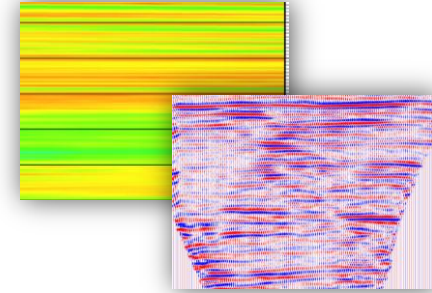


Downhole logging (Cross well Seismic) Applications from the Oil field to Mining

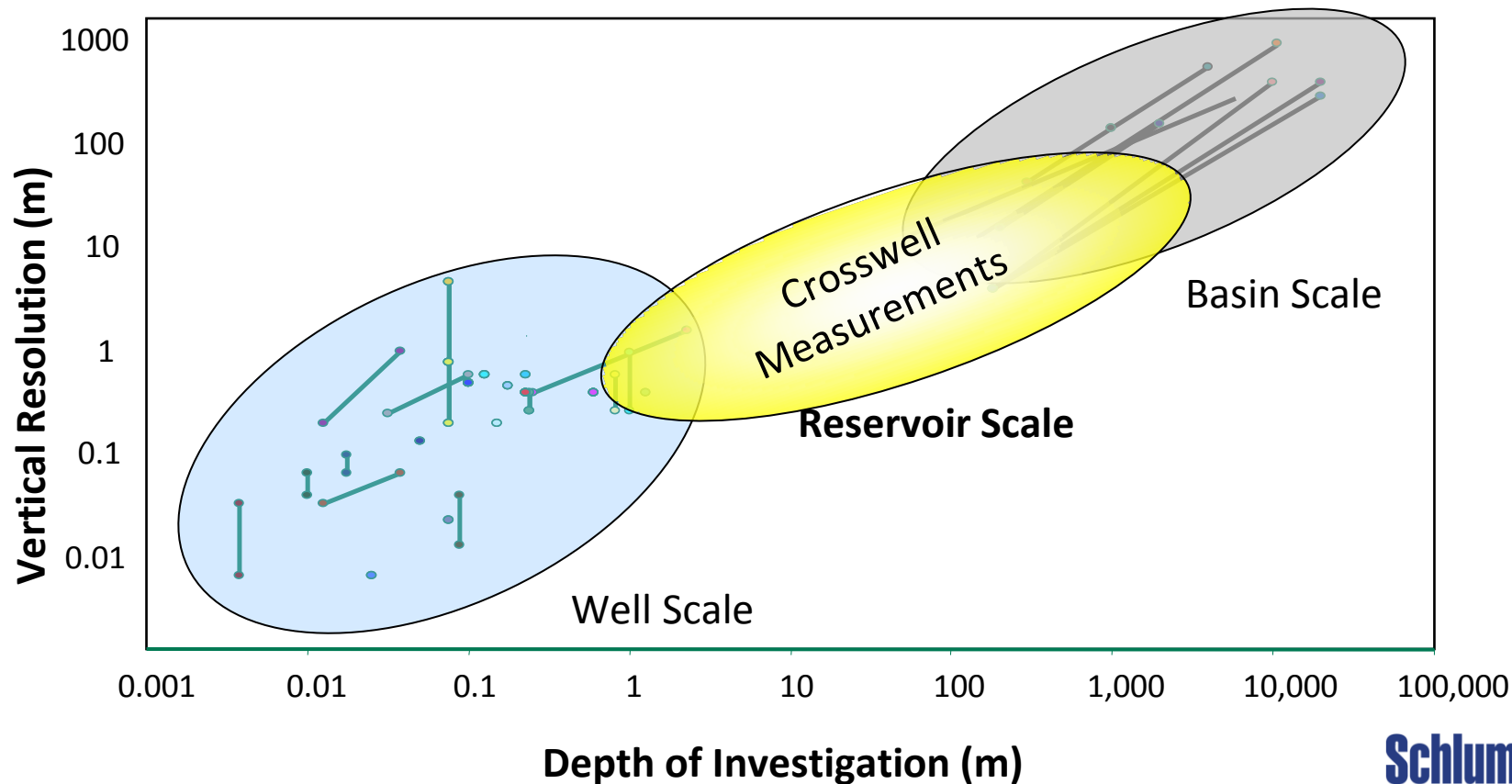


Shafiq Muhammad
Borehole Seismic Domain Champion
Australia, New Zealand & PNG

Agenda

- Introduction
- Acquisition
- Case Studies

Crosswell measurements target the reservoir

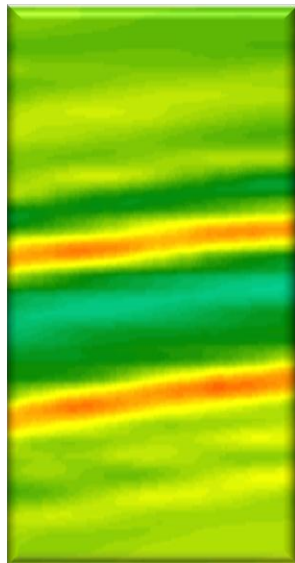


Resolution scales in reservoir interpretation

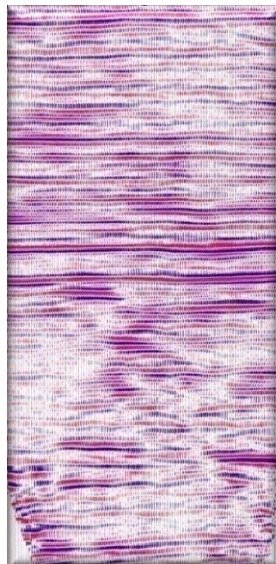
Increasing vertical resolution →



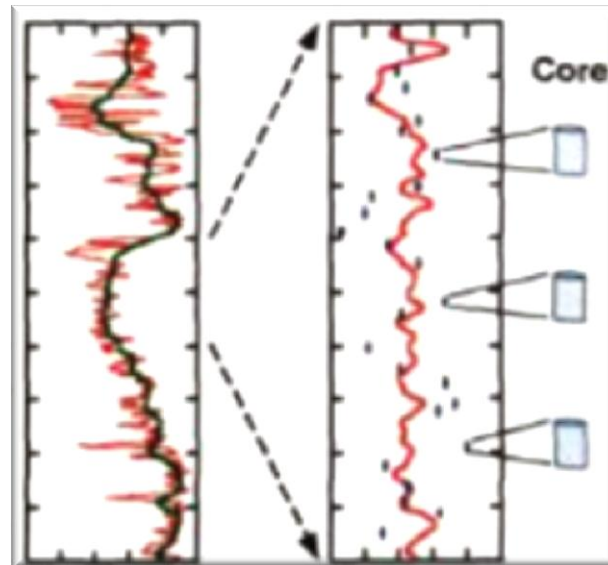
Surface



Crosswell
EM



Crosswell
Seismic

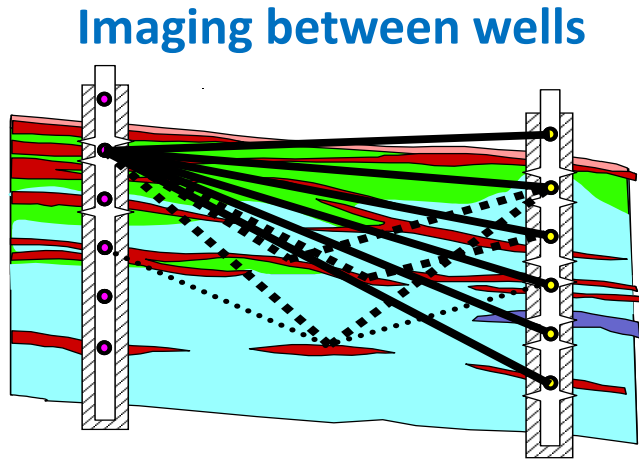


Logs

Core

After Harris et al. (1995)

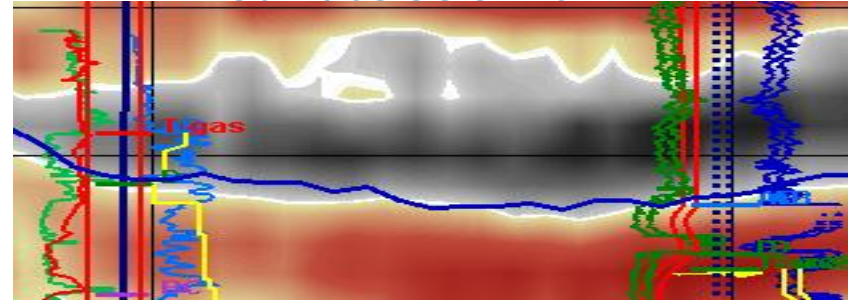
Imaging seismic between wells



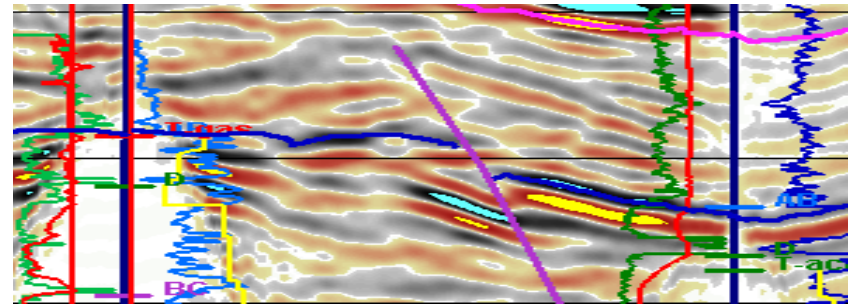
100 m

100 m

Surface Seismic



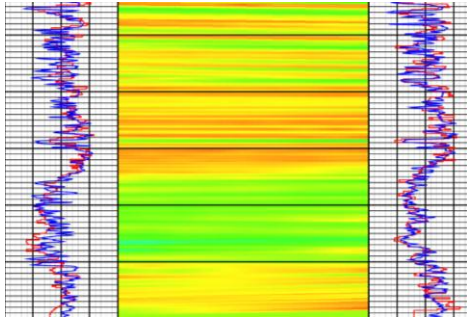
Crosswell Seismic



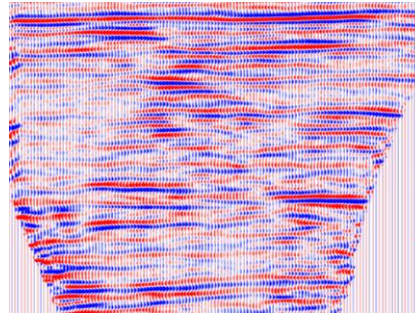
**Typical Source
Frequency Ranges**

Surface Seismic	VSP	Xwell Seismic
5-120Hz	5-200Hz	30-800Hz (clamped) 100-2000Hz (piezo electric)

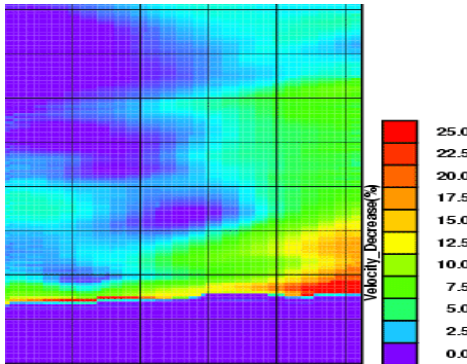
Crosswell seismic solutions



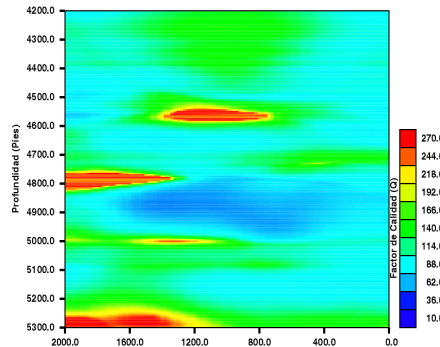
Velocity – P&S



Reflectivity



Velocity Difference



Attenuation

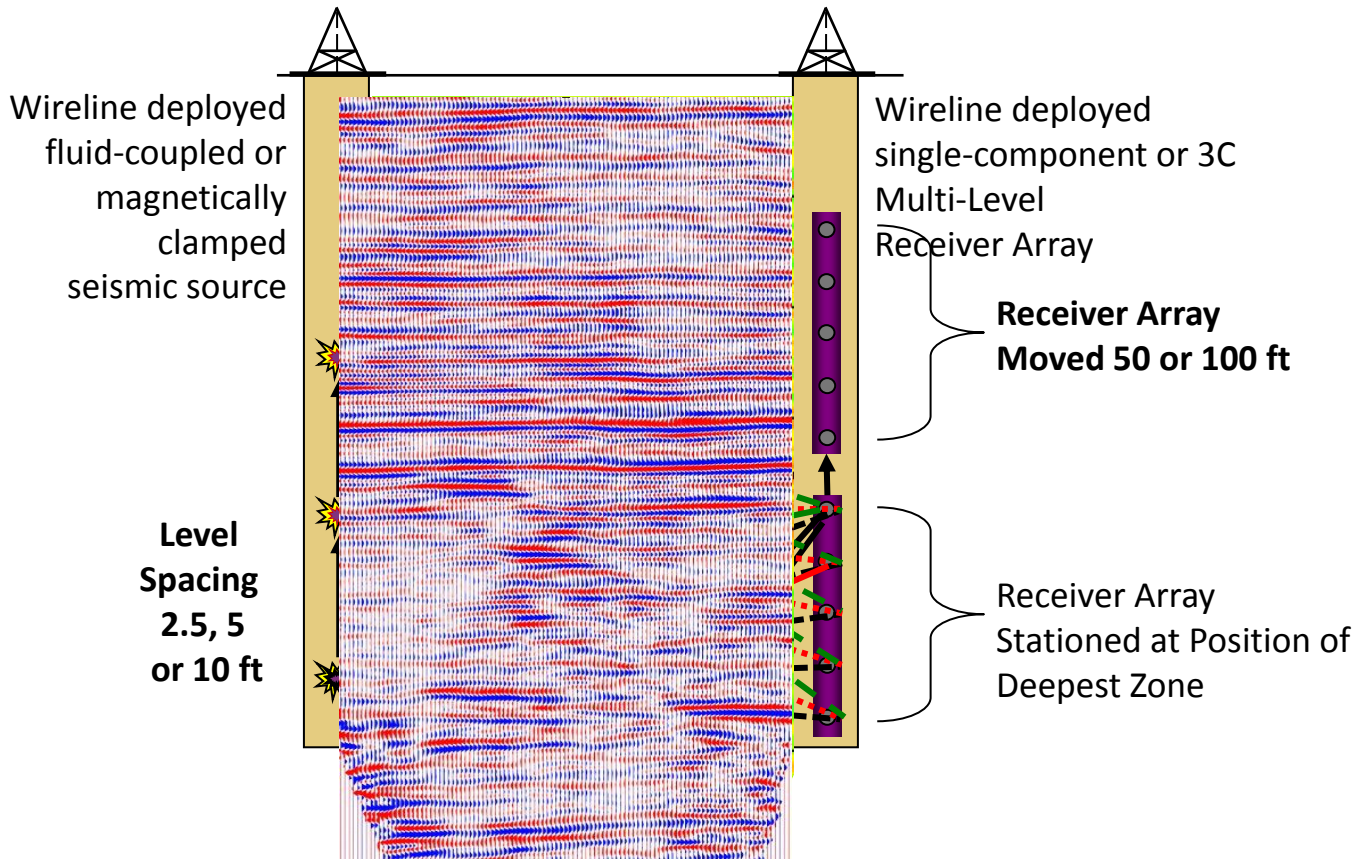
CSG Applications

- High-resolution reservoir characterization
 - Development planning
-
-
-
-
-
-
-
-
-
-
- 4D monitoring
- IOR/EOR

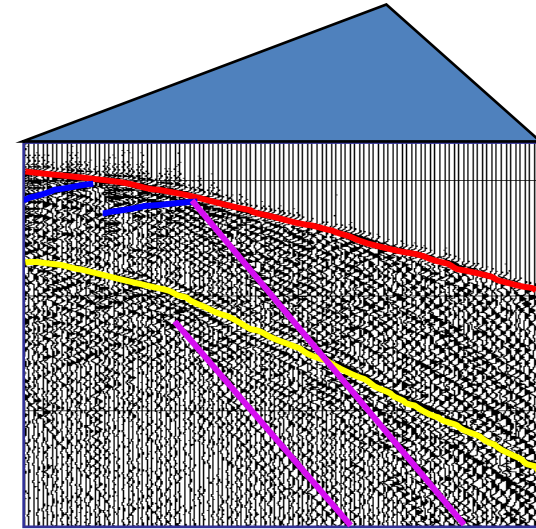
Agenda

- Introduction
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Crosswell seismic acquisition



One profile for per source position (profile)



Resolution is dependent on:

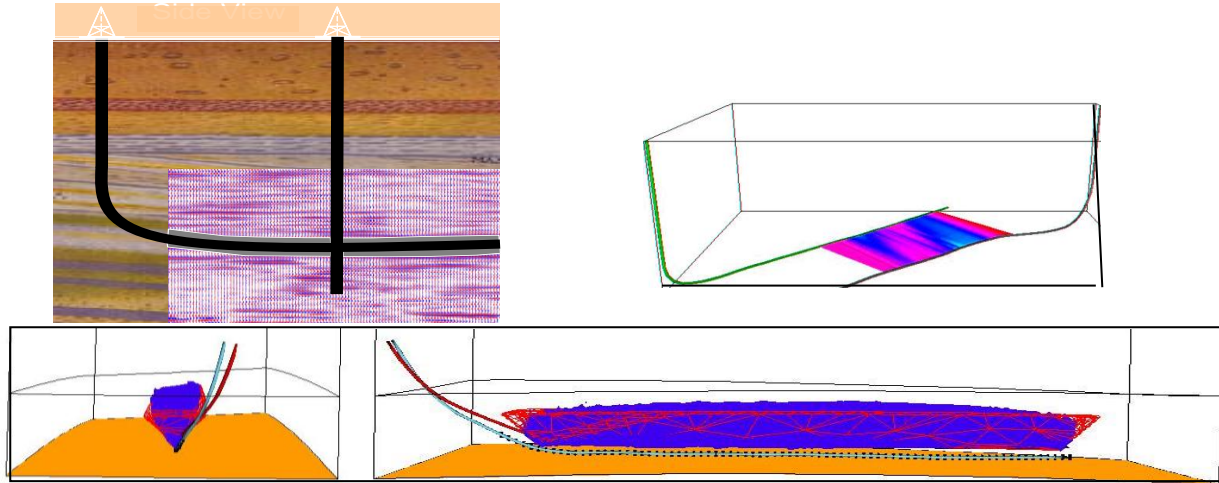
- Frequency
- Formation attenuation
- Interwell distance

Acquisition considerations

Well Casing & Separation

Transmitter Well	Receiver Well	Max Spacing*
Piezo Source	Hydrophones/3C	1000m
Any casing	Any casing	
Clamped Source	Hydrophones/3C	2500m
Steel or Magnetic Cr	Any	

Well Geometries

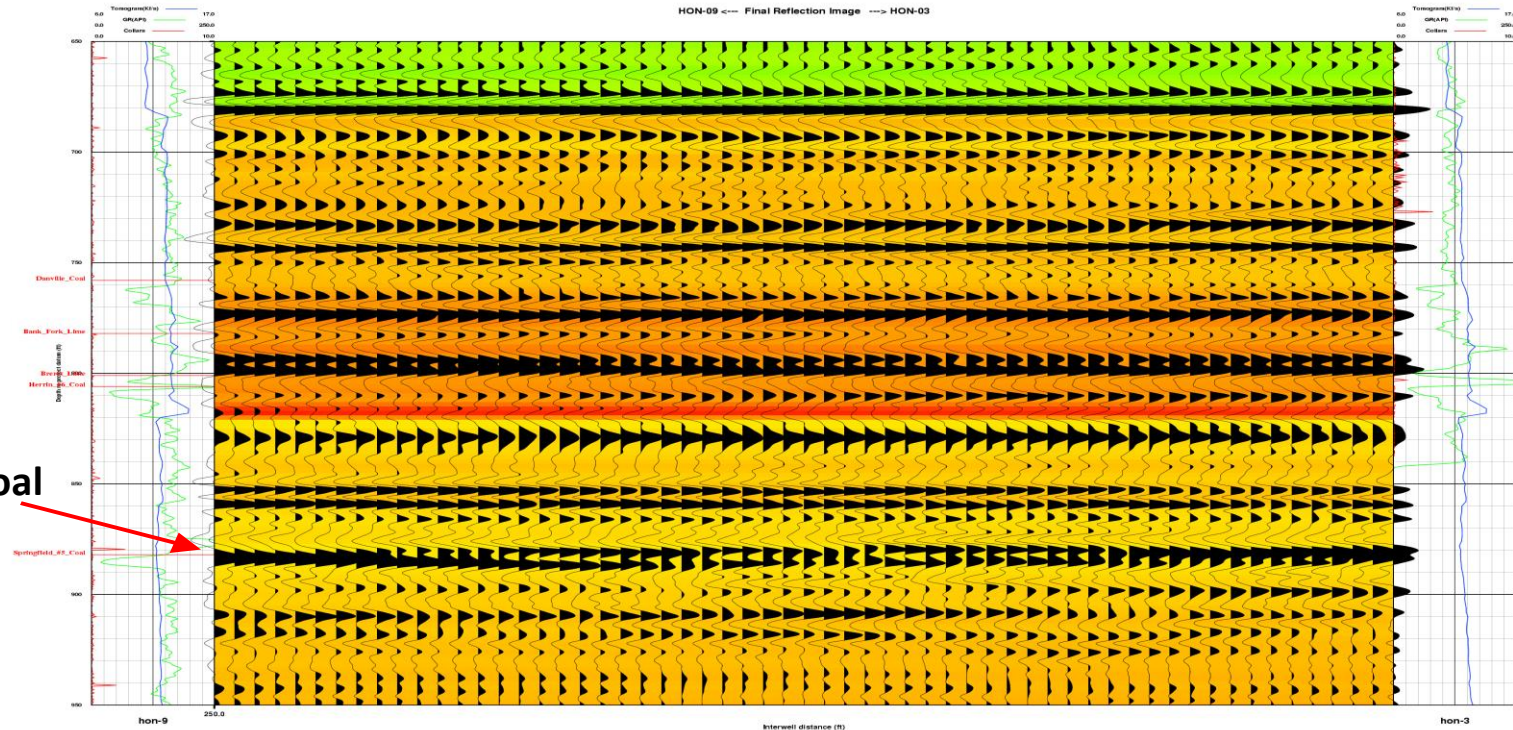


* The exact well separation achievable is obtained from pre-survey modelling

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High Resolution Imaging of coal seams



Conclusions

- **Allows operators to drill and target the seams with more accuracy than is possible with any other technique**
- **Strengthens reservoir understanding by integrating with other seismic measurements and frac monitoring (HFM)**
- **Allows a better understanding of often complex interbedded coal / shale sequences so the cleanest, highest-producing zones can be targeted**
- **Provides a detailed view of the natural faulted structures within the coal**
- **Time lapse crosswell seismic monitoring using velocity clearly indicates gas/fluid effects from methane extraction**
- **Xwell Seismic can be used in mining industry too for similar applications.**

Thank You & Questions