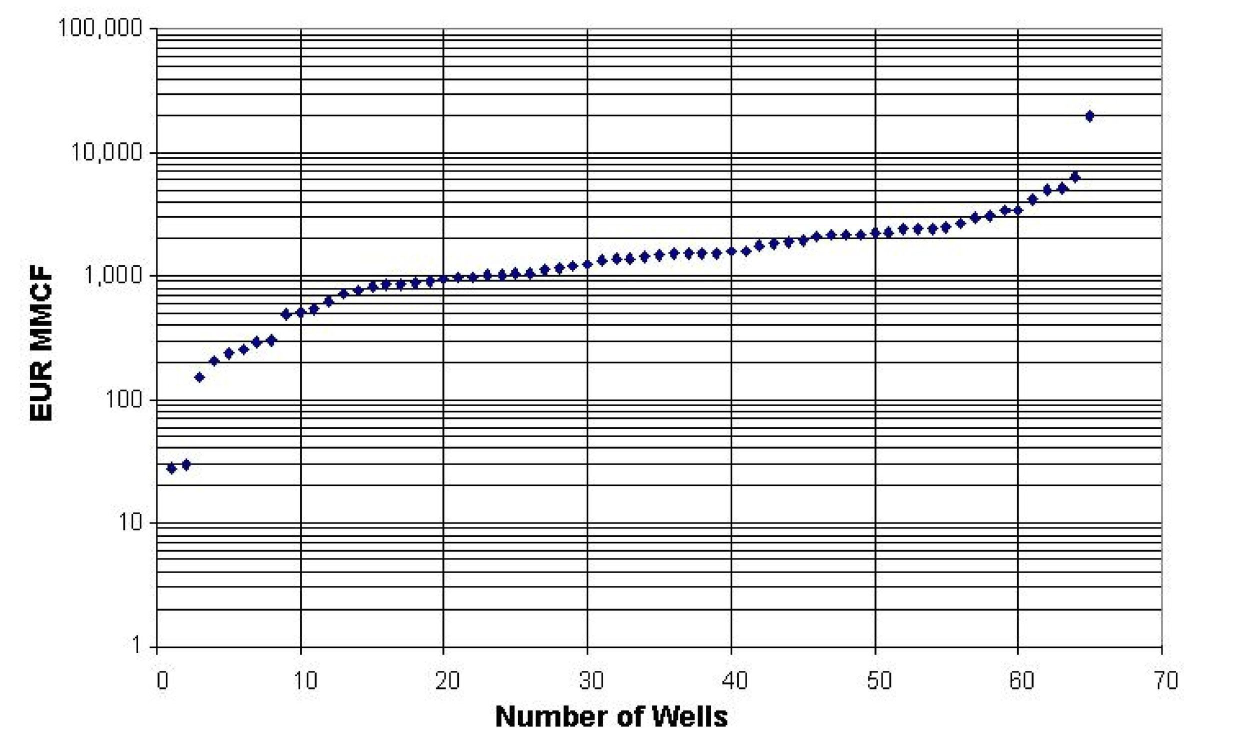
Click here to go to eighth poster.

Production Analysis

Figure 1 - Select Almond Well Estimated Ultimate Recovery

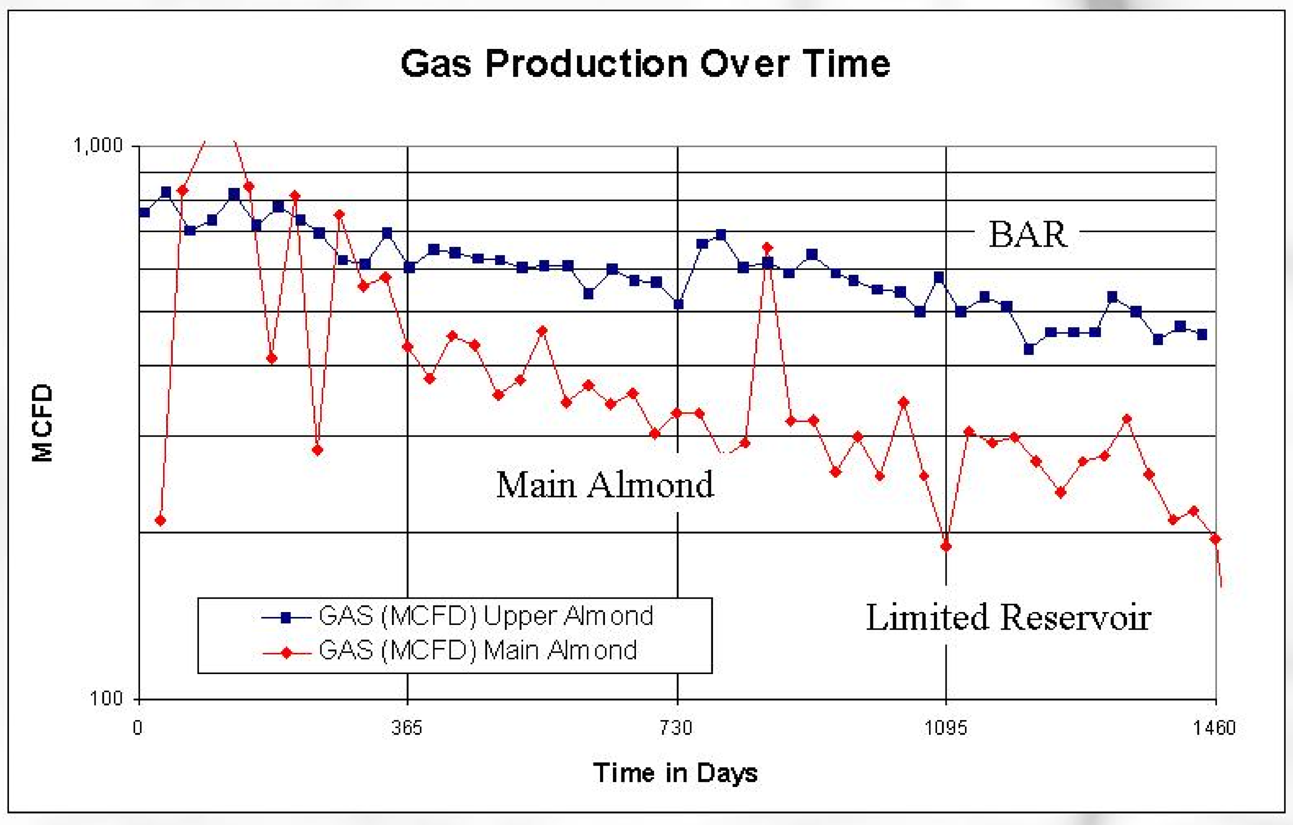


Gas production in Siberia Ridge Field is quite variable, with estimated ultimate recoveries (EUR) averaging 1.8 BCF and ranging from less than 0.5 to nearly 20 BCF (figure 1). *Are productive sweet spots controlled by increased natural fracturing, better matrix quality, completions practices, or by a combination of these factors?*

Most wells are completed in both the Almond Bar and Main Almond. Almond gas production is usually commingled, making accurate assessment of interval productivity difficult.

Initial production rates for the Main Almond are higher and decline more rapidly than production from the Almond Bar (figure 2). This is due to the areally limited size of Main Almond reservoirs. Production logs (figures 3 and 4) support this geologic interpretation which is also observed in the decline curves for Main Almond wells. However, water production also becomes an issue when perforating and producing the lower Main Almond formation.

Figure 2
Production Decline Curves for Almond Bar and Main Almond



Perforating the lower Main Almond increases exposure to high water production. Many of the Almond 600 and Almond 700 perforations are plugged back and few wells are perforated below the Almond 400 interval (figure 5). Historically, water saturation is calculated assuming a long, single hydrocarbon column, yet water often produces from the lower Main Almond and Ericson intervals. Conventional log analysis has not yet adequately determined why these reservoirs produce water, given an increasing resistivity profile with depth. Porosity is still developed in the lower Main Almond intervals, and log analysis generally indicates better gas saturation in these intervals than in the Upper Almond Bar. Variations in R_w have been proposed to explain the apparent saturation change, and a radical change in R_w from 40,000 ppm in the bar, to 5,000 ppm would be needed to calculate a "wet" zone in the lower Almond intervals. Two things are needed to support a change in R_w; one would be a fresh water source from the coals (probably during gas migration), the other would be vertical compartmentalization within the Almond Formation. More work to understand the mechanics of coal gas generation, water migration and vertical compartmentalization in the lower Main Almond is needed. The combination of high natural fracture density (from this study) and a drastic change in rock type from the Upper Almond bar to the Ericson Formation can account for the difficulty in determining "wet" zones in this field. An approach utilizing capillary pressure techniques may be better suited to determine saturation.

Figure 5 –Almond Formation Perforation and Plug Back Record

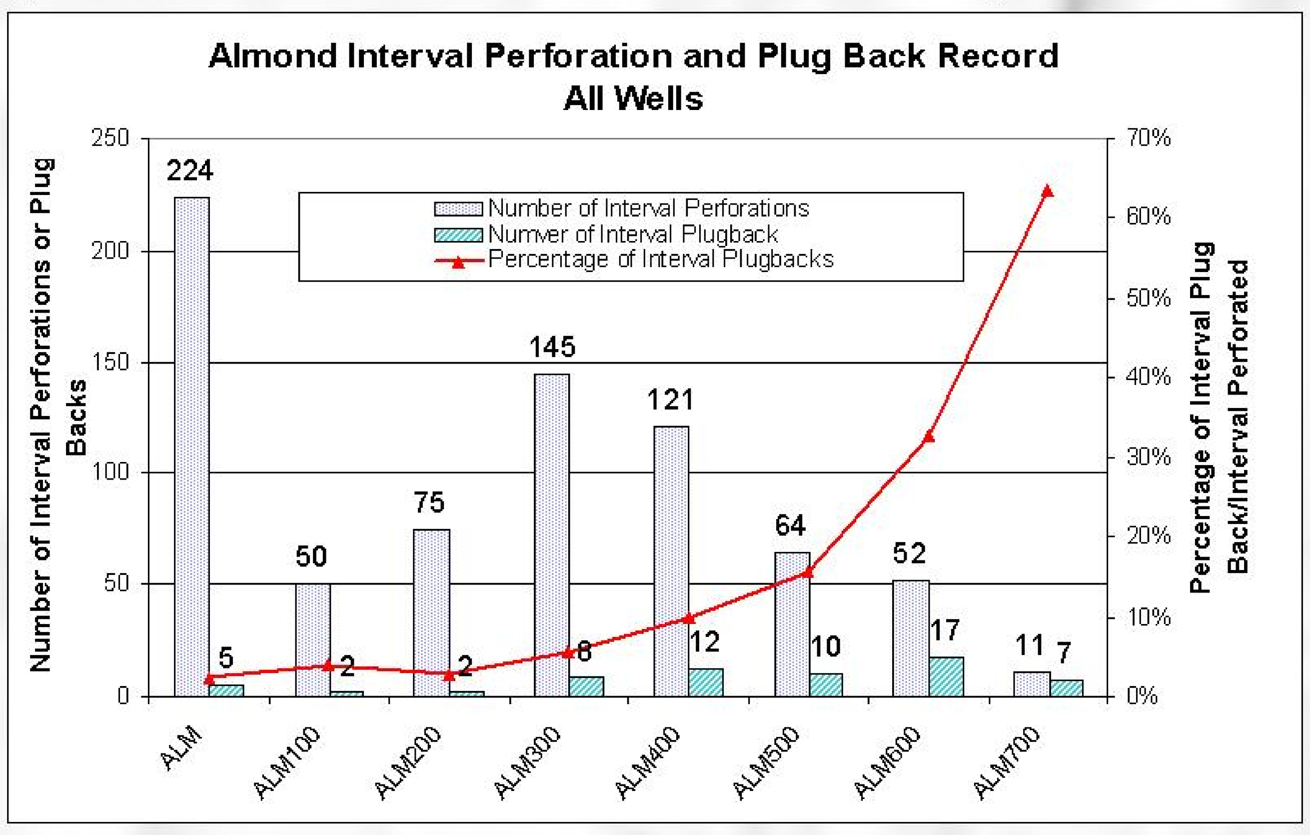


Figure 3
Formation Productivity SRU #5-2

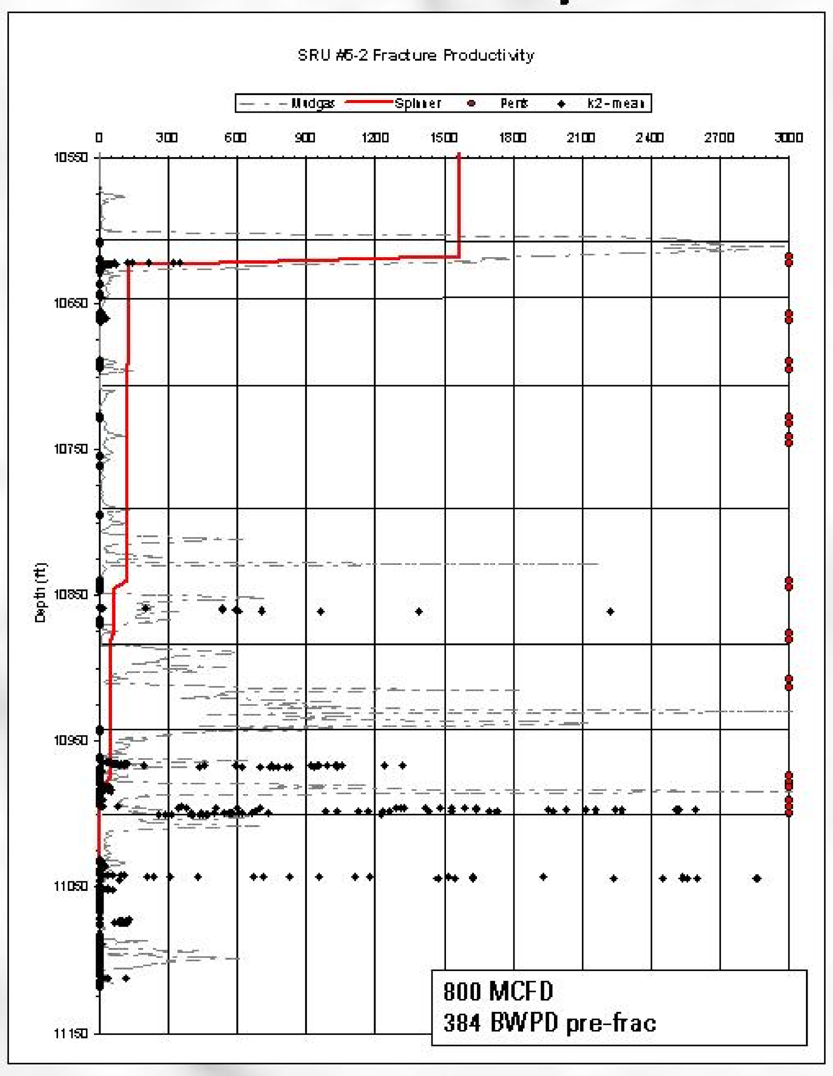
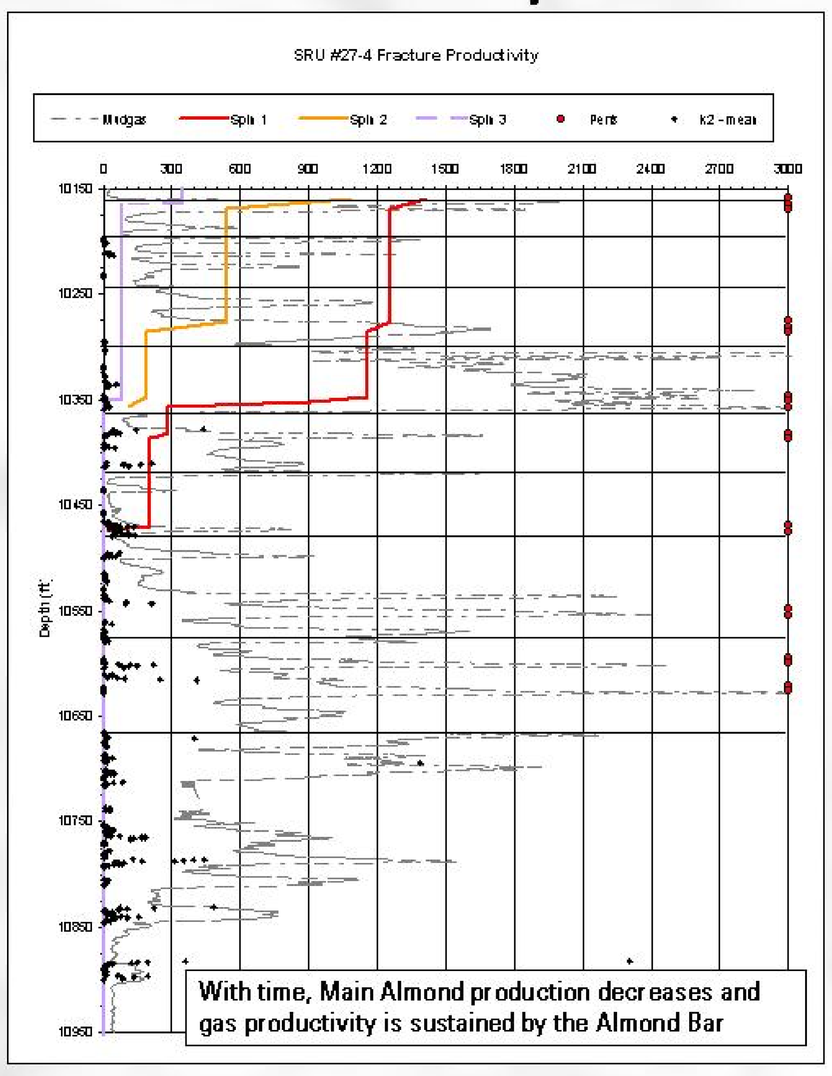


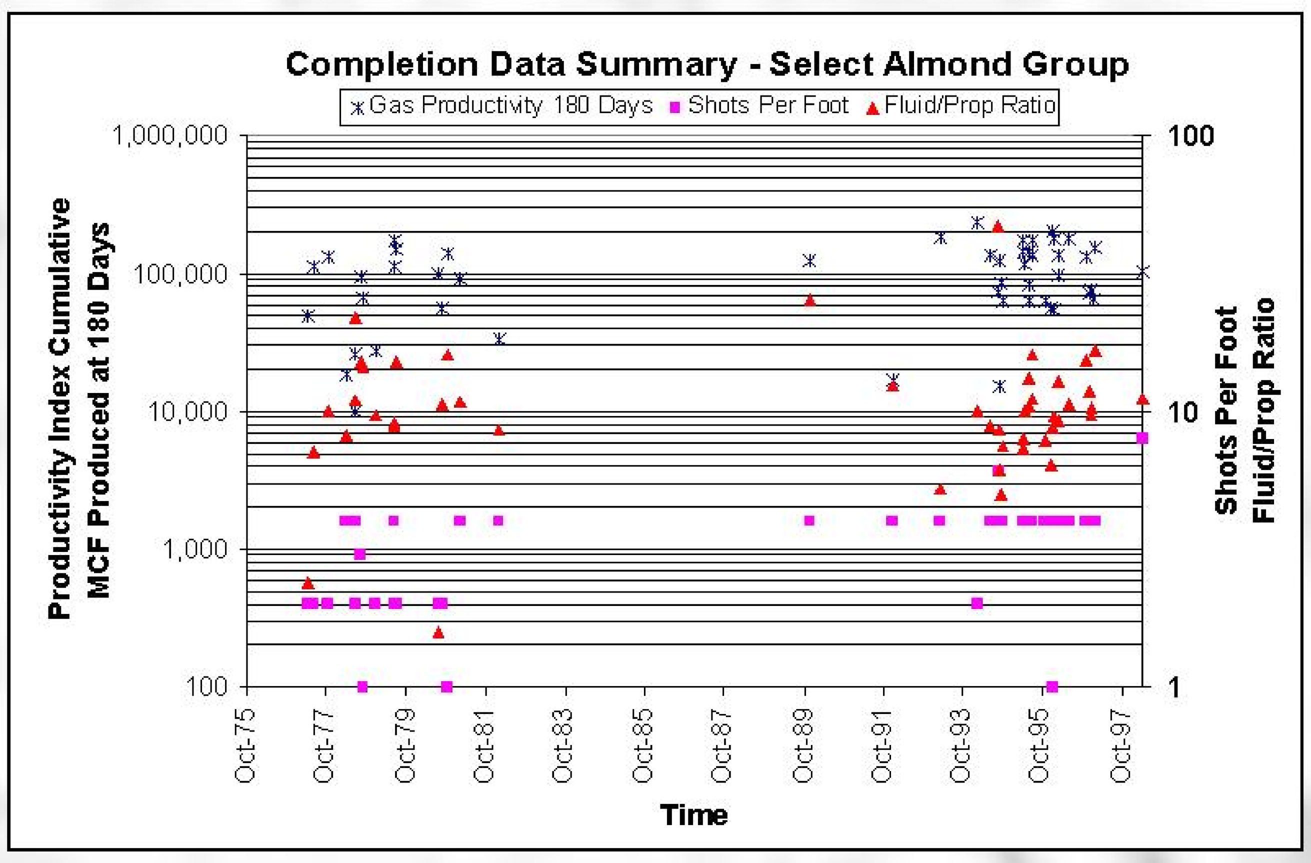
Figure 4
Formation Productivity SRU #27-4



Fracture productivity. Vertical profile of spinner, fracture permeability, and mud-gas data. Horizontal lines represent stratigraphic interval markers.

What is the impact of different completion technologies? The graphs below demonstrate that higher perforation density (figure 6), limiting the gross stimulated interval to under 100 feet (figure 7) and utilizing discrete or point sources treatment methods improve gas recovery.

Figure 6 –Completion Data Compared to Productivity



An increase in initial and long term productivity is observed in some wells intersecting linear features. The level of increased productivity may depend on the stratigraphic intersection (Table 1). Intersection in the Upper Almond interval potentially exposes a larger productive area than the smaller lenticular reservoirs of the Main Almond intervals. Linear feature intersection at or below the Almond 400, where fracture density normally increases significantly, also increases exposure to potential water sources.

For wells perforated only in the Upper Almond-interval, simple linear regression between EUR and distance to linear feature results in a R^2 value of 0.28; whereas a regression between EUR and kh results in a R^2value of 0.64. A multilinear regression of EUR with kh and distance to linear feature results in a R^2 value of 0.744, suggesting that the distance to the linear feature improves the overall correlation. This finding supports the idea that kh is more significant than distance to linear feature in long term productivity, but also indicates that distance to linear feature is a factor in long term productivity.

Figure 7 –Stimulation Interval Completion Data

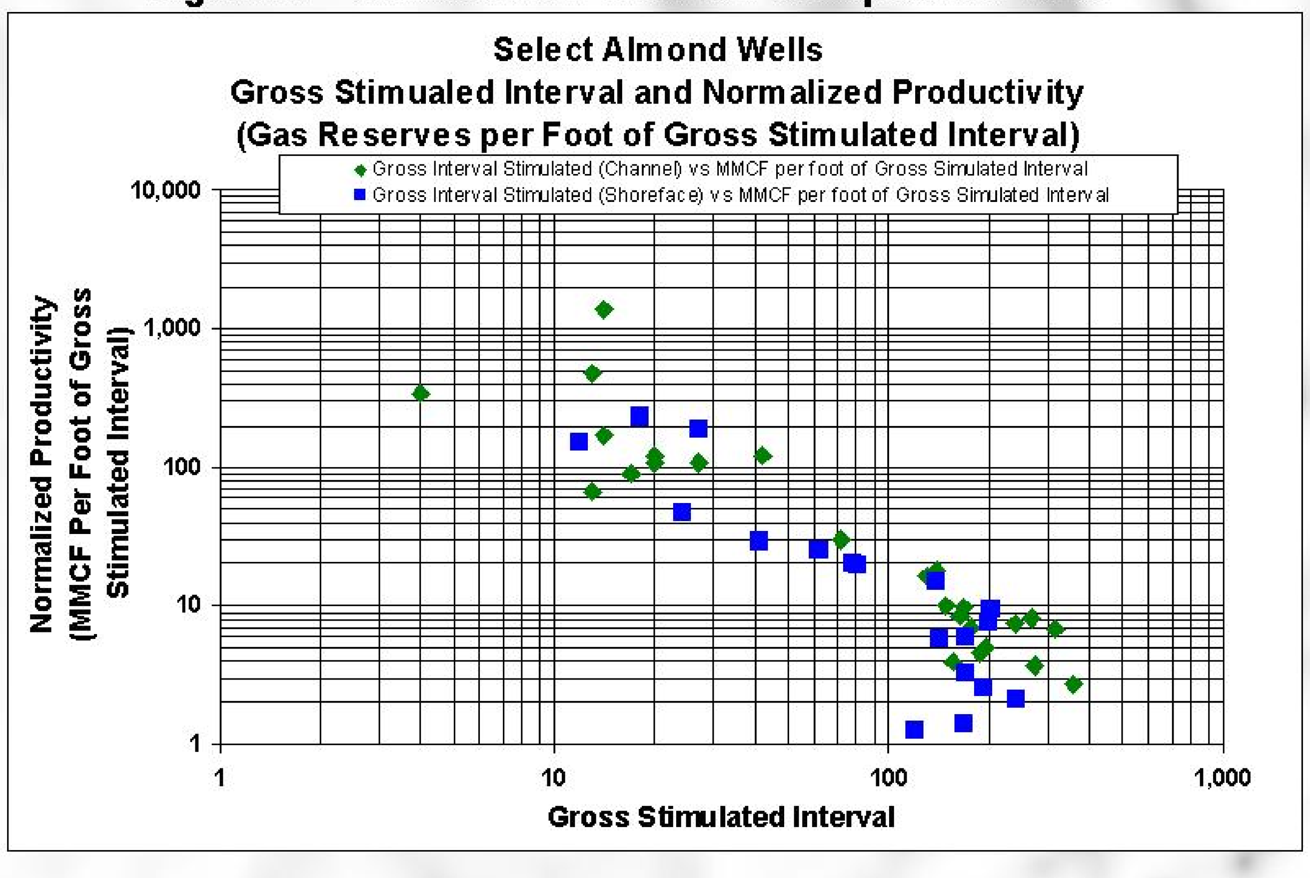


Table 1 – Productivity Comparison Determined by Distance from Linear Feature

	Distance from Known Linear Feature			
	0 to 200'	0 to 500'	0 to 1000'	All Wells
Average EUR – BCF	3.3	2.5	2.1	1.8
Average Cumulative Production at 180 Days – MCF	161,016	145,269	130,230	113,589
Percentage of Total Projected EUR	28%	45%	55%	100%
Average Distance from Linear Feature	134'	242'	407'	1,333'
Number of Wells	7	15	22	46

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