Time-dependent Stress Shadow Model Explains Tracer Observations in Denver-Julesburg Basin

Scope

Hydraulic fracturing causes local stress shadows that influence fluid propagation on future stimulated stages and wells. Stress dissipates over time and returns to the virgin stress state. Analysis of injected well-specific tracer chemicals during production on 7 horizontal wells treated over a 25-day period in the Denver-Julesburg basin demonstrates that stress-shadows dissipate after ~12 days. Results suggest that fluid from offset wells treated <12 days from the parent well treatment will be contained close to the treatment well. After 12 days, stress shadows have dissipated, and tracer is produced up to 2000 ft laterally from the injection well.

Method

Microseismicity detected during hydraulic stimulation of 7 horizontal wells were analyzed to establish a correlation among stage lag (time change between current stage treatment and offset neighboring stage treated) and event-population centroid with respect to each stage treated. The correlation is used to constrain the stage lag time it takes for local stress shadows to dissipate allowing fluid to propagate back toward previously treated wellbores along the newly created fractured network. Tracer production is analyzed for each well to test the hypothesis.

Results

Figure 1 shows the correlation between stage lag time and microseismic centroid distance in the X-direction (- is West, + is East) with respect to stage center. Production of well-specific tracer corroborates the hypothesis that local stress-shadows dissipate after ~12 days. Over 90% of tracer recovered for wells with stage lag times <12 days were produced on the same well that the tracer was injected. After ~12 days, stress dissipates and on average <60% of tracer is recovered by the same well that the tracer was injected.

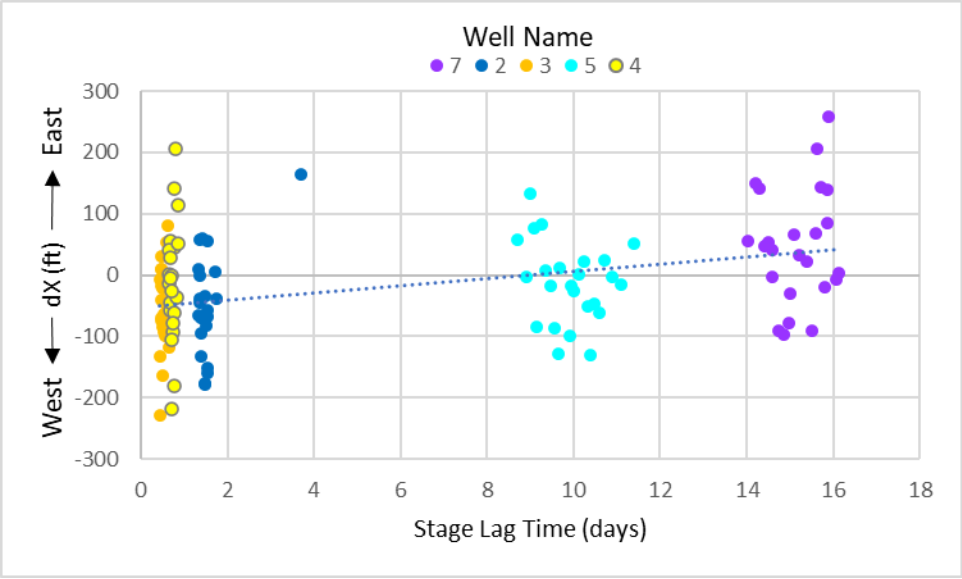

Figure 1. Stage lag vs. event population centroid in X direction.

Injection Well	Partner Well	dT Avg (days)	dX Avg (ft)	% of Tracer Recovered by Injection Well
1	8	>360	29	10.7
2	1	1.6	-47	81.2
3	2	0.5	-73	92.8
4	5	0.7	-11	99.4
5	3	9.9	-13	98
6	9	>360	93	99.2
7	1	15.2	46	58.9

Table 1. Stage lag (dT), average event population centroid (dX) and percent of injected tracer recovered by each injection well (i.e. 98 means 98% of injected tracer produced by same well that it was injected into.)