Application of integrated risking on a South African prospect

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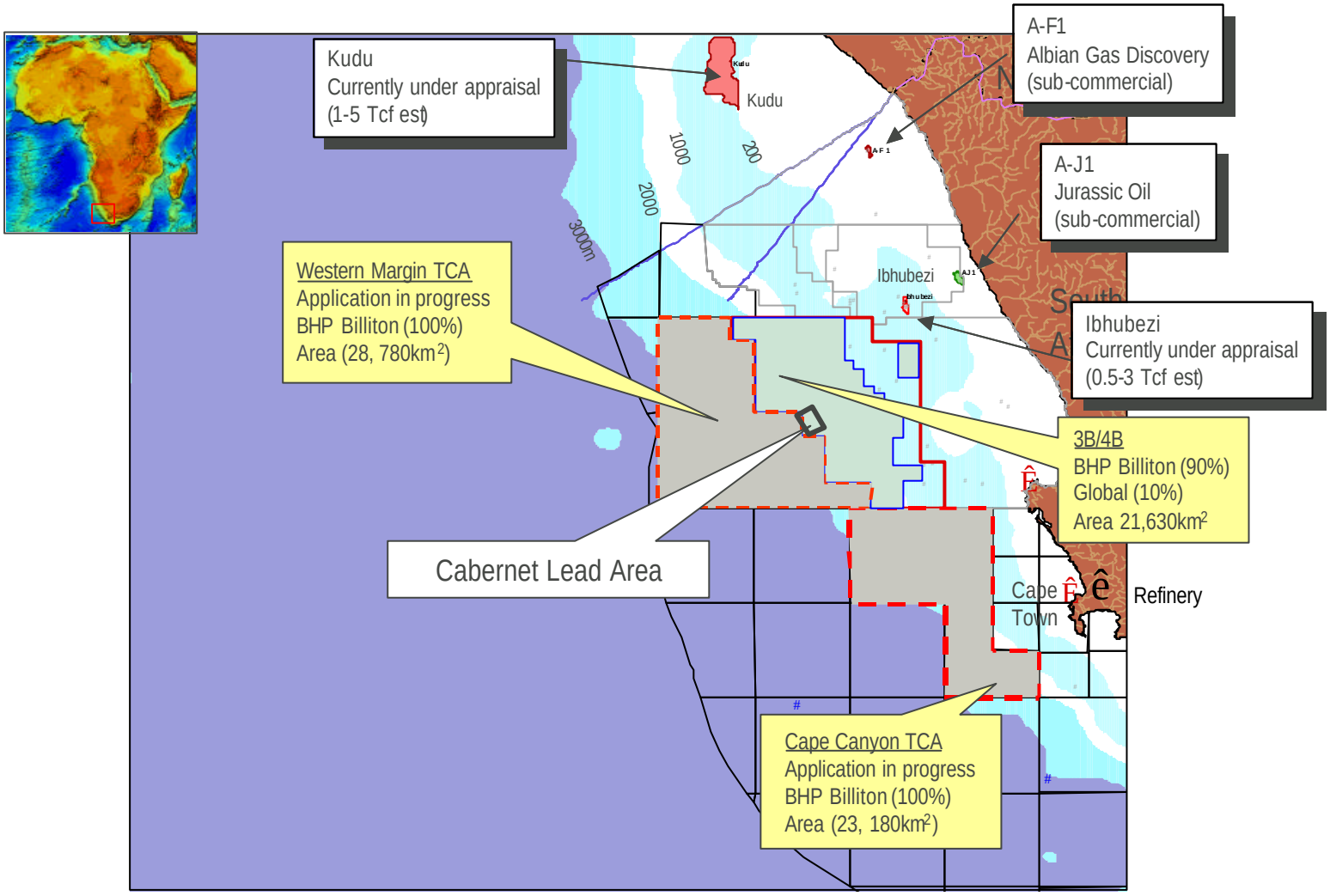
Important ingredients and outcomes of integrated risking

- Information add together nonlinearly, we consider QI information:
  - Seismic imaging velocity
  - Size of seismic amplitude response and AVO
  - Structural footprint of amplitude response
  - Spectral decomposition
- Information saturates, probability between zero and one
- Information distilled in a way that decision makers can use
- Repeatable and auditable methodology used
  - Bayesian updating for quantitative information
  - Fuzzy logic for qualitative information
- Guides information that can be acquired to reduce risk
- Guides technical development which can be integrated

Location of South African lead Cabernet



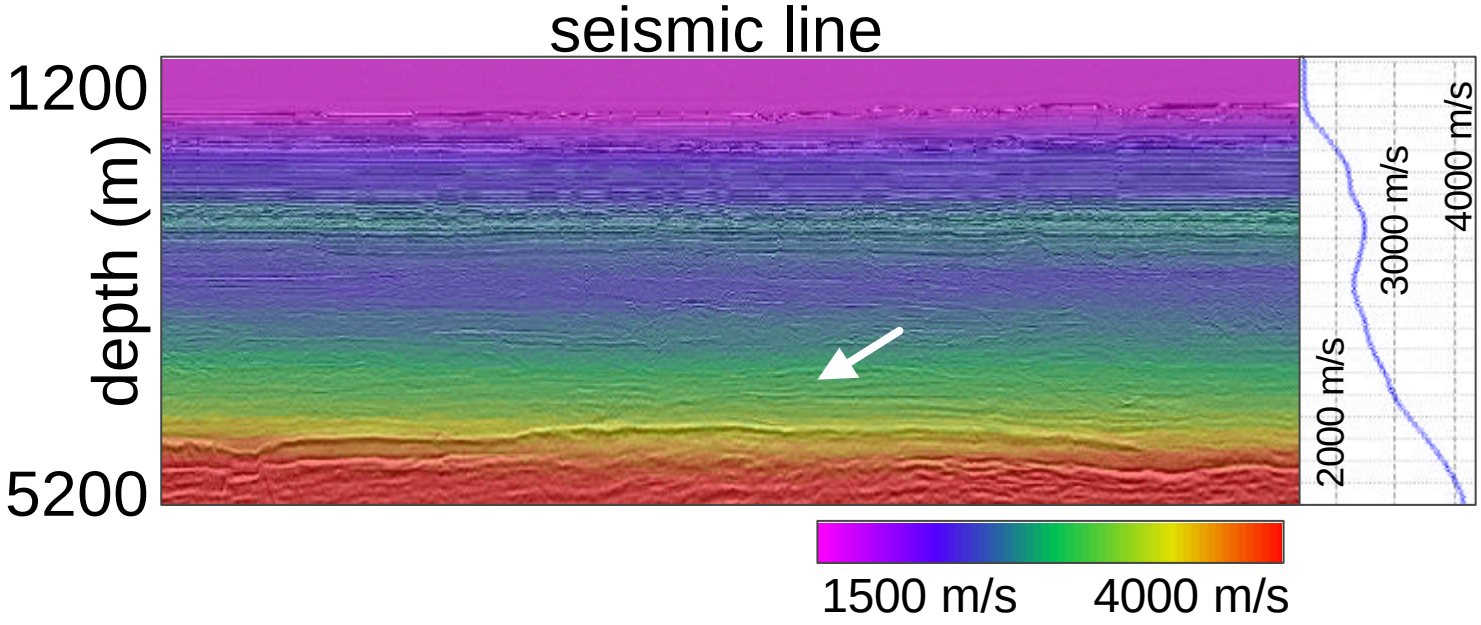
Geologic risks without the explicit consideration of QI information

- Reservoir: 44%
  - Sequence stratigraphy and seismic character support reservoir presence. Risk from course 2D grid and lack of calibration.
- Trap: 69%
  - Three sided structure. Risk from course 2D grid and having to rely on a stratigraphic pinchout to the east.
- Seal: 51%
  - As per reservoir.
- Source, migration and timing: 88%
  - DSDP361 and surrounding wells, combined with geochemical modelling and seismic mapping supports mid-Aptian source rock being present and oil mature.
- Only gas charge: 24%
  - Lack of calibration and the possibility of gas flushing.

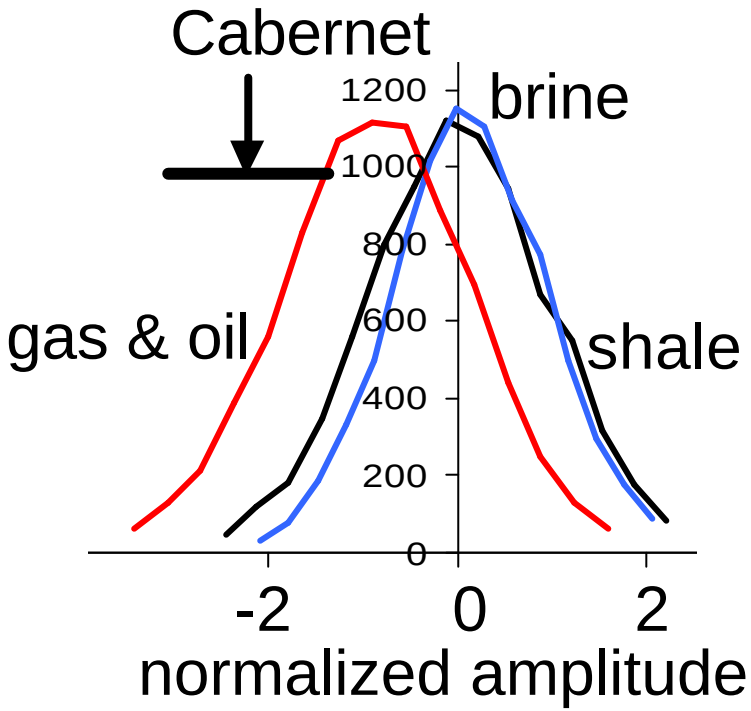
Probability of hydrocarbons = 14%

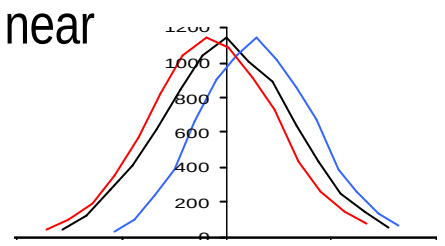
Probability of oil = 10%

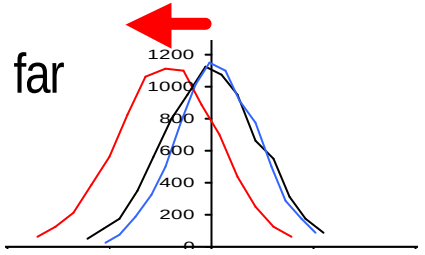
Seismic imaging velocity information eliminates limestone or low porosity clastic



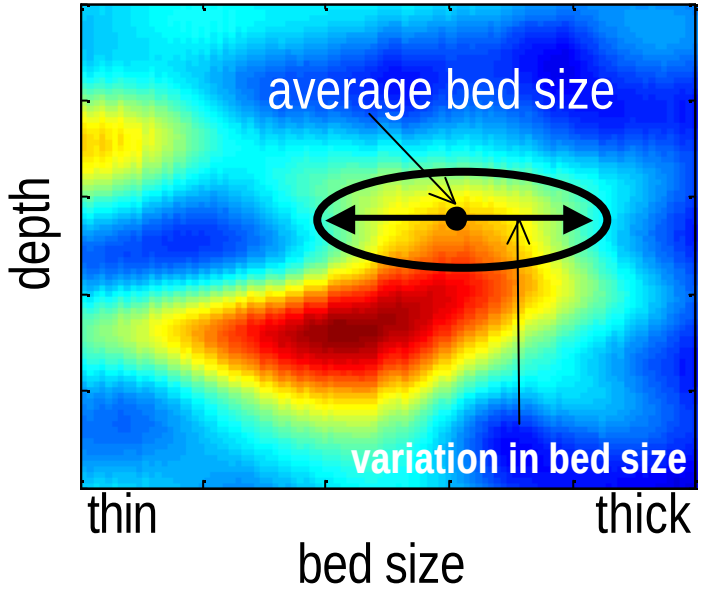
Stochastic petrophysical analysis predicts a soft seismic reflection increasing with offset

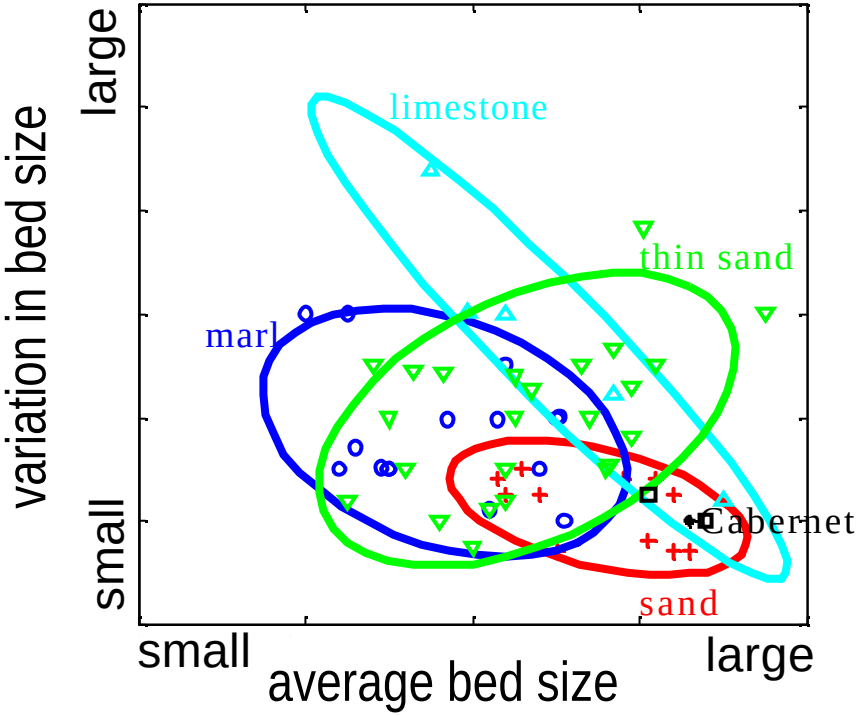




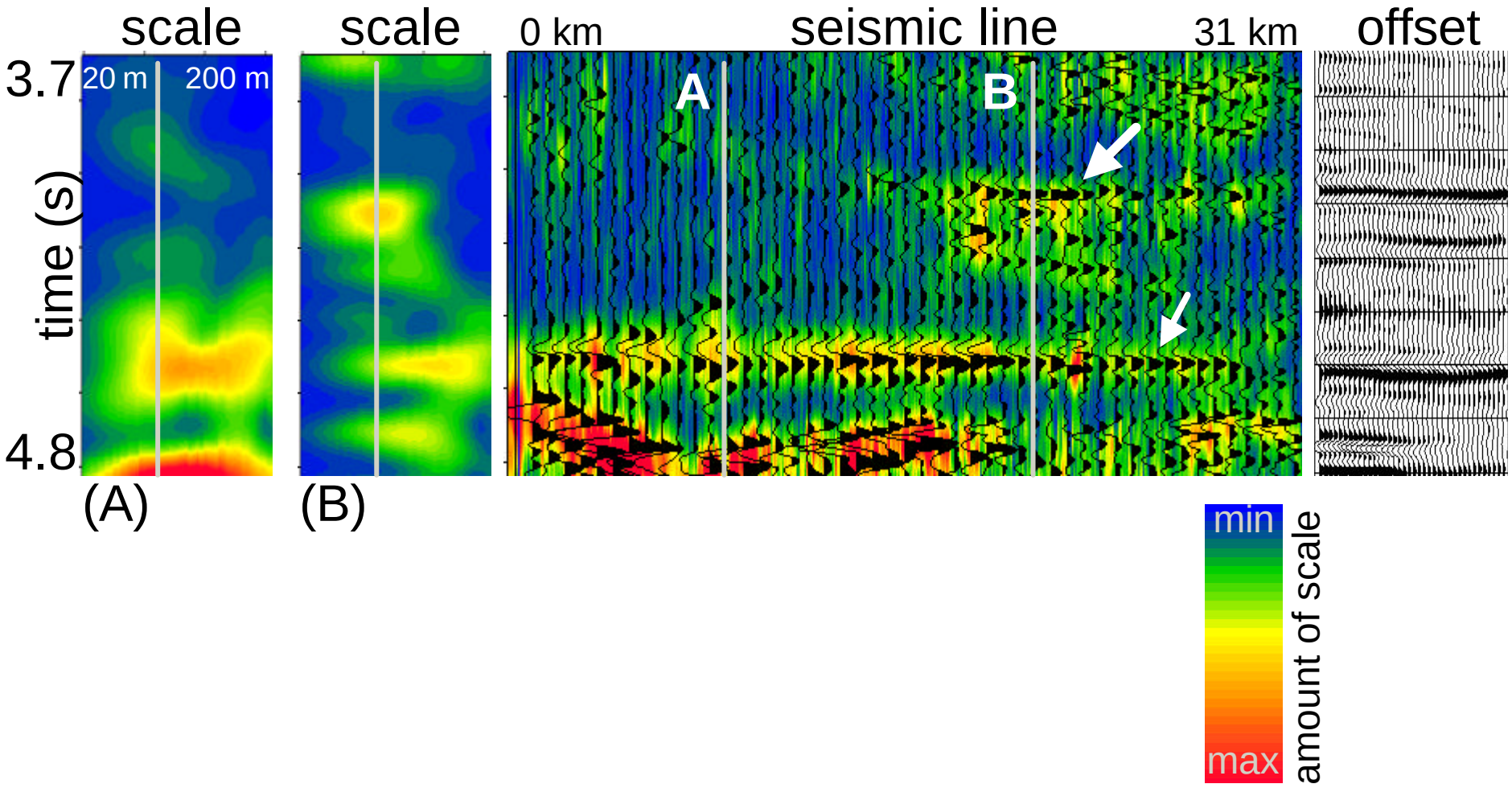


Well log analysis enables discrimination of geologic facies with spectral decomposition





Amplitude and spectral decomposition supports reservoir and hydrocarbons



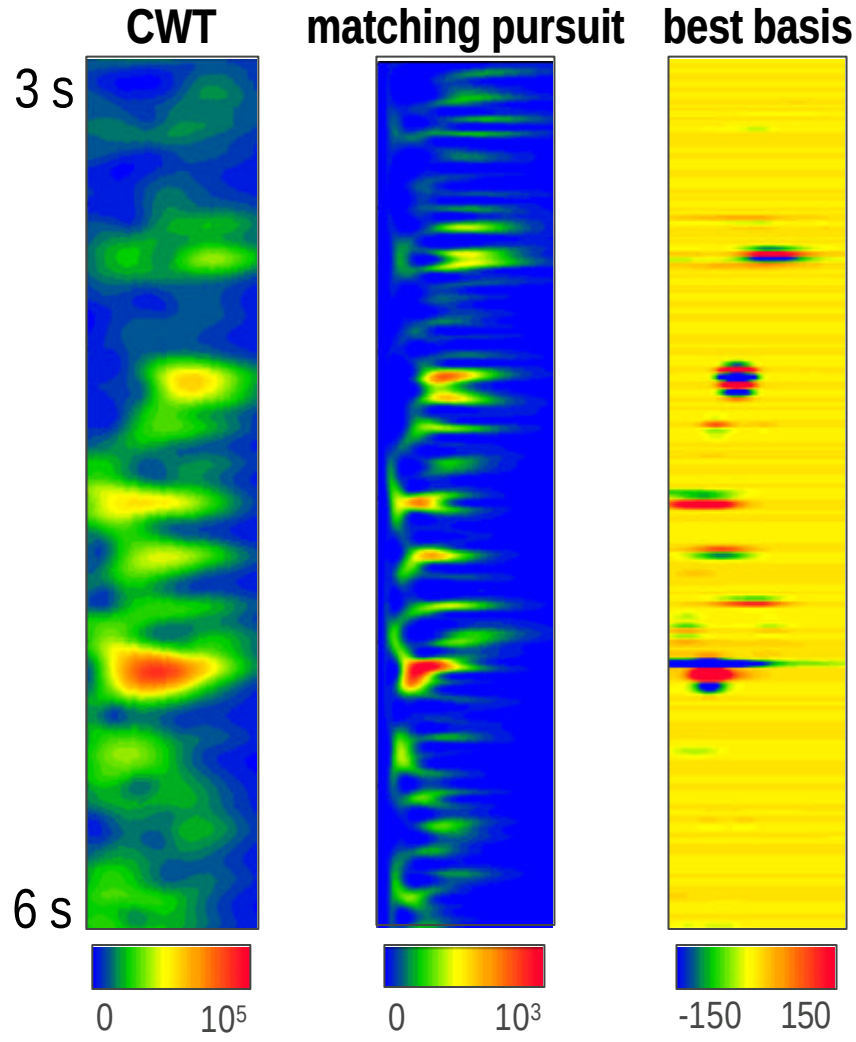
Comparison of different methods of spectral decomposition (I)

Stratigraphically flattened

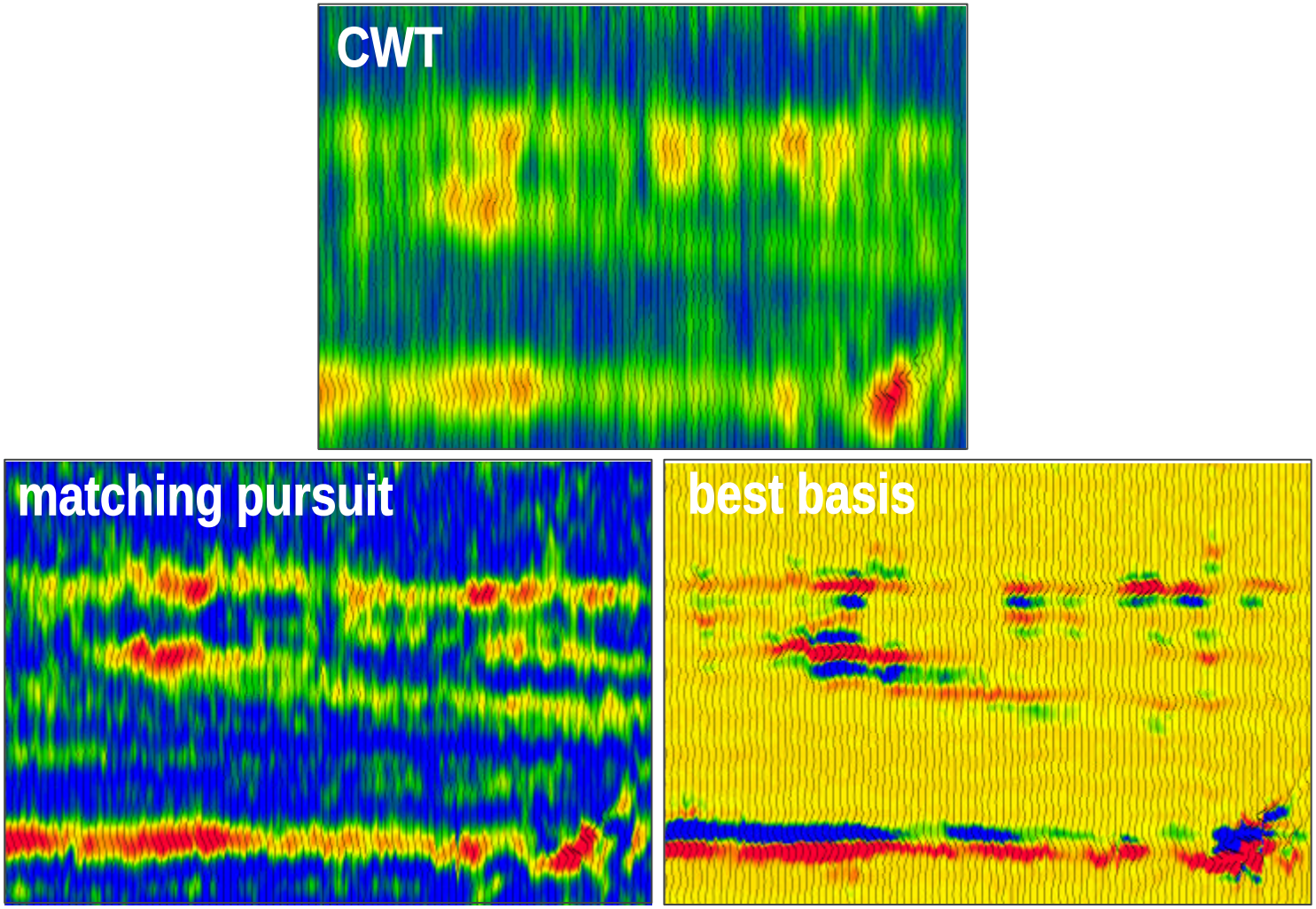
CWT 6-60 Hz (log scale)

matching pursuit 2-60 Hz

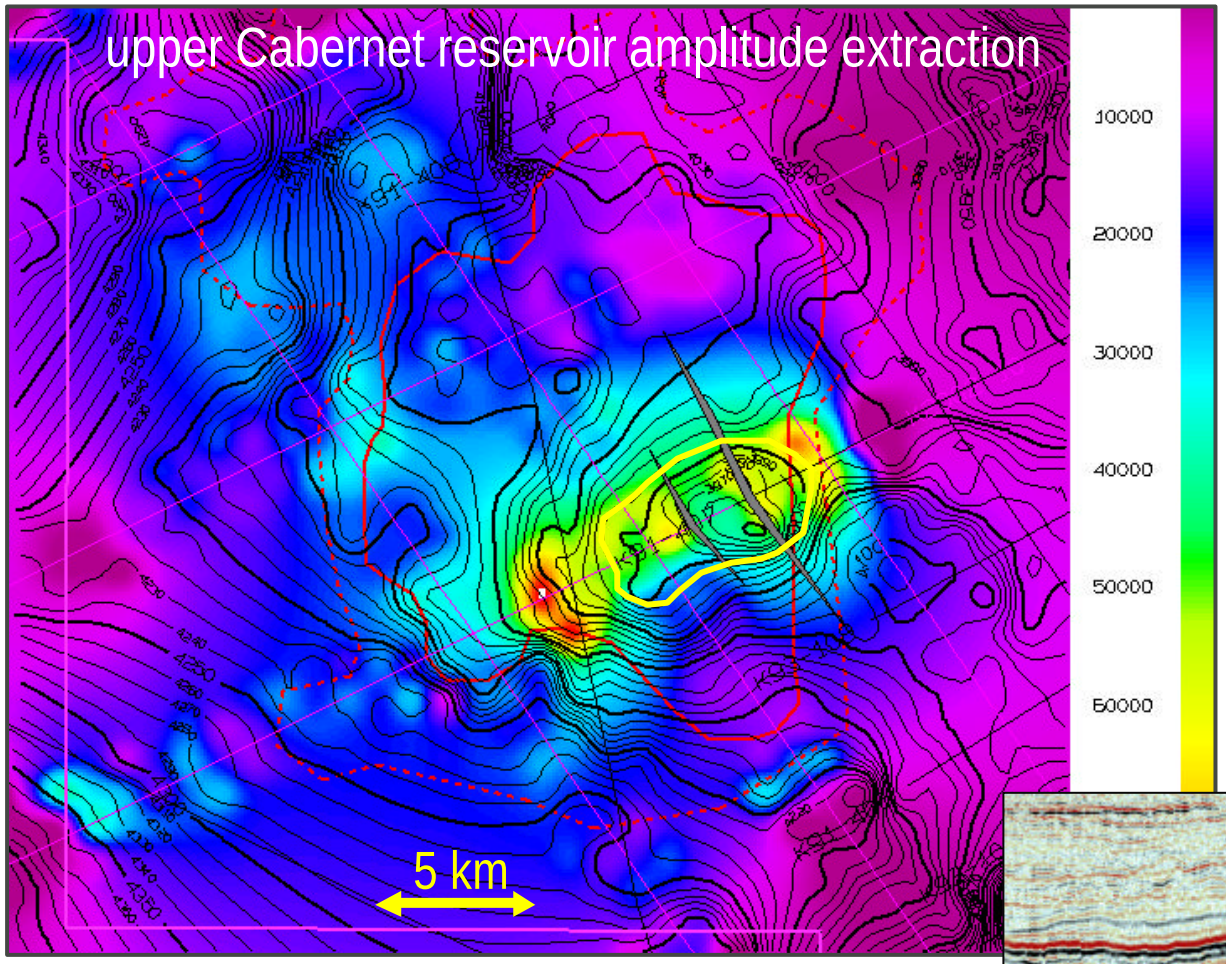
best basis 2-60 Hz



Comparison of different methods of spectral decomposition (II)



Some support from structural footprint

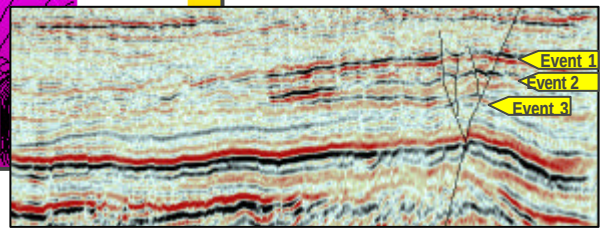


Aptian closure serves as a natural drainpoint for HCs

Turonian Closure

Aptian Closure

Greater Aptian Closure

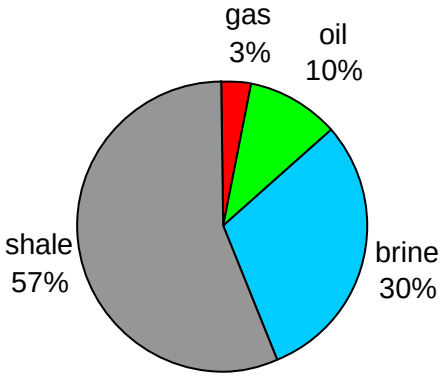


Seismic phase matched to well and rotated 90 degrees for secant amplitude extraction.

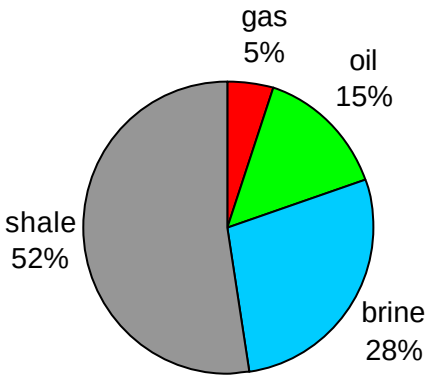
Other factors used in integrated risking

- Confidence in the fidelity of seismic amplitudes: 31%
  - Derived by fuzzy logic from answers to set of questions
- Confidence in the spectral decomposition: 40%
  - More robust than seismic amplitudes
- Structural footprint evidence: 50% to 57%
  - Comparison to catalogue
- Spectral decomposition attenuation: +3% to structural
  - No quantitative theoretical explanation

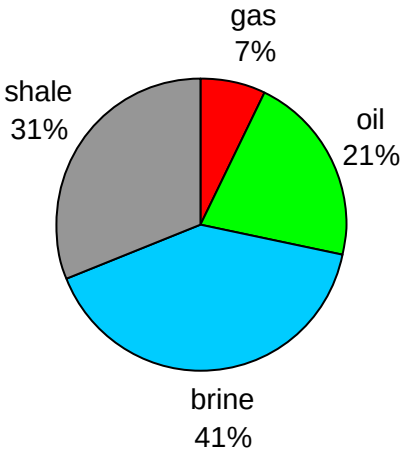
Addition of information reduces risk



geology and petroleum system



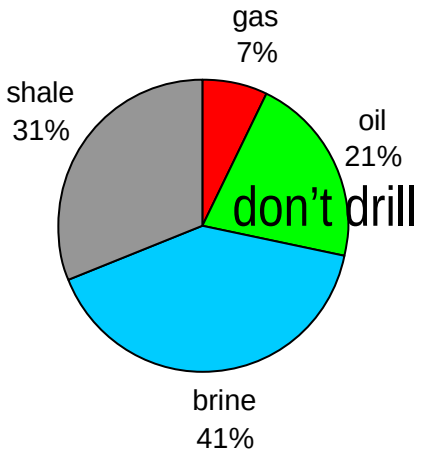
+ seismic amplitude

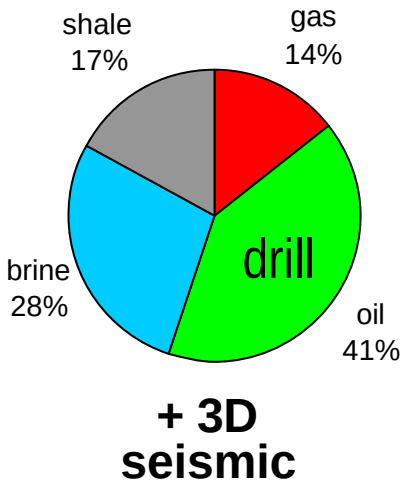


+ spectral decomposition

What is the influence of acquiring 3D seismic data (positive outcome)

- Confidence in amplitude fidelity of seismic data
  - Increase to 90% from 31%
- Confidence in spectral decomposition
  - Increase to 50% from 40%
- Structural footprint evidence
  - Increase from 57% to 77%





Outcomes and conclusions

- Decision made to acquire 3D, has been acquired, currently being processed
- Repeatability, auditability and fuzzy logic allows for feedback
  - Learning and improvement
- Decision process to leading order not nearest percentage point
  - 1 in 10 before QI information
  - 1 in 5 currently with 2D data
  - 2 in 5 possible with 3D data