Silo Field - Southeast Wyoming: An Example of the Relationship of Exploration Signatures LLC Fracture Density and Hydrocarbon Induced Mineral Alteration Mapping to Production

Silo Oil Field lies in the northern part of the Denver Basin in Laramie County, Wyoming, approximately 17 miles northeast of Cheyenne. The discovery well was drilled in 1981. The initial wells were drilled vertically (40 wells total). Horizontal drilling began in late 1990 (as of September 2012, 68 horizontal wells have been drilled). As of 2011, the field has produced more than 10.4 million barrels of oil.

Production is from the Niobrara Formation (limestone/chalk and interbedded, calcareous, organic-rich shales). As in many shale resource plays, fracturing (both natural and induced) plays an important role in production.

Although not initially regarded as a resource play, Silo shares several characteristics with ”typical” resource plays. The Niobrara is both the source and the reservoir, production is aerially extensive and bears little relationship to structural or stratigraphic controls, fracturing plays an important role in production, and the accumulation lies near the center of the basin with little water present.

Several years ago, in conjunction with an exploration play and subsequent prospect development immediately to the north, we mapped the fracture density and hydrocarbon induced mineral alteration associated with the leakage of hydrocarbons in the region that included Silo (Figure 1).

Of the wells with cumulative production greater than 200,000 barrels, 13 (76%) lie within the area of high fracture density and 4 (24%) lie on the edge of the fracture density high. If one considers the bottom hole location of the wells drilled horizontally (Figure 2), then 14 (82%) lie within the area of high fracture density and 3 (18%) lie on the edge of the fracture density high. None of the > 200,000 barrel wells lies in an area of low fracture density (i.e., 100% of the > 200,000 barrel wells are associated with the fracture density high.

Of the wells that are clearly economic (i.e., those with cumulative production of greater than 50,000 barrels of oil) 42 (75%) are within the strong fracture density high and 14 (25%) lie immediately outside of the strong fracture density high. Considering both the bottom hole and surface location of the > 50,000 barrel horizontal wells, 46 (82%) are located in areas of high fracture density and 10 (18%) lie outside. Only one (< 2%) of these > 50,000 barrel wells lies in an area of low fracture density (i.e., > 98% of the > 50,000 barrel wells are associated with the fracture density high).

A halo like hydrocarbon induced mineral alteration anomaly is associated with the area of high fracture density. Several other untested hydrocarbon induced mineral alteration anomalies associated with relative fracture density highs lie outside the Silo Field area. All of the high yield wells (100% of the > 200,000 barrel wells) lie with in the spectral anomaly that is associated with the area of high fracture density. Only 4 of the clearly economic wells (7% of the > 50,000 barrel wells) lie outside of hydrocarbon induced mineral alteration anomalies when one considers both the surface and bottom hole locations of the wells.

We also examined the fracture density of northwest-trending, naturally open-standing fractures (Figure 3). Most (82%) of the >50,000 barrel (economic) and > 200,000 barrel (high yield) wells lie within areas of high, northwest-trending, naturally open-standing fracture density when both the surface and bottom hole locations of the wells are considered.

The use of our fracture density and hydrocarbon induced mineral alteration mapping produces results far better than industry standard [which is 1 in 14 (7%) for exploration wells and 1 in 2 (50%) for development wells] by identifying those areas with the best economic production 75% - 100% of the time and by focusing the exploration effort, saving substantial amounts of time and money.

Figure 1: Total Fracture Density, Hydrocarbon Induced Mineral Alteration Anomalies, and Well Locations - Silo Field

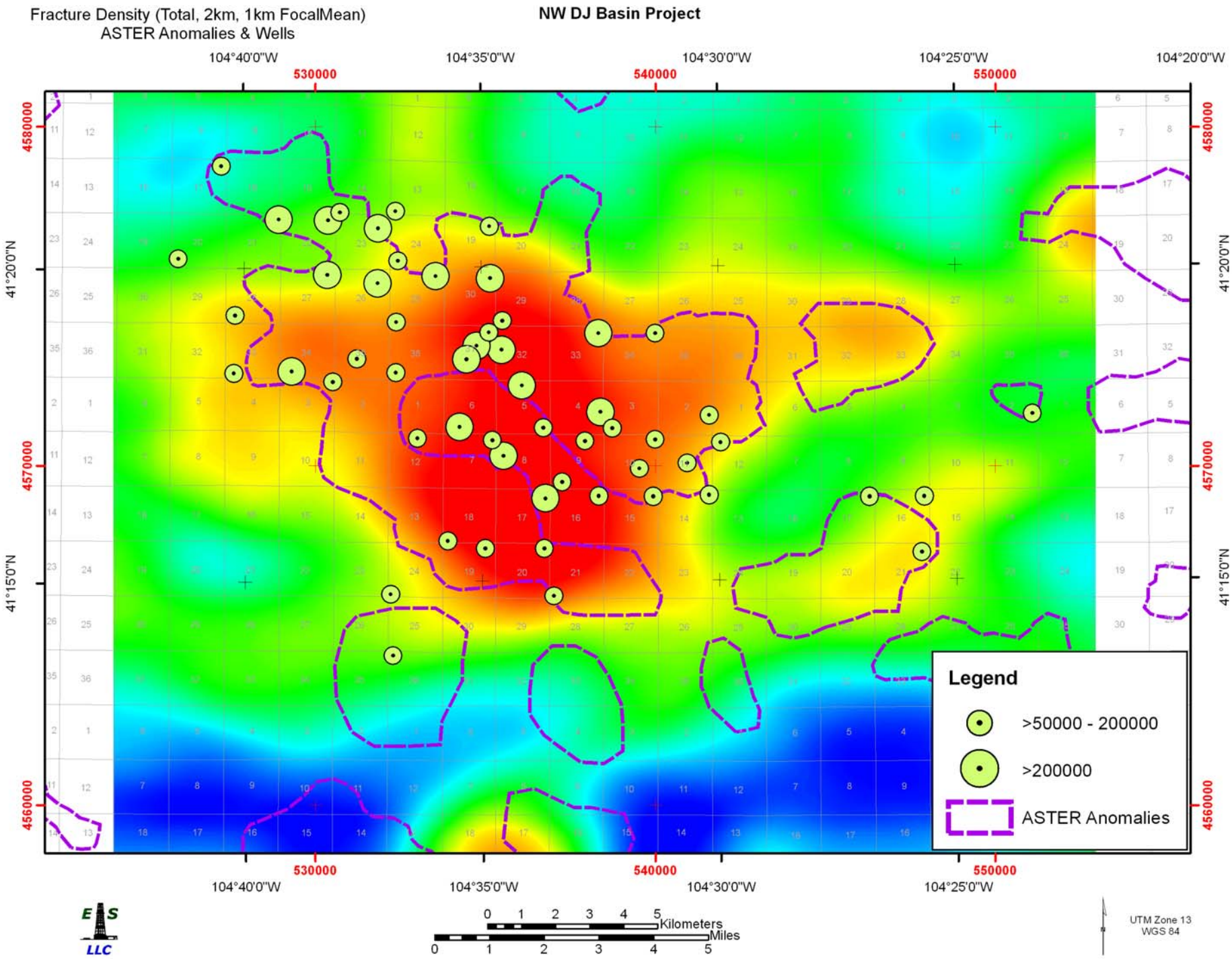

Figure 2: Total Fracture Density, Hydrocarbon Induced Mineral Alteration Anomalies, and Horizontal Well Bottom Hole Locations - Silo Field

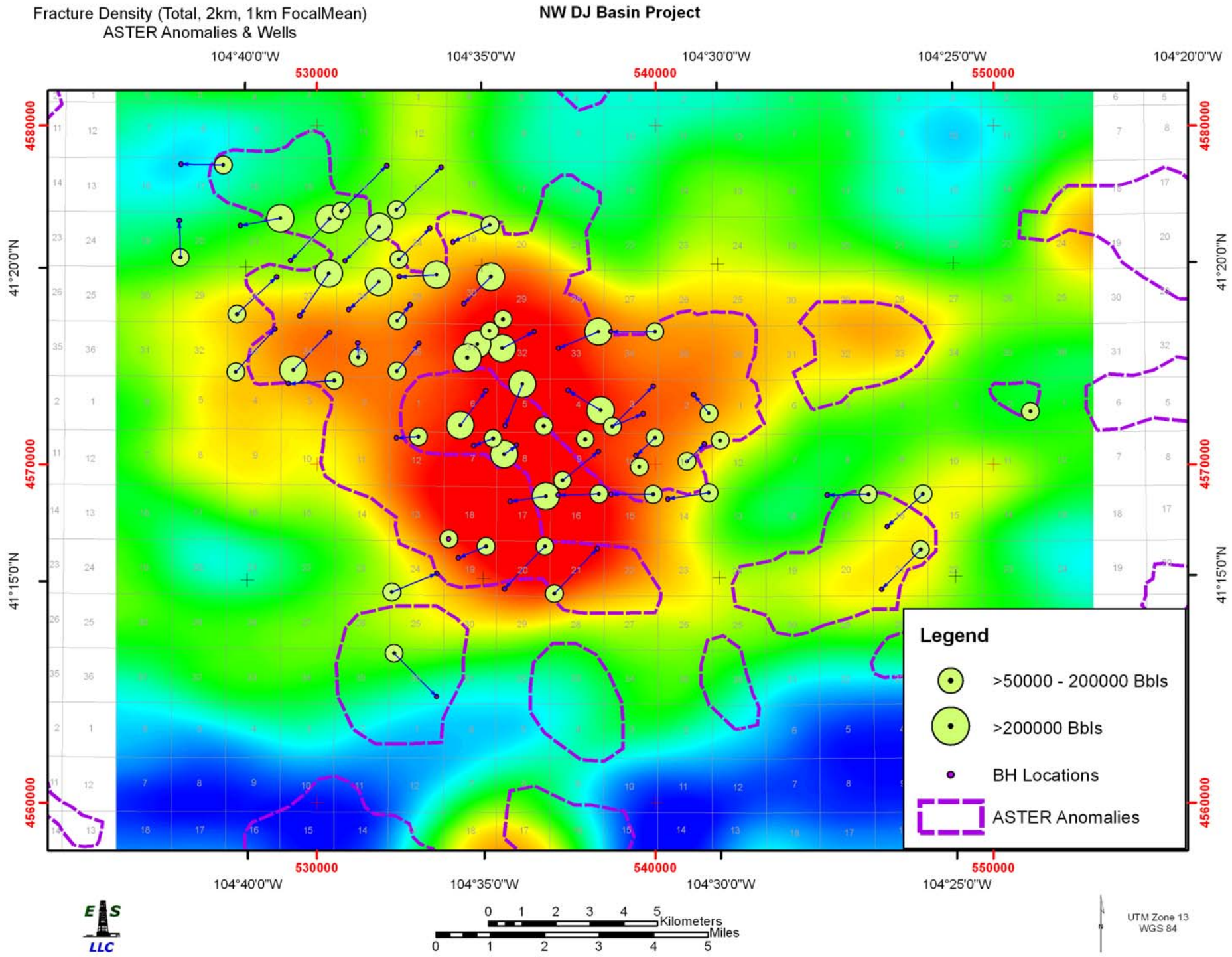

Figure 2: 285º-305º Fracture Density, Hydrocarbon Induced Mineral Alteration Anomalies, and Horizontal Well Bottom Hole Locations - Silo Field