The GBA sits in the heart of the Central North Sea

- Multiple large companies, major developments and established infrastructure surrounds the GBA
- The GBA volumes are highly attractive to:
  - Companies with portfolios in need of growth
  - Infrastructure in need of additional throughput
JOG’s acreage in the Greater Buchan Area

**Verbier**
- P2170 Blocks Block 20/5b & 21/1d
- 88% operated working interest
  - CIECO 12%

**Buchan & J2**
- P2498 Blocks 20/5a & 21/1a
- 100% working interest and operatorship
- Straight to Second Term (4 years)

**Glenn**
- P2499 Block 21/2a
- 100% working interest and operatorship
- Initial Term (Phase A - 2 yrs, Drill or drop)

**Zermatt**
- P2497 Block 20/4c
- 100% working interest and operatorship
- Initial Term (Phase A - 2 yrs, Drill or drop)

Substantial potential hub asset with opportunity for multiple tie-backs
Buchan history

- Field production 1981-2017, 147Mmbbls produced
- Reservoir: Devonian age Buchan Group sandstones. Dual porosity system
- Seal: Lower Cretaceous mudstones
- Production via FPV Buchan Alpha, taken off station 2017 due to failed safety case
- Producing 3500 BOPD at COP with 50% WC
- Solid production history allows DCA for remaining resource estimation, independent of STOIIP and recovery factor based estimates
- Open fracture system provides flow to well bores but volumetrically insufficient for recovered volumes implying substantial matrix contribution
- New seismic data has resulted in a revision to the view of the field structure and origin with positive implications for more accurate dynamic modelling

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil gravity</td>
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<tr>
<td>Formation Volume Factor</td>
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<td>At 222°F, 7506 psig</td>
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<td>Initial GOR</td>
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<tr>
<td>Bubble point pressure</td>
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<tr>
<td>Oil viscosity</td>
<td>cP</td>
<td>1.025</td>
<td>At 222°F, 7506 psig</td>
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</table>

36 years of production history
Buchan producers

Key Reservoir Parameters
Oil Column: 585m (1900ft)
NTG: >70%
Porosity: <15% (up to 28%)
Perm: <20mD (0.02-200 mD)
Sw: 50-70%
Fm Water Salinity: 180000 ppm NaCl
OODT: 3155m
OWUT: 3173m
OOWC: 3164m

Significant oil production from core area
Tectonic elements of GBA

Tectonically active domain

[Map showing tectonic features and discoveries in the GBA region, with labels for areas such as South Halibut Platform, Goldeneye, Kildare, Hanbay, West Rochelle, East Rochelle, Tweedsmuir, North Buchan Graben, South Buchan Graben, Glenn, and Block 21/2a. The map also highlights the distribution of geological formations like Palaeogene (heavy oil), Lower Cretaceous (light oil/condensate), Upper Jurassic (oil), and Devonian (oil).]
Old Red Sandstone Depositional setting

Depositional Environments

- Arid fluvial
- Mostly braided and low sinuosity channels from Caledonian uplifts
- Axial or an alluvial fan system
- Predominantly subarkosic sandstones and siltstones with occasional thin shales and calcrete conglomerates.

Braided fluvial

High sinuosity fluvial and floodplain

Proven reservoir
Old Red Sandstone Depositional setting

Over Bank deposits

Channel fills

Sand rich system
Evolution of Buchan field definition

- Earlier mapping only recognised E-W faulting
- New seismic data has identified a secondary suite of N-S faults

Benefits of 2018 seismic data

- Fault framework revision
- Fault position uncertainty
- Lost section estimation
- Field-wide correlation and zonation
- Well-bore/fault correlation
- Fault intersection and flow indicators (PLT)
- Effective fracture network

Success lies in structural mapping
Reservoir management

PLT was used for surveillance, WSO and sidetrack

Integration of PLT with interpretation shows almost all producers have been drilled through faults, which have aided production as there are fracture corridors around these faults

Significant production has also been attributed to channel sands

### Channel sands

<table>
<thead>
<tr>
<th>Zone</th>
<th>Water shut-off</th>
<th>Side-tracked</th>
<th>Converted to Water Injector/disposal</th>
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</thead>
<tbody>
<tr>
<td>Zone L20</td>
<td>F6</td>
<td>F5</td>
<td>F15C</td>
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<tr>
<td>Zone L20</td>
<td></td>
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</tbody>
</table>

**Integration of PLT with geological interpretation**
Buchan pressure data

Pressure Data
- All central horst wells on common trend (except B4 & B8)
- Pressure stabilized after ~1992

Evidence of aquifer support
The Bubble point is 1,286 psi, while current reservoir press is above @2,500 psi; no Secondary Gas Cap

**Significant column height**
Facies associations organised into a series of fining upward packages

- **Floodplain**
  - Mudstones
  - Finely laminated/ wave rippled siltstones

- **Bar-top**
  - Very fine to fine sandstones
  - Parallel laminated/wavy bedded
  - Current rippled sandstones
  - Parallel laminated sandstones

- **Barform**
  - Low angle plane bed stratified sandstones
  - Planar tabular cross-bedded sandstones

- **Channel fill facies**
  - Trough cross stratified sandstones
  - Massive sandstone
  - Intra-clast channel lag deposit / intra-formational conglomerate
  - Erosion surface

---

High Net-to-Gross system
Buchan Facies Characterisation 21/1-6 (B1)

**Channel basal lag 2765.5m MD**

- Trough cross stratified, poorly sorted, micaceous, medium to coarse grained sandstones
- Often associated with conglomerates and massive sandstones
- Multi-storey channel fill complexes or isolated channel units

**Barform to Bar top with fractures 3076.5m MD**

- Normaly overlays channel fill
- Planar tabular cross-bedded sandstones and to a lesser extent Low angle plane bed stratified sandstones
- Moderately sorted fine sandstone

**Bar top with calcrete 2707m MD**

- Overlay the bar form facies and maybe overlain by the floodplain facies
- Finely laminated siltstones and mudstones
- Very fine to fine sandstones Parallel laminated/wavy bedded very fine sandstone; Current rippled sandstones fine sandstone
- Modification of exposed bar tops during the low stage of the fluvial system, calcretes and occasional bioturbation
Facies associations

**Cross-bedded sandstone**
Sub-rounded grains; clay rims inhibit quartz cementation. Some pore filling calcite and feldspar replacing dolomite rhombi. Cross-cutting cemented fracture.

**Cross-bedded, channel fill sandstone**
Thick authigenic clay rims surround detrital grains, occlude pores and restricts quartz overgrowth. Plagioclase dissolution leaves grain ghosting clay rims; note lack of subsequent compaction.
Porosity – 16%

Preserved porosity in Devonian rocks
Buchan fractures

21/01-6 oil-stained fracture in channel fill sandstone with mud rip-up clasts - 2984m MD

21/01-6 Deformation bands in planar bedded bar-form sandstone - 3080m MD

Fractures aid fluid flow
Fracture model

Fault framework model with fractures distribution

Fracture characterization
Buchan decline curve analysis vs simulation

DCA
- DCA performed for each well
- Summed for the field
- Gives data based forecast for water cut
- Simulation
- Earlier work in alignment with DCA
- Future development with new highly deviated wells could exceed vertical well DCA trend

Significant resources available
Cross-section across Buchan Field

- Initial Oil Column: 1,900 ft
- Surface location
- Oil
- Aquifer
- Initial Oil
- Water Contact
- Buchan fluid contact

[Diagram showing cross-section with labeled features and measurements]
Buchan subsurface development scenario

**Initial development (‘80s)**
- Wells
  - 9 vertical producers
  - 2 water disposal
- Artificial Lift
  - Gas Lift
- Water shut off (WSO)

**Challenges**
- Overpressure
- Unknown reservoir performance
- Unoptimized development
- Vertical wells
- No Pressure support
- Retrofit artificial lift system

**Redevelopment (Today)**
- Producer Wells
  - 3-6 highly deviated producers
- Injector wells
  - 2-3 water injectors for pressure maintenance
- Artificial Lift
  - Gas Lift
  - ESP
- Smart completions for WSO

**Opportunities**
- 36 years of production performance
- Stabilized reservoir pressure
- Active aquifer
- Modern technology
- Maximum economic recovery
- Energy transition

**Buchan second oil**
Greater Buchan Area conceptual development

Gas Export

Oil Export

Verbier (J62-J64) manifold

Buchan & J2 Platform Wells

Spare slots for future production, gas lift and water injection risers

Umbilical
Water Injection
Oil Export
Oil (well fluids)
Future
Future manifold

Hub development
Platform electrification – a new reality

Facility simplification – a route to de-manning

- Heating Medium System
  - 270 tonnes
  - 15 pieces of kit

- Gas Fuel System
  - 70 tonnes
  - 16 pieces of kit

- Instrument Air System
  - 80 tonnes
  - 78 pieces of kit
Conclusions

✓ Buchan is a conventional clastic sandstone reservoir with oil storage in matrix

✓ 2018 PGS seismic has helped better structural characterization of the field

✓ Complex tectonics/faulting has resulted in fracture development

✓ Most wells have encountered fault cuts

✓ PLT has shown significant production from matrix dominated reservoir facies

✓ Fractures enhance the matrix permeability

✓ The GBA is a perfect candidate for regional hub development
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