



Advanced Technology and Collaboration: Clean Coal Development

John M. Pope, Ph.D. CEO | November 2017 | Clean Coal Industry Forum, NETL

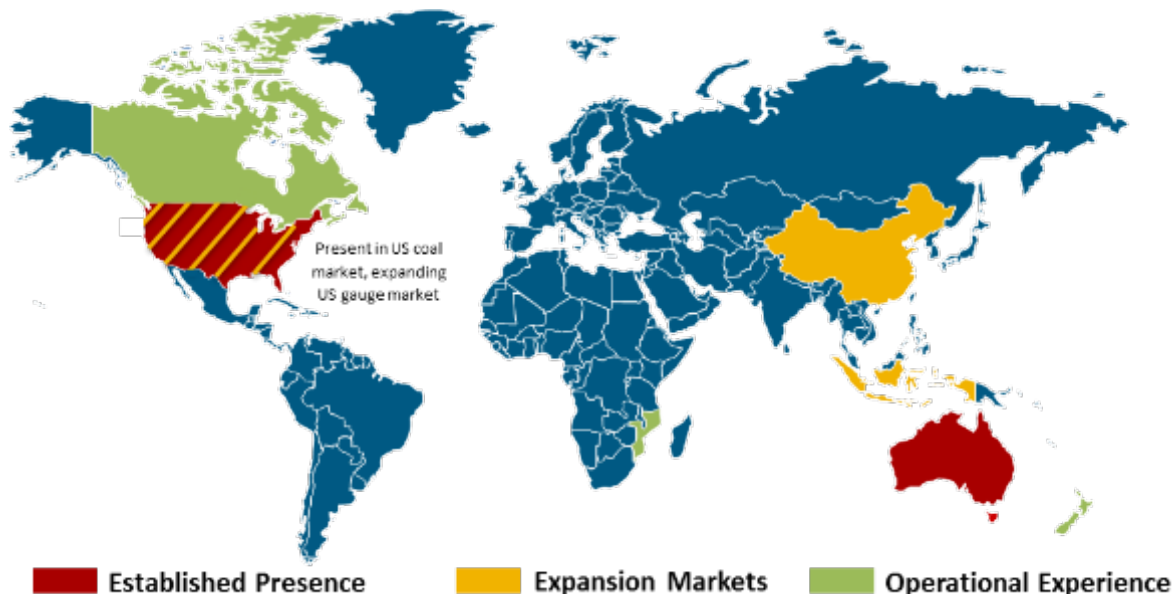
WellDog technical product and service company

Founded: 1999 in Laramie, Wyoming, USA

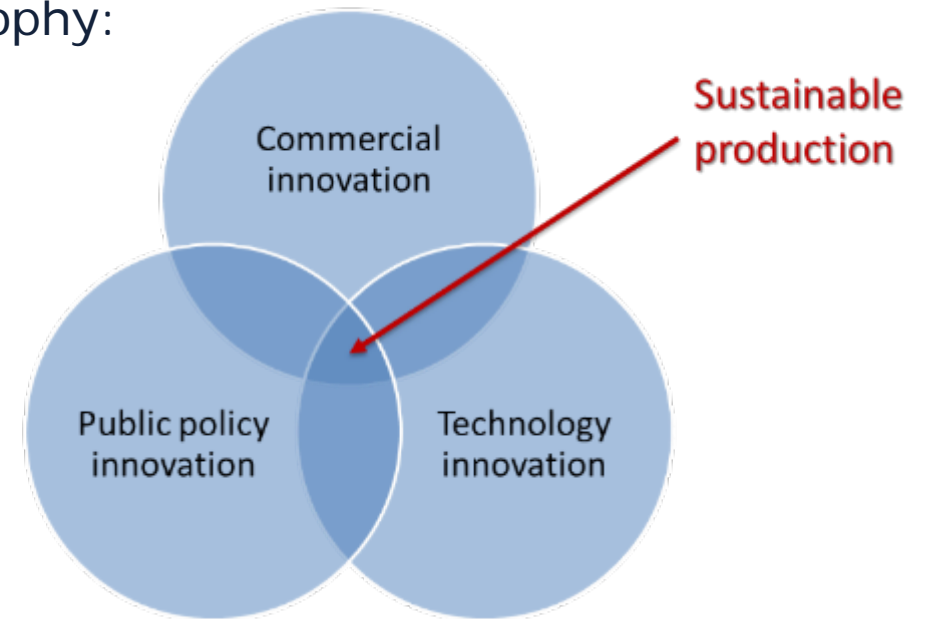
Mission: Driving global sustainability through georesource innovation

Industries: Coal mining, coalbed methane, shale gas and oil, tight gas, CCS

Geographies:



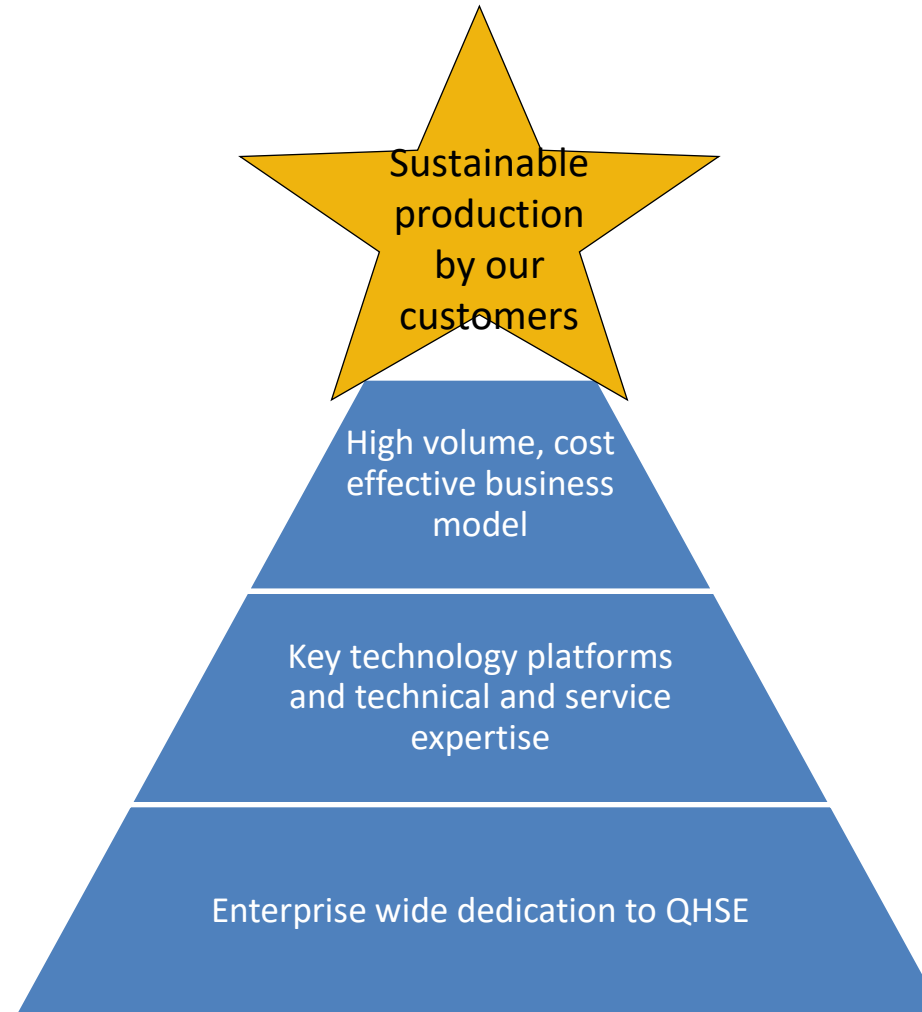
Philosophy:



WellDog technical product and service company

+ Business model:

- Practical technical innovation
- Sustained customer focus
- Value-driven business innovation



WellDog technical product and service company

+ Credentials:

- Leading downhole technology company
 - Backed by Shell Technology Ventures
 - Over 3,000 wells tested or optimized
- Impacts:
 - Located 600 Bcf gas in CBM wells
 - Increased Australian CBM output by 15% (65 Bcm) worth A\$500MM
 - Reduced coal mining pre-drainage time and cost by 33%
- Industry firsts:
 - Pre-drainage measurement of coal seam gas and permeability in 13 hours (with BHP Billiton)
 - Direct measurement of downhole gas in CBM wells; first alternative to core desorption
 - Direct measurement of downhole gas in shale wells; observation of imbibition (with Shell)
 - Direct measurement of injected CO₂ across multiple coal seams (with DOE)
 - First and only direct measurement of shale thermal maturity
 - First direct measurement of frac wings in shale well

Awards:



Safety



BG GROUP

Contract Efficiency

World's Best
Technologies
2004



Proud Recipients of the Presidents
Excellence in Exporting "E" Award



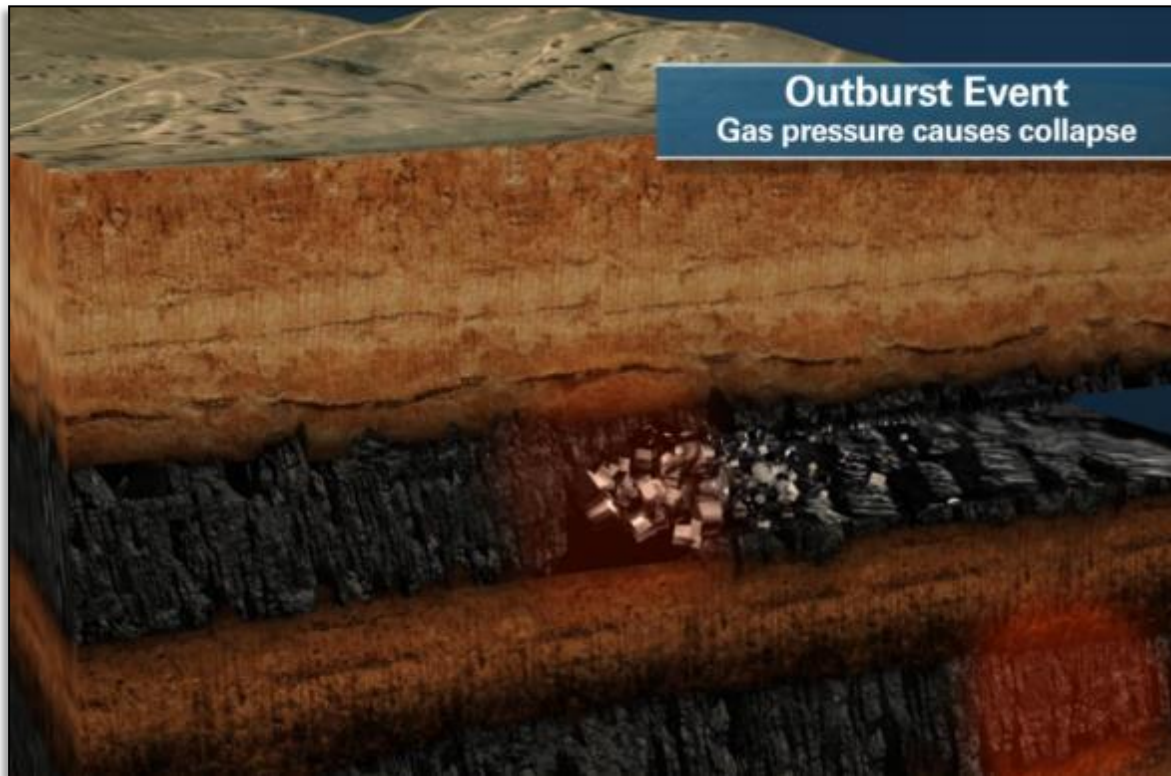
CCIA

Colorado Cleantech Industries Association

WELLD OG

WellDog innovates clean coal production

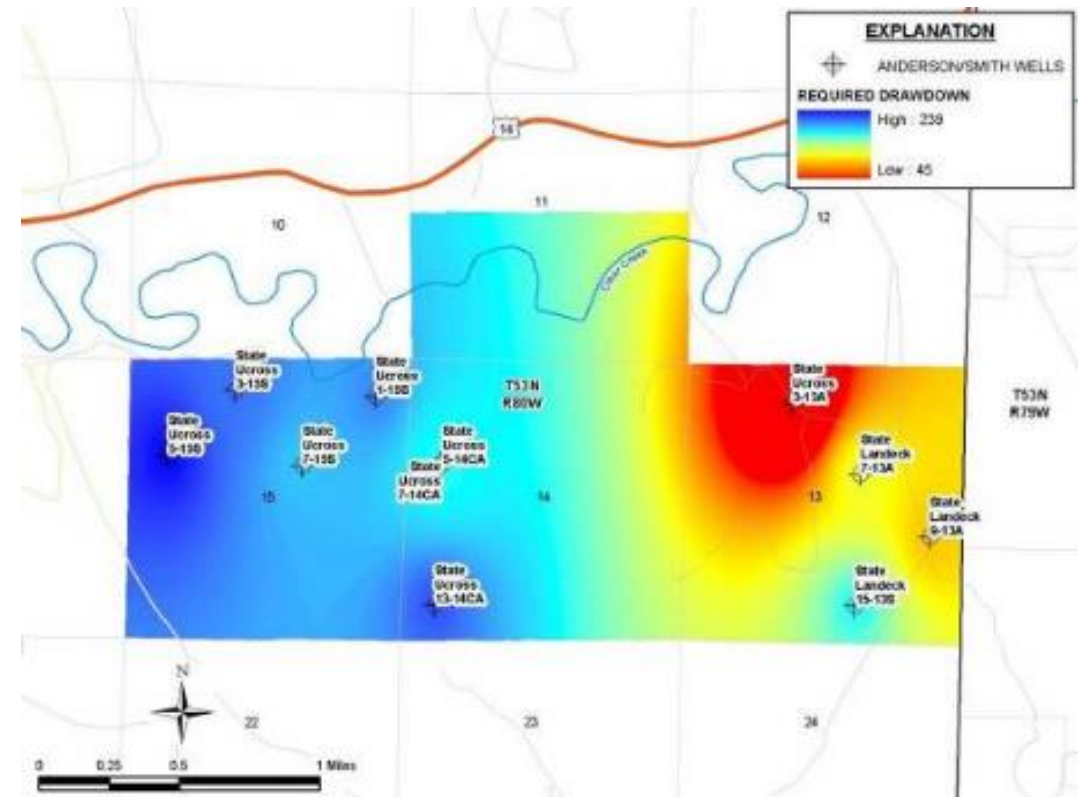
- + Pre-drainage planning and management
- + Coal gas production
- + VAM/GHG emissions reductions



WellDog innovates clean coal production

+ Pre-drainage/coal gas production

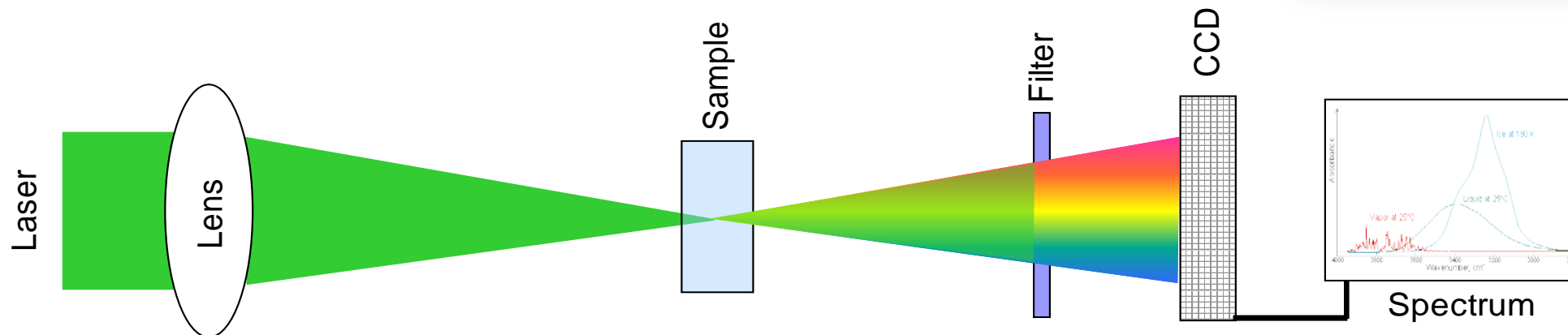
- Identify key pre-drainage locations and depths
- Minimize pre-drainage time
- Validate resulting gas levels
- Test at wellhead or downhole, alone or with permeability
- Wet or dry coals



WellDog innovates clean coal production

+ Pre-drainage/coal gas production

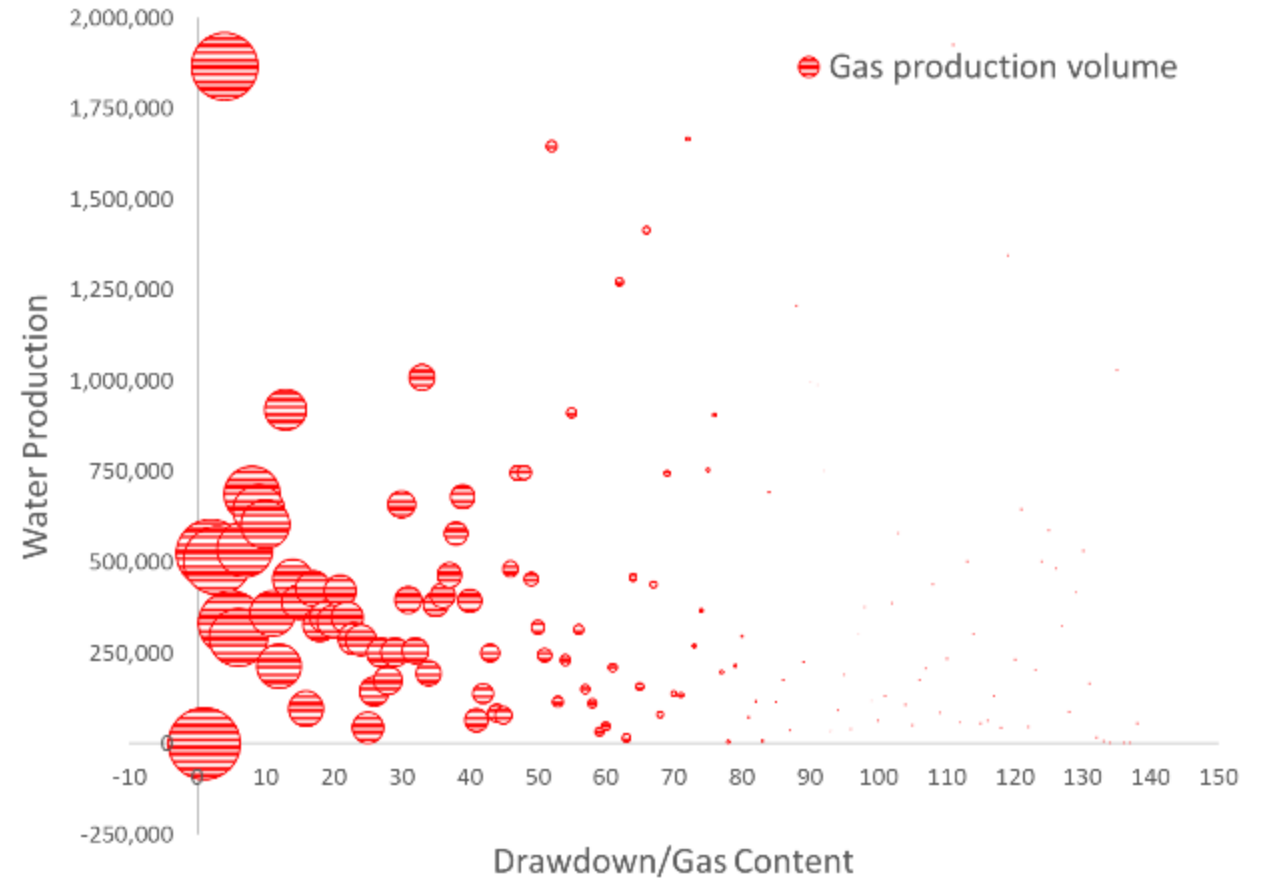
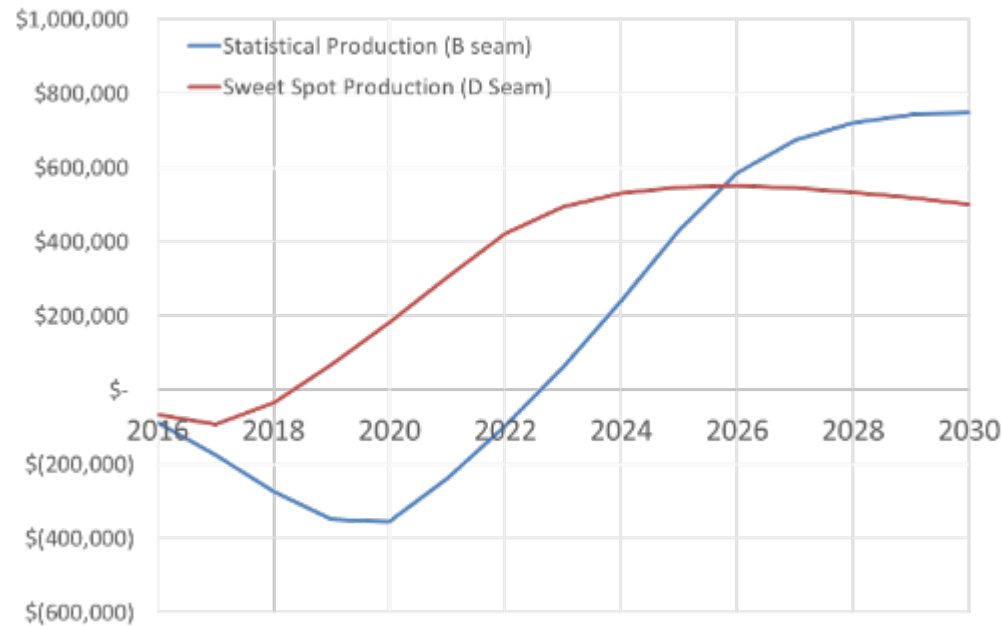
- Uses unique, proprietary Raman system for measurement
- Highly accurate: Results accepted by CBM reserves auditors



WellDog innovates clean coal production

+ Pre-drainage/coal gas production

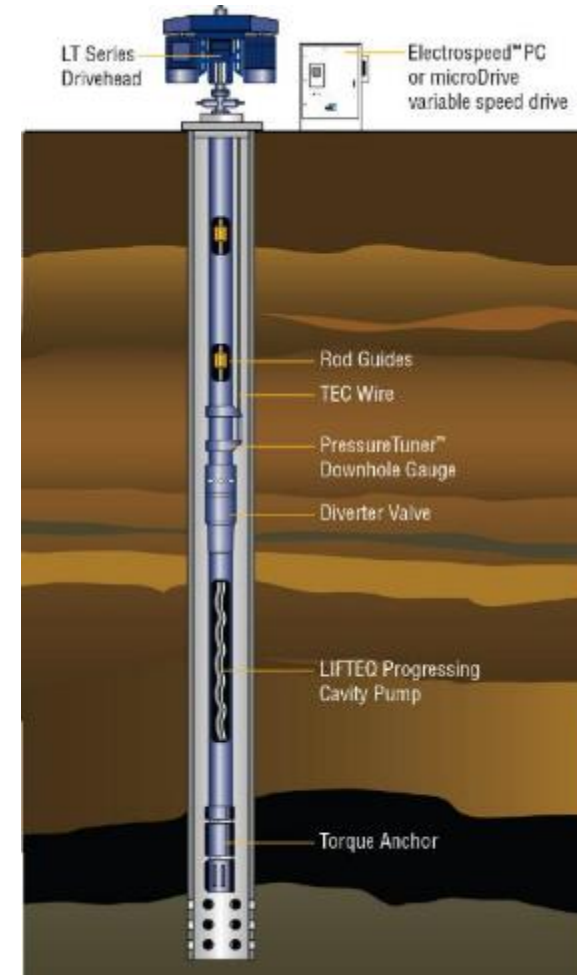
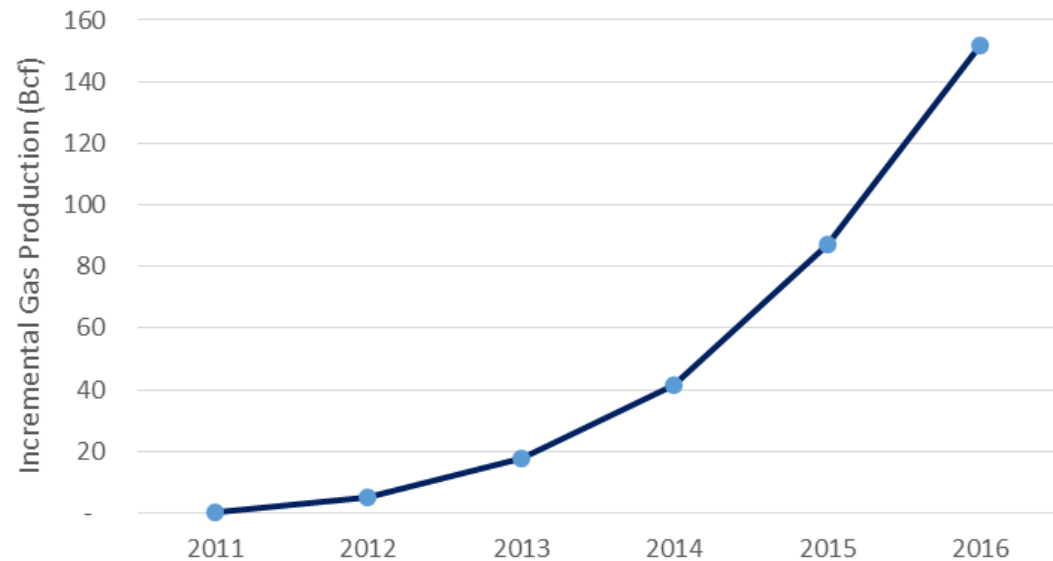
- Predicts which coals will drain first
- Test occurs before any production commences



WellDog innovates clean coal production

+ Pre-drainage/coal gas production

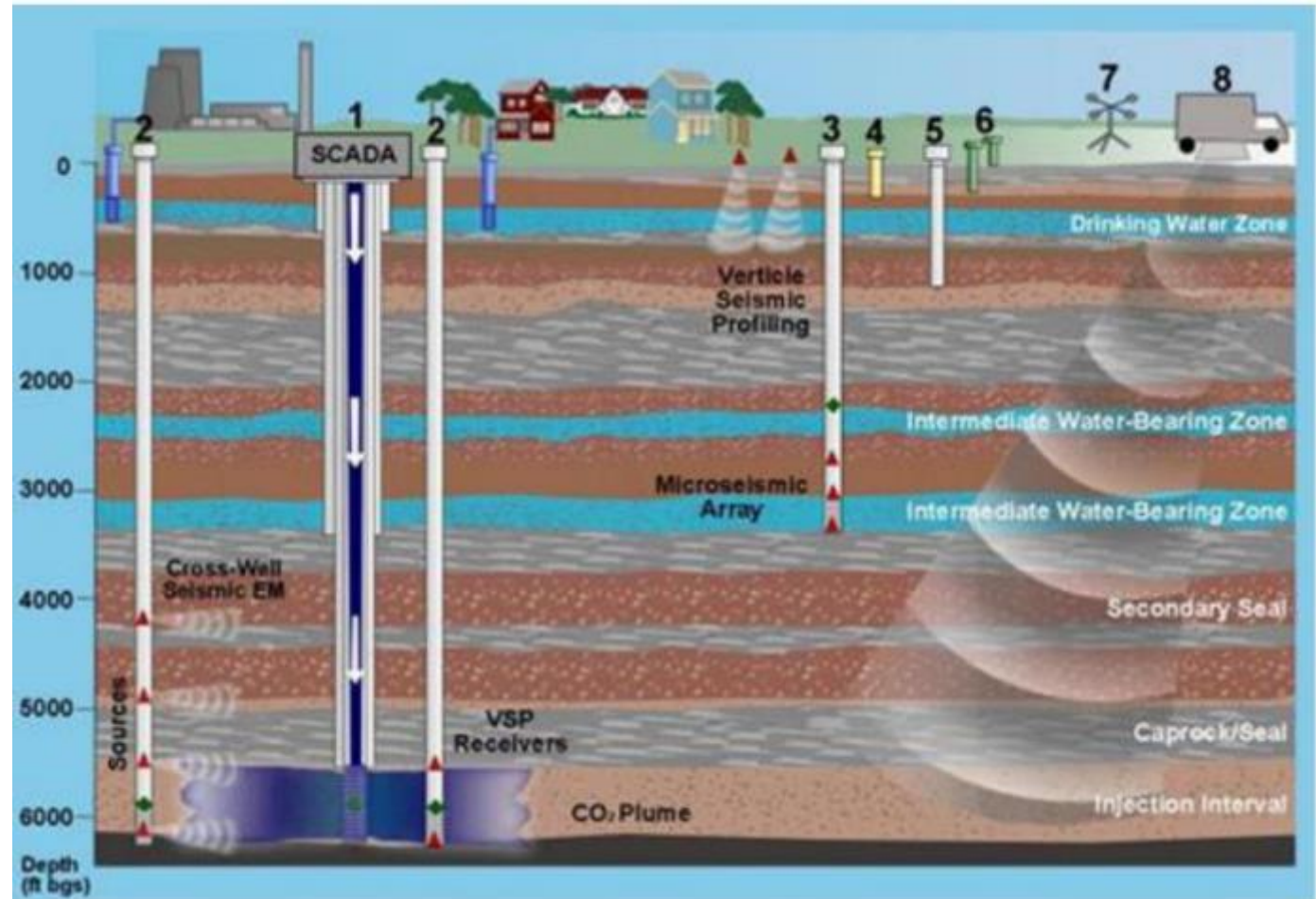
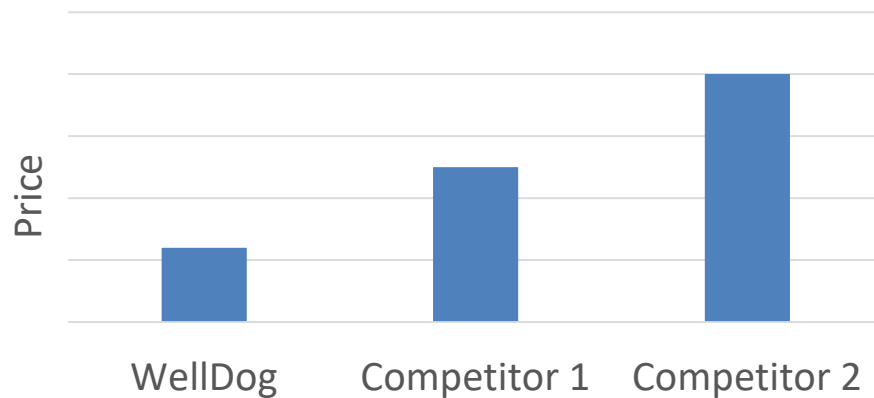
- Monitor subsequent drainage with WatchDog systems
 - Maximize drainage rate without damaging coal face
 - Confirm drainage rate and completion



WellDog innovates clean coal production

+ Carbon sequestration monitoring

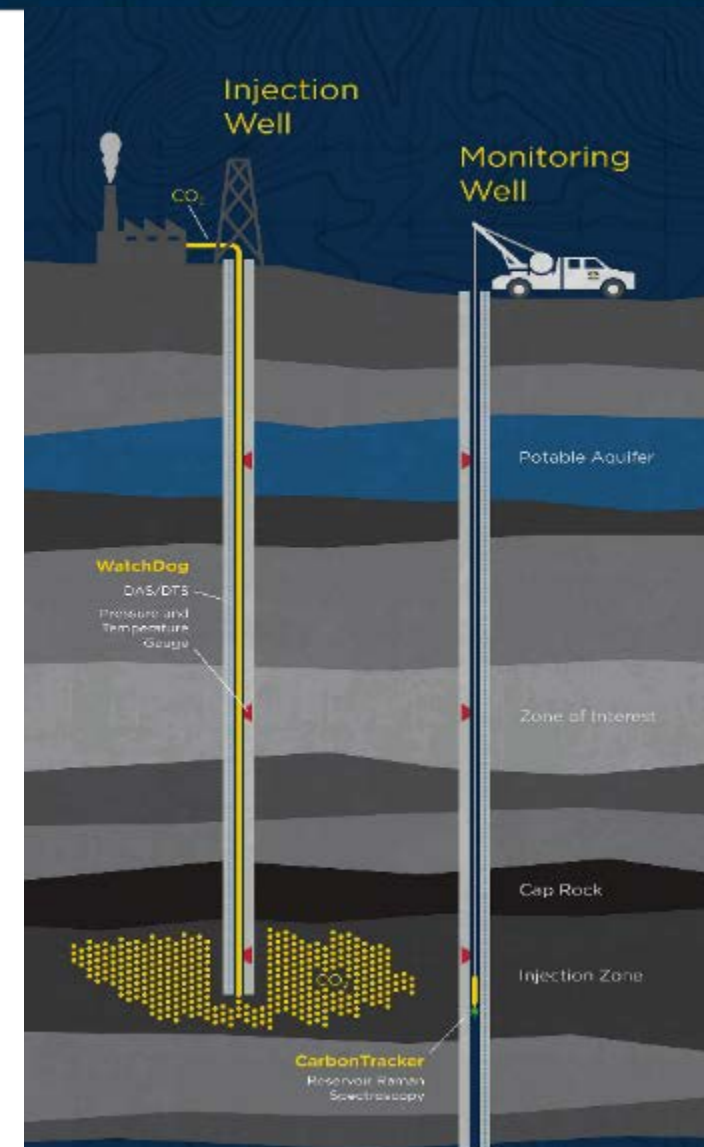
- Standard verification, monitoring and assessment services
- Assess possible sinks, monitor and verify sequestration
- Downhole microseismic, pressure and other sensor systems
- Low cost, high volume services suitable for commercial scale up



WellDog innovates clean coal production

+ Carbon sequestration monitoring

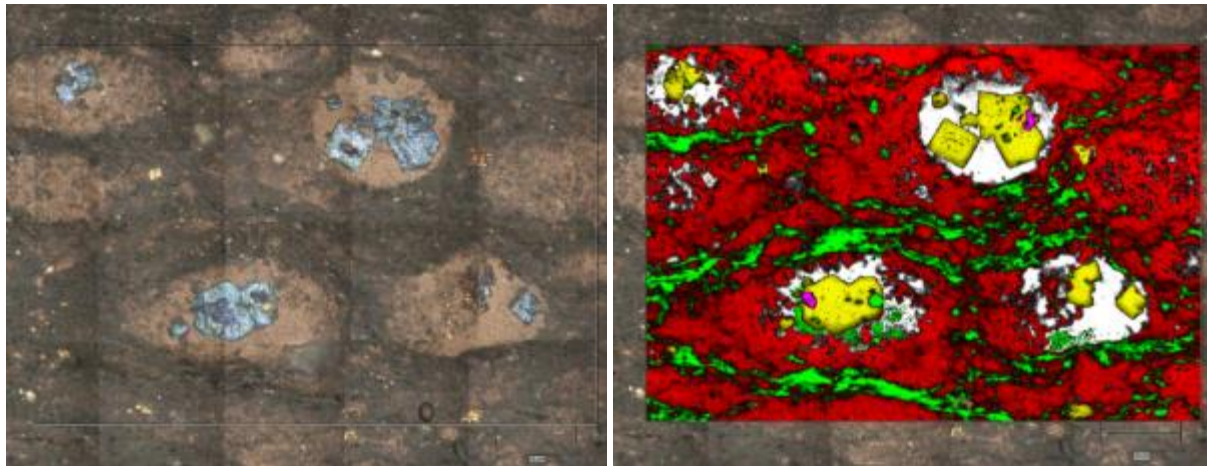
- Directly monitor CO₂ sequestration
 - The only system that does so
- Wellhead or downhole test, alone or with permeability test
- Open hole or cased hole tests
- Performed on multiple US-DOE CCS projects in the US
- Performed on CCS wells in Australia
- Reveals which zones uptake CO₂
- Shows the extent of reservoir loading
- Shows methane vs. CO₂ flowback



WellDog delivers key services to shale oil and gas

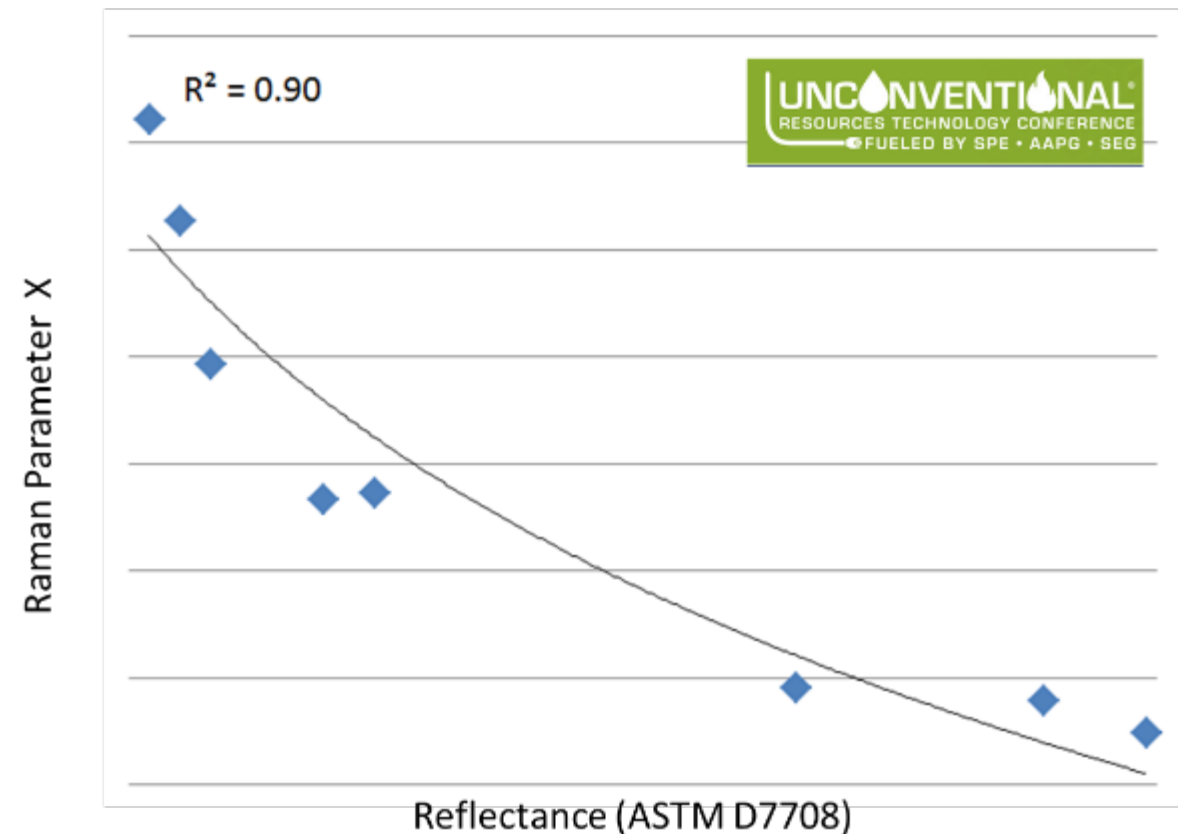
+ Shale oil and gas (laboratory)

- Identify shale mineralogy
- Identify shale thermal maturity directly and accurately



- Quartz
- Pyrite
- Marcasite
- Solid Bitumen
- Dispersed amorphous carbon in fine-grained matrix

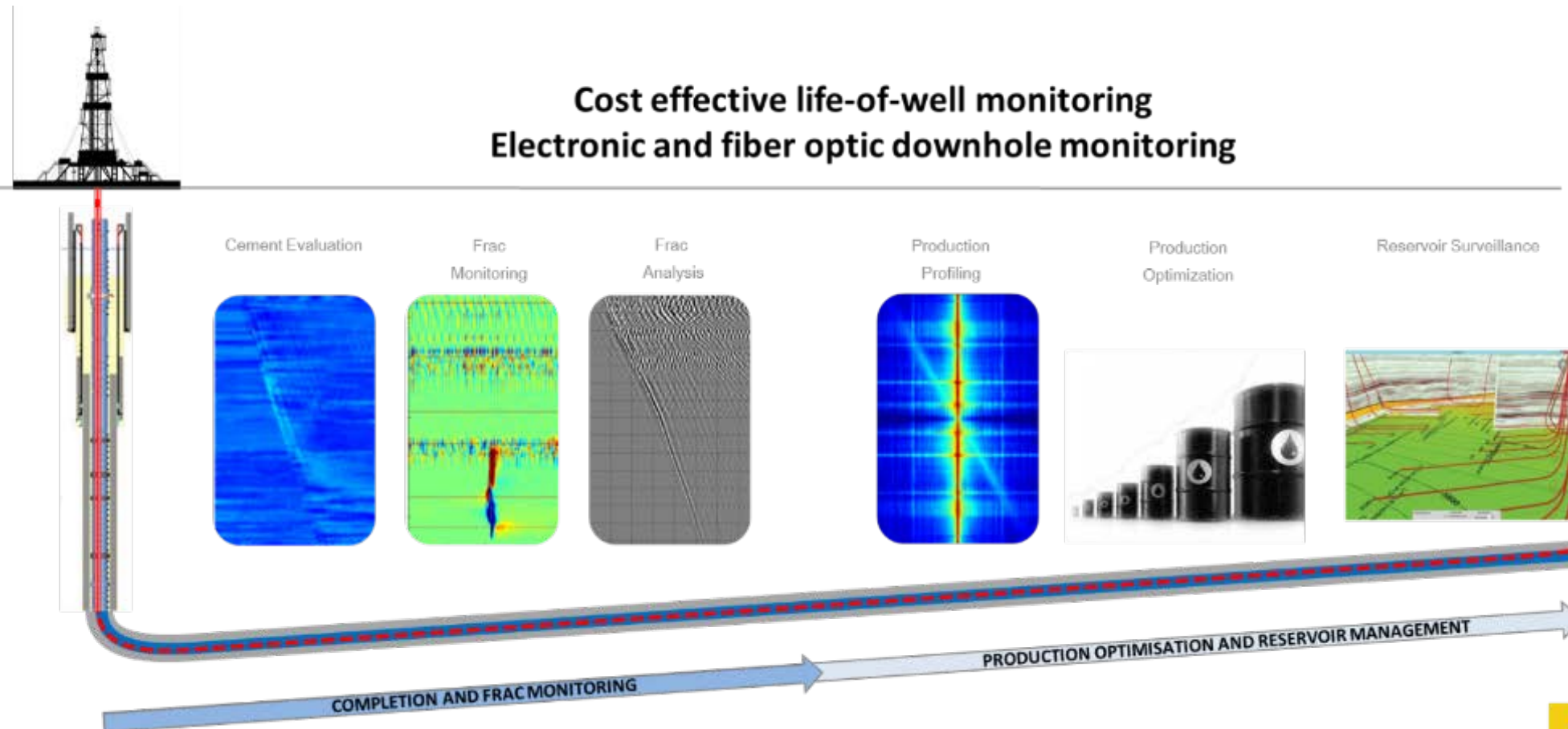
High Correlation with Standard Maturity Measurement



WellDog delivers key services to shale oil and gas

+ Shale oil and gas (downhole)

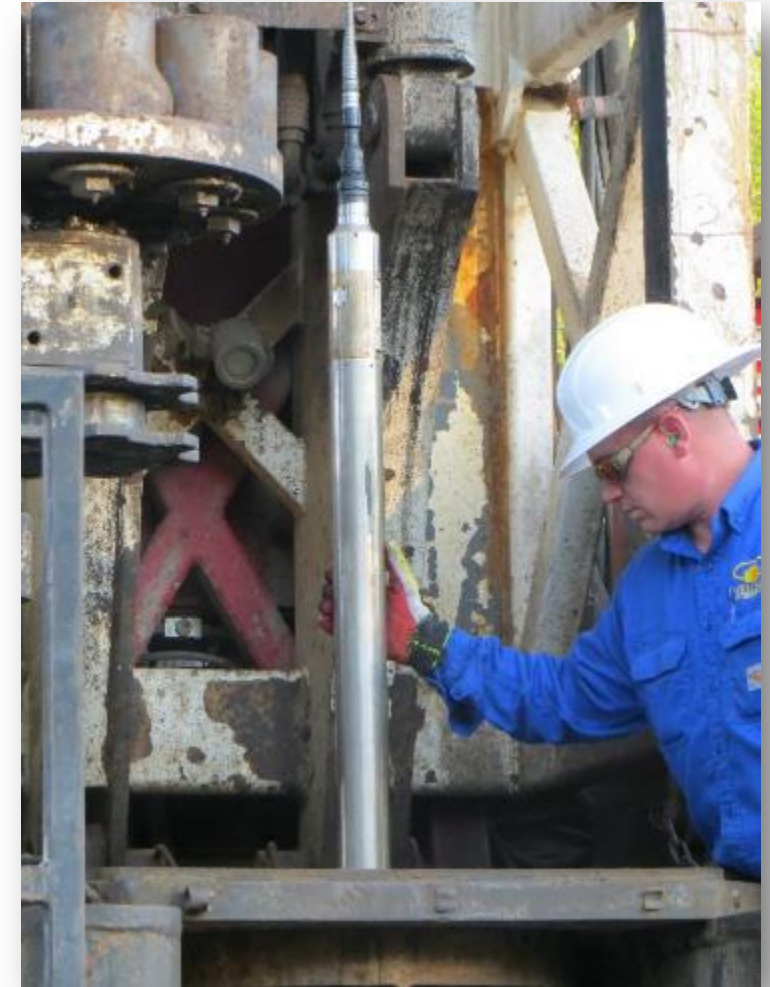
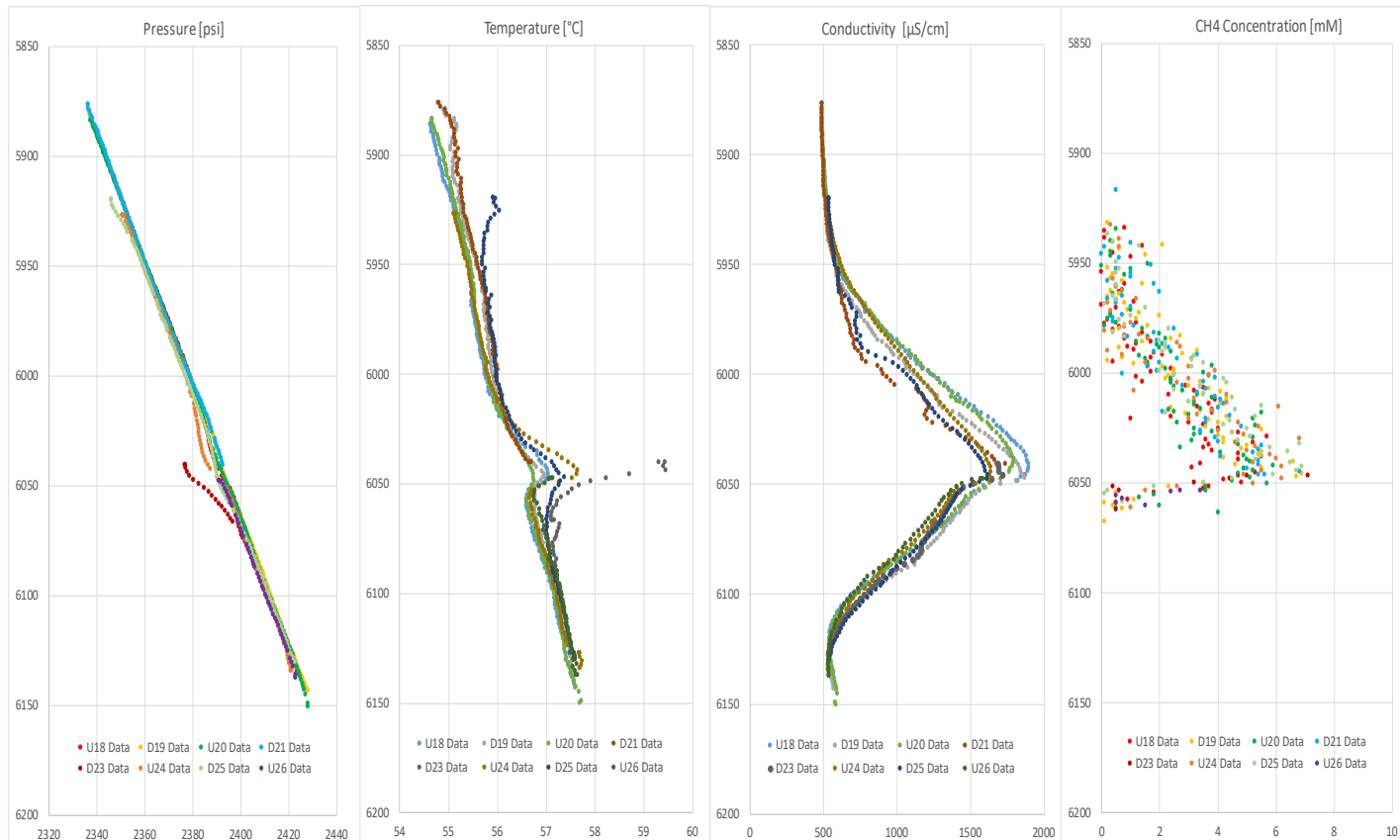
- Measure downhole pressures to optimize completion and production success



WellDog delivers key services to shale oil and gas

+ Shale oil and gas (downhole)

- Locate and identify the hydrocarbon directly



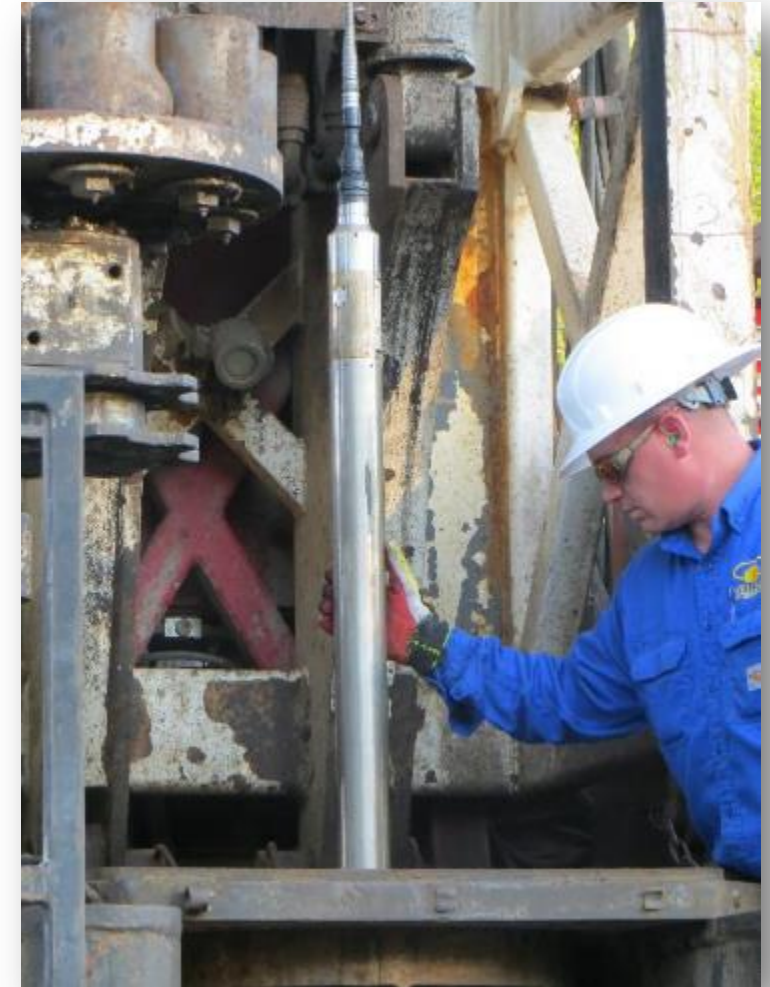
WellDog delivers key services to shale oil and gas

+ Shale oil and gas (downhole)

- Locate and identify the hydrocarbon directly



	Basal	Middle	Upper	
Formation Density	2.35	2.55	2.55	<i>g/cm3</i>
TOC	10.0	4.4	8.0	<i>wt %</i>
Sg	0.78	0.68	0.72	
Porosity	0.15	0.06	0.10	<i>mole %</i>
DRRS Gas Content	474	602	976	<i>scf/ton</i>



WellDog provides integrated operator services

- + Sister company Carbon GeoCycle now operates oil, gas and CCS projects
- + Works closely with WellDog to provide integrated project management to customers around the world
- + Specializes in sustainable CBM, conventional onshore oil and gas, and CCS operations
- + Engaged in JV with oil and gas company in USA focused on ECBM
- + Participating (as subcontractor) in Shaanxi JV



WellDog delivers its services in China

- + WellDog products and services are available in China now
 - Shaanxi
 - Shaanxi WellDog Energy Technology Limited: Cooperative JV between WellDog and SPIERCE
 - CJV signed 4 June 2017 in front of Wyo Gov Mead and Shaanxi Gov Hu
 - WellDog providing commercial and technical innovation
 - SPIERCE providing technical and public policy innovation

WellDog delivers its services in China

- + Shaanxi WellDog Energy Technology Limited: Cooperative JV between WellDog and SPIERCE



WellDog delivers its services in China

- + WellDog products and services are available in China now
 - Shaanxi: Shaanxi WellDog Energy Technology Limited
 - Goal: Enable a more sustainable Shaanxi resource industry through:
 - Accurate reservoir data
 - Best practices development decision making
 - Advanced production/sequestration optimization tools
 - Now working to deliver on three projects in 2018
 - PRC, other
 - Services sold through agent based in Beijing
 - Testing equipment is in country now
 - Previous jobs have included Ordos Basin CBM testing

