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Bakken Sweetspots, Production Statistics, Bounding Pronghorn Facies and Magnetic Anomalies

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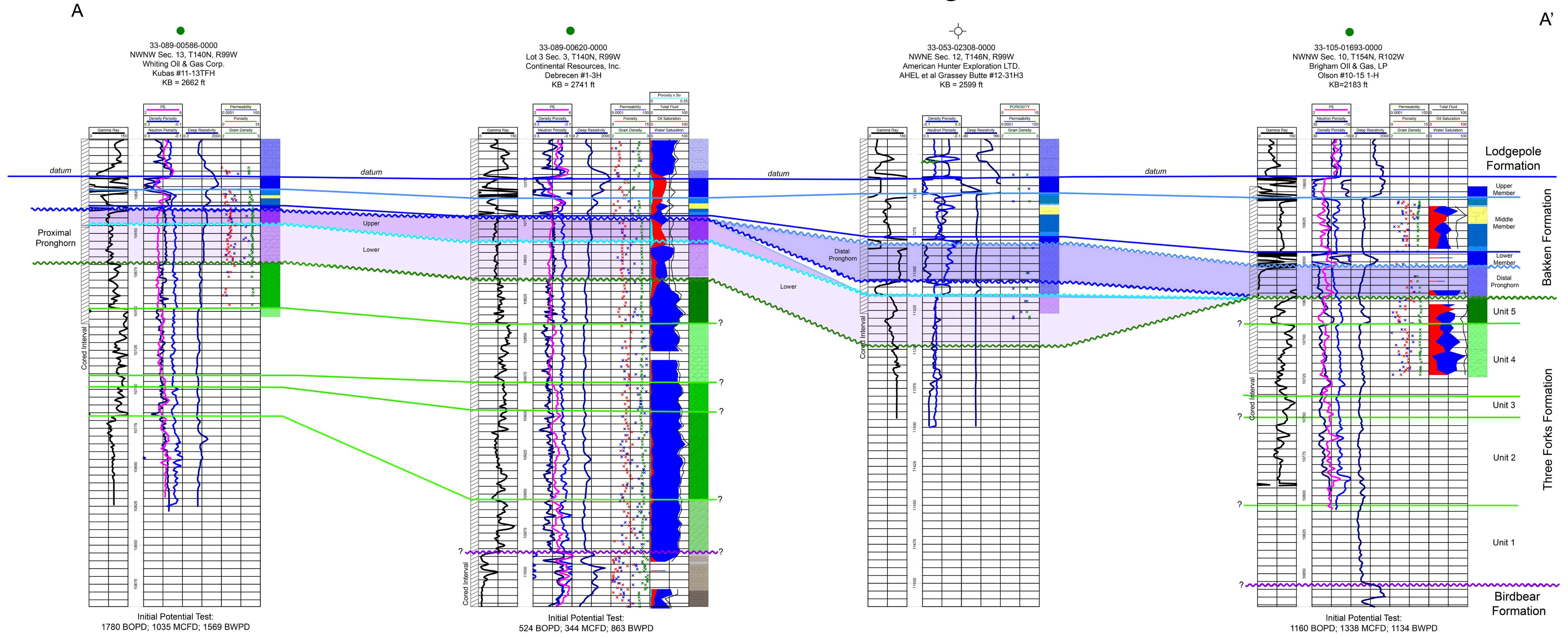

Figure 7. Maps of the percentile ranked cumulative production for the region outlined in Figure I. Maps labeled 7a-7e show the extent and intensity of Bakken Source System production in North Dakota contoured as a fractional percentile for 60, 120, 240, 480 and 960 days cumulative production. Figure 7a represents the 60 day percentile ranking with an overlay of the thickness of the distal facies of the Pronghorn Member of the Bakken Formation. Figure 7b represents the 120 decimal percentile ranking of cumulative production with an overlay of the proximal facies of the Pronghorn Member of the Bakken Formation. Figure 7c represents the 240 day decimal percentile ranking of cumulative production with an overlay depicting the anomaly map of the total aeromagnetic field strength at 1000m above the surface. Black contour lines define regions in which the magnetic field strength is greater than the regional average and light gray contours enclose regions in which the field strength is less than the regional average. Figure 7d shows the fractional percentile ranking at 480 days and Figure 7e represents the fractional percentile ranking of cumulative production after 960 days service. Anticlines and faults are shown are shown as heavy dark gray or black lines.

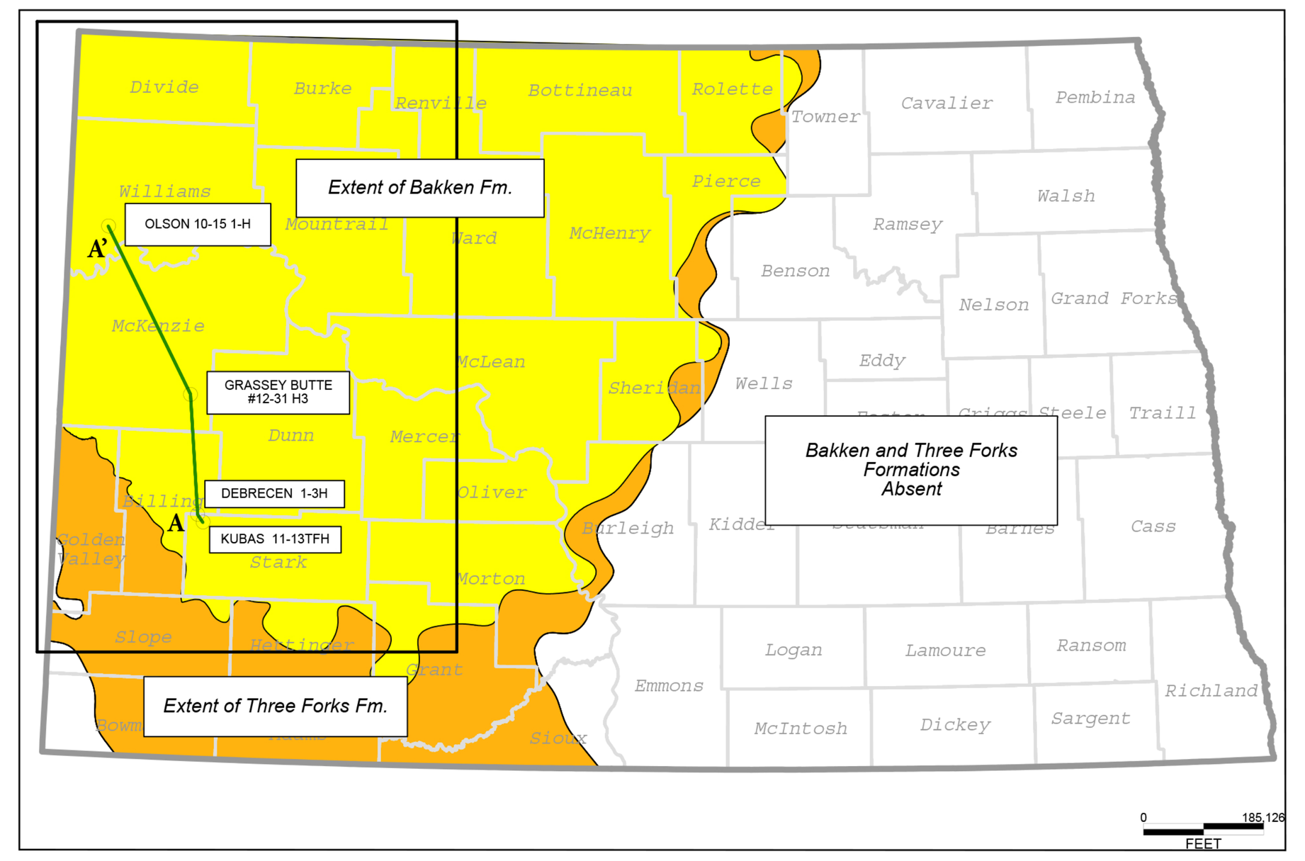

Figure 1. Location map showing the distribution of the Bakken Formation (yellow fill) and Three Forks Formation (orange fill) in North Dakota. The rectangle in the northwest portion of this map represents the boundaries of the production maps shown in Figures 7a-7e. The location of the Debrecen and Kubas wells used in the cross-section in Figure 2 are shown by small labeled circles.

Figure 2. The cross-section (A-A') shows the Bakken and Three Fork Formations across the study area. Emphasis is placed on the Pronghorn Member its facies relationships from the proximal to the distal portions of the basin. A surface divides the HCS-bedded dolomitic mudstone into an upper and lower part (shades of purple). The lower portion appears to correlate with an increase in production as shown on Map 7b. Both parts have similar porosities however; the lower portion has higher permeability increasing the effectiveness of the porosity. Production is also limited by the organic-rich mudstones of the distal portion (dark purple and Fig. 7a).

Figure 3. Histograms (in blue) showing the number of wells classed by cumulative production using 60, 120, 240, 480 and 960 days of production. Linear interpolation between bounding production reports is used to estimate the cumulative production for the five time periods used. The histograms in red are generated by Beta distributions that are obtained using the parameters listed in Table 1. The data include all production from the Bakken Source System in North Dakota that was available on December 9, 2013.

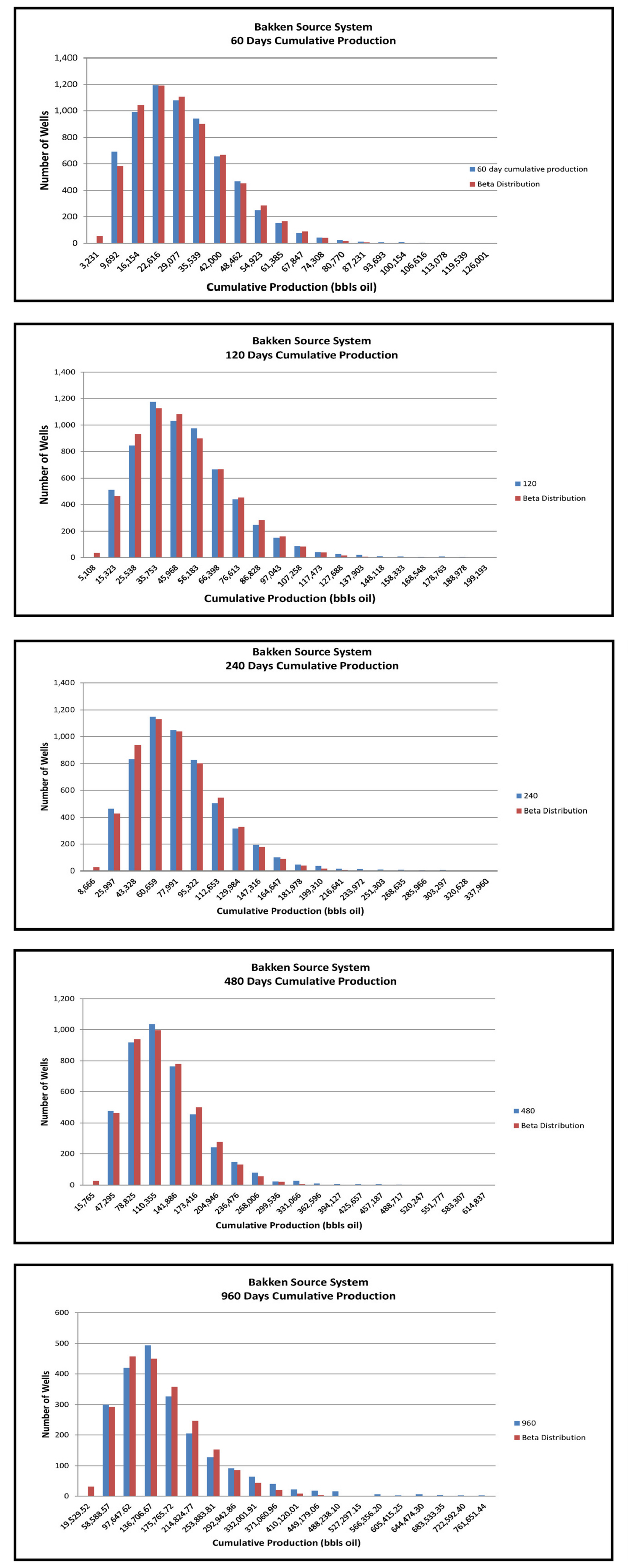

Table 1. Parameters used to fit Beta distributions to cumulative oil production statistics obtained December 9, 2013. The mean of the Beta distribution (E[X}) is given by $\alpha/(\alpha+\beta)$; the median by $(\alpha-1/3)/(\alpha+\beta-2/3)$ and the mode by $(\alpha-1)/(\alpha+\beta-2)$.

Days Production	Number of Wells	Beta Distribution Parameters: α	β	Min	Max	Error	Central Tendency (bbls oil): Mean	Median	Mode
60	6,609	2.50	9.35	0	129,232	23,352	27,257	25,030	19,670
120	6,250	2.71	9.85	0	204,300	23,622	44,061	40,804	33,055
240	5,556	3.01	12.03	0	346,625	16,100	69,364	64,544	53,426
480	4,204	3.15	15.40	0	630,602	8,041	107,210	99,456	82,074
960	2,150	2.48	11.95	0	781,181	9,164	134,373	121,967	93,164

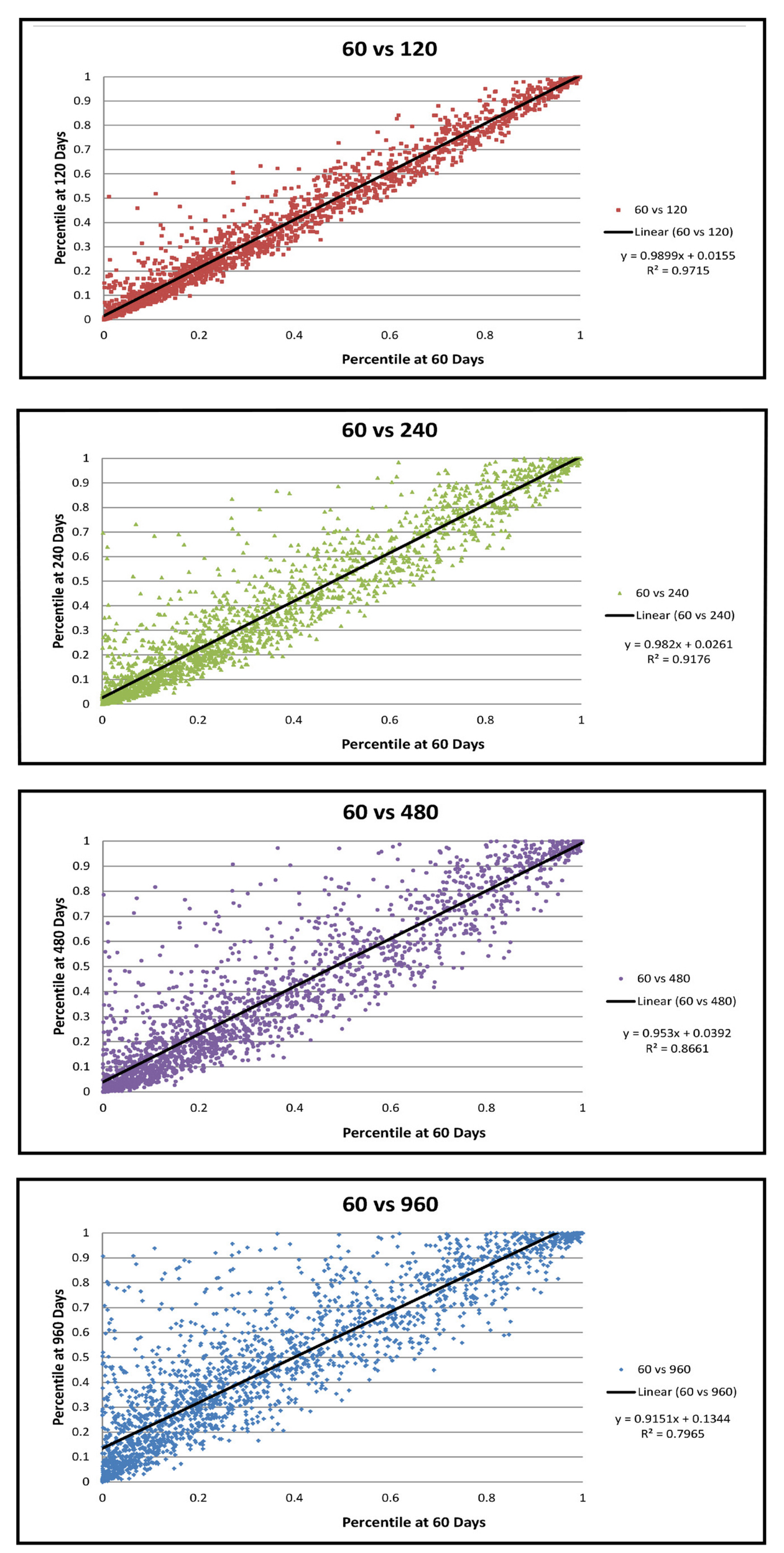

Figure 4. Scatter diagrams showing relationship between the Beta distribution defined decimal percentile score at 60 days production versus 120, 240, 480 and 960 days production.

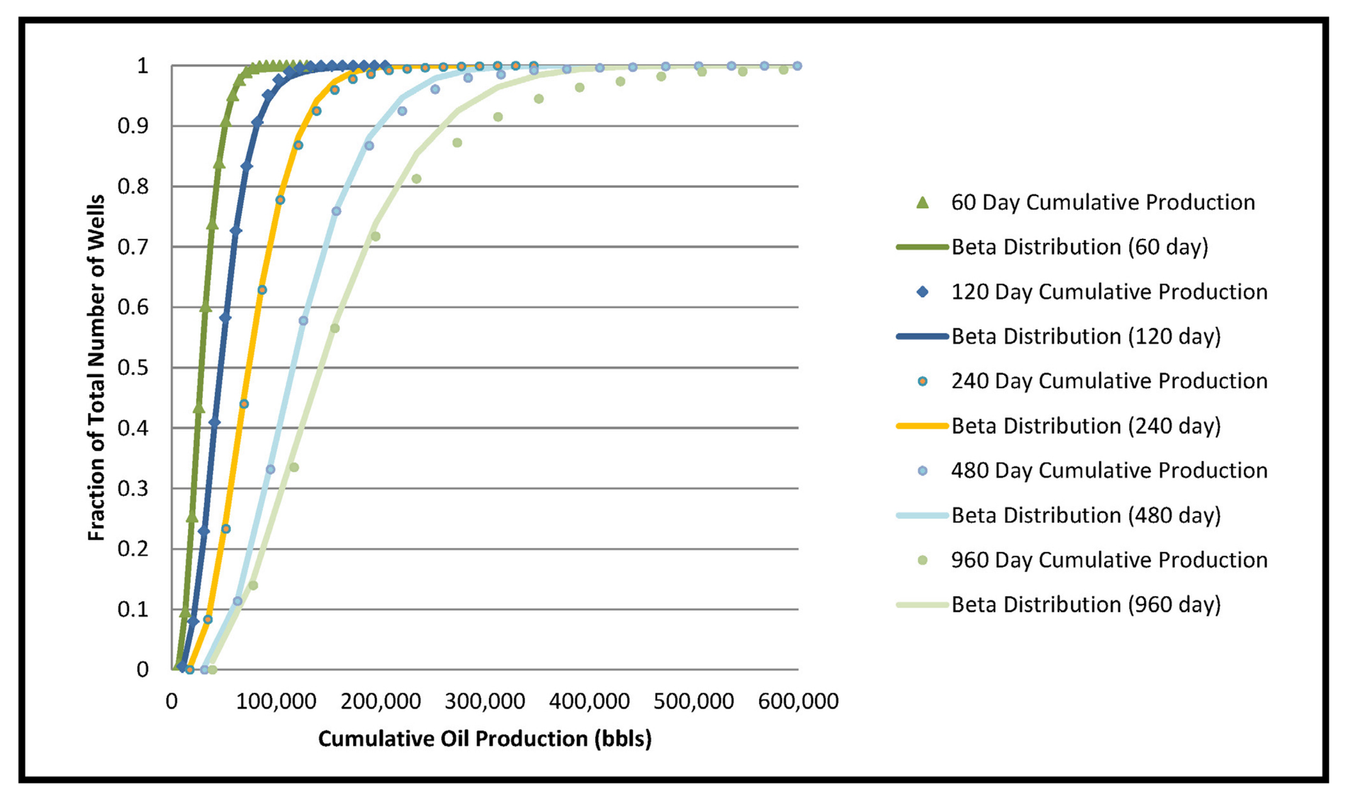

Figure 5. Graph showing the observed (symbols) and Beta distribution predicted decimal percentile ranking (line) versus the corresponding cumulative oil production (in barrels). The time intervals used are 60 (dark green), 120 (dark blue), 240 (yellow), 480 (light blue) and 960 (light green) days.

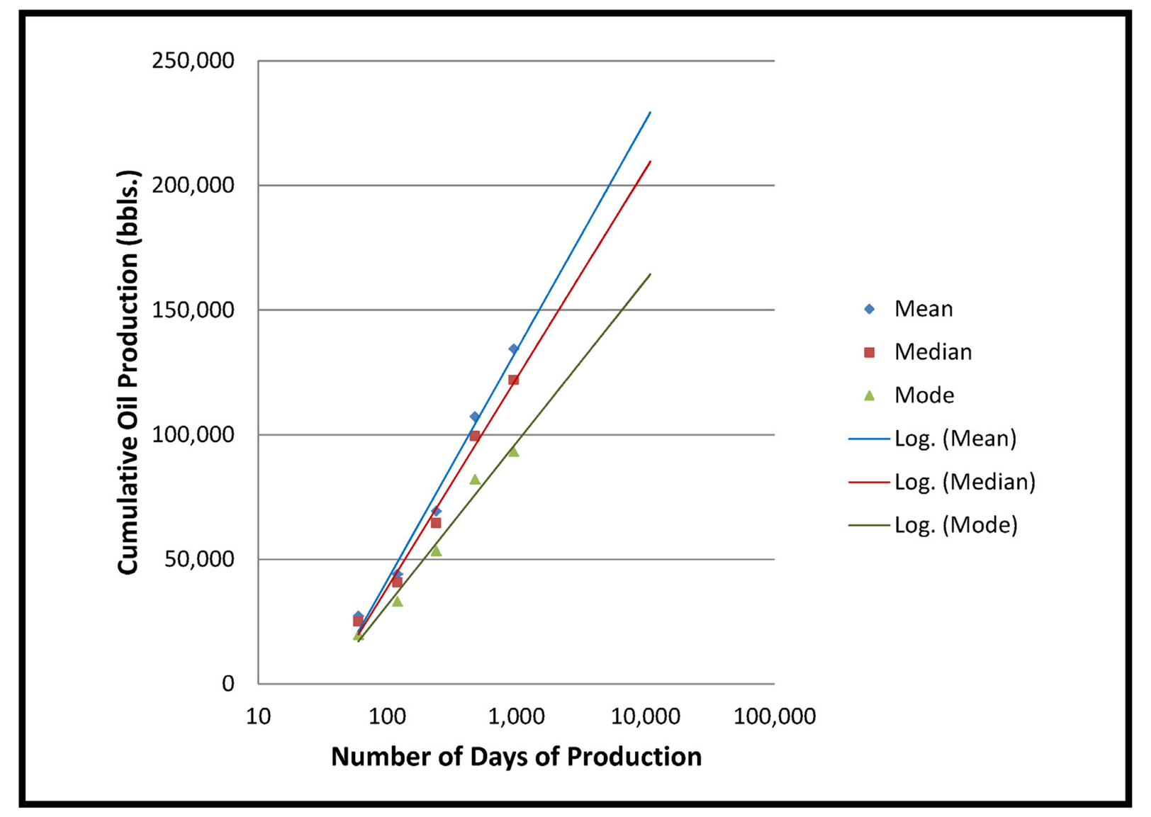

Figure 6. Semi-logarithmic plot of the mean, median and mode of the Beta distributions fit to the production data shown in Figure 3. The solid lines are obtained by regression and are extrapolated to 10,000 days (27.4 years) production.