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Impact of Laboratory Testing Variability in Fracture Conductivity for Stimulation Effectiveness in Permian Deep Coal Source Rocks, Cooper Basin, South Australia

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Abstract

Hydraulic fracture stimulation of low-permeability source rock-reservoirs is increasing in the industry. Low-permeability, deeply buried coals, or "Deep Coals", represent a large underdeveloped resource in the many basins of Australia. Numerous treatments have been performed in the Cooper Basin with overall technical success but varied productivity. Data indicate that when treatments transitioned from slick-water, low-concentration sand (i.e., ~0.5 lbm/ft^2) to higher viscosity, crosslinked gel, higher-concentration (i.e., 1-2.5lbm/ft^2) and ceramic proppant treatments, flow rates per stimulation stage improved (see Figure 1). Thus, it was important to understand the potential fracture conductivity resulting from stimulations in the Permian Deep Coal play by evaluating the key treatment variables affecting post-frac results.

Proppant conductivity tests were conducted on samples from two preserved Deep Coal cores of differing thermal maturity in laboratory conditions replicating reservoir conditions. Varying concentrations and mesh sizes of lightweight ceramic (LWC) and sand proppants were tested at 250˚F, under closure stresses ranging from 2,000 to 10,000 psi, using representative hydraulic fracturing fluids. Results revealed a significant conductivity difference between the two coal thermal maturity ranks due to resulting variations in mechanical properties.

Varying proppant concentration testing revealed that effective conductivity values at higher stresses occurs within a narrow window. This window is a balance between insufficiently low concentrations resulting in significant conductivity loss, and excessive, non-linear conductivity gains in higher concentrations. Results from these studies are integrated into hydraulic fracture and reservoir stimulation modelling software to up-scale the observed results versus the laboratory data. Finally, laboratory results helped explain trends for success in stimulation designs based on observed post-frac, flow rates.

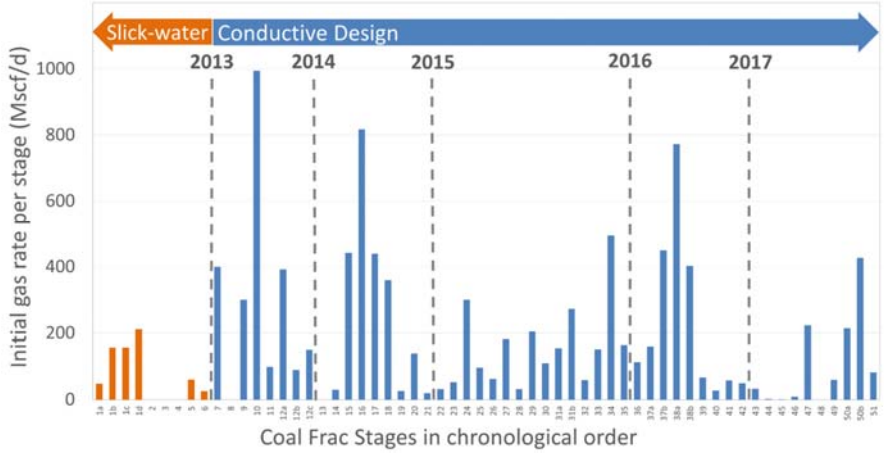

Figure 1 Results of frac treatments in Deep Coal hydraulic fracturing programme.