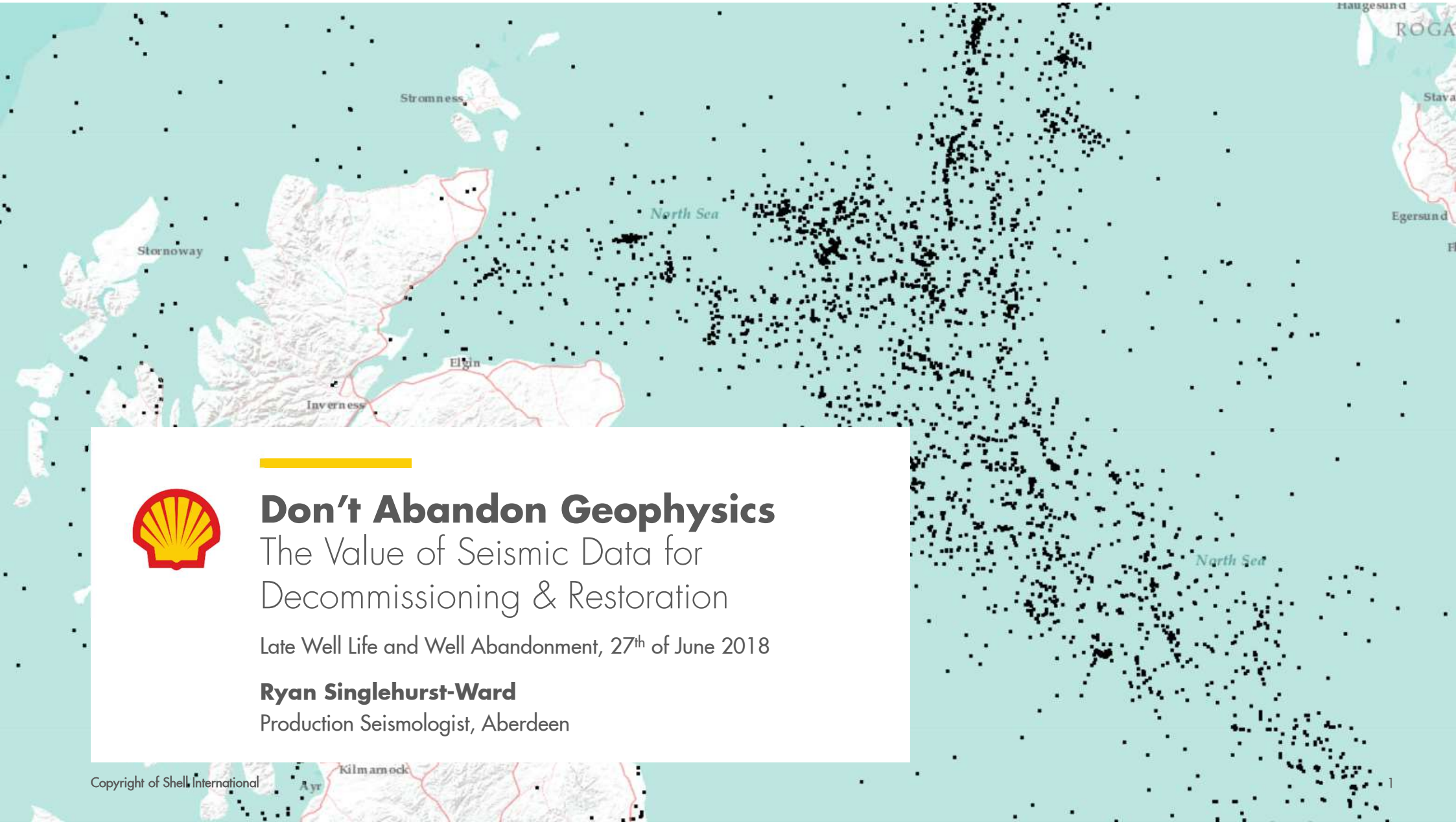


Don't Abandon Geophysics

The Value of Seismic Data for Decommissioning & Restoration

Late Well Life and Well Abandonment, 27th of June 2018

Ryan Singlehurst-Ward
Production Seismologist, Aberdeen

DEFINITIONS & CAUTIONARY NOTE

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this "Shell", "Shell group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to subsidiaries in general or to those who work for them. These expressions are also used where no useful purpose is served by identifying the particular company or companies. ''Subsidiaries'', "Shell subsidiaries" and "Shell companies" as used in this presentation refers to companies over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to "joint ventures" and "joint operations" respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in a venture, partnership or company, after exclusion of all third-party interest.

This presentation contains forward-looking statements concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as ''anticipate'', ''believe'', ''could'', ''estimate'', ''expect'', ''goals'', ''intend'', ''may'', ''objectives'', ''outlook'', ''plan'', ''probably'', ''project'', ''risks'', "schedule", ''seek'', ''should'', ''target'', ''will'' and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell's 20-F for the year ended December 31, 2016 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation **2nd of May 2018**. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

This presentation may contain references to Shell's website. These references are for the readers' convenience only. Shell is not incorporating by reference any information posted on www.shell.com.

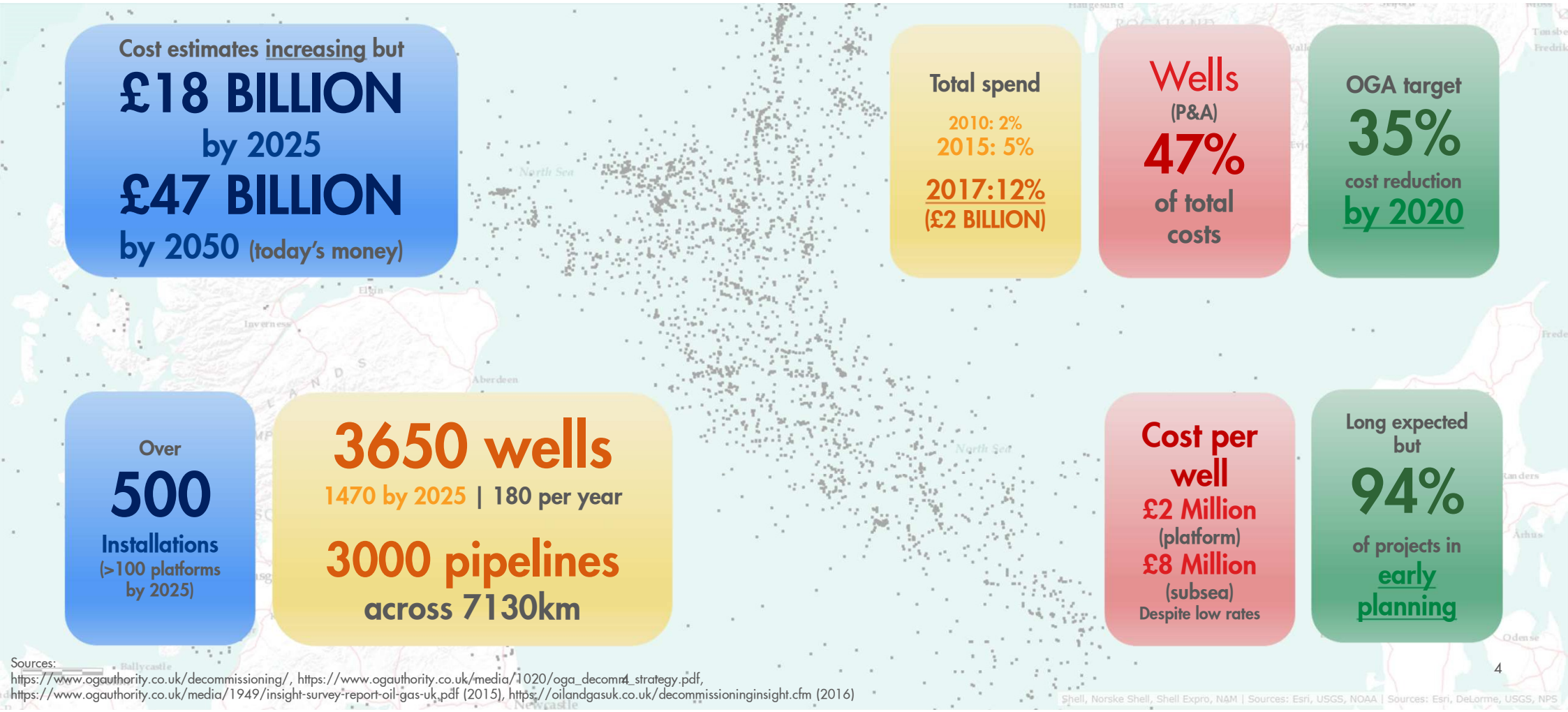
We may have used certain terms, such as resources, in this presentation that United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

Agenda

- **The big picture** – decommissioning in the UKCS
- **What we are trying to do** – Legislation, guidelines and strategy
- **Subsurface Isolation Strategy** – How we decide where to isolate and the seismic contribution
- **Gannet C Case Study**

- **I will not talk about :**
  - Assessment for 'Cessation of Production'

Decommissioning in the UKCS



Sources:
https://www.ogauthority.co.uk/decommissioning/, https://www.ogauthority.co.uk/media/1020/oga_decomm_strategy.pdf,
https://www.ogauthority.co.uk/media/1949/insight-survey-report-oil-gas-uk.pdf (2015), https://oilandgasuk.co.uk/decommissioninginsight.cfm (2016)

Legislation, Guidelines and Strategy – For 'Perpetuity'

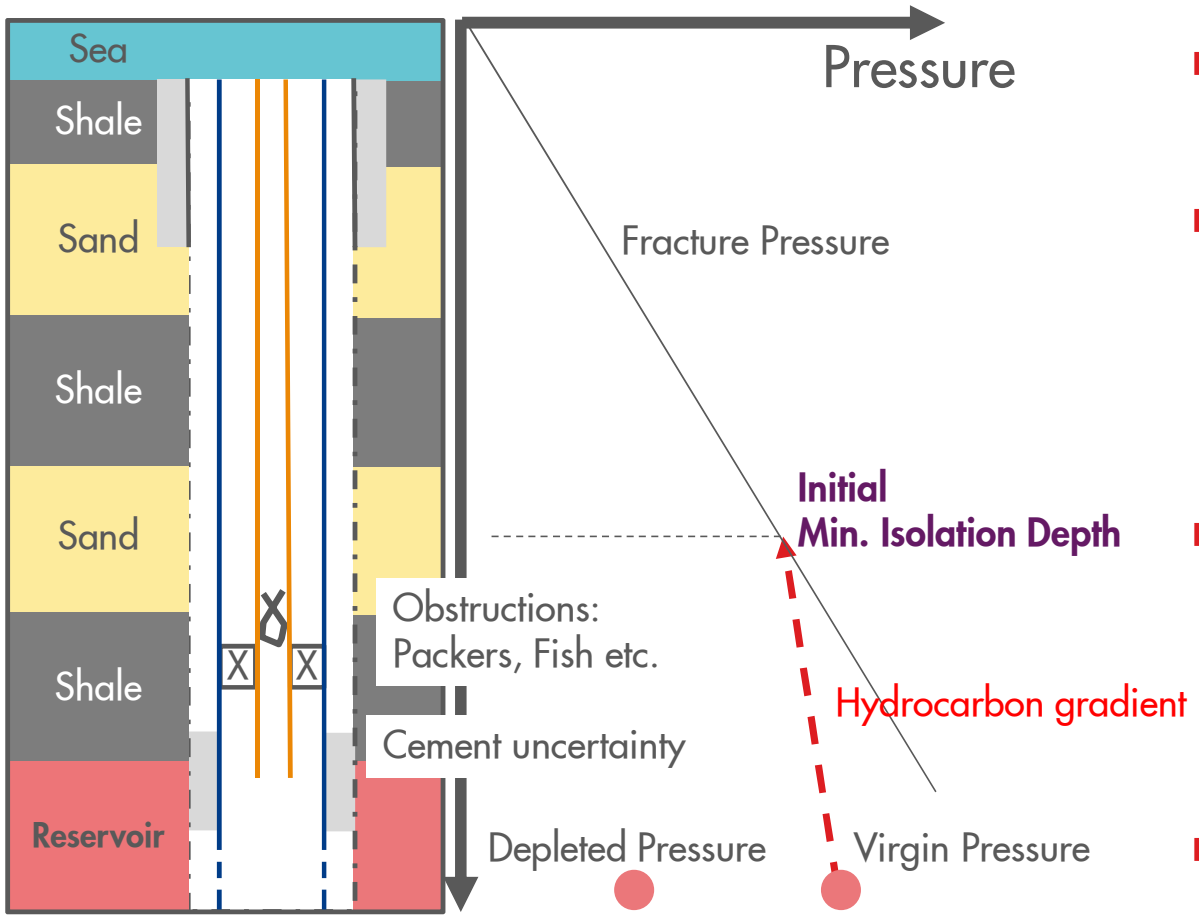
- **Industry Legislation***: "so far as is reasonably practicable, there can be no unplanned escape of fluids"
- **Industry Guidelines**** (Good Practice)
  - 2015 update: Isolate "**flow potential**" not "**permeable zones**"
  - Formations can be grouped **if** crossflow acceptable, allowing fewer isolations

*(The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996)
**(Oil & Gas UK Guidelines for the Abandonment of Wells (Issue 5, July 2015)

- An integrated **Subsurface Isolation Strategy (SIS)** is created to address:
  - Which formations to isolate
  - Which depth range isolations can be placed

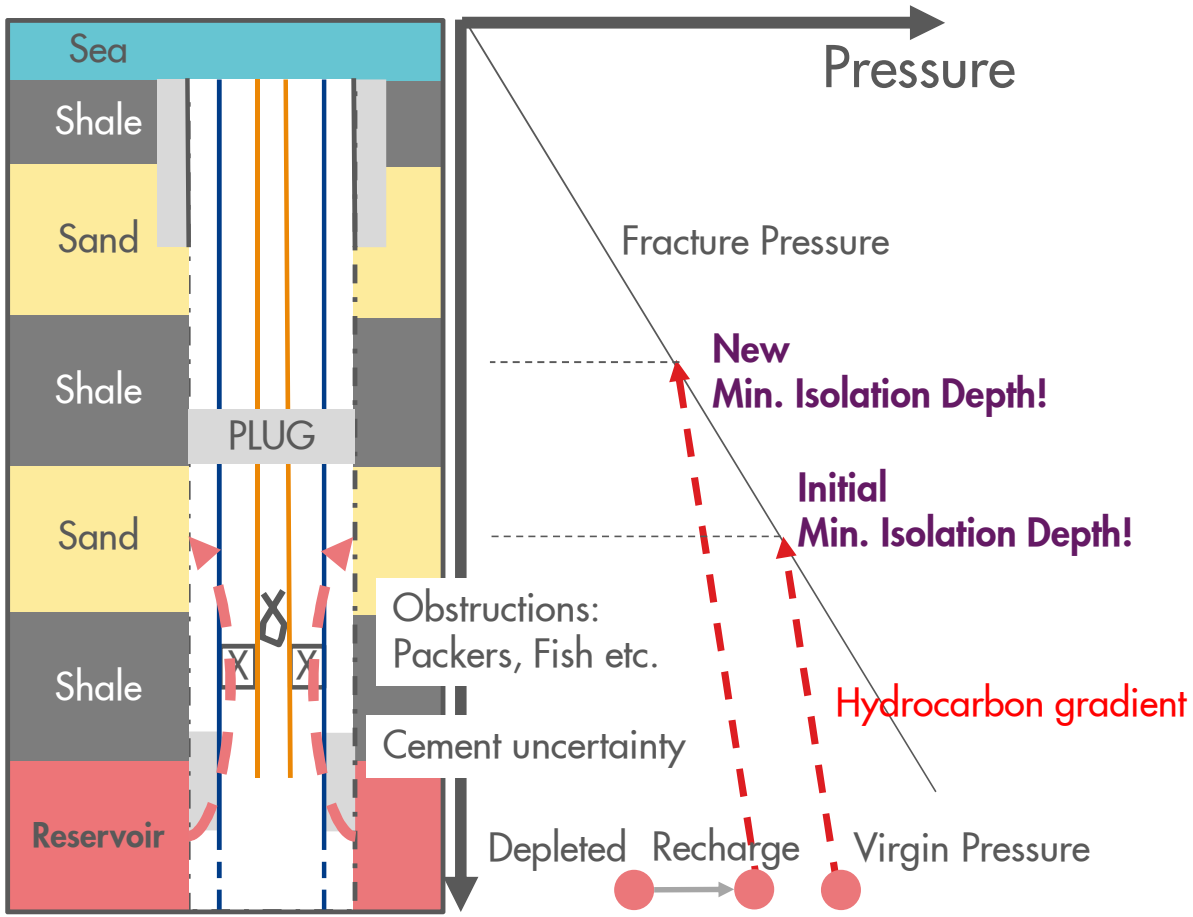
- Integrated SISs reduced **300days scope and >350,000hrs** exposure from Shell UK subsea abandonment portfolio with significant additions from an optimised execution strategy.

Considerations for the SIS



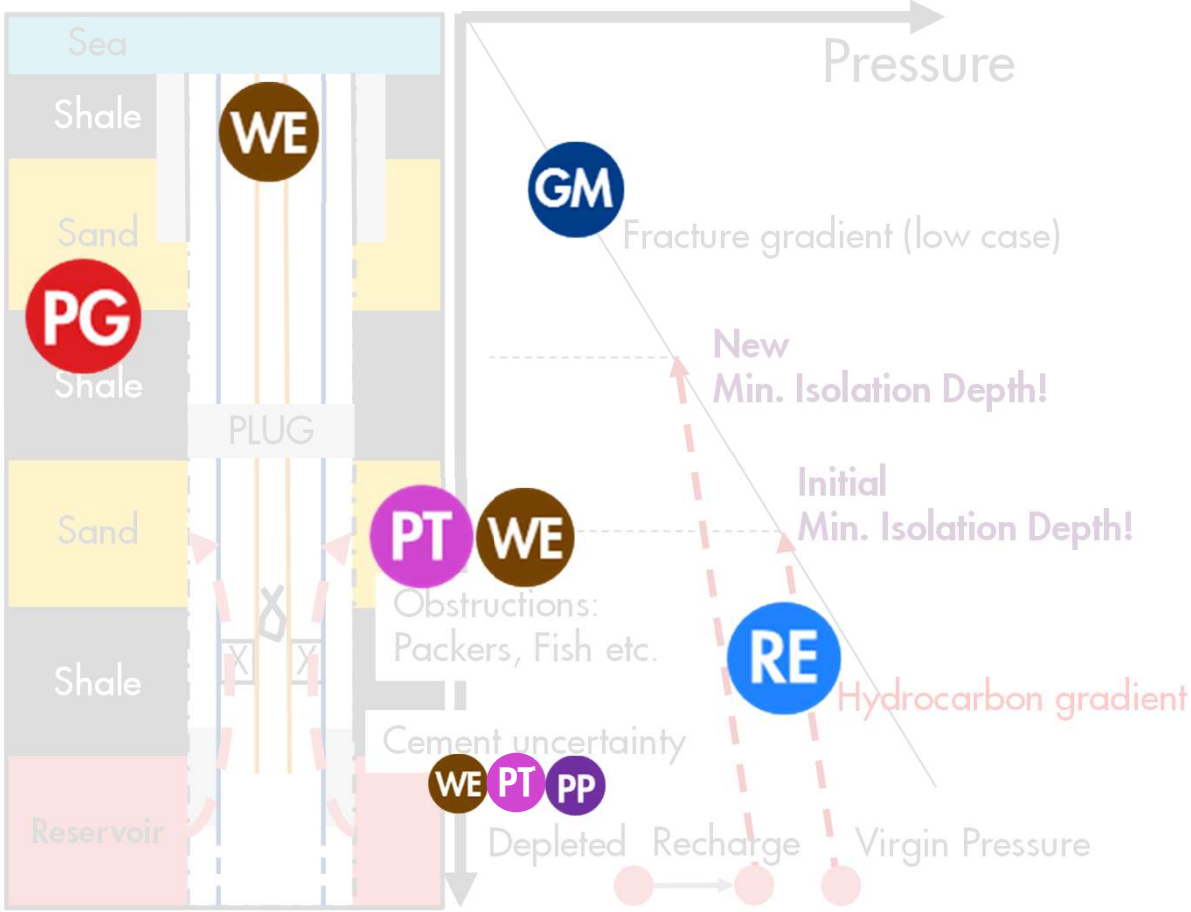
- Aim to isolate flow potential from surface
- However, obstructions make it difficult (costly!) to reach some depths and set plugs
- Avoiding obstructions with shallower isolations can create pressure/cross-flow risks
- Data mining is a key challenge

Considerations for the SIS



- Geophysics contributions:
  - Permeable/flow potential identification
  - Aquifer size
  - Connected reservoirs (+ aquifer)
  - 'Thief' sand extent & traps
  - Fault mapping (reactivation)
  - Connection to other wells
    - Introducing hydrocarbons/pressure to previously benign formations
- Repeat for the overburden!

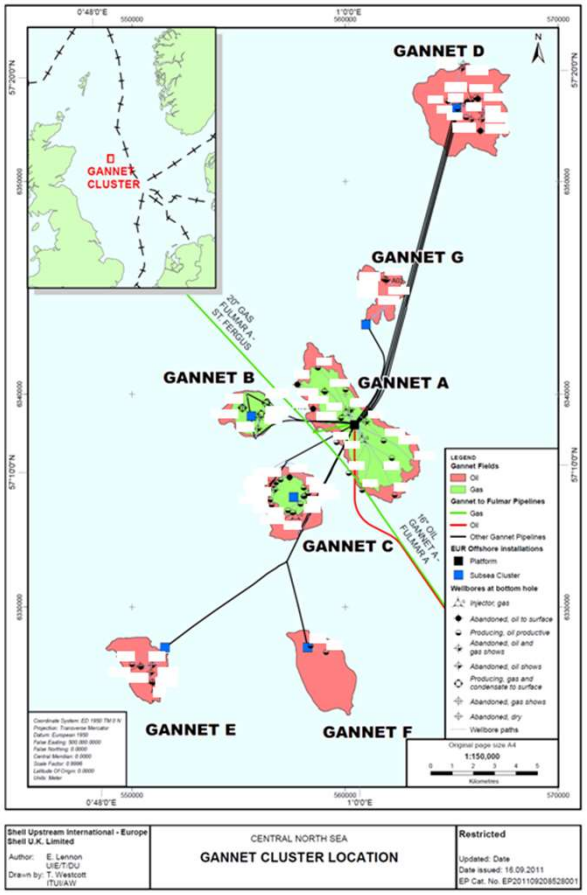
Considerations for the SIS

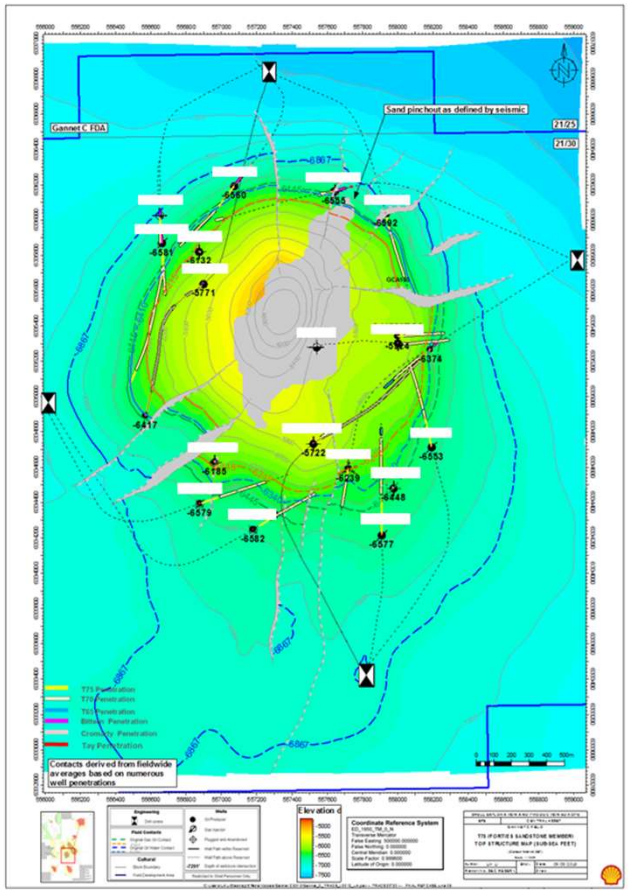


- Geophysics contributions: GP
  - Permeable/flow potential identification PG PP
  - Aquifer size RE PG
  - Connected reservoirs (+ aquifer) RE PG
  - 'Thief' sand extent & traps PG
  - Fault mapping (reactivation) GM
  - Other wells WE
    - Introducing hydrocarbons/pressure to previously benign formations
- Repeat for the overburden!

Discipline integration is key!

Gannet C Introduction

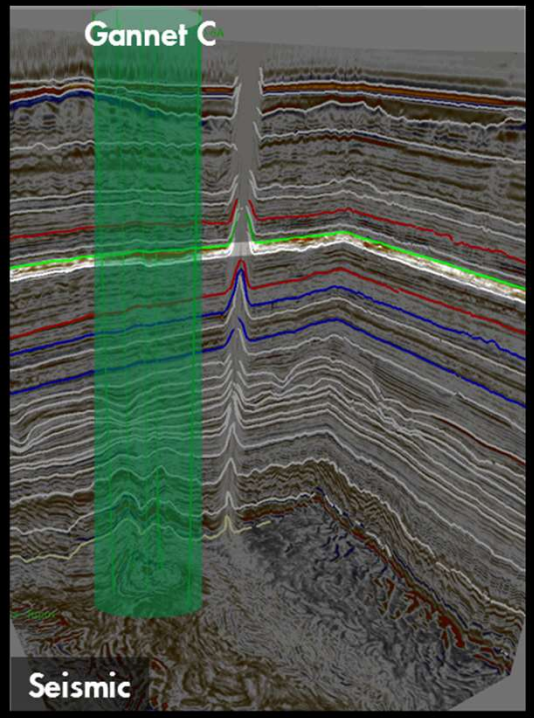


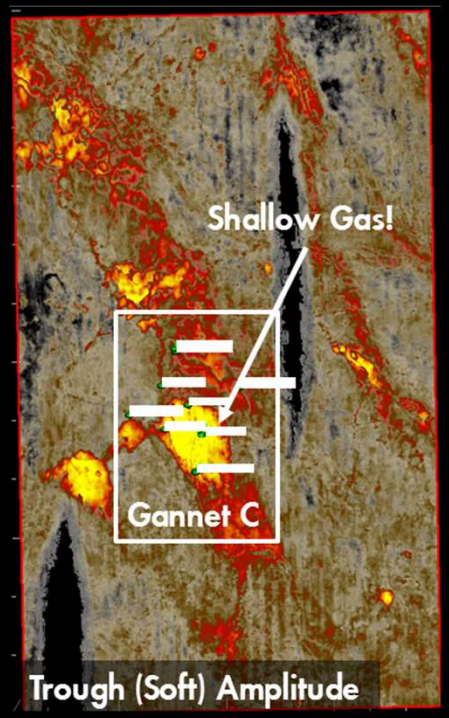


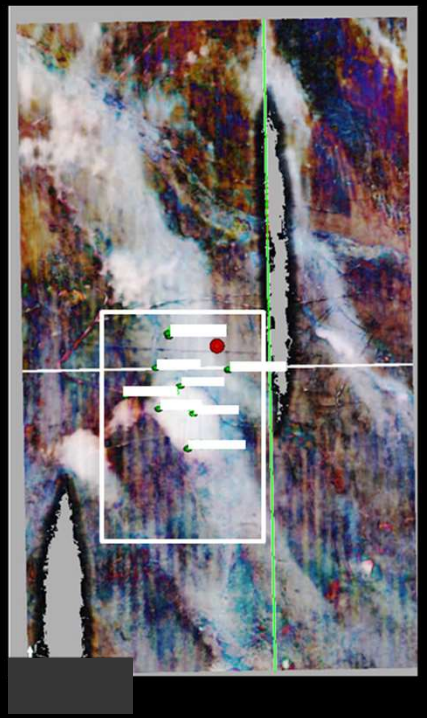
- Stacked Palaeocene/Eocene turbidite reservoirs encircling a salt diapir – all connected
  - Forties, Bittern, Cromarty, Gannet Tay
- Hydrostatic virgin pressure, strong aquifer support
- 4 drill centres, 11 Production wells, 4 E&A wells (plus sidetracks).
- **Abandon 7/9 watered out oil rim wells.**

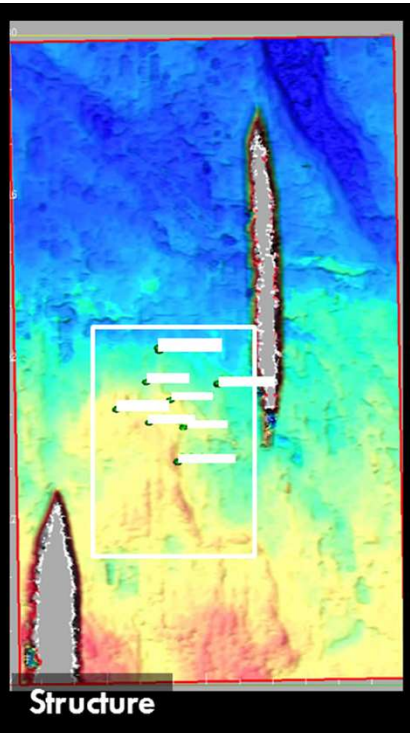
Gannet C Overburden

Interpretation over large areas (of no previous interest) to assess flow potential - crucial where there was no well data available. **Shallow gas mapping justified removal of 5 plugs.** **Saving: 3,283 man-hrs, 23days rig time**





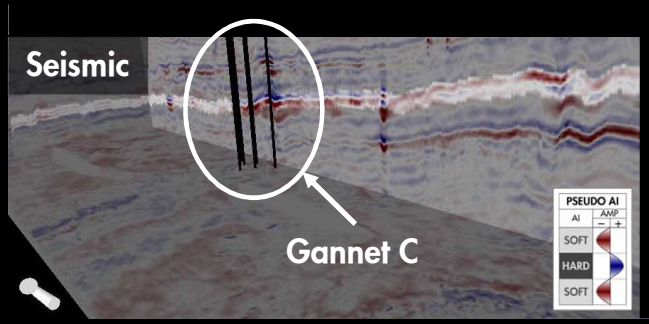


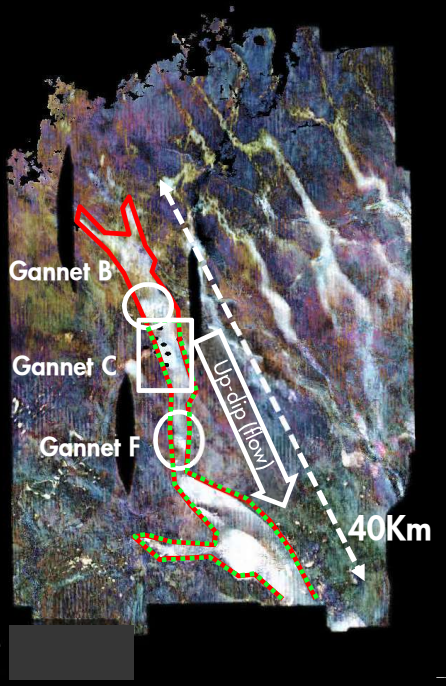


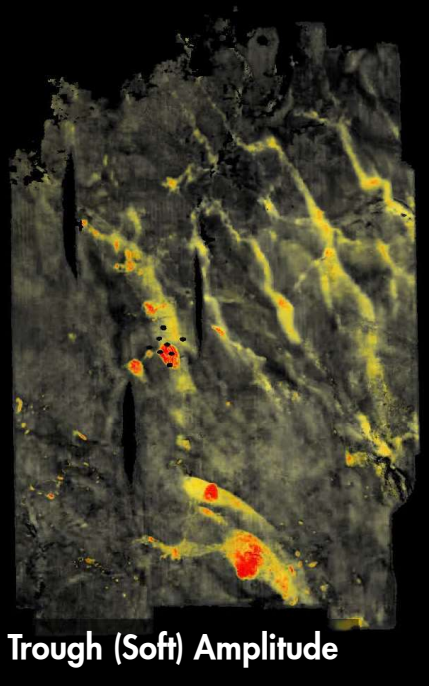
Data courtesy of CGG

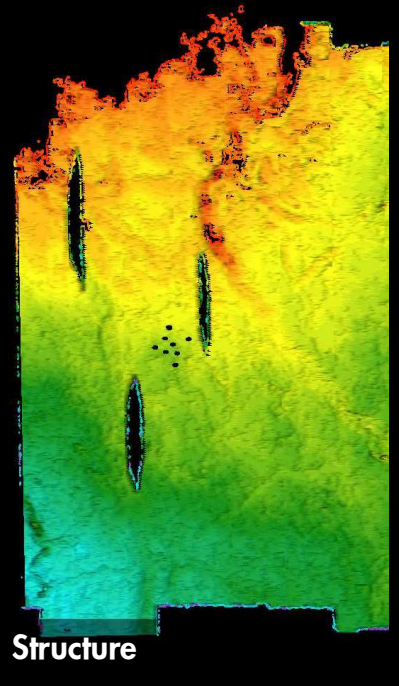
Regional Overburden Assessment

Even larger areas interpreted, mapping sand coverage and connectivity to investigate removing additional isolations. Insufficient understanding and legacy wells ultimately prevented this option.






Trough (Soft) Amplitude


Structure

Data courtesy of CGG

Summary

- More than ever we work with large **incomplete datasets, short time frames and risk** to:

Improve HSE, cost and asset value

- **Seismic data is key whenever we need to see away from the well, or where there is incomplete well data to predict the subsurface properties (particularly flow potential).**

- For example, for Gannet C, Geophysics is directly responsible for:

Saving 3,283man-hrs, 23 Days rig time

- We still have a lot to learn and a long way to go!

Acknowledgements

- Nicola Stewart (Geologist), Rafaella Madella (Well Engineer), Diana Cristancho (Petrophysicist), Manoochehr Salehabadi (Geomechanic), Calum Hunter & Tom Calder (Reservoir Engineers), Mostafa Soleimani & Obinna Ugoala (Production Technologists), Gatsbyd Forsyth (former Ultra Late Life WRFM Lead), Andrew Vaughan (Mature Assets Development/WRFM lead)
- Many others: Ultra Late Life team, Gannet Asset Team, Well Engineering, Technical Assurers, Subsea & Pipelines, Various specialists etc.