Multisensor, Multi-Azimuth Quantitative Interpretation: A Case Study from the South Viking Graben, Norway

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& with a lot of background work by T. Bird & L. Goswami
Outline

- Introduction
  - Area of Interest
  - The Challenges
  - The Value Proposition

- Results Overview:
  - rockAVO in the area
  - Azimuthal seismic overview and results
  - QI / Brief prospectivity results

- Summary and Conclusions
Major Norwegian fields are located in this area over several stratigraphic intervals:

- **Balder, Grane, Svalin**
  - Eocene – Balder sands
  - Paleocene – Heimdal sands
- **Hanz field**
  - Upper Jurassic – Draupne
- **Johan Sverdrup**
  - Upper Jurassic intra-Draupne sandstone
- **Ivar Aasen**
  - Late Triassic to Mid. Jurassic
- **Edvarg Grieg**
  - Late Triassic to Early Cretaceous sandstone

- **Verdandi** discovery in 2003 and more recent discovery with **Lille Prinsen** in 2018:
  - various hydrocarbon intervals in
    - Eocene (Grid sand), Paleocene (Heimdal sand) and Permian (Zechstein Group).
Area of Interest | Viking Graben - The Challenges

Challenges:
- Shallow subsurface channels, shallow gas,
- Tertiary low velocity anomalies and high velocity sand injectites - V-brights
- Paleogene polygonal faults and
- High impedance rugose Late Cretaceous Chalk
Multi-Azimuth Multisensor Viking Graben | Acquisition Parameters 2019

- **Wide Tow Triple Source**
  - Source separation: 112.5
  - Total source separation: 225m

- **12 Streamer Spread with Tails**
  - 10 Streamers: 6,000m
  - 2 Streamers: 10,000m

- **Multi-Azimuth**
  - 1 legacy GeoStreamer
  - 2 additional GeoStreamer (2019)

- **Dense Spread**
  - Streamer separation: 85m

Addressing imaging challenges in the Viking Graben with multi-azimuth acquisition, longer offsets, and wide-tow sources. SEG International Exposition and 90th Annual Meeting
Sail line processing, line-by-line
Denoise, wavefield separation, deghosting/designature

Comprehensive 3D demultiple (SWIM & SRME)

Full Waveform Inversion using:
refraction up to 12Hz (0-10 km) +
reflection up to 15Hz (0-6 km)

4D/5D data regularization
All surveys/azimuths
Offset/azimuth binning and regularization

Kirchhoff PSDM
Offset/azimuth CDP gathers

Optimized azimuthal correction & weighted stack
RMO/gather flatness, denoise, MAZ stack, Az. stack

Revealing new opportunities with a cost-effective towed streamer MAZ solution in the South Viking Graben, Norway, First Break, 38, 95-101, DOI: 10.3997/1365-2397.fb2020085
### Legacy | Multi-Azimuth Multisensor Regional Section (Relief section)

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<tr>
<th>Legacy</th>
<th>Multi-Azimuth Multisensor 2019</th>
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**Top Chalk**

Better reflector continuity (sharper – cleaner) and improved signal to noise ratio
Top Balder - Fault Detection & Resolution Improvement

Top Balder Incoherency map showing polygonal faulting in the Lille Prinsen field vicinity. Enhanced discontinuity contrast and visibility with the Multi-Azimuth multisensor dataset.
rockAVO - 16/1-29ST2 (Lille Prinsen) – Clastic Section

More information about rockAVO can be found on: rockAVO | Well Data | Seismic | Offshore Oil and Gas Exploration | PGS or please contact rockAVO.info@pgs.com
Relative Acoustic Impedance
Co-rendered with full stack seismic
Attributes: Relative Acoustic Impedance

Arbitrary Line Lille Prinsen (Heimdal + Zechstein)

Lille Prinsen and Verdandi Oil & Gas Discoveries (Grid + Heimdal sst. Reservoirs)

Lille Prinsen look-alike prospects Zechstein and/or UR Jur. reservoirs

Arbitrary Line Lille Prinsen (Heimdal + Zechstein)
Elastic Attributes MAZ vs. Azimuthal

Significant Improvement between the NAZ legacy data to the Azimuthal Acquisition.

- Improved SNR
- Higher Resolution
- Accurate Fluid Identification and prediction
- Improved Leads – Prospects Identification and Derisking
Summary

- **Innovative acquisition** set-up with wide-towed sources (3) MAZ multisensor dataset has:
  - Overcome some complex geological & geophysical challenges
  - Lead to:
    - Very broadband wavelet beneficial for the inversion
    - Very good match at the wells
    - Multi-Azimuth Anisotropy analysis for extraction of Isotropic Gradient and subsequent Isotropic Vp/Vs (work on-going)

- **Mapping of existing fields** at numerous stratigraphic interval (Paleocene, UR Jur. & Permian)

- Highlighting some clear leads and opportunities
Thank you