RISC

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Critical Factors in Frontier Exploration Success

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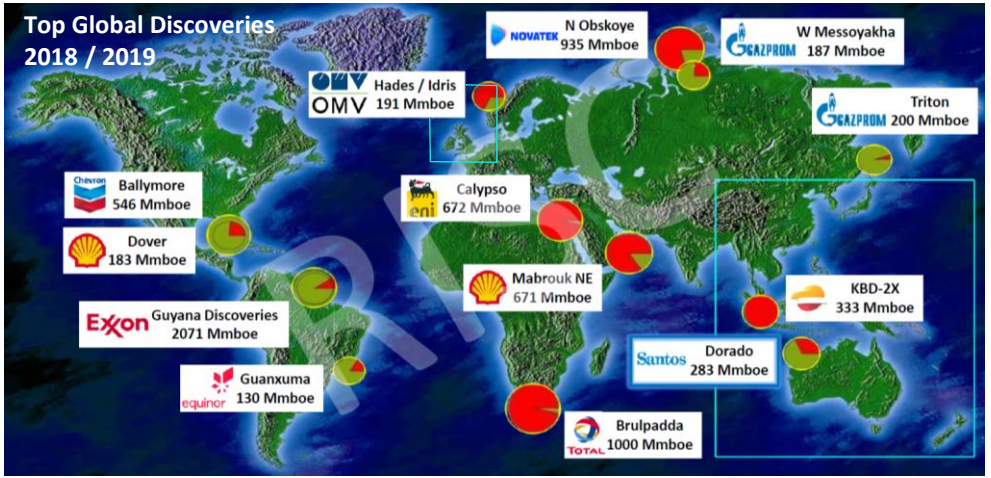


Exploration Success: Fundamentals of Supply

Oil & Gas Authority

On 13 Sept 2020, OGA published UK Oil and Gas Reserves and Resources as at end 2019*

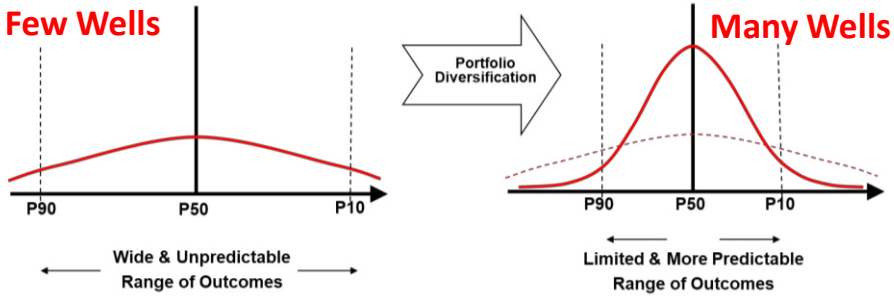
- Exploration success in **2019** delivered an addition of **240 Million Boe** of contingent resources
- UK **P50 contingent resources** (discovered, undeveloped) of **7.4 Billion Boe**
- **Maturation of contingent resources** presents significant opportunity for continued development of UK's resources. This will require substantial investment in new field developments and incremental projects

*Estimates unchanged since end 2018

Exploration Success: Value of Portfolio Prediction

Gambling

Portfolio Risk Management



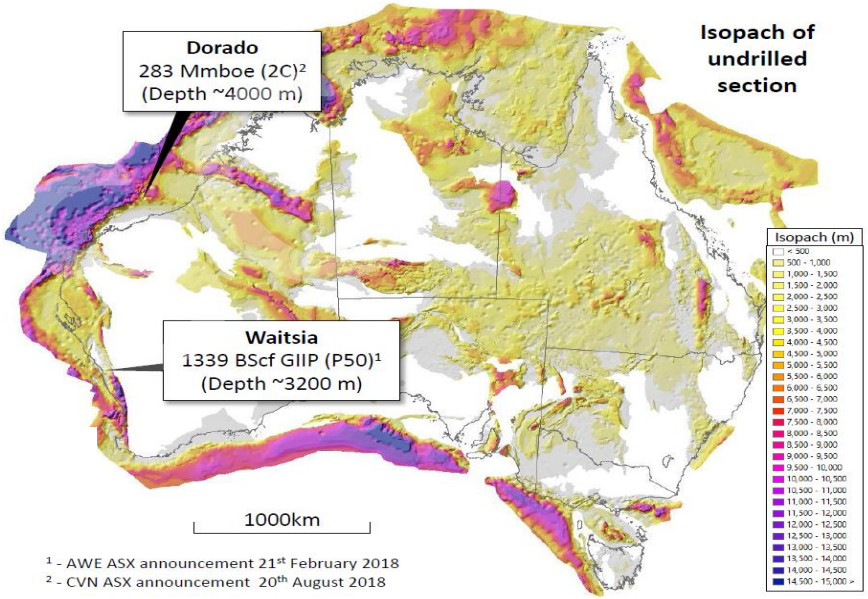
- **Success Value** = Σ Dry holes + Uneconomic Discoveries + Production > 0
- **Failure Cost** = **Pg** success but **Pe/Pc** failure = Accounting Dry Holes expensed in P&L as uneconomic discoveries

- **Who Added Value** to whose bottom line?
  - **Catcher** area '*undiscovered*' by Pan Canadian but developed and value realised by Encore/Premier?
  - **Cambo** '*undiscovered*' by Amerada Hess but developed and value realised by Siccar Point?
  - **Buzzard** '*undiscovered*' by BPAmoco but developed and value realised by PanCanadian/Nexen/CNOOC?

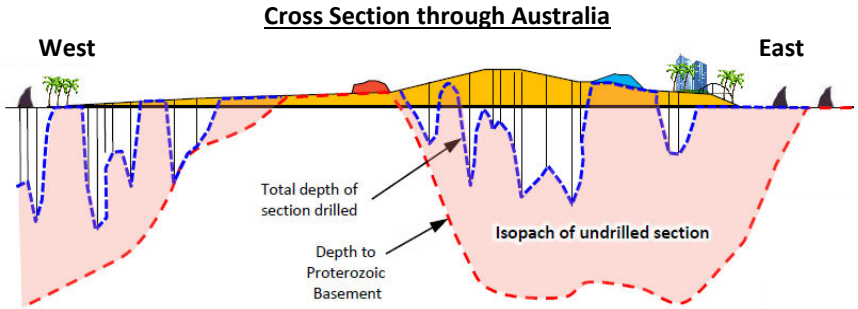
Pg = Probability of Geological Success, Pc = Probability of Commercial Success (Point forward economics), Pe = Probability of Economic Success (Full cycle economics)

Lessons from other basins: Australia

- Australia ~ 3 MMBoe/day in 2019, UK ~ 1.7 MMBoe/day in 2018
- Australian licenced acreage fell over last 5 years **BUT** exploration success in 2018 & 2019



¹ - AWE ASX announcement 21st February 2018
² - CVN ASX announcement 20th August 2018

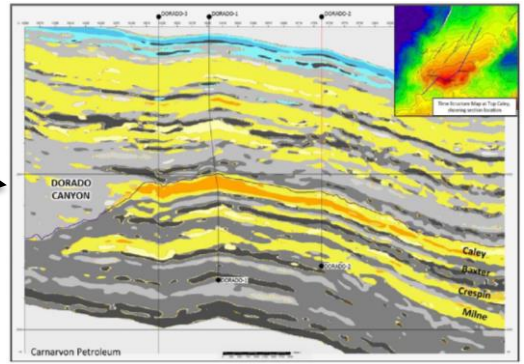


Lessons from other basins: Australia

- Australia had 45% exploration success rate in **2019** (9 discoveries from 20 exploration wells)
- Appraisal drilling of **Dorado** discovery in 2018 confirmed major recoverable resource of between **176 and 614 MMBoe**
- **Success Factors**
  1) **Seismic**
     - Acquisition of **large multi-client 3D seismic** (>20,000 km^2) identified Dorado Canyon
     - **Focused 3D seismic** (<10,000 km^2) stimulate exploration in Vulcan Sub-basin with discoveries at Orchid & Bratwurst
  2) **Paradigms tested**: Reservoir preserved at depths deeper than historically thought

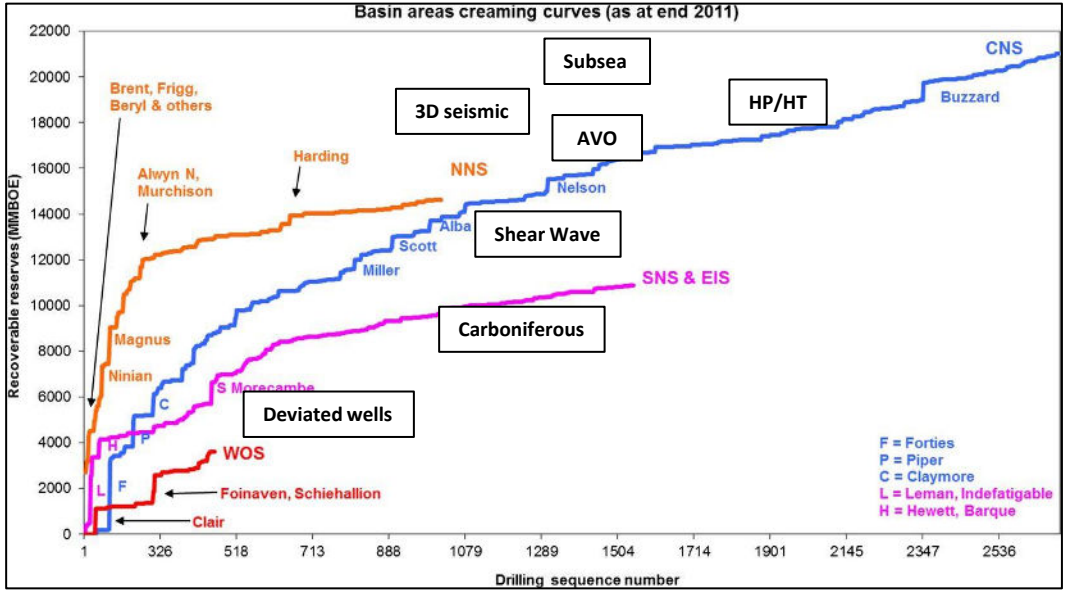
Australia – Exploration Success

2014	Waitsia	786 Bcf (2P)
2018	Dorado	283 MMBoe (2C)
2019	West Erregulla	513 Bcf (2C)
2019	Beharra Springs Deep	500 Bcf
2019	Bratwurst	100 MMBoe
TBD	Triassic objective	@5,500m (~18,000 ft)

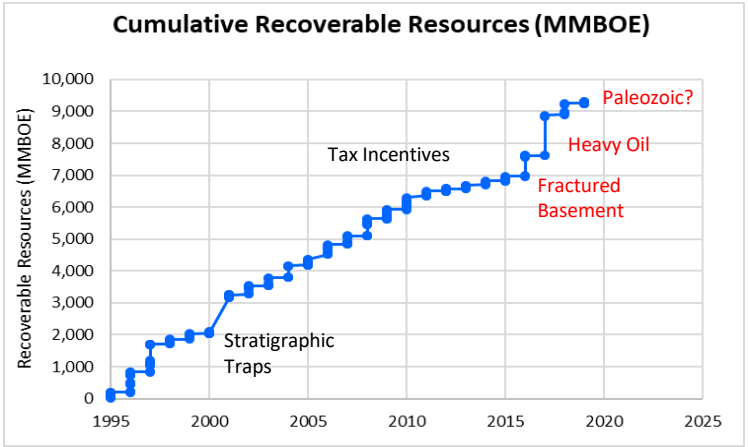


Drilling Performance UK North Sea: Creaming Curves

- Is there any **more** room for positive Technology Shocks?



Source: Lyell collection, J. A. Austin, S. J. C. Cannon and D. Ellis

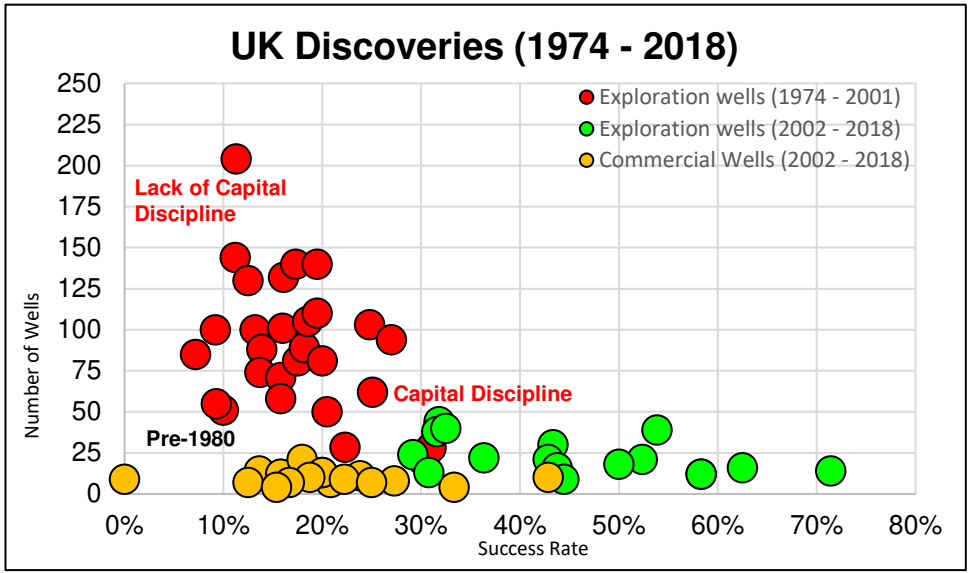


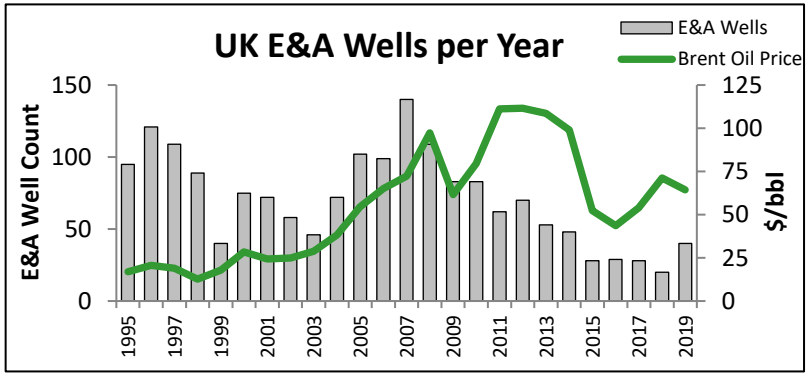
Source: GlobalData Oil and Gas Intelligence Center

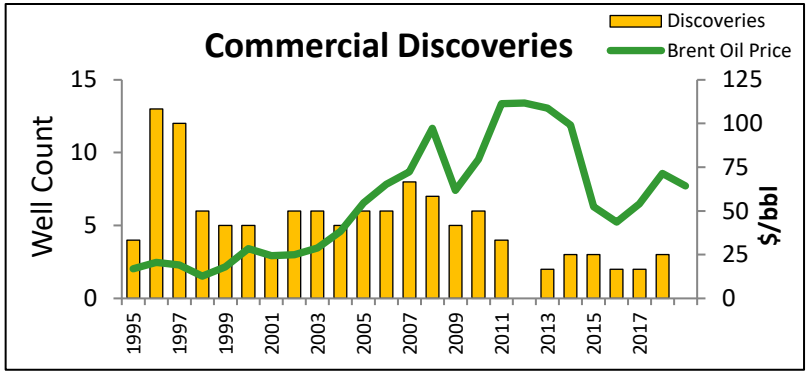
Drilling Performance UK North Sea: Exploration Success Rate

"One of the great advantages of having a large portfolio is the ability to be increasingly selective about which prospects to drill. It's about choice" - Andy Wood,Shell International E&P, EAGE 2001

Present situation due to basin maturity **AND** low oil price

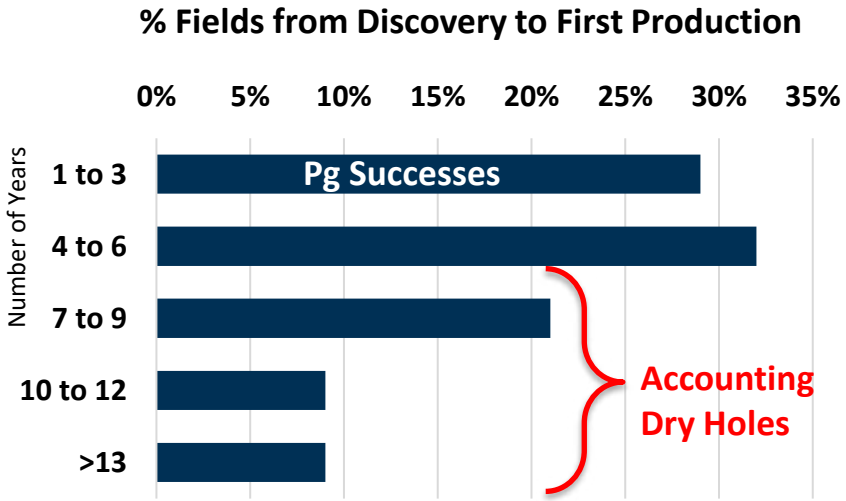


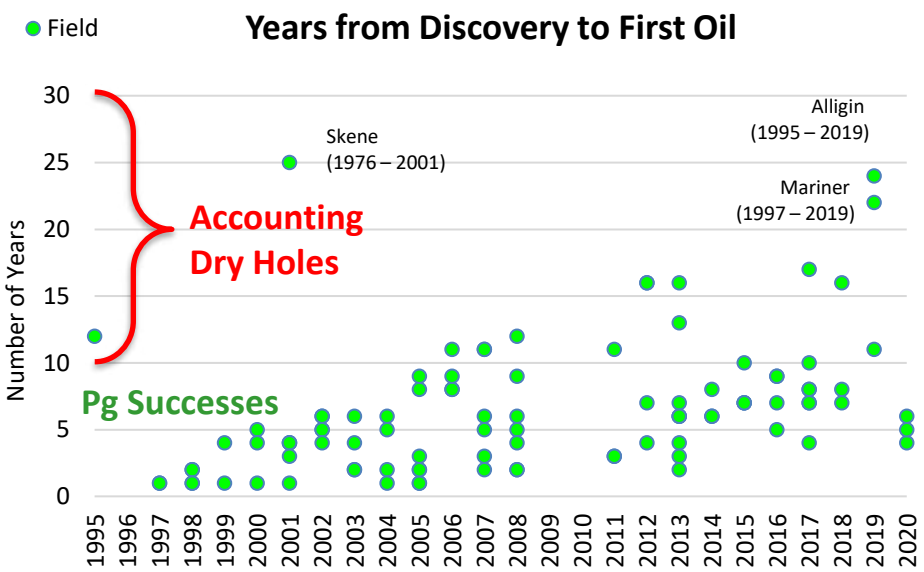




Data source 1974 - 2001: PESGB Newsletter
Data source 2002 – 2018: GlobalData Oil and Gas Intelligence Center
Discoveries include commercial and currently non-commercial discoveries

Drilling Performance UK North Sea: Time to First Oil



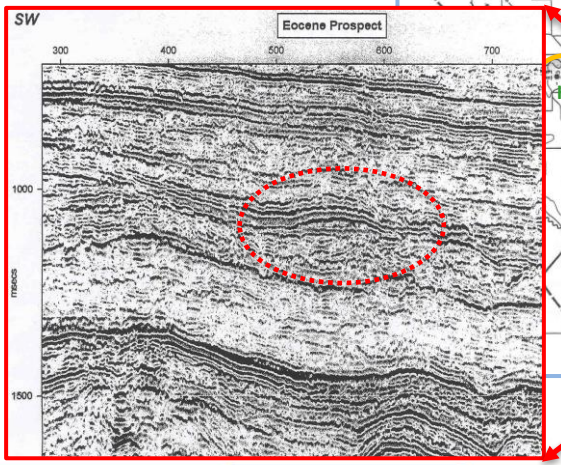


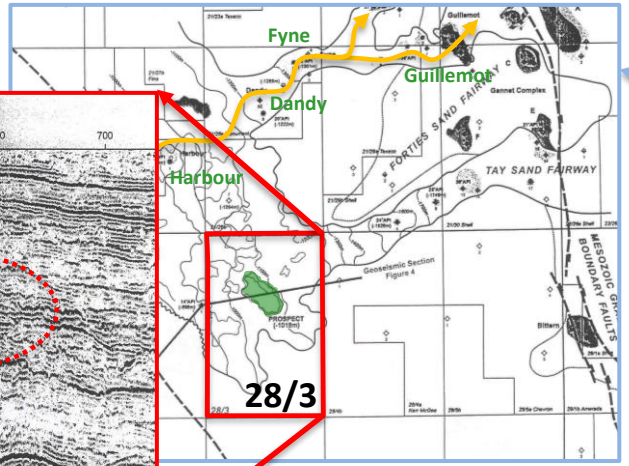
Source: GlobalData Oil and Gas Intelligence Center

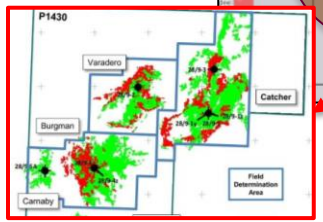
Case History #1: Seismic Data

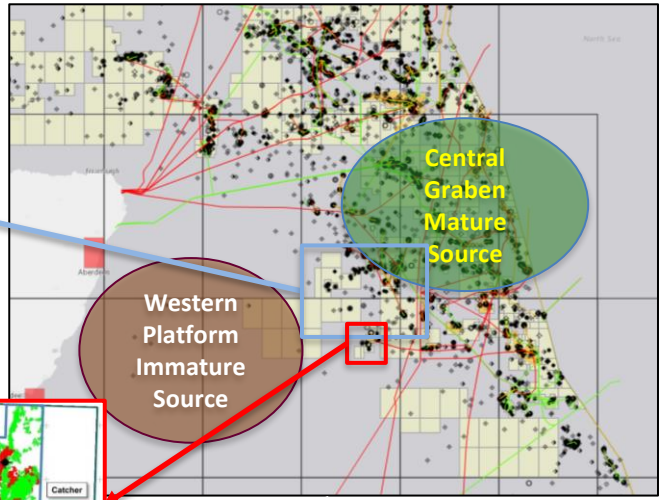
Encore: one of the success factors was exploring the edges of the mature basins

- Eocene & Paleocene Channel features recognized and discovered on Western Platform in 1980's
  - EG: Pilot & Harbour (21/27), Fyne & Dandy (21/28), Guillemot (21/29)
- **Charge considered an issue**: Pilot & Harbour API gravities 12° to 17° and viscosities approx 100 cP to 1200 cP
- 28/3-1 well (Murphy 2000) found biodegraded oil circa 13° API









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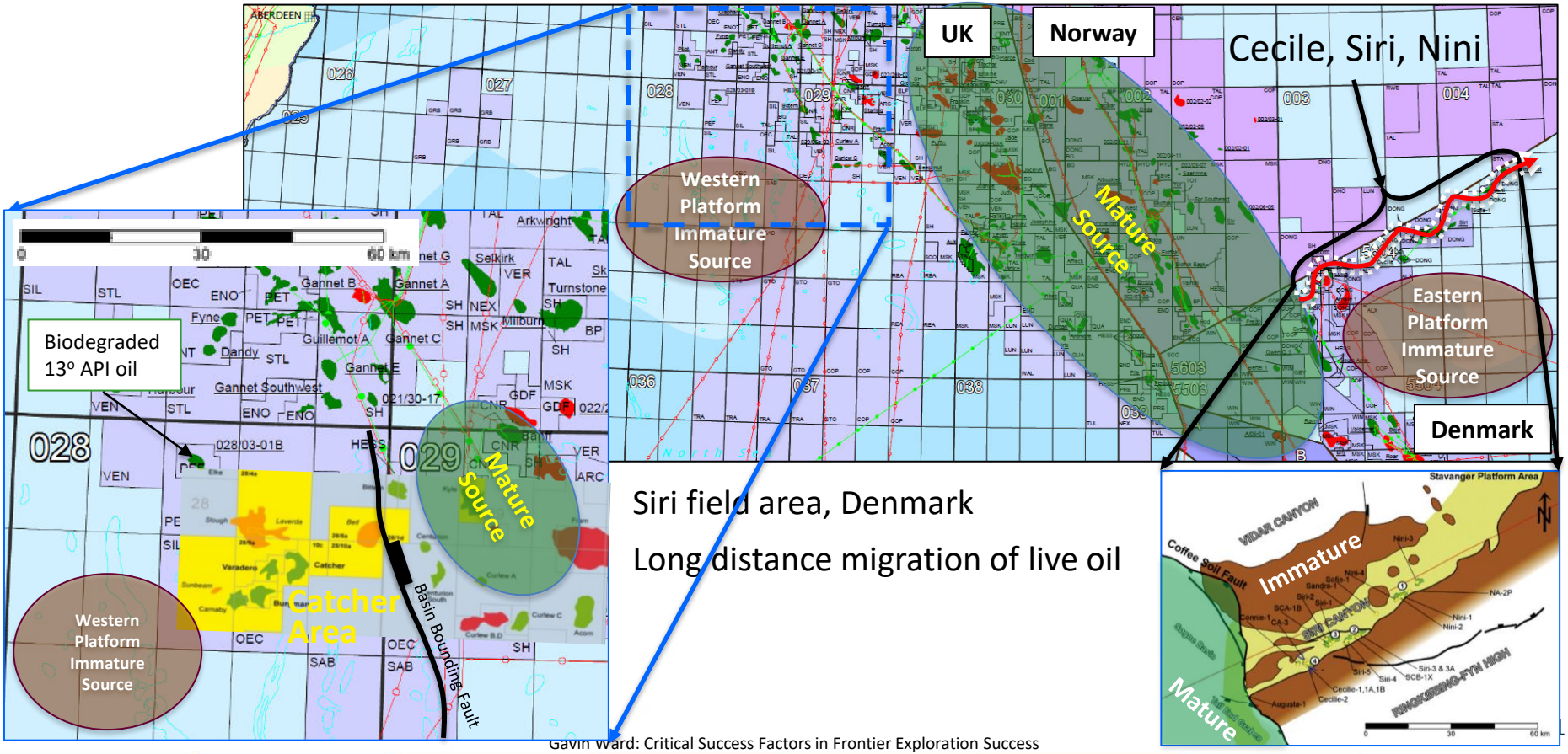


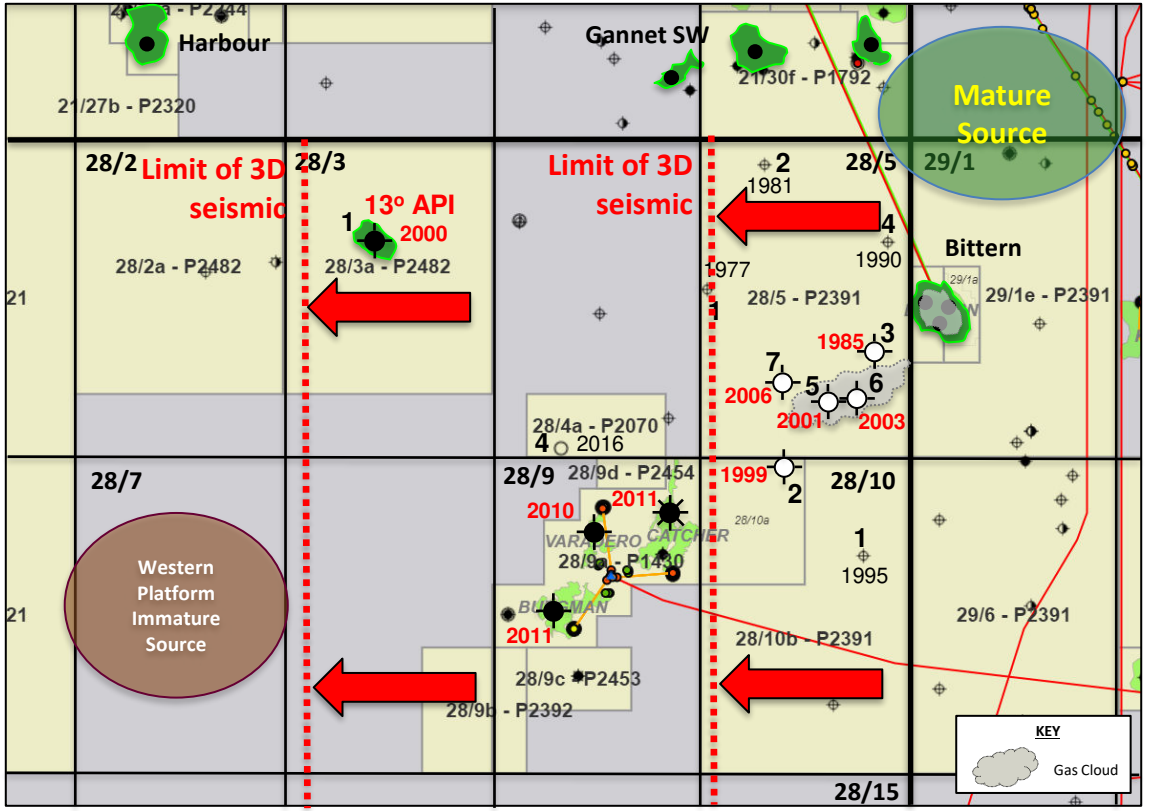
Siri field area, Denmark

Long distance migration of live oil

Case History #1: Seismic Data

Encore's Feedback on Farm-in*

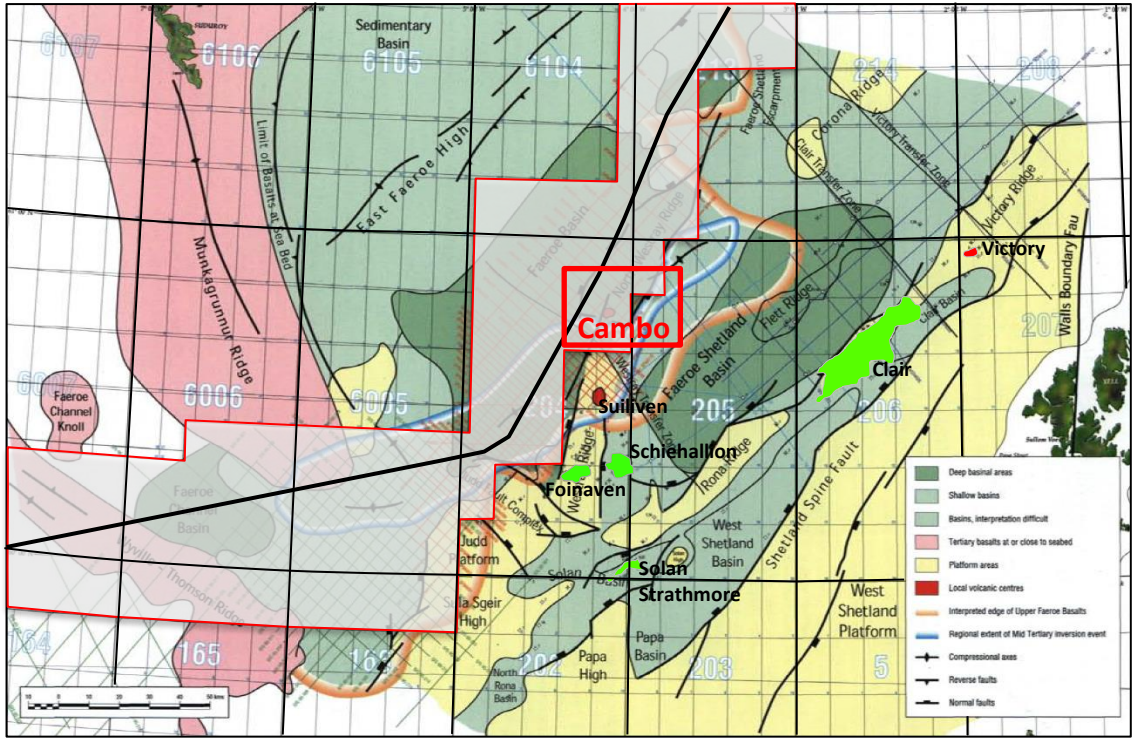
1) "*If one works they should all work and the block would be full of oil*"
2) "***There can't possibly be sand back there***"
3) "*Tay will be silty like 28/10a-2*"
4) "*The oil will spill into the Tay and leak up-dip*"
5) "*There is no "lookey likey" in the area*"
6) "***It is too far from the source – requires long distance migration***"
7) "***There is no 4 way dip closure on the amplitudes – no trap!"***
8) "***The oil will be too heavy at 4,500 ft***"
9) "*Catcher is probably a small gas prospect*"
10) "*The Prospect is too small*"
11) "*Shallow gas present so faults must be leaky*"
12) "*Didn't pass peer review in HQ – too risky*"
13) "*We can't get it through our system*"



*Source: Permission granted by Paul Young (formerly: Encore)

Case History #2: Reservoir Stratigraphy

- **Early 1990's**: Regional 2D seismic
- **AVO**: Foinaven (1990), Schiehallion (1993)
- **1996**: No licences in region known as the 'White Zone', awaiting agreement on international border with Faroe Islands
- **1995 – 1997:** Speculative 3D seismic
- **1996 – 1998**: Multi-client 3D seismic
- **1999**: International border settled
- **Risk v Reward**: Little exploration @$25/Boe
- **2002**: Cambo field discovered



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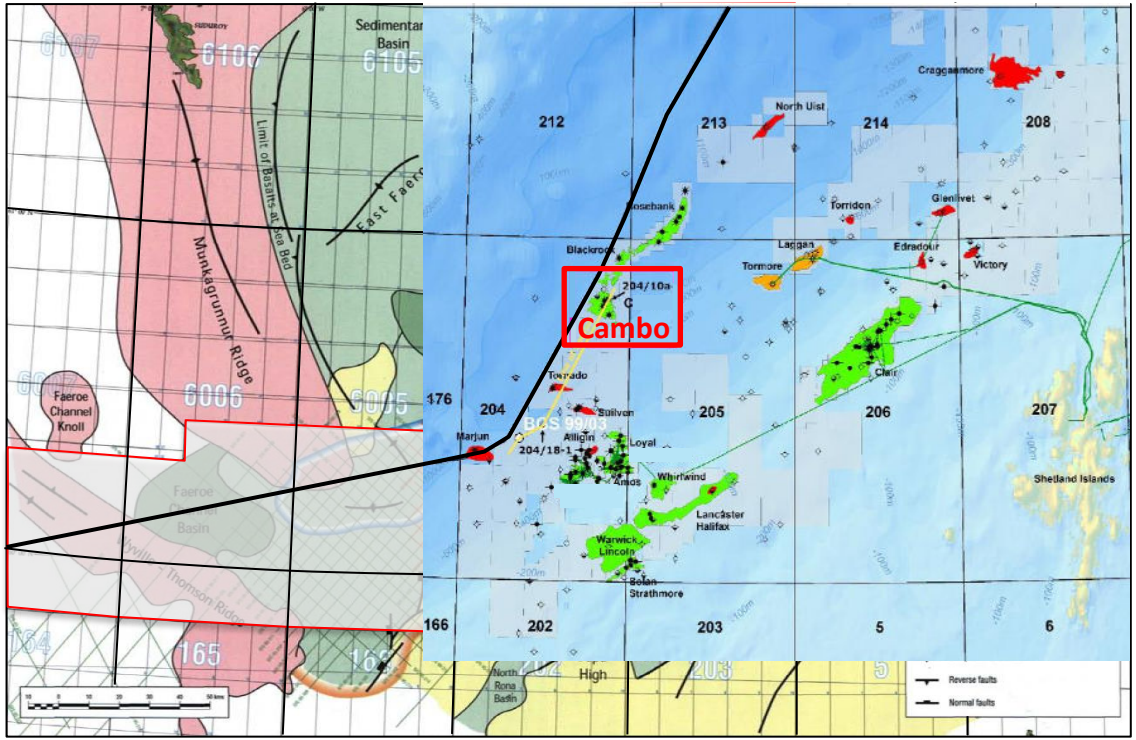
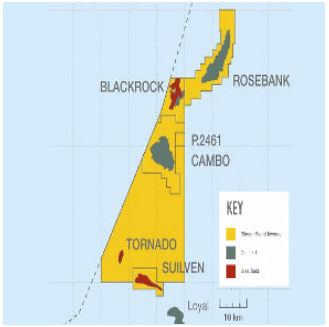
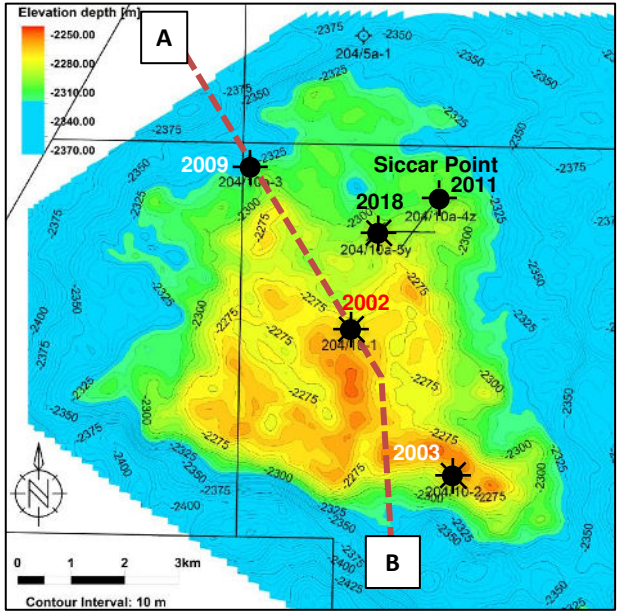
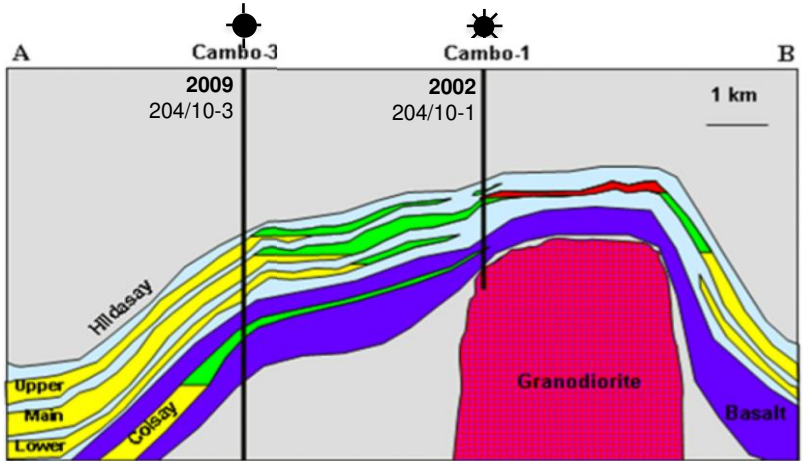


Case History #2: Reservoir Stratigraphy: Bald Highs & deposition in Lows

- Cambo prospect possibly bald high for Schiehallion/Foinaven sands, Critical risk = reservoir presence
- **2002**: 204/10-1 Hess discovered Cambo with different reservoir sequence & appraised in 2003 with 204/10-2
- **2009**: 204/10-3 Discovery in yet different sands (sands in 204/10-1 water wet)
- Nearing FID after 18 years and > £100 million[1]





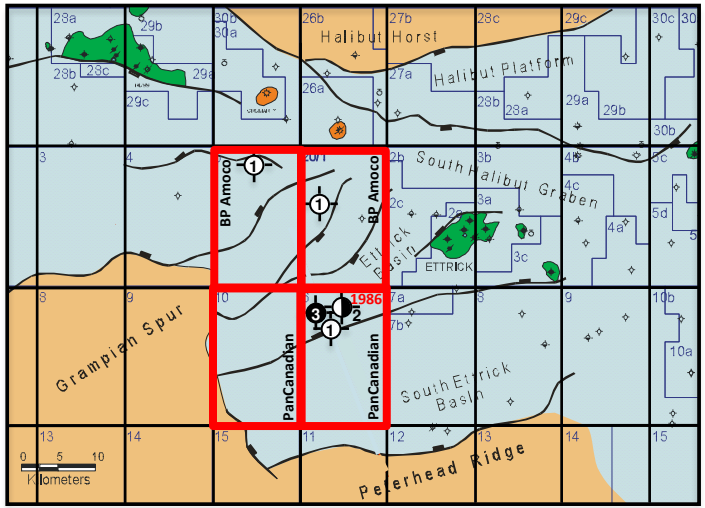


[1]Costs quoted as of 2014

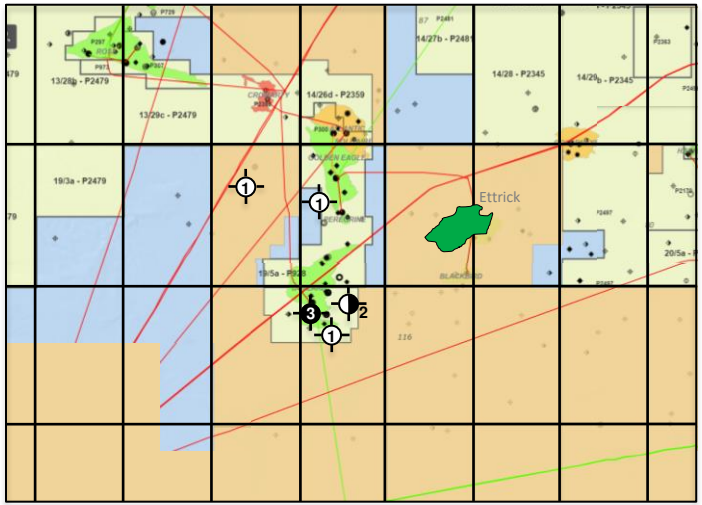
Case History #3: Challenge Dry Holes

- **1986**: 20/6-2 has >300’ of good quality Jurassic sand and 11’ oil column within very small closure around the well
- **1995**: Amoco 16th Round award blocks 19/5 and 20/1 (Broom prospect: stratigraphic pinchout of Jurassic updip to west)
- **1998**: Pan Canadian* 18th Round award blocks 19/10 & 20/6 (Buzzard prospect: stratigraphic pinchout of Jurassic updip to west)
- **2000**: BP Amoco had an outstanding well commitment to be drilled by June 2001
- **2001**: Pan Canadian discovery well 20/6-3, updip of 20/6-2

Up to 1995 Year 1995 - 2000



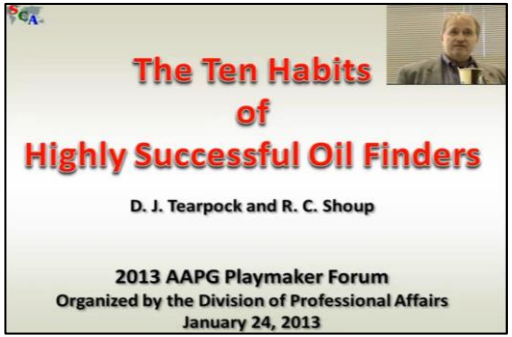
Year 2020

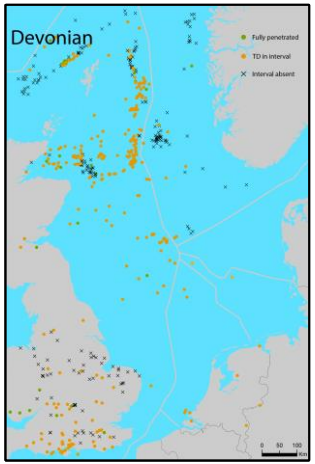


*PanCanadian -> Encana -> Nexen -> CNOOC

Conclusions: Critical Factors in Frontier Exploration Success

- **Good Geoscience** (eg: Cambo Reservoir Stratigraphy)





Courtesy of Henk Kombrink, Expronews & North Sea Core

4 x S's for Success

1) **Supply**: Undrilled deeper reservoirs, stratigraphy & regions
2) **Seismic**: Volume & Quality (eg: Australia & Catcher field, UK)
3) **Status Quo**: Challenge and question (eg: Australia reservoir preservation & Buzzard 20/6-2)
4) **Sample Sizes:** Enough prospects to predict portfolio performance with some semblance of accuracy

Thank you to co-author Daniel Rogers of GlobalData.

Also my thanks to other contributors

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[1]and JV partner Shell