A Source Rock Story

From seismic data in The Gambia and Guinea Bissau

De-risking Source Rock Steps

1. **Regional** plate tectonic and paleogeographic reconstructions

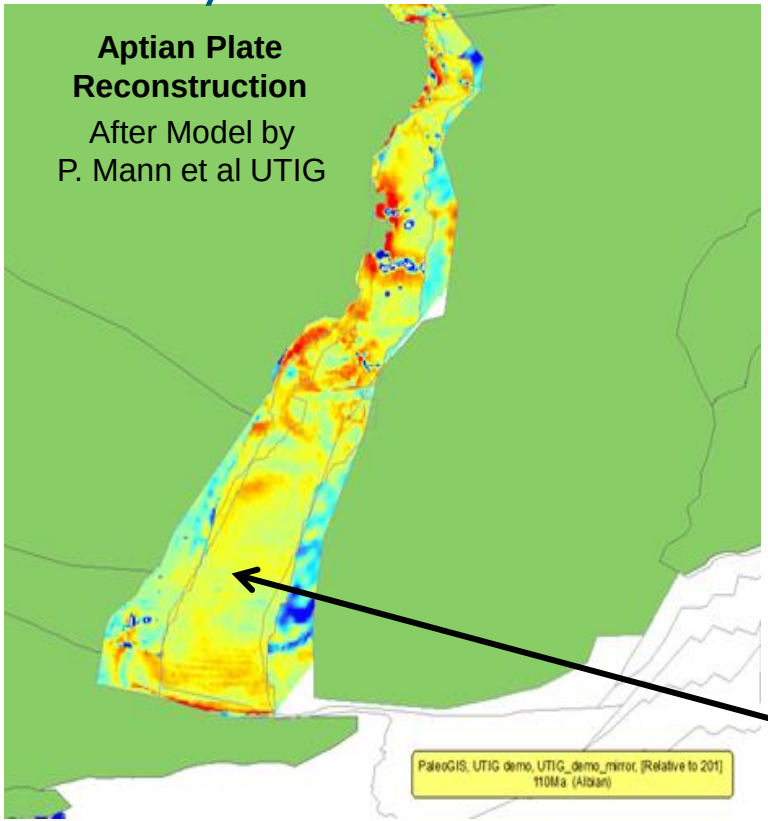
2. **Seismic** observation and analysis including source rock characterization and seismic sequence stratigraphy models

3. **Hydrocarbon evidence** and integration of slick clusters from satellite imagery

4. **Conjugate margin correlation**

Source Rock Evaluation Seismic Database

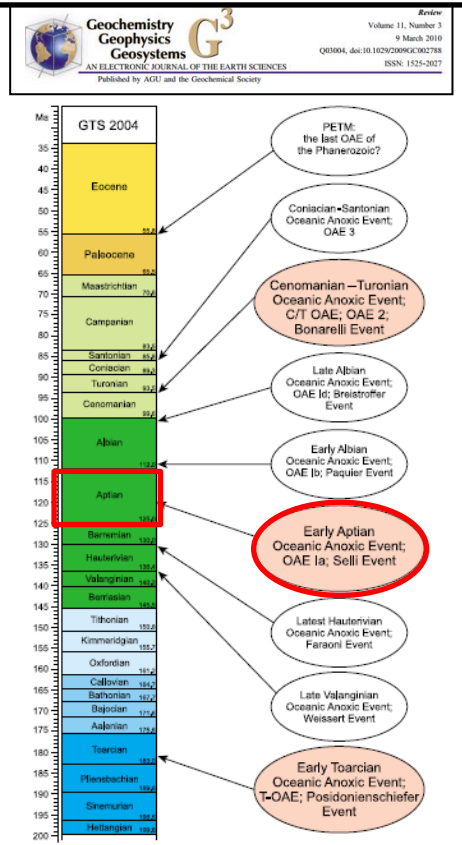
1 Early Cretaceous Drift Basin



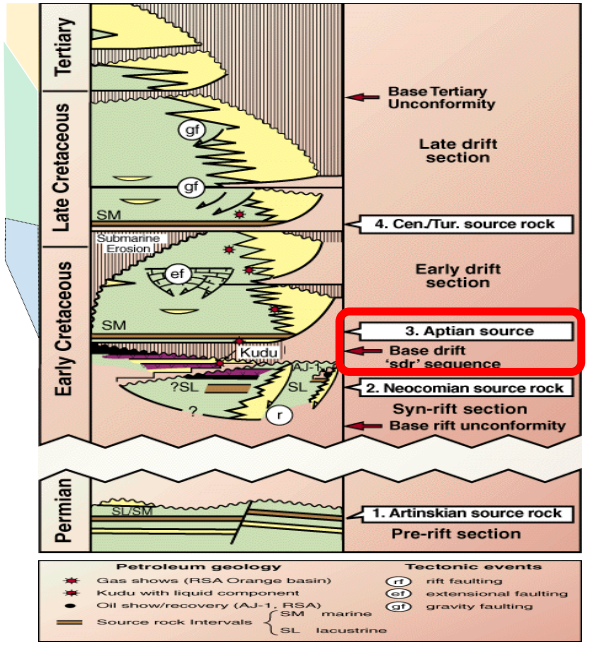
Widespread Aptian Source Rock

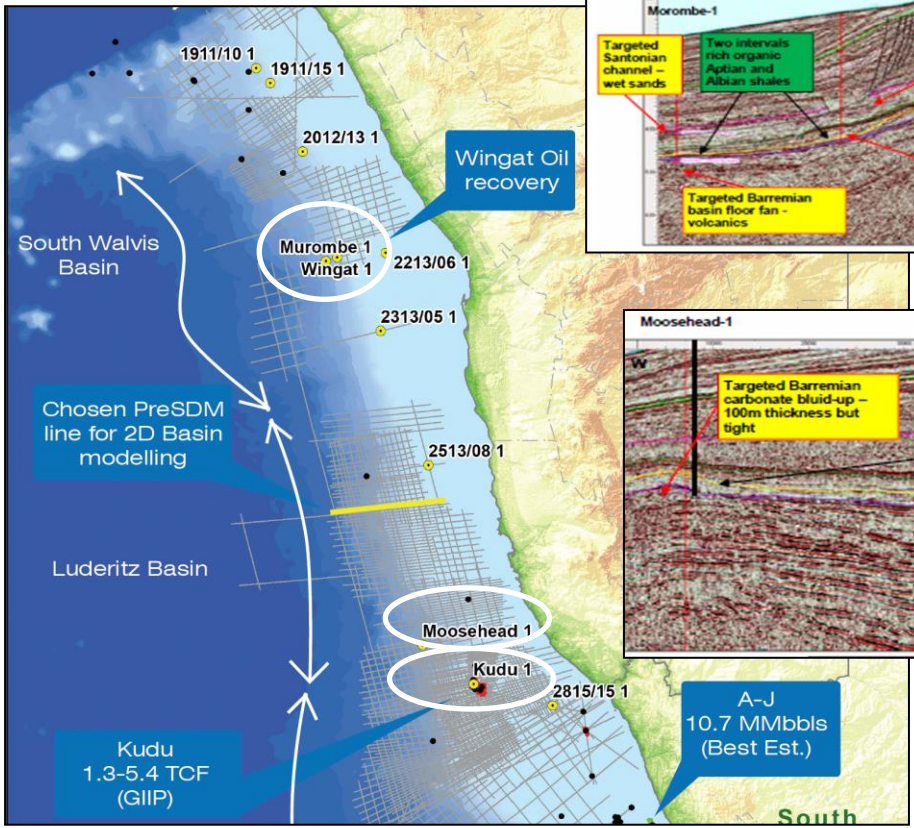
Oceanic Anoxic Events

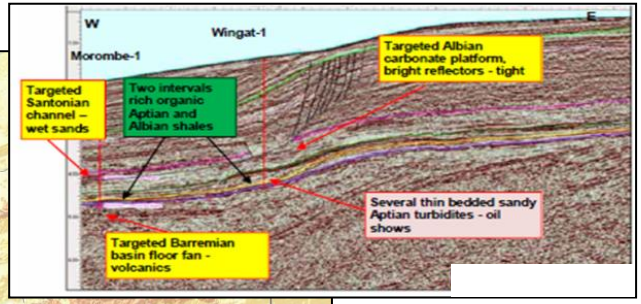
- Intervals when large areas of the seafloor became anoxic
- Abrupt rise in temperature induced by rapid influx of CO_2 into the atmosphere (volcanogenic and/or methanogenic sources)
- Increased flux of organic matter favoured intense oxygen demand and intense rates of marine and lacustrine carbon burial
- **Particularly effective in restricted oceans and seaways**

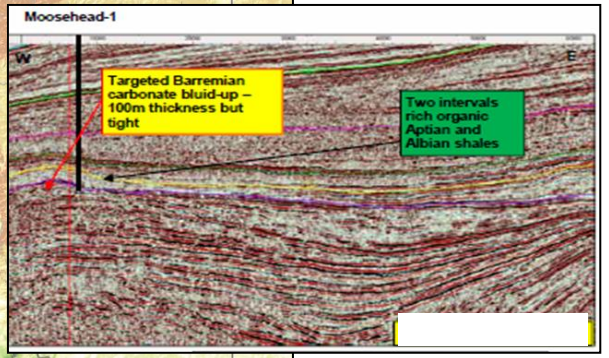


Aptian Source Rock









After Bray et al. 1998

Criteria for Source Rock Characterization

Top source rock characterised by

1. Significant **reduction in AI** resulting in a soft kick at the top of the unit.

2. **Reduction in Amplitude with increasing angle**
   - Best measured on anisotropically migrated data.
   - Isotropic data will give a weak dimming effect

3. Density is inversely related to TOC, therefore the **amplitude profile broadly follows the TOC%,** increasing, decreasing or bell curve.

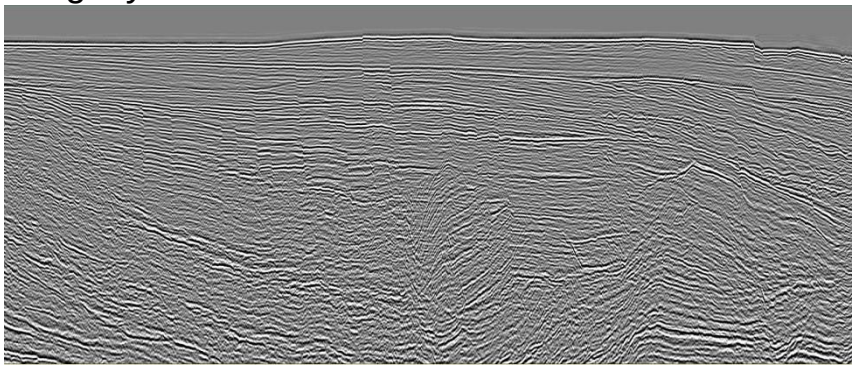
4. **Lateral changes in Amplitude can represent lateral changes in TOC**.

Can hydrocarbon source rocks be identified on seismic data?

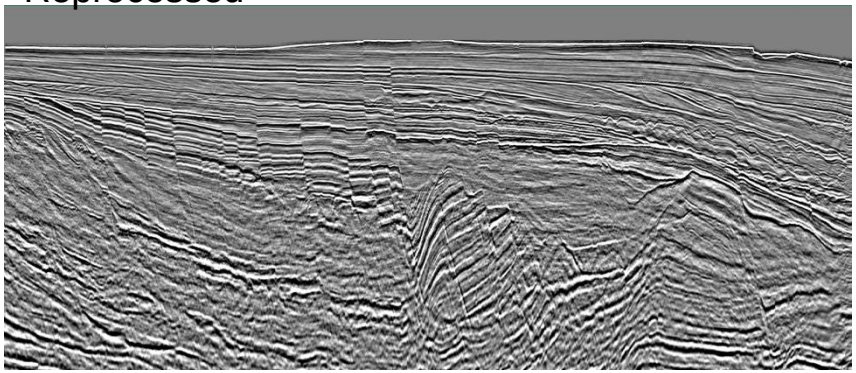
Helge Løseth[1], Lars Wensaas[1], Marita Gading[1], Kenneth Duffaut[1], and Michael Springer[2]

Reprocessed Seismic Data Essential

Legacy



Reprocessed

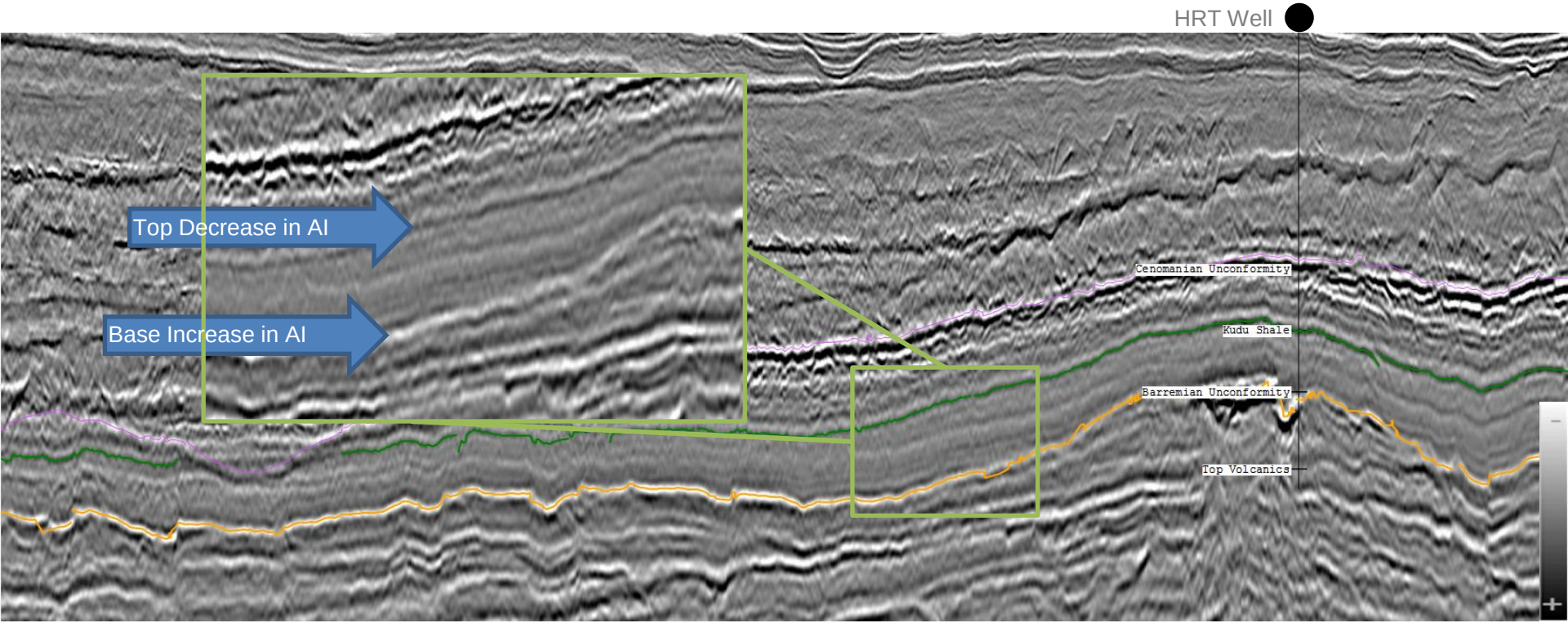


- Survey VNOB03 over Kudu wells recently reprocessed
- Legacy data angle stacks not reliable due to uncertainties in AVO compliance
  - Methodology of calculation not clear (what is a background amplitude correction?)

```
REMOVAL OF INTERPOLATED TRACES, BACKGROUND AMPLITUDE CORRECTION,
PRE-STACK TIME MIGRATION USING FULL CURVED RAY KIRCHHOFF,
NMO USING FINAL VELOCITY MODEL PICKED EVERY 1KM,
HIGH RESOLUTION RADON MULTIPLE ATTENUATION,
25 DEGREE INNER MUTE AND 40 DEGREE OUTER MUTE,
```

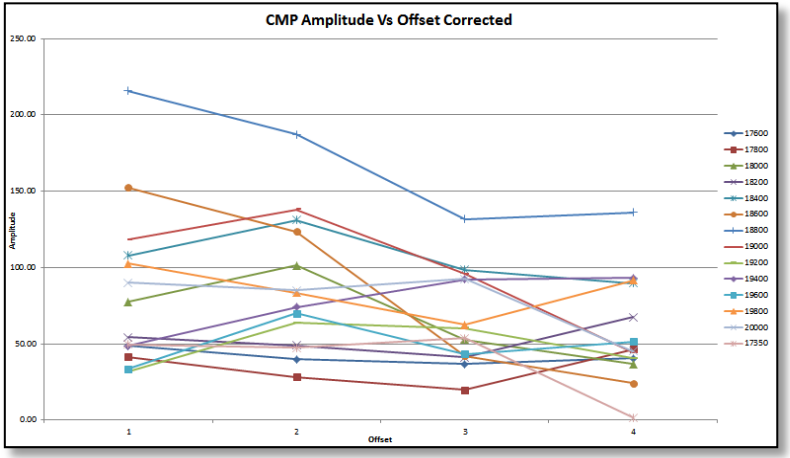
- Reprocessed data is significantly less noisy as demutiple/denoise techniques have improved considerably over the last 15 years.

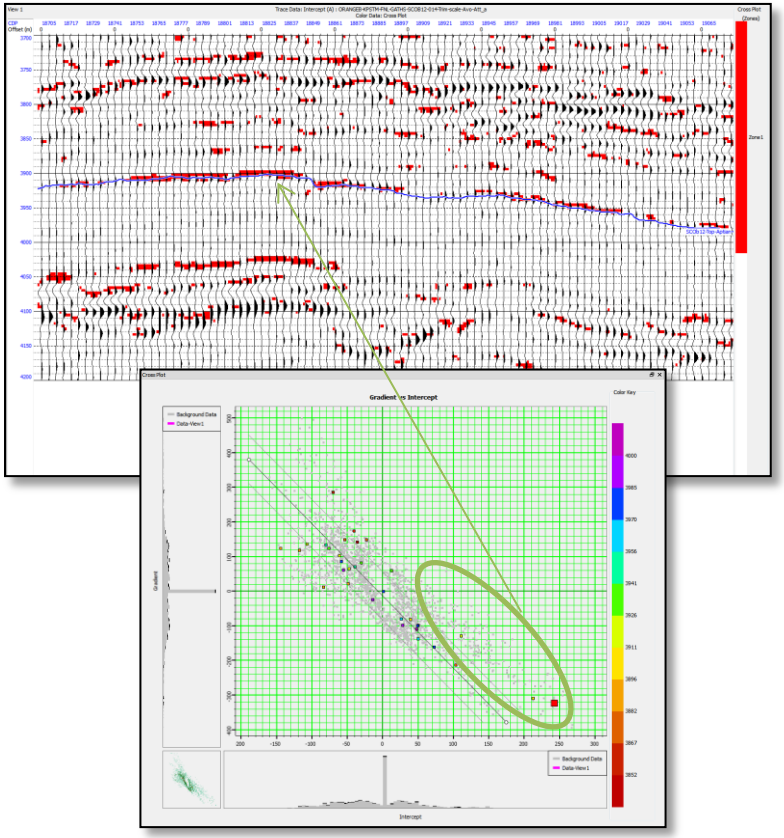
Scob-12 Kudu Shale Picks



SCOB12 - Final Stack Broadband PSTM Repro 2018

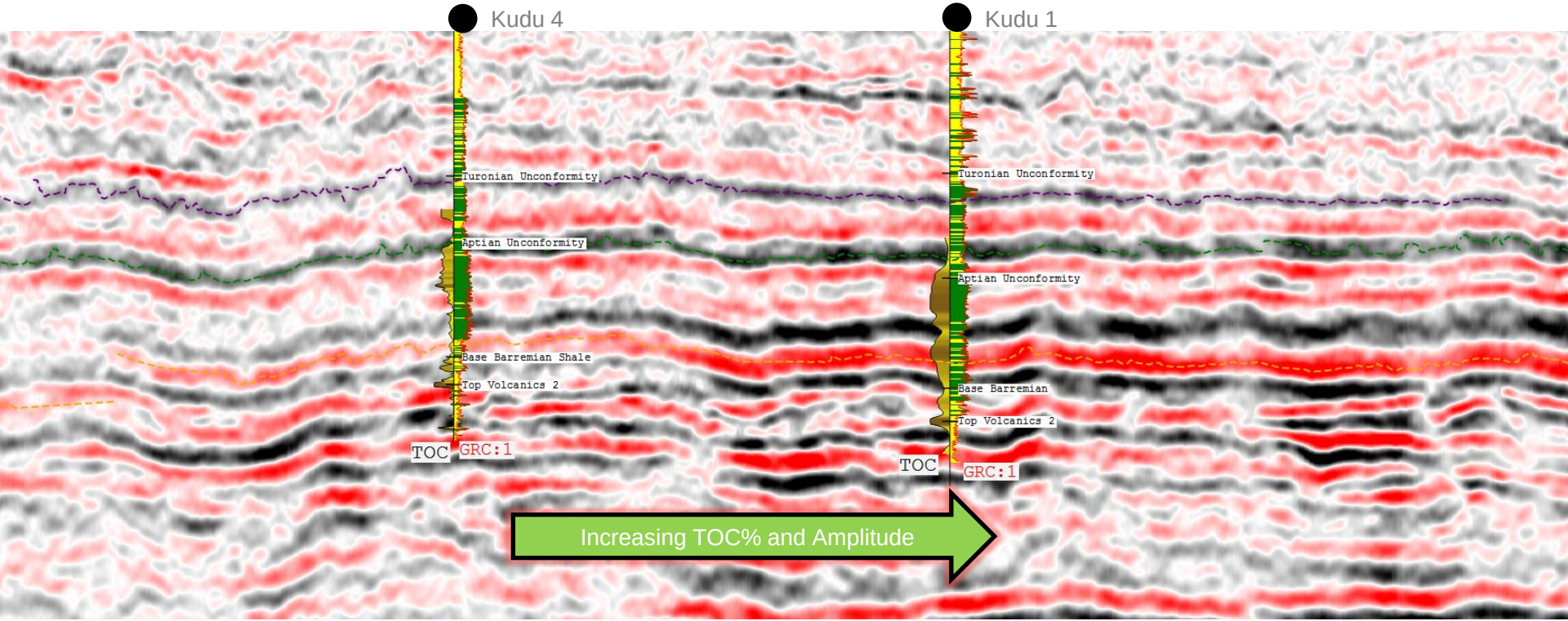
2) Reduction of Amplitude with Angle/Offset





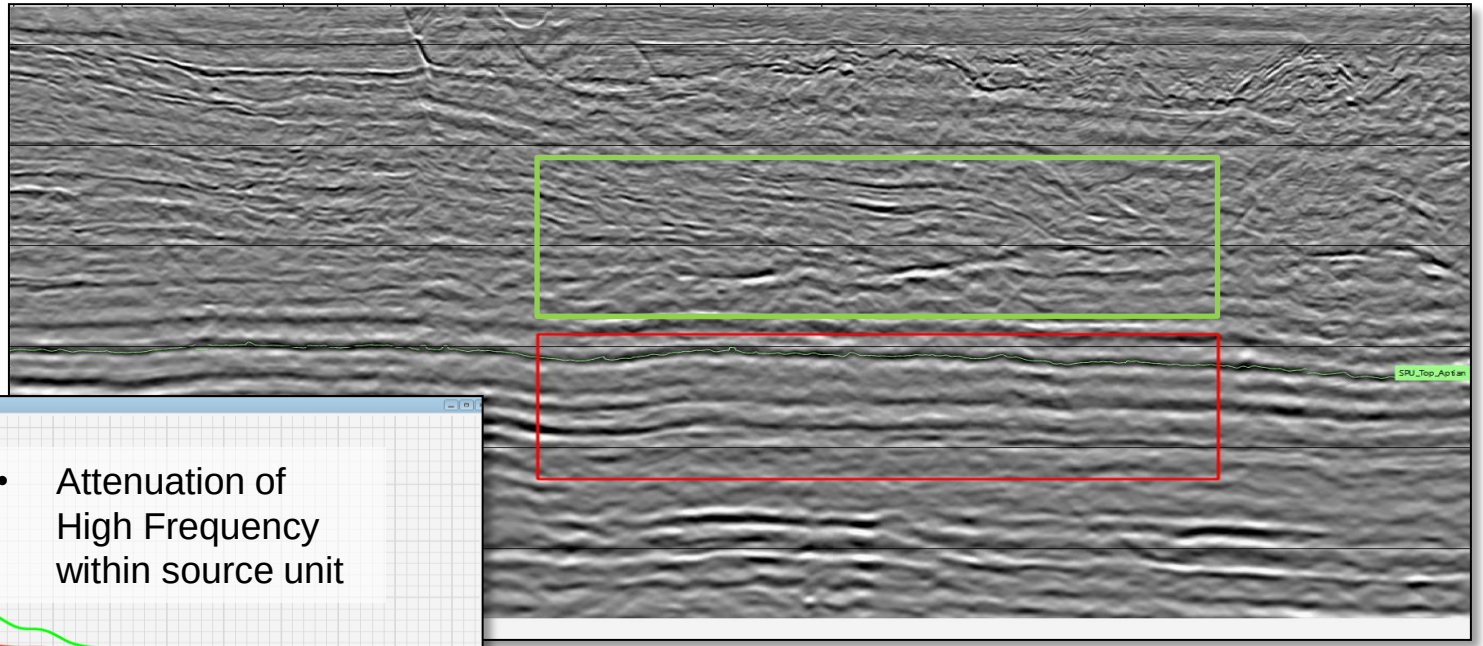
HRT Well

TOC% and Amplitude Relationship



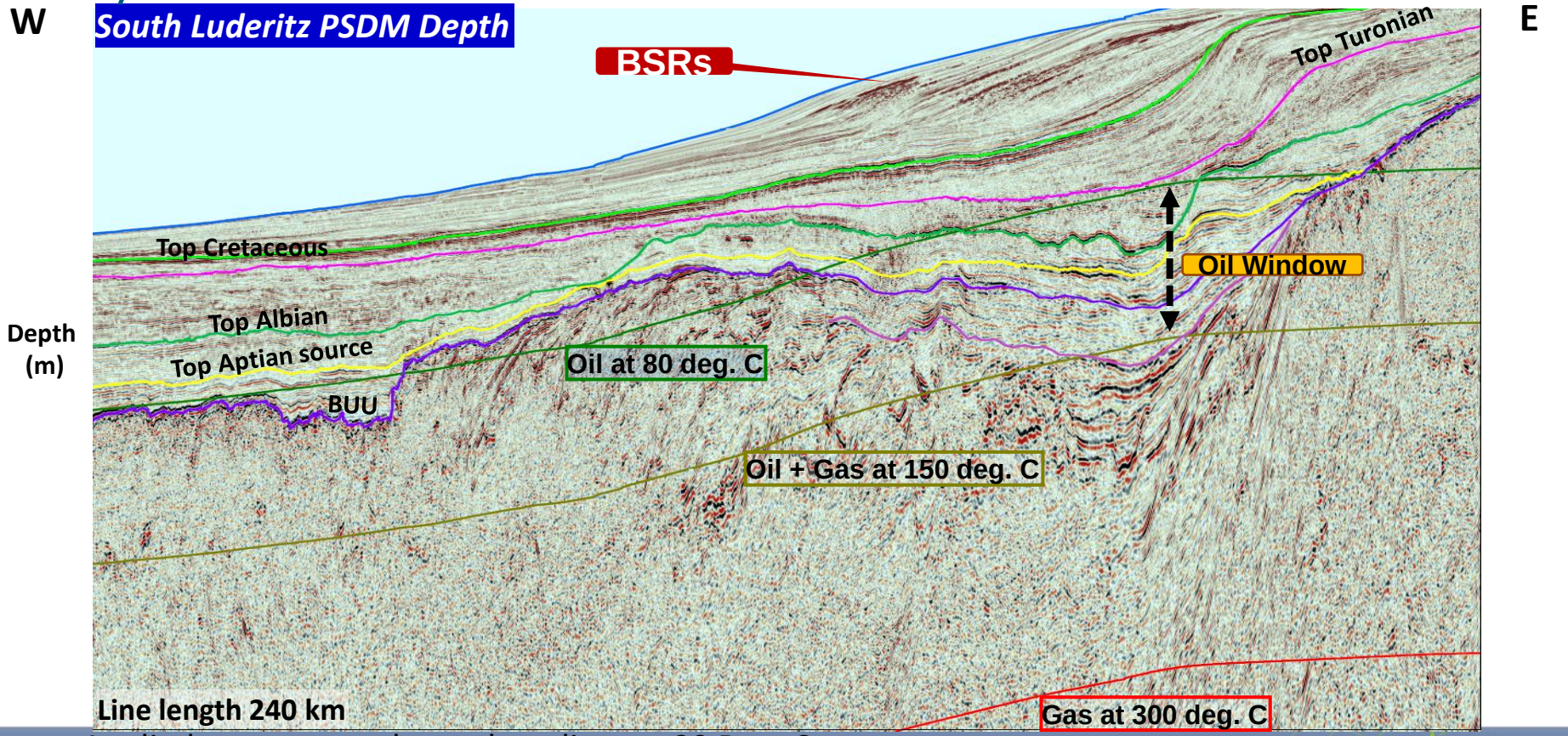
Namibia Regional Reprocessing 2018 PSTM

Frequency Content



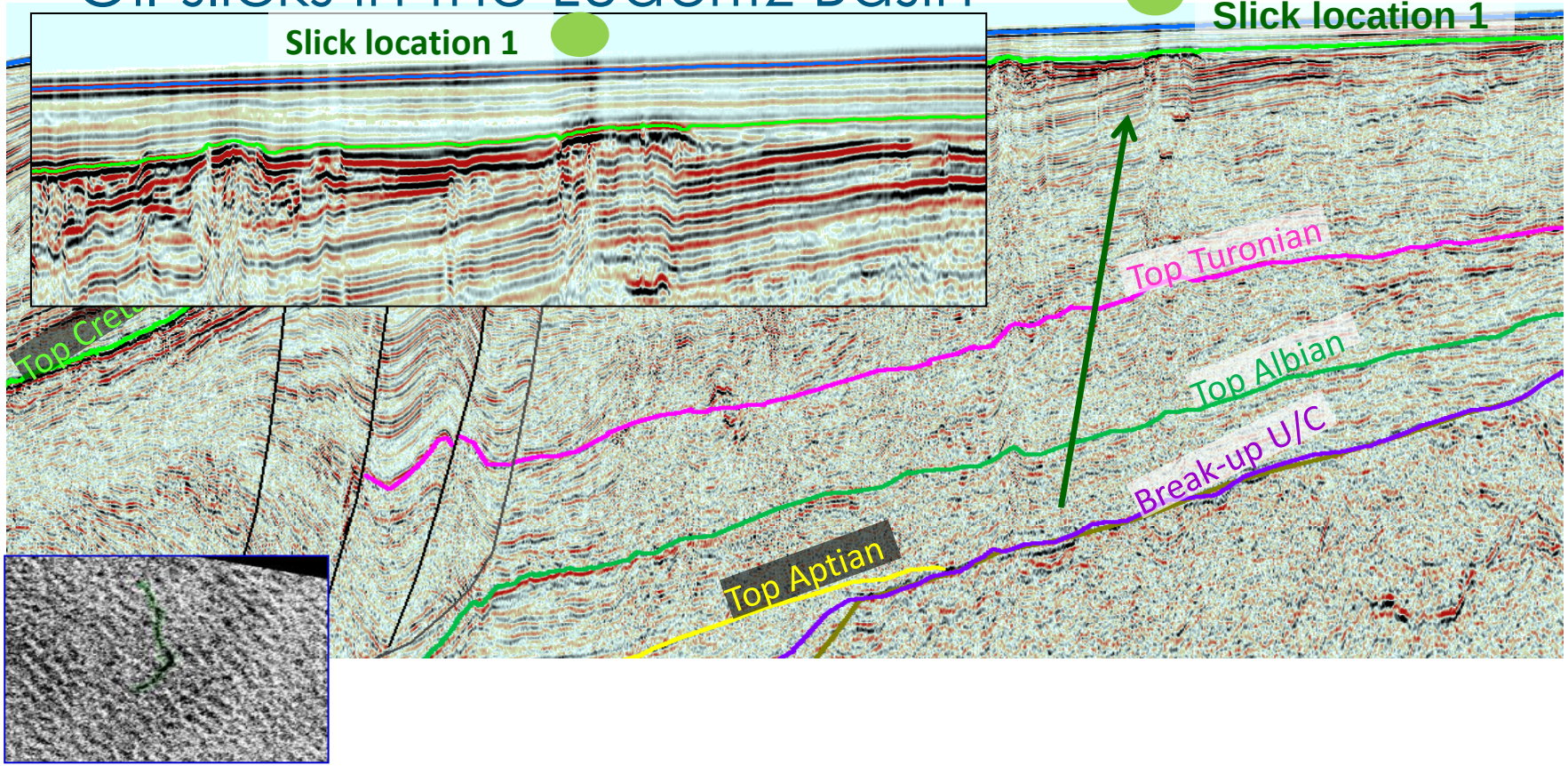
- Attenuation of High Frequency within source unit

Hydrocarbon Generation Model

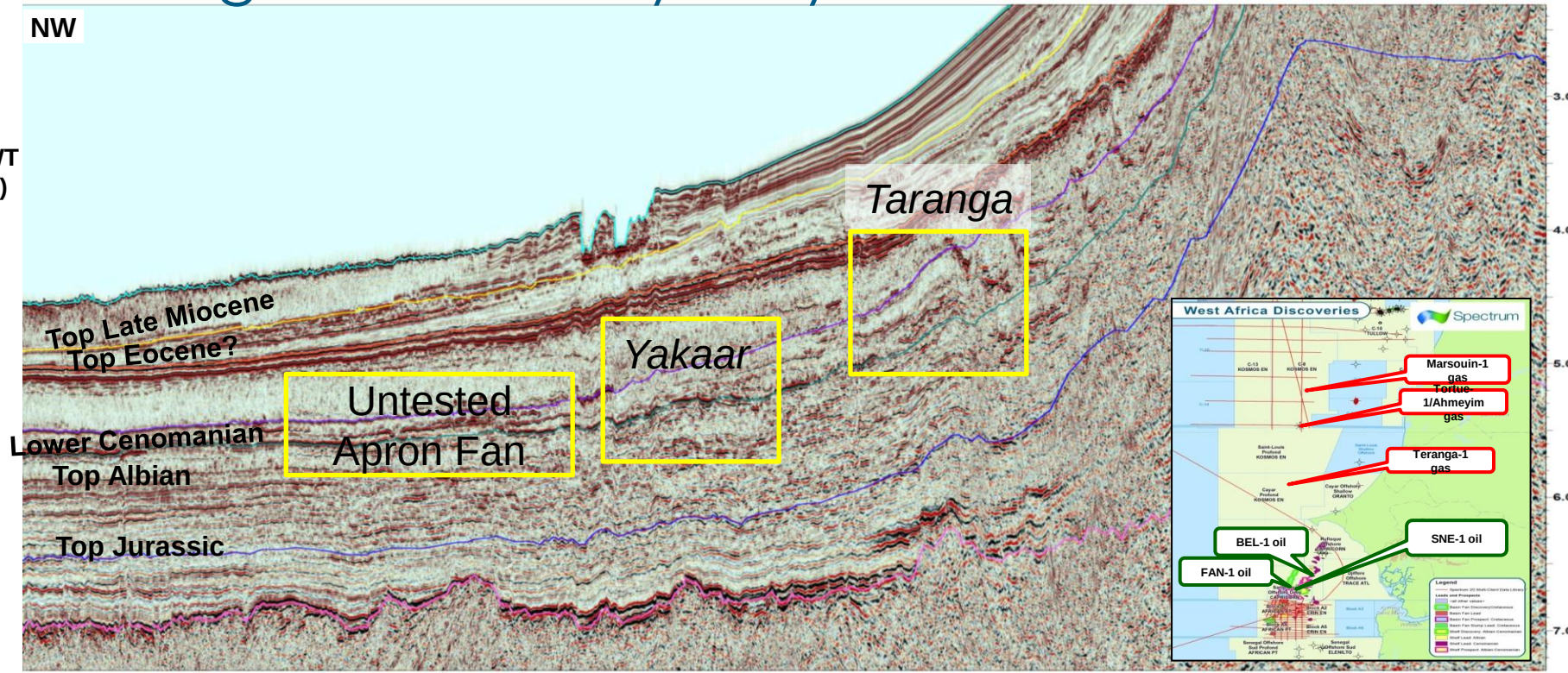


Applied average geothermal gradient at 30 Deg. C

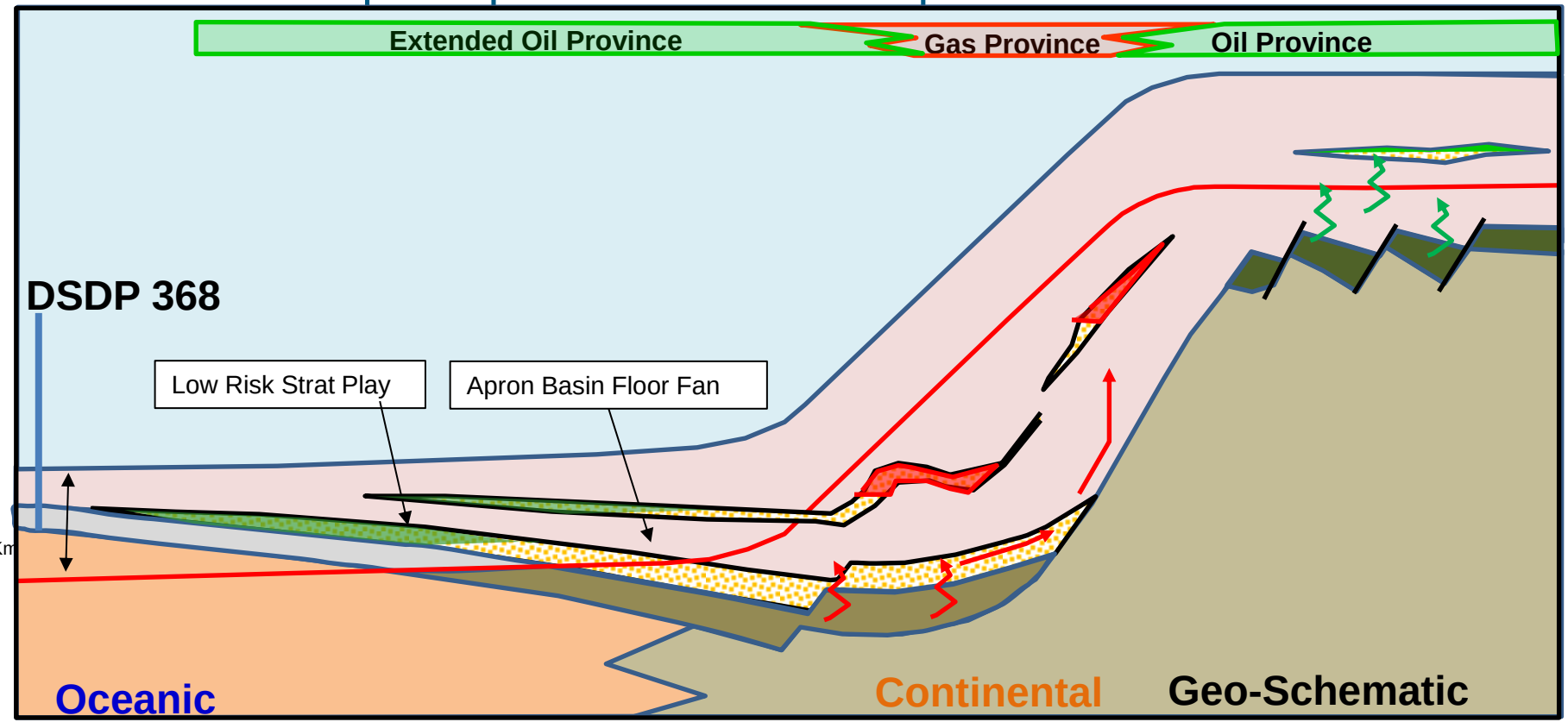
Oil-slicks in the Lüderitz Basin



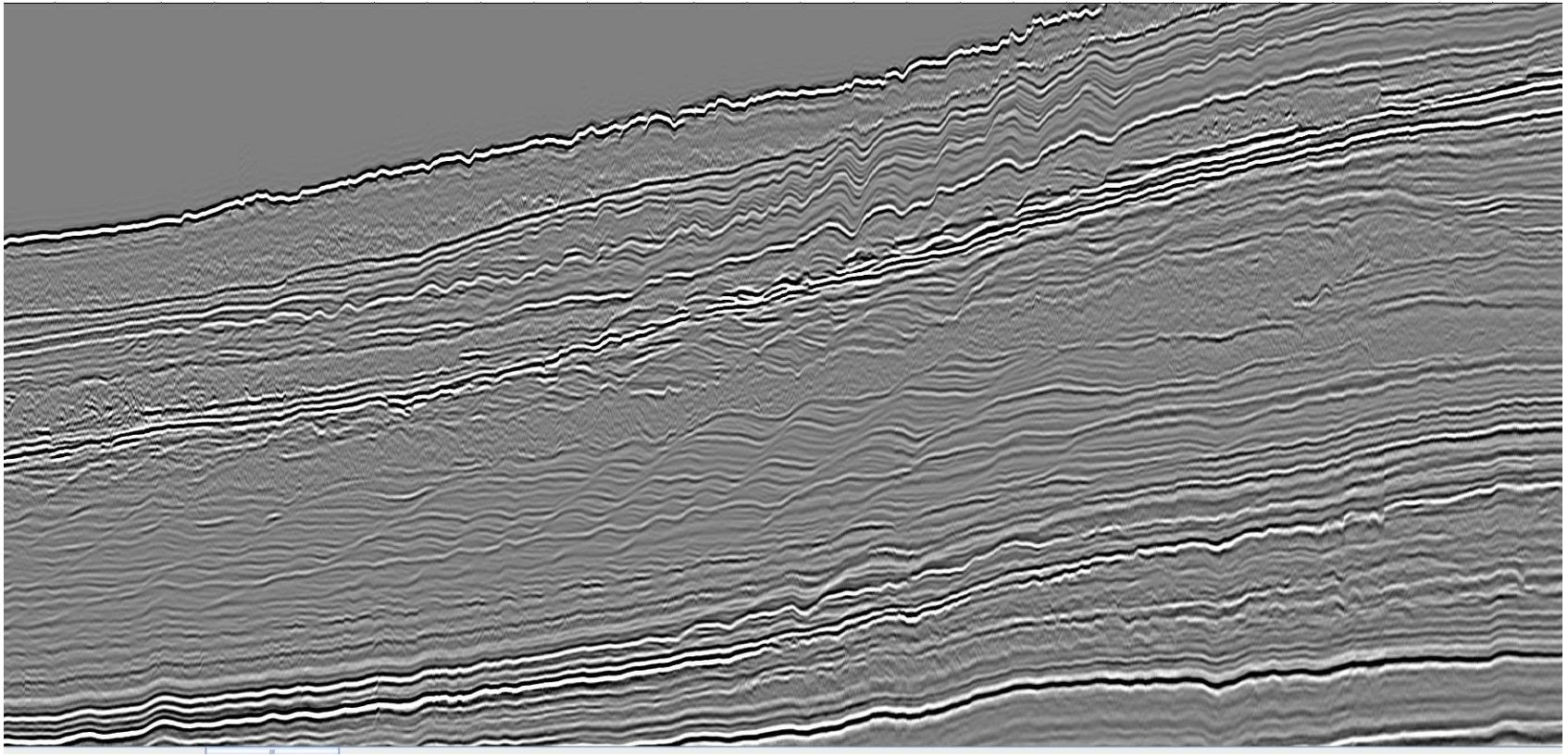
2 Senegal: Spectrum PSTM TWT Taranga-1 Discovery May 2016



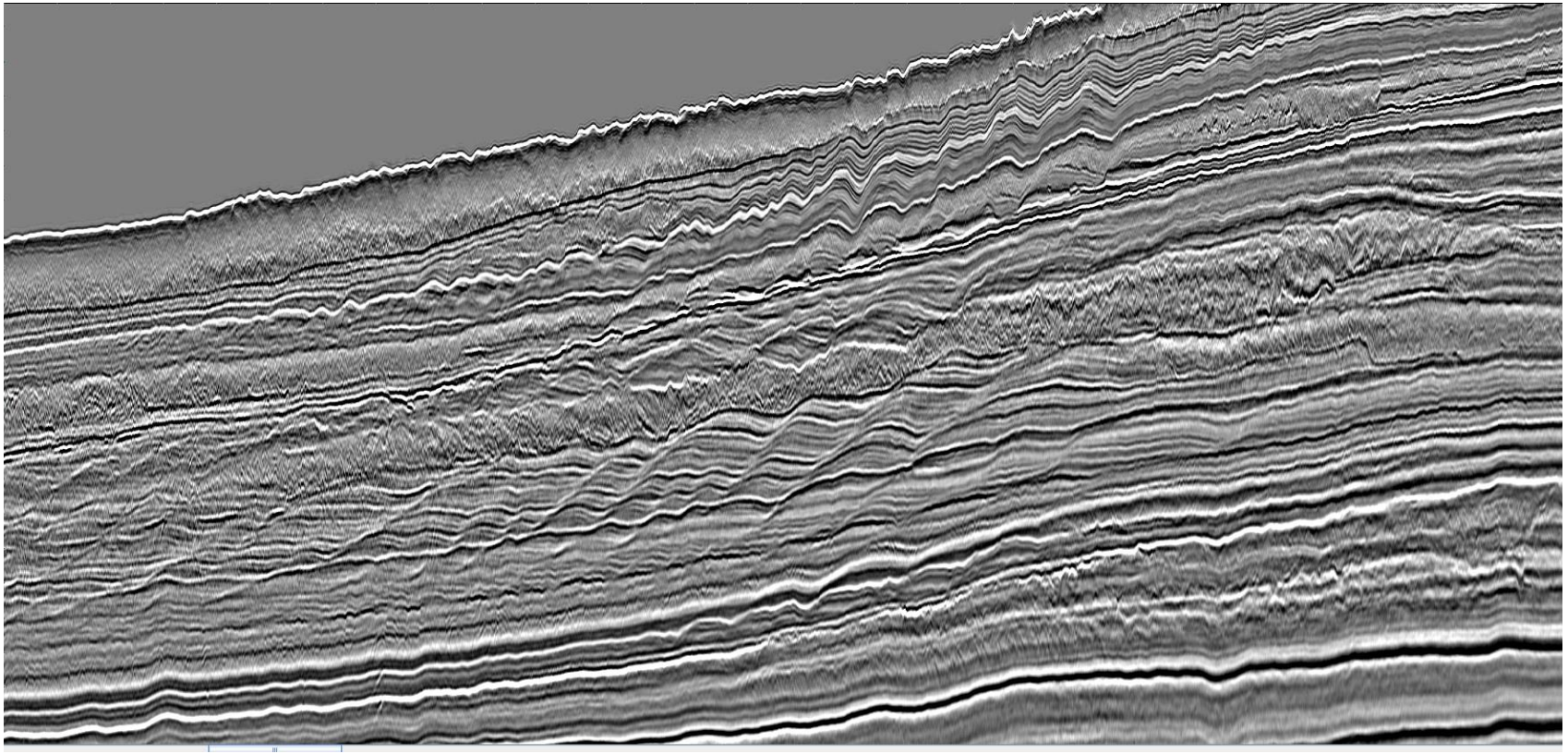
MSGBC Up-Dip closure of Apron Fan



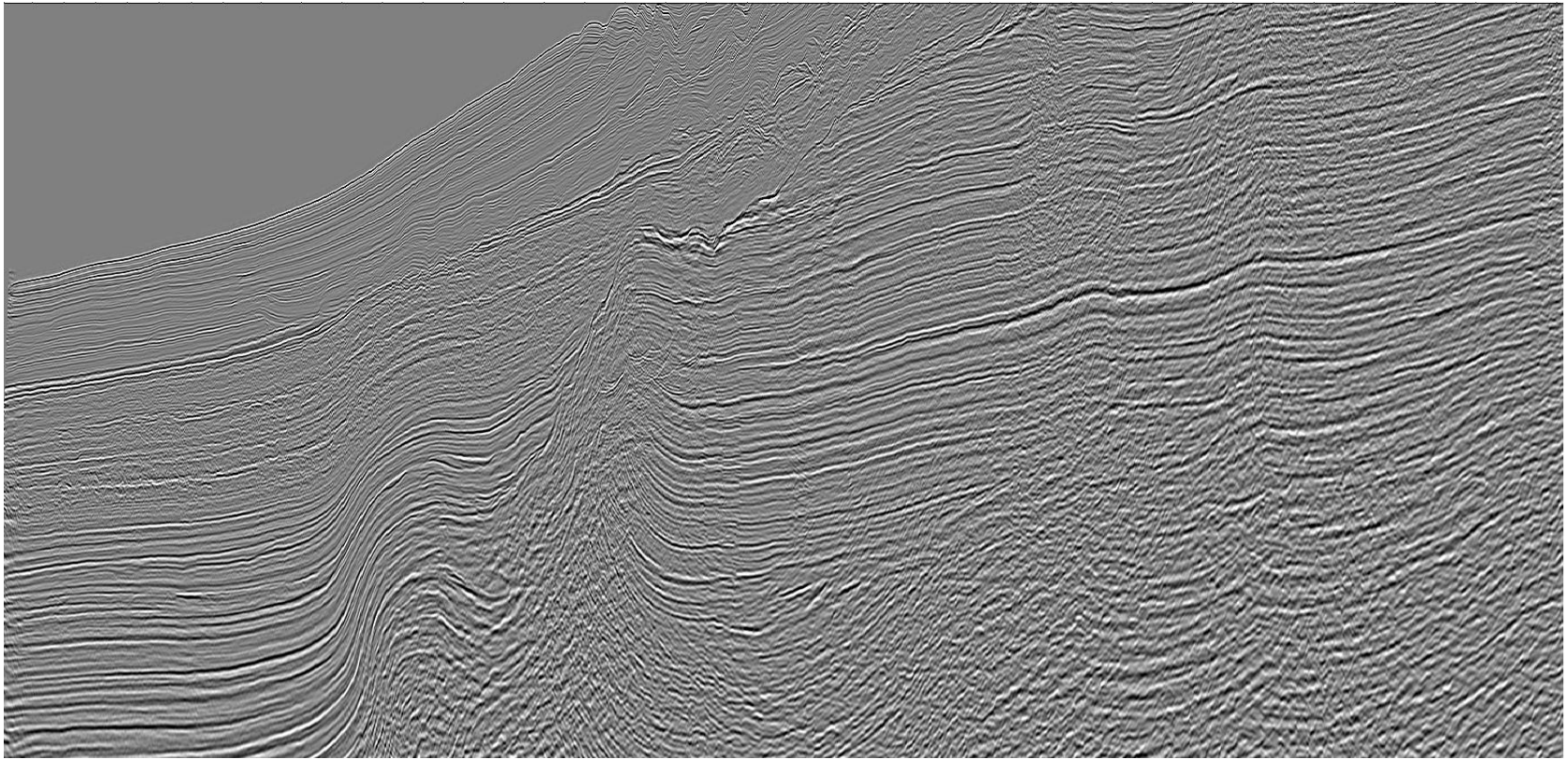
Line VER01MWT-02 2013 Legacy Stack



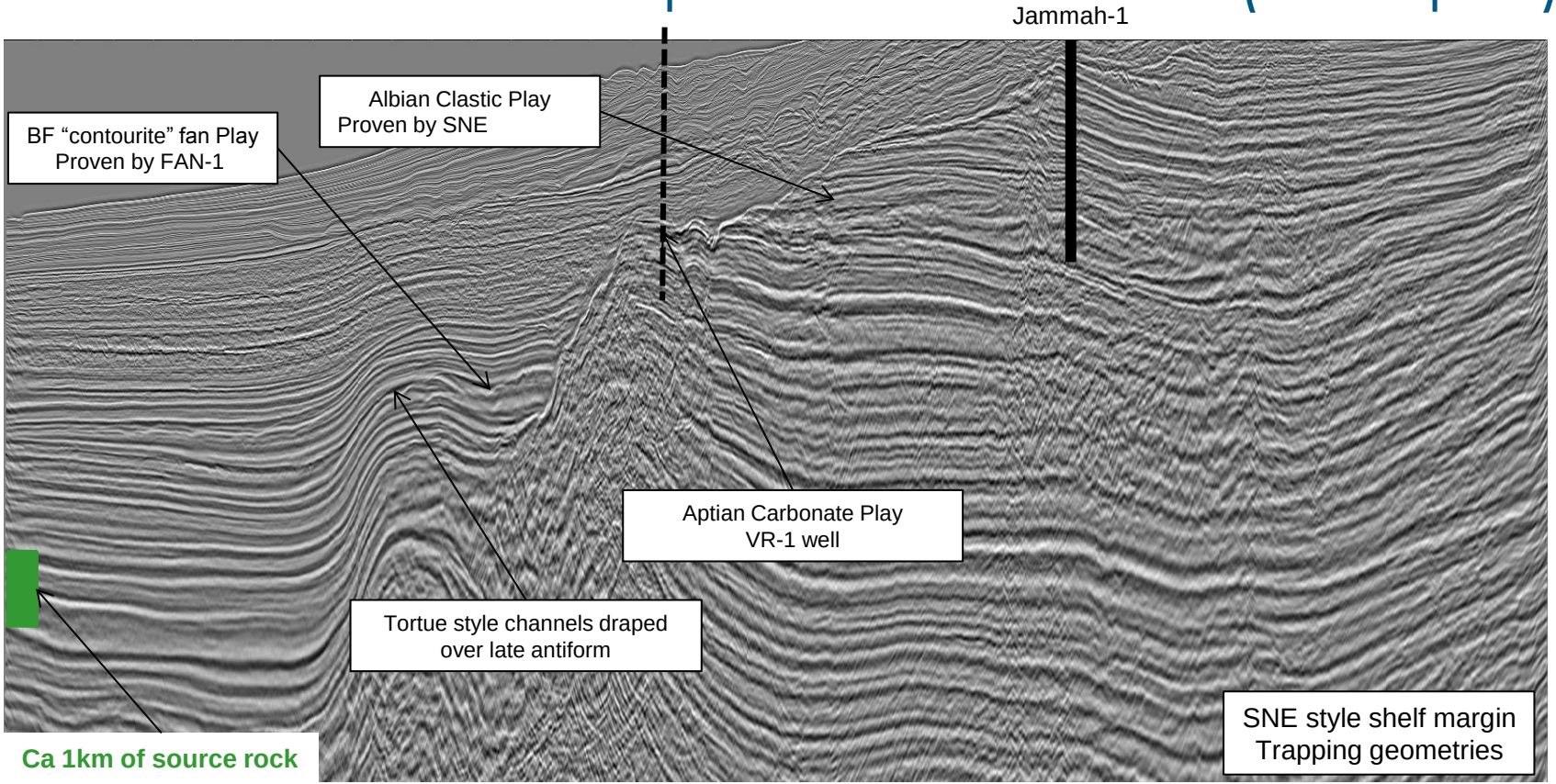
Line VER01MWT-02 Final PSTM 2017



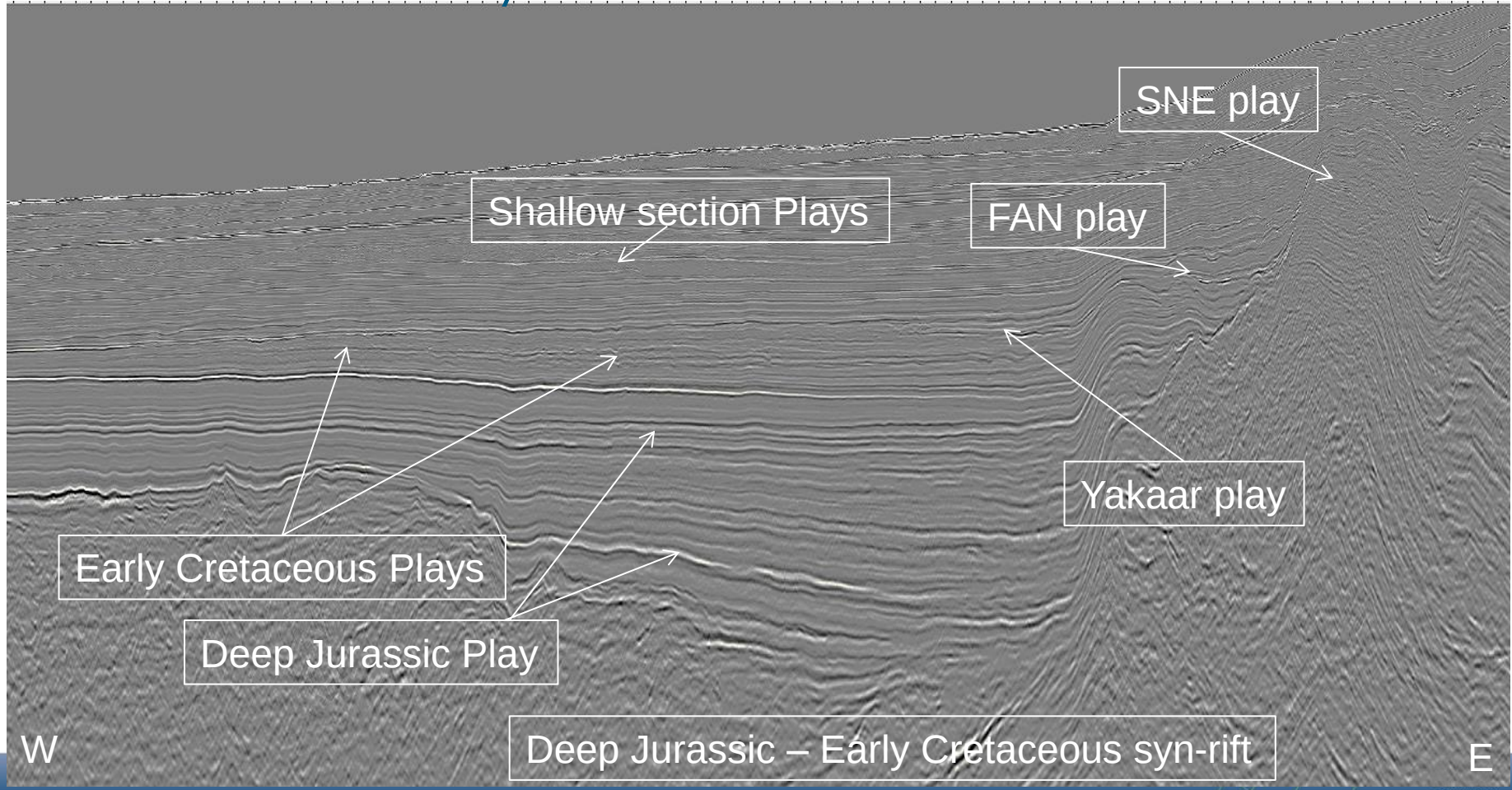
The Gambia Legacy Stack Example



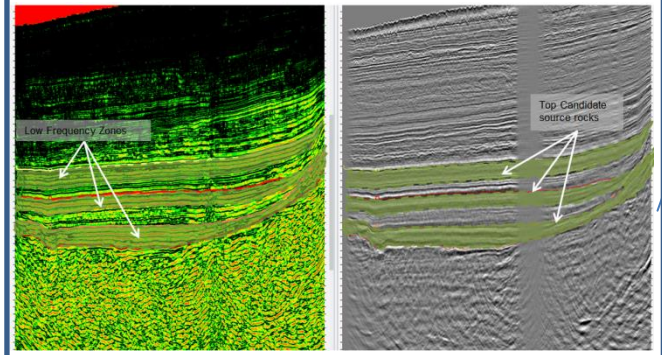
The Gambia Final Reprocessed PSDM (in depth)



The Gambia Plays

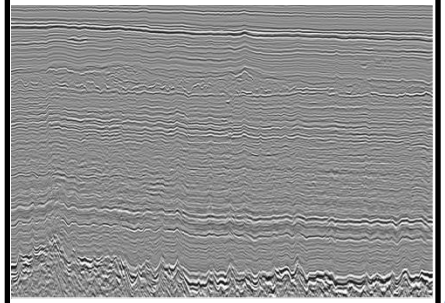


The Gambia Source Rock Characterization

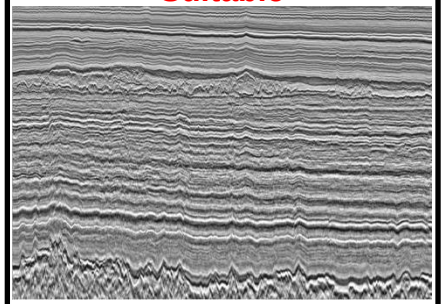


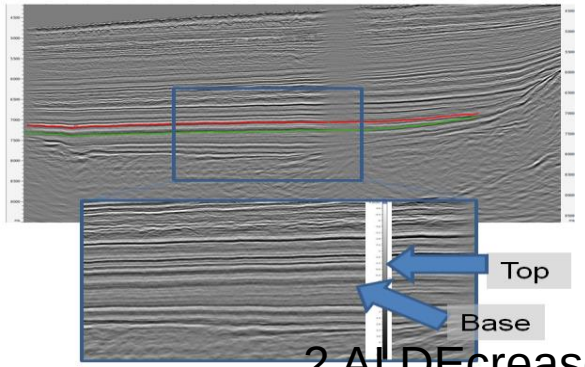
1 Low Frequency

Legacy Seismic NOT Suitable



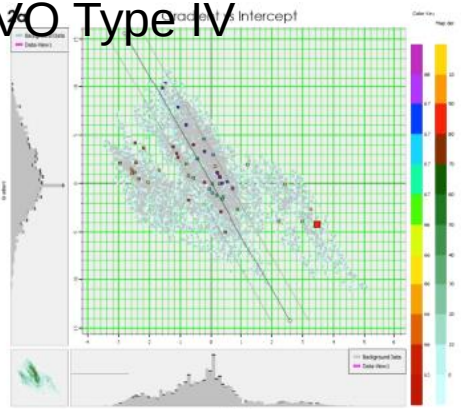
Reprocessed Seismic Suitable



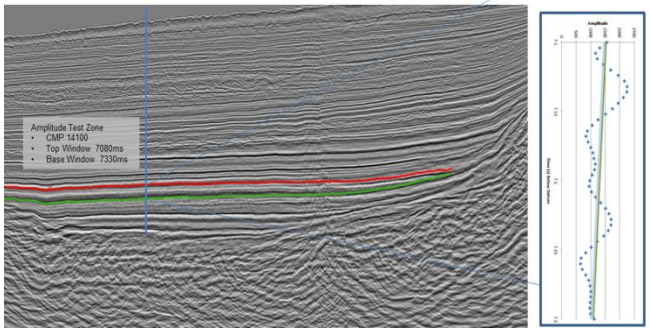


2 AI DEcrease

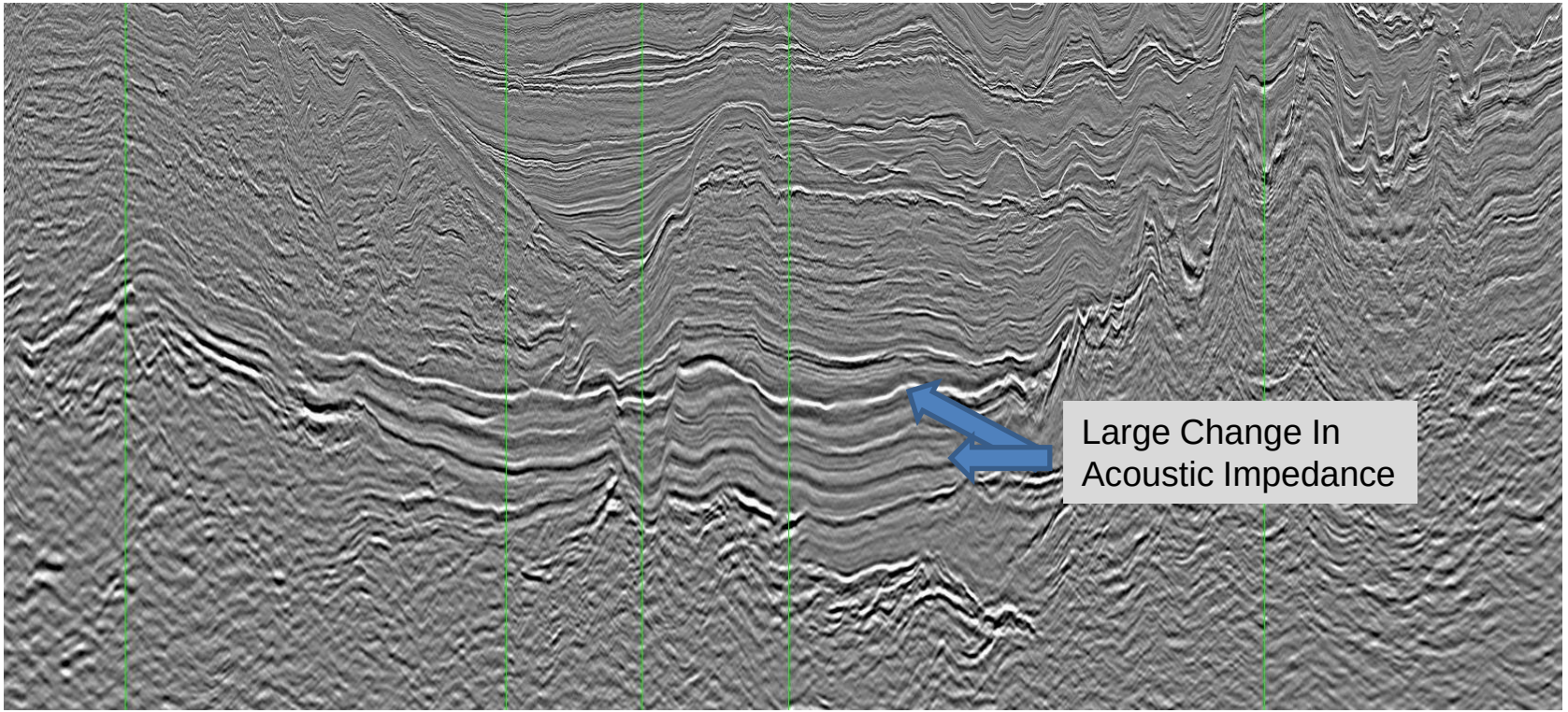
3 AVO Type IV



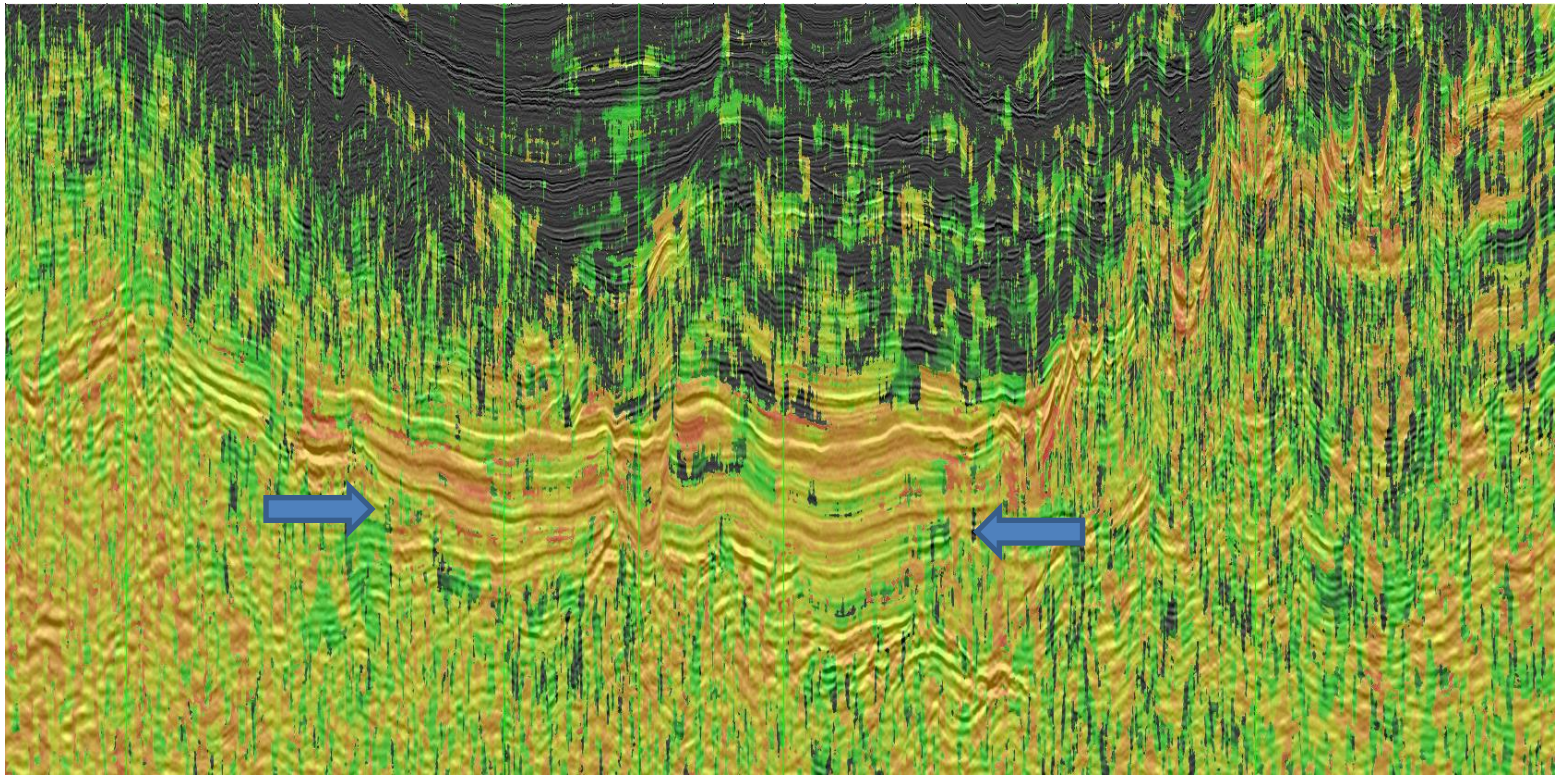
4 Amplitude Related to TOC



Guinea Bissau Jurassic Source Rock Analysis



Jurassic Source Interval Low Frequency



Source Rock Evaluation Spectrum Projects