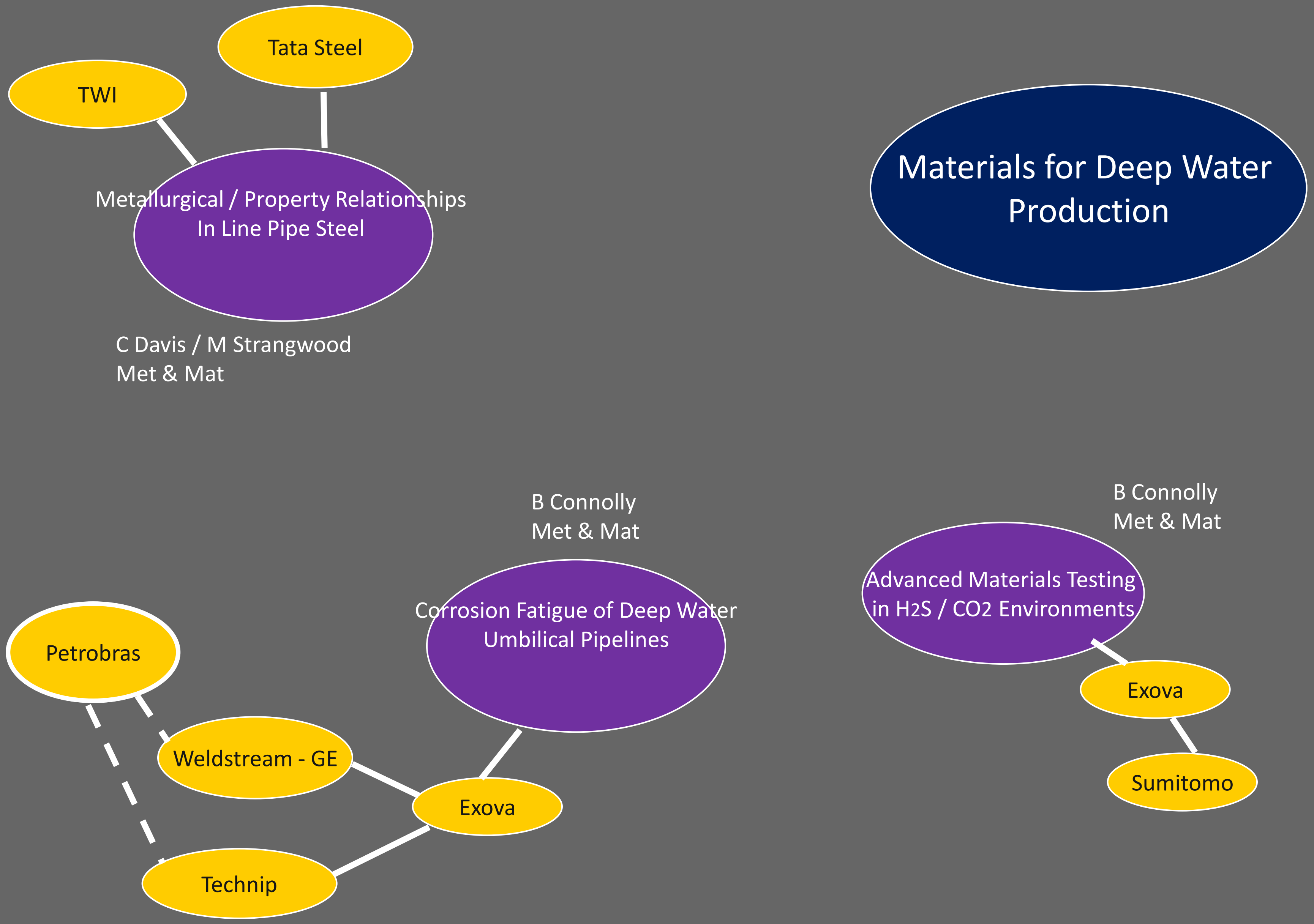


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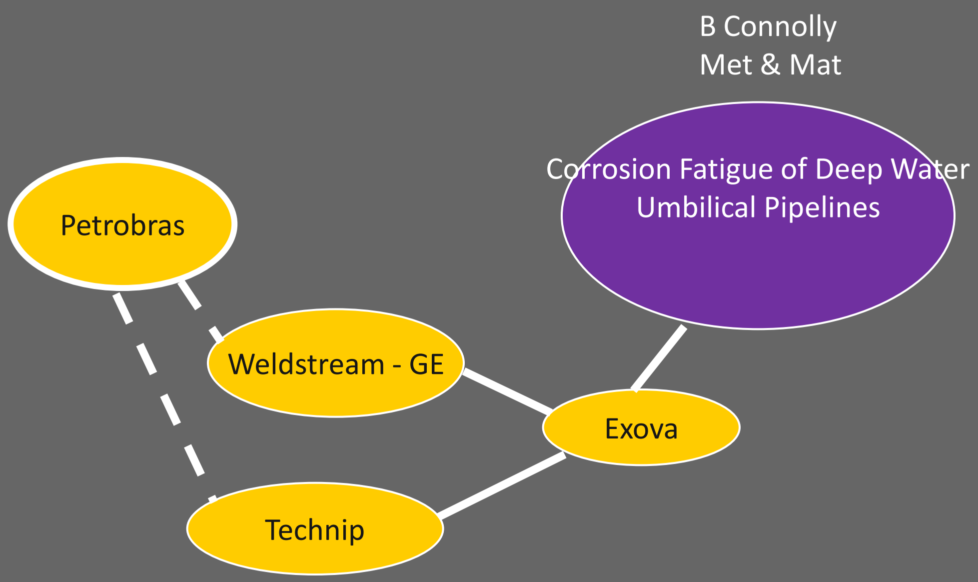
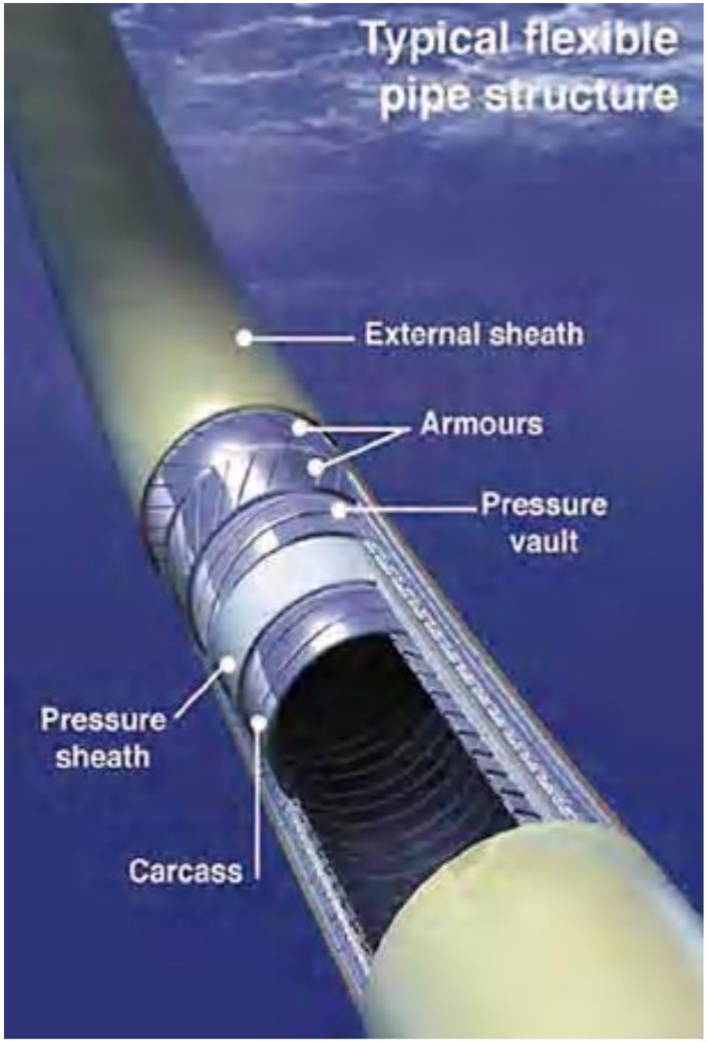
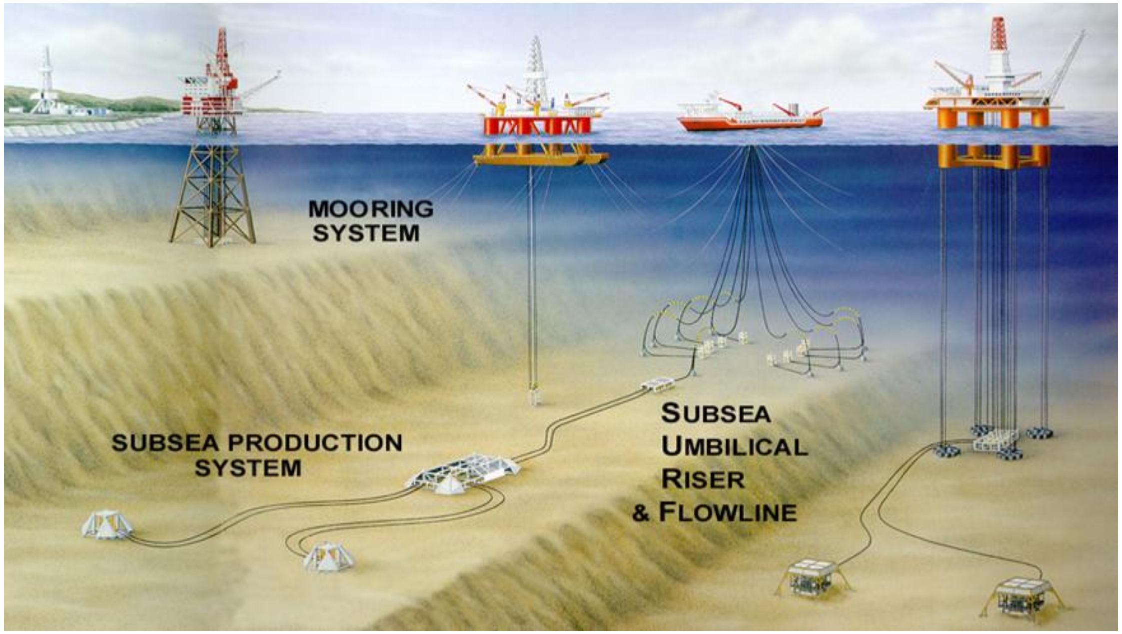
# Materials for Deep Water Production



# Deep Water Platforms Why use Flexible Pipeline/Riser?

- Focus changed from traditional fixed platforms to floating production facilities (FPSO's) in deeper water and marginal fields
- Flexible dynamic risers have allowed this technology to develop
- Relatively easy/quick to install and re-useable when used in marginal fields
- Design of flexible pipe structure can be tailored to specific field conditions

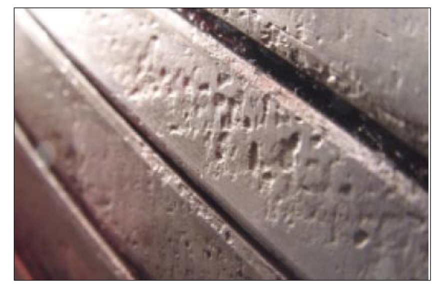


# Development of a Corrosive Environment

- Stainless steel carcass – provides strength against external hydrostatic pressure
- Extruded thermoplastic pressure sheath – provides a seal to contain the produced fluids in the bore
- Pressure armour – resists hoop stresses due to internal pressure (carbon steel)
- Tensile Armour Wires – helically wound to provide strength against axial stress caused by internal pressure and external loads (carbon steel)
- External Sheath – provides a seal against the sea water

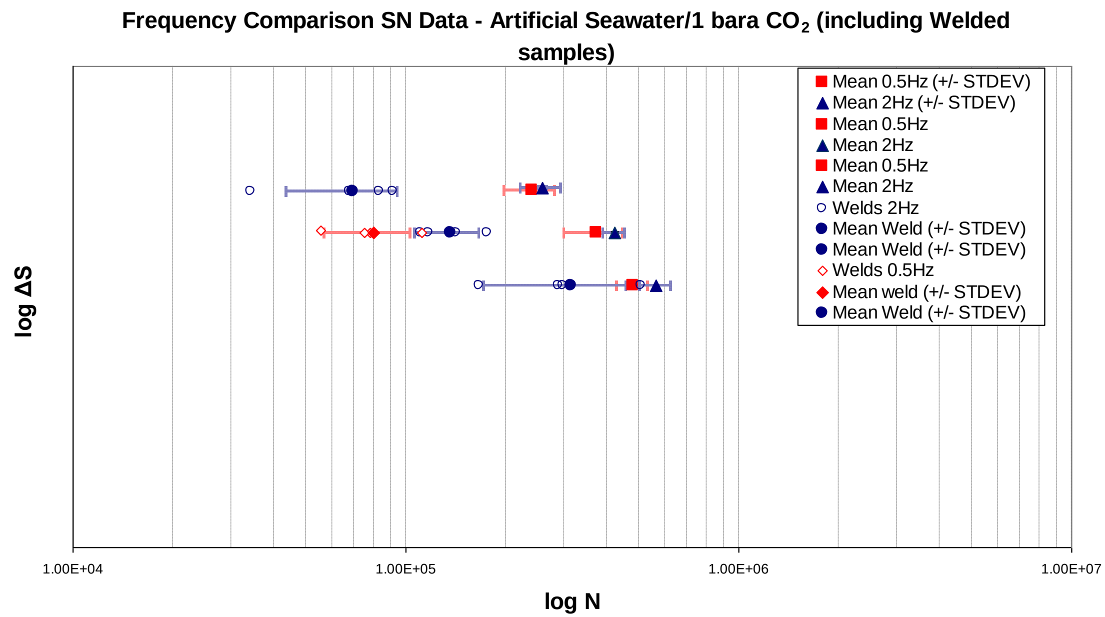
- $CO_2$ &/or $H_2S$ diffuse from the bore of the pipeline into the annulus
- When dissolved in either condensed water from the bore or sea water from a leak in the external sheath the annulus environment can be very corrosive
- The carbon steel components located in the annulus are at risk

# Advanced Materials Testing – Knowledge Transfer

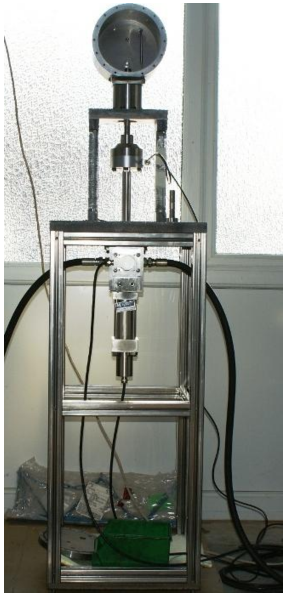
**Exova** Corrosion Testing Centre (Dudley/Daventry UK)

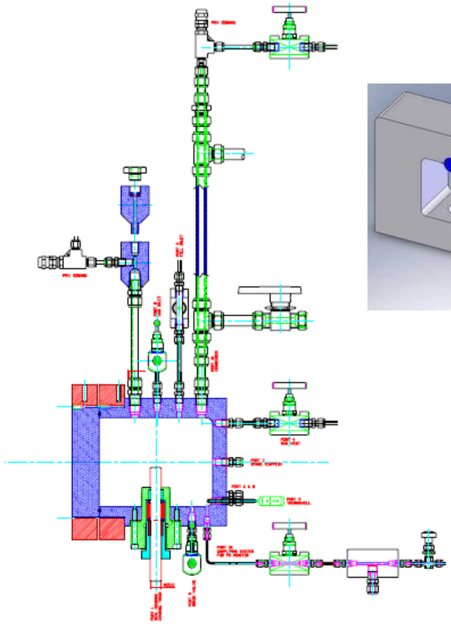
**£ 2.0 M** investment (UK/Japan/France) to develop unique High Temperature, High Pressure Corrosion Fatigue Testing Facility for Corrosive Oil and Gas Well Environments

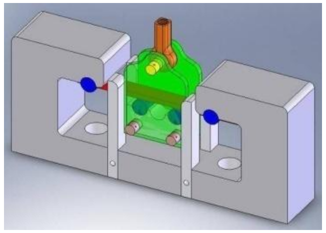



**Design Aspects**

- ❑ C276 Autoclave capable of testing up to 50bar & 100°C in sour environments
- ❑ Servo-hydraulic test machine, load controlled tests (28kN load capacity)
- ❑ Four point bend loading configuration
- ❑ Secondary micro-autoclave for elevated pressure pH measurements (up to 50bar)







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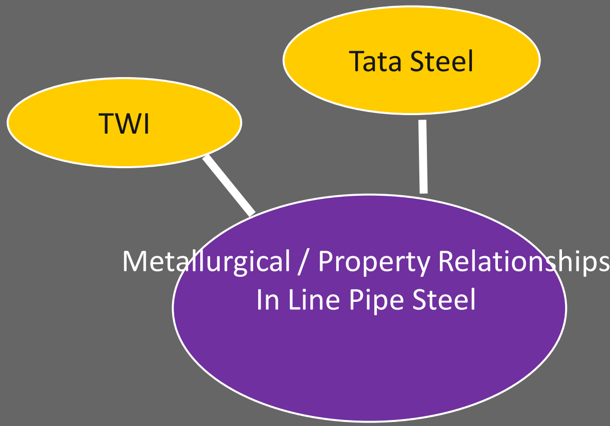


C Davis / M Strangwood
Met & Mat

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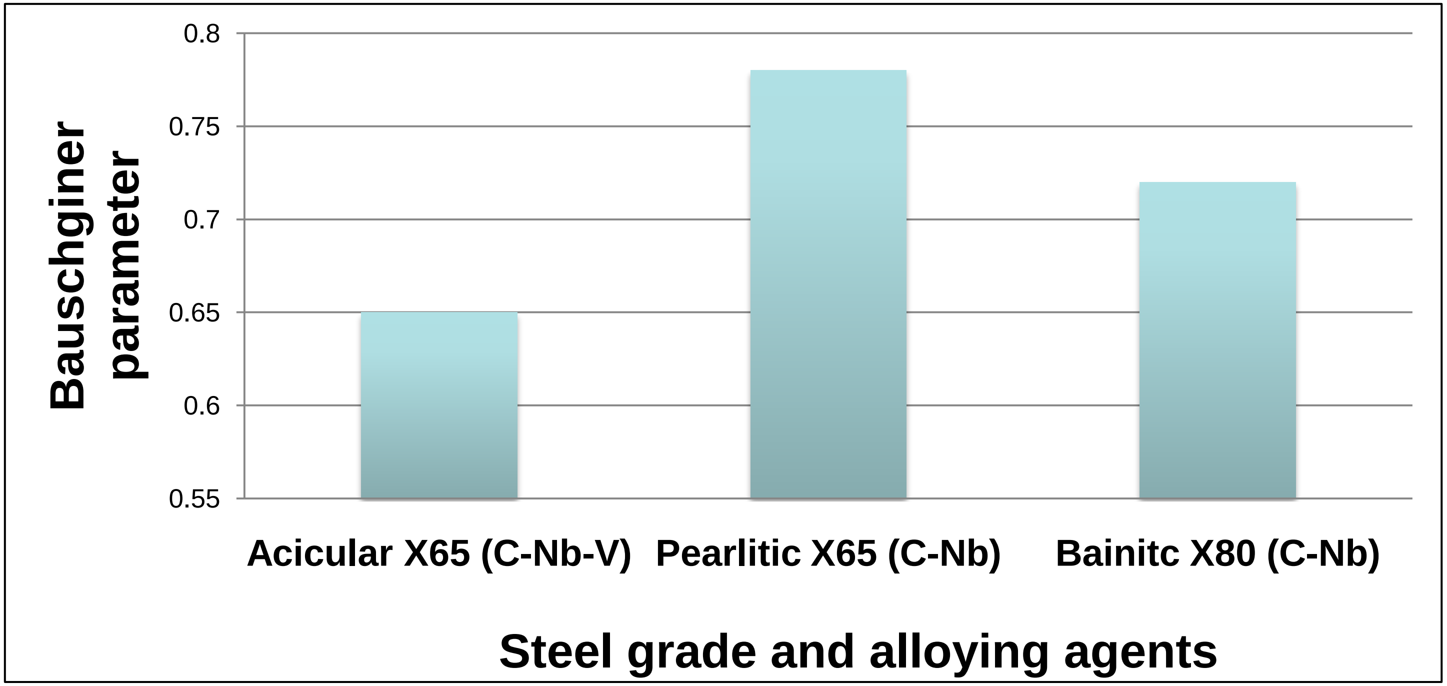
# Evaluating Line Pipe Steel Properties as a Function of Steel Metallurgy

During large diameter line-pipe production, by the ‘UOE’ process, the steel plate experiences reverse loading.  The strength of the line-pipe can be higher or lower than the original steel plate depending whether work hardening or work softening (via the Bauschinger effect) dominates.

Research is being undertaken to understand the relationship between steel grade (composition, strength and microstructure) and the Bauschinger parameters.



Hydrocarbon Exploration
(Petroleum Geology)

Materials for Deep Water
Production

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Energy Initiative

Advanced Oil Recovery
Technology

Thank you for your attention

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