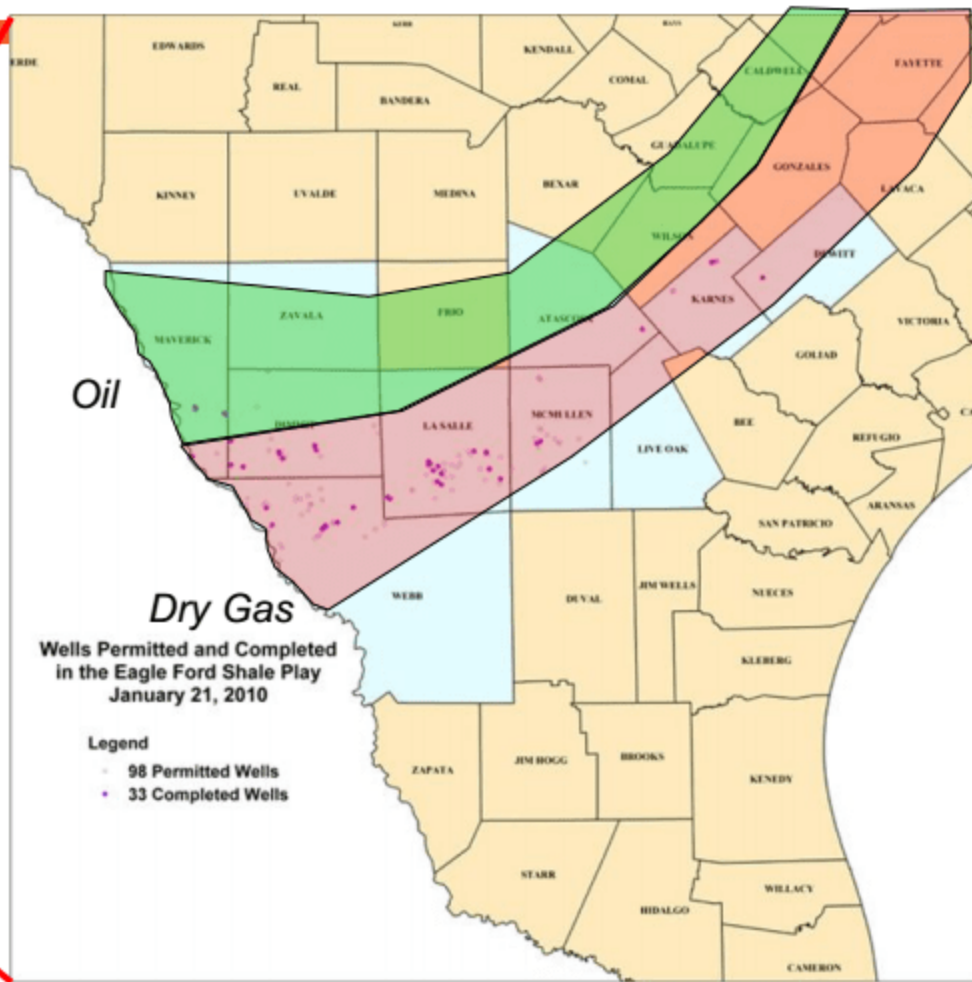


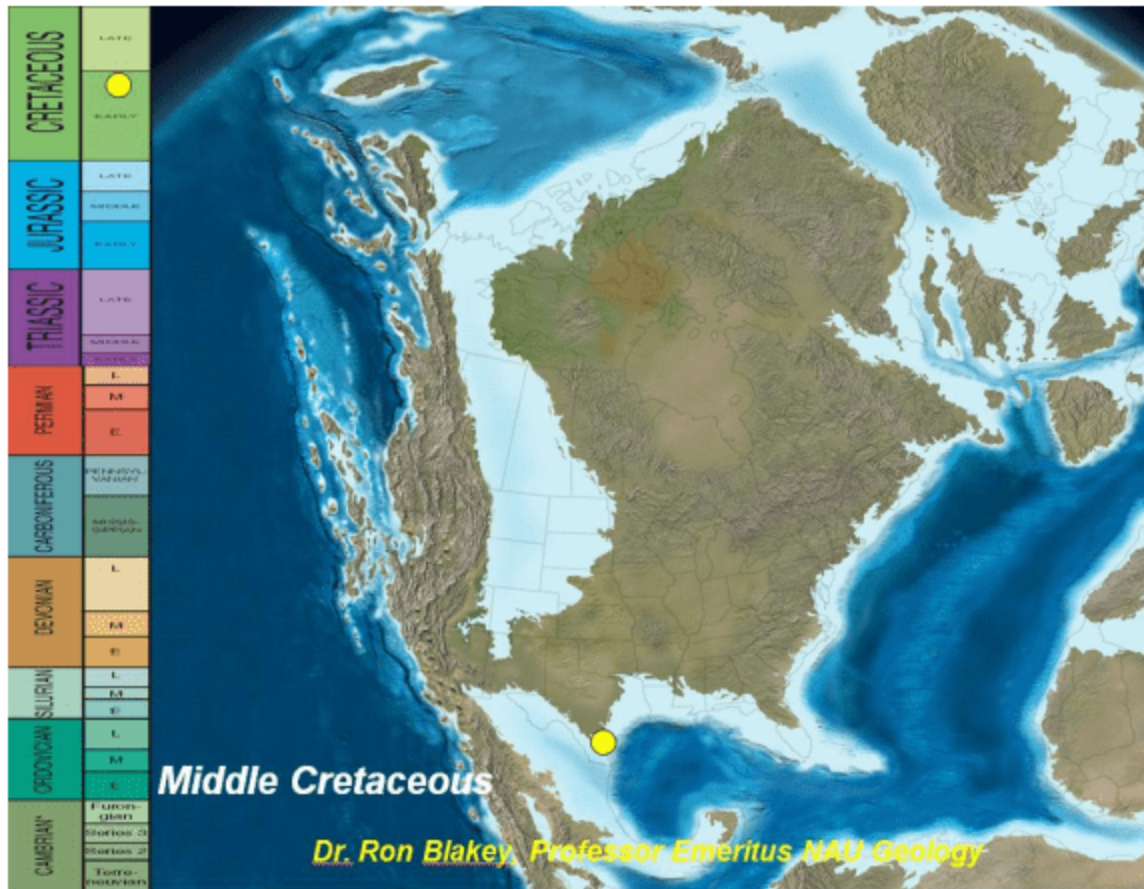
Eagle Ford Shale Case Study

Transform Reservoir Analytics

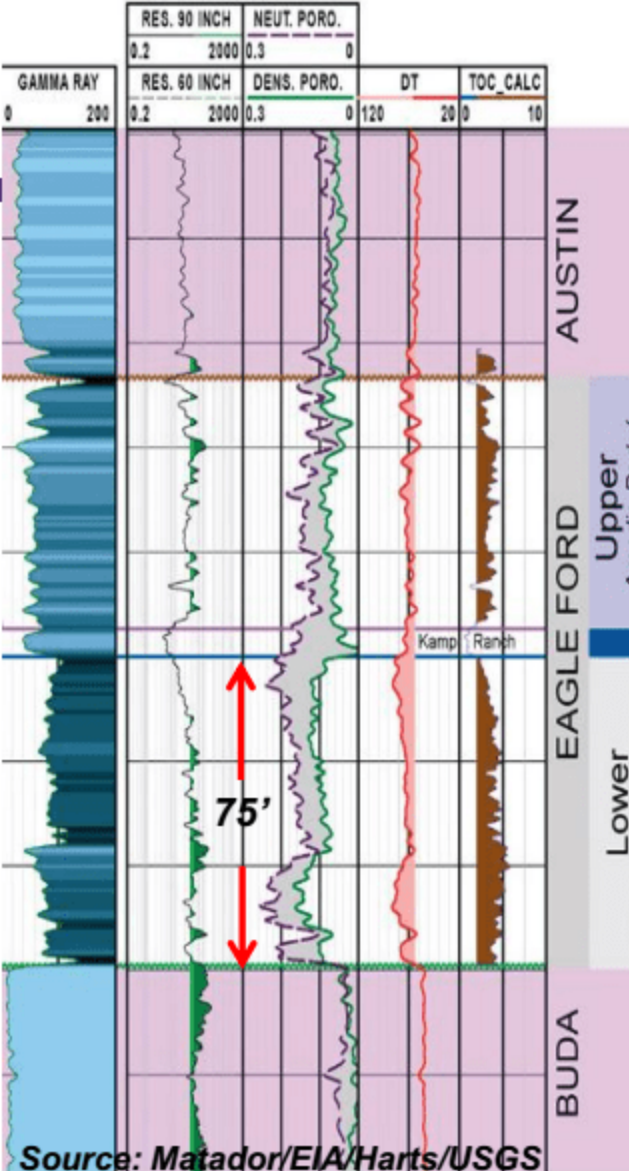
Eagle Ford Location



Eagle Ford Paleo History



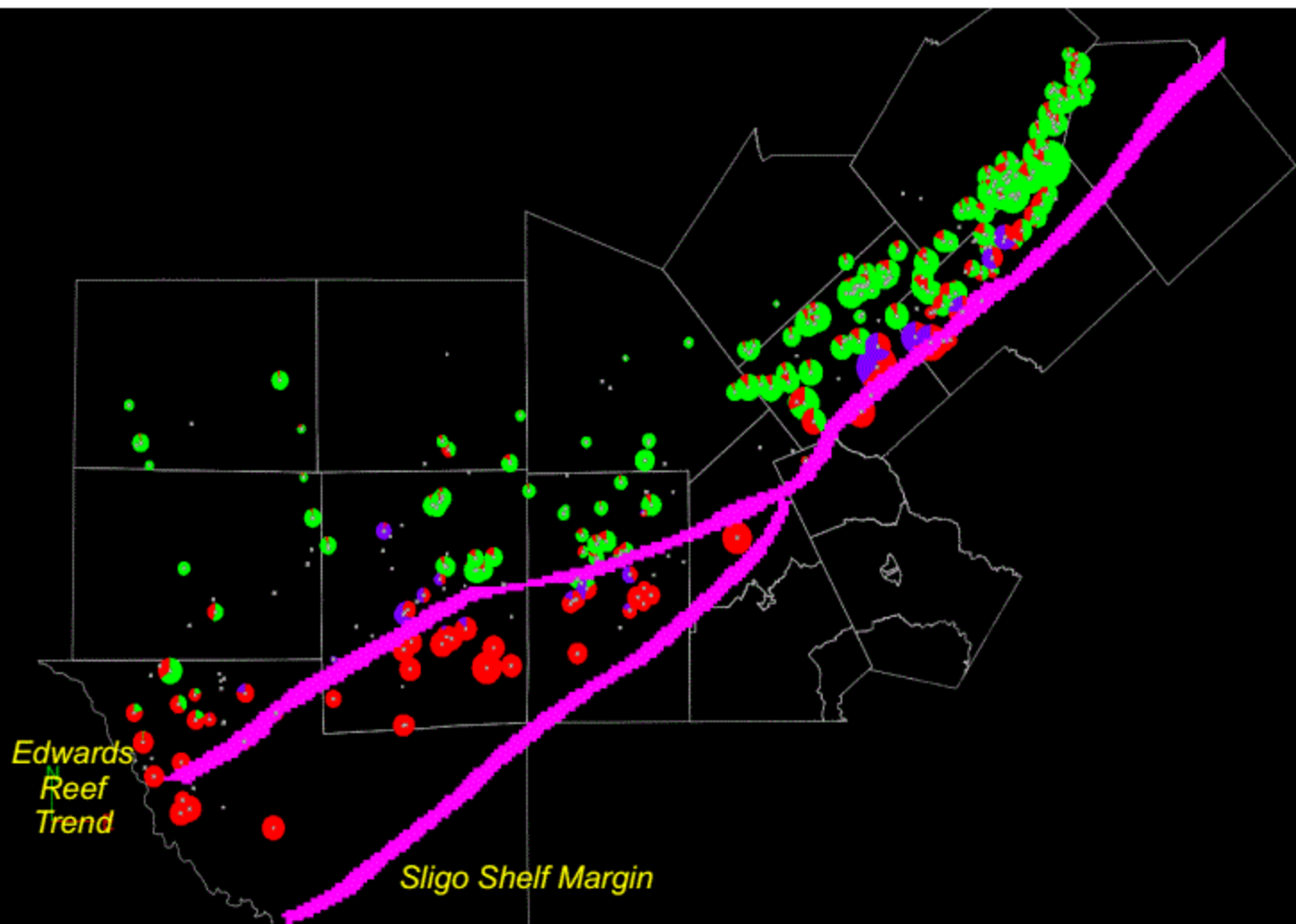
Eagle Ford Geologic Details



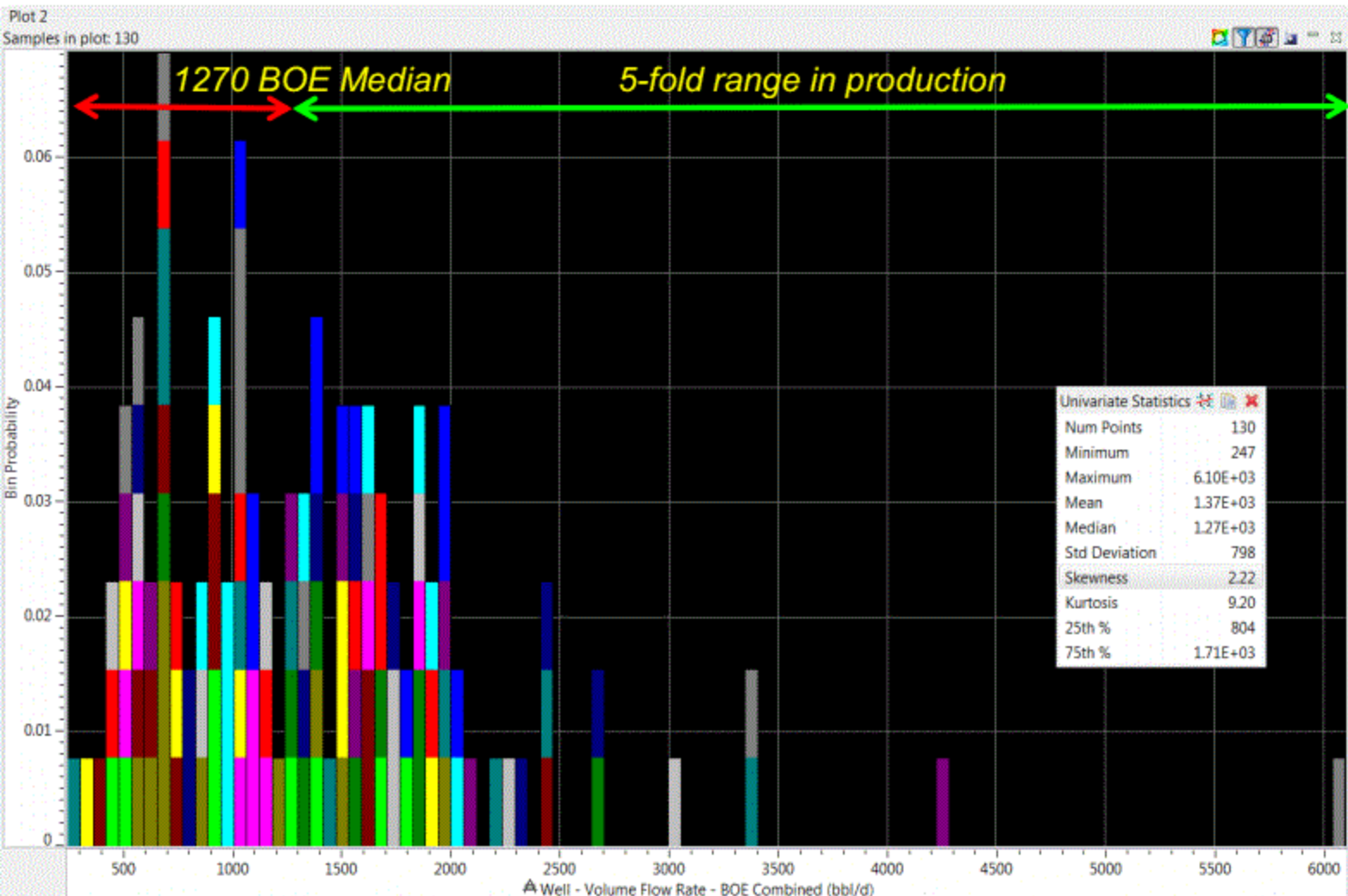
Geologic Age	<i>Eagle Ford</i>
Lithology	Calcareous shale
Total Area Size (sq mi)	1350
Total Gas (tcf)	84
GIP (bcf/sq mi)	200
Producible Gas (tcf)	9 (3 BBOE)
Depth (feet)	11500
Thickness (feet)	250
Hor Well Cost (\$M)	4.8
Average EUR	2-6
Pressure (psi)	5200
Temperature (F)	335
Ro	1.5
TOC (%)	4.5
Porosity (%)	4-10
Matrix Permeability (nD)	100-1500
Pressure Gradient (psi/ft)	0.65
Clay Content (%)	8
Adsorbed Gas (%)	8

Source: Matador/EIA/Harts/USGS

Eagle Ford Oil/Gas/Condensate Well Production



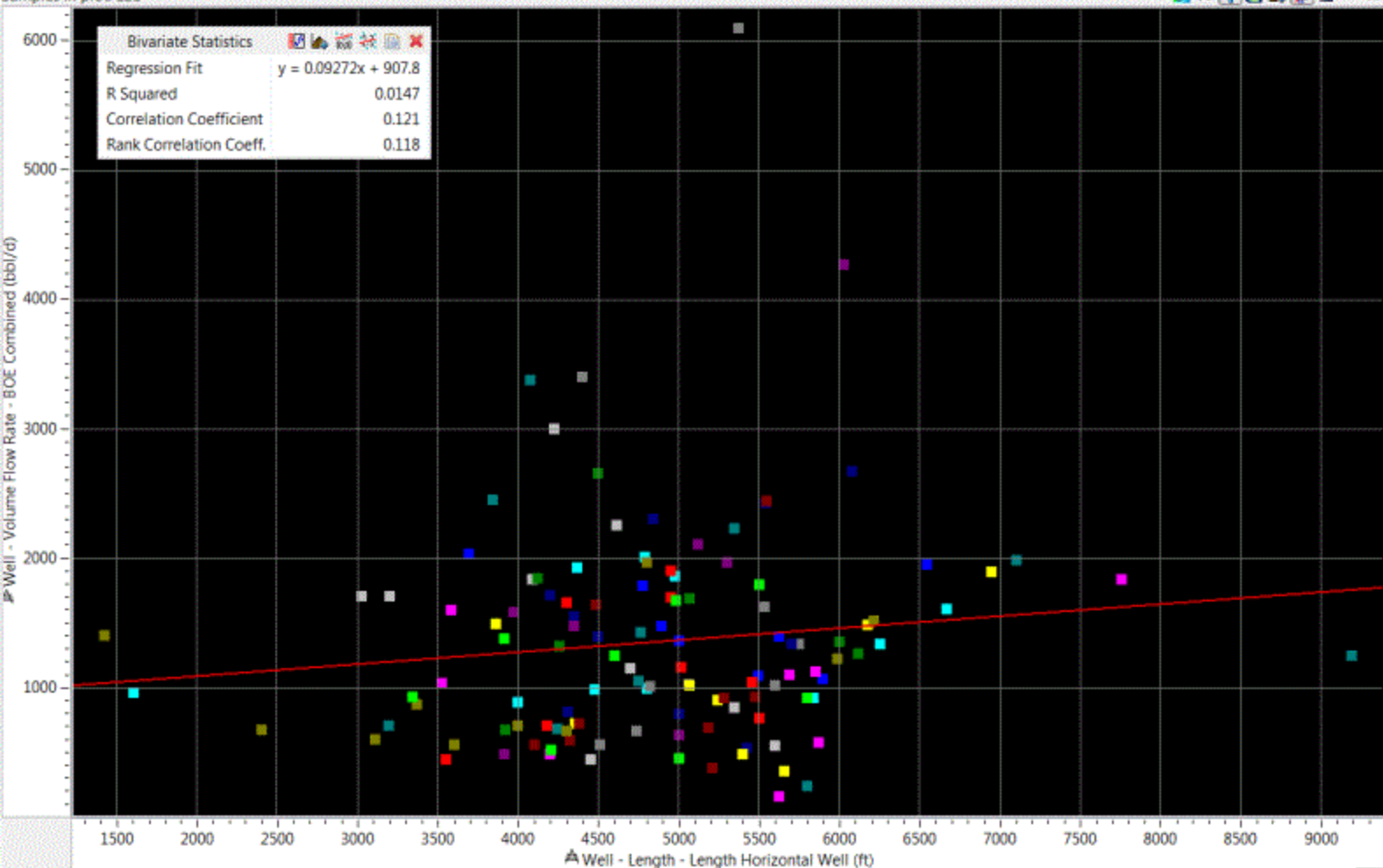
Well IP (BOE) – Not a “factory”



Production versus Well Length

Plot 3

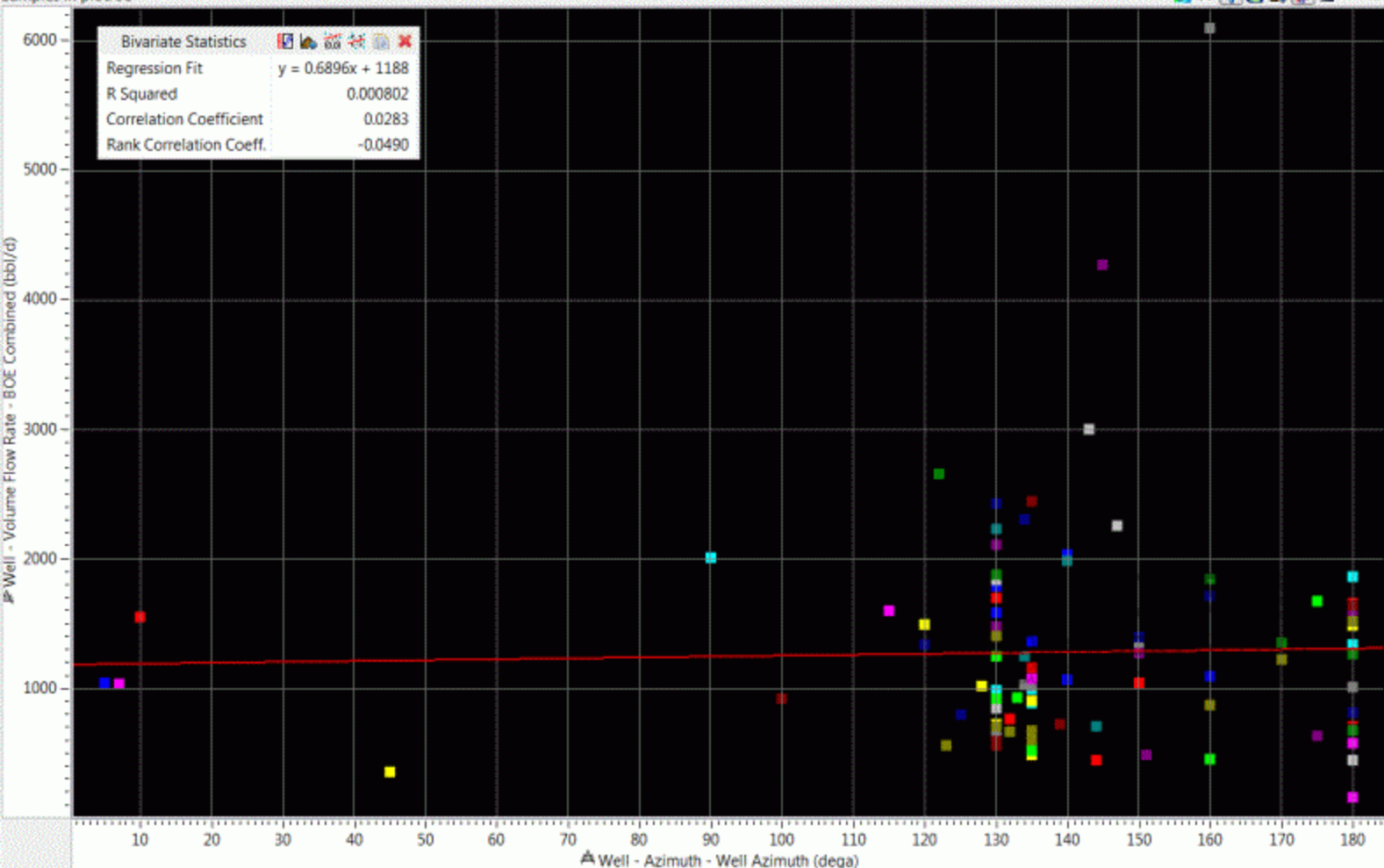
Samples in plot: 121



Production versus Wellbore Azimuth

Plot 3

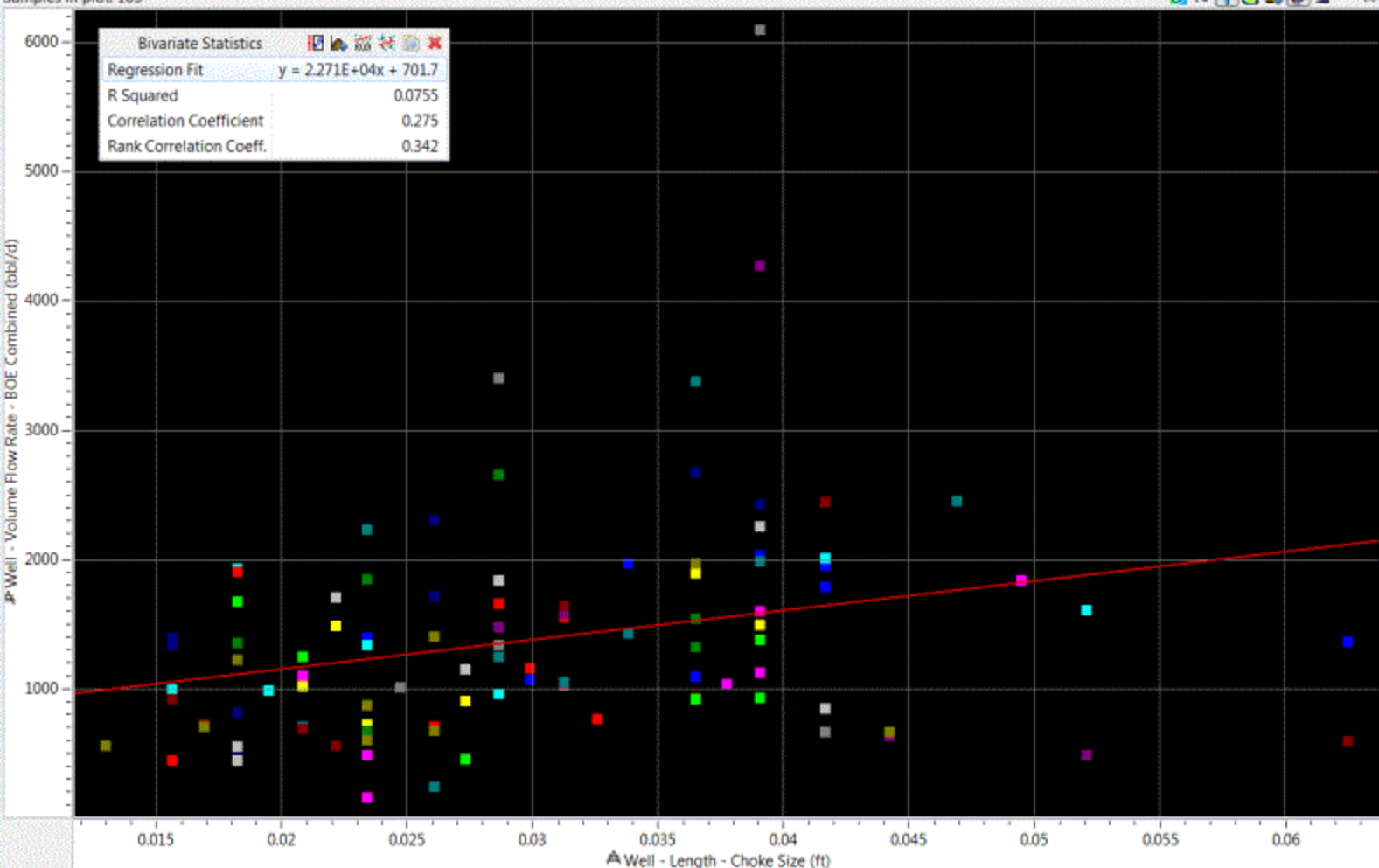
Samples in plot: 98



Production versus Choke Size

Plot 3

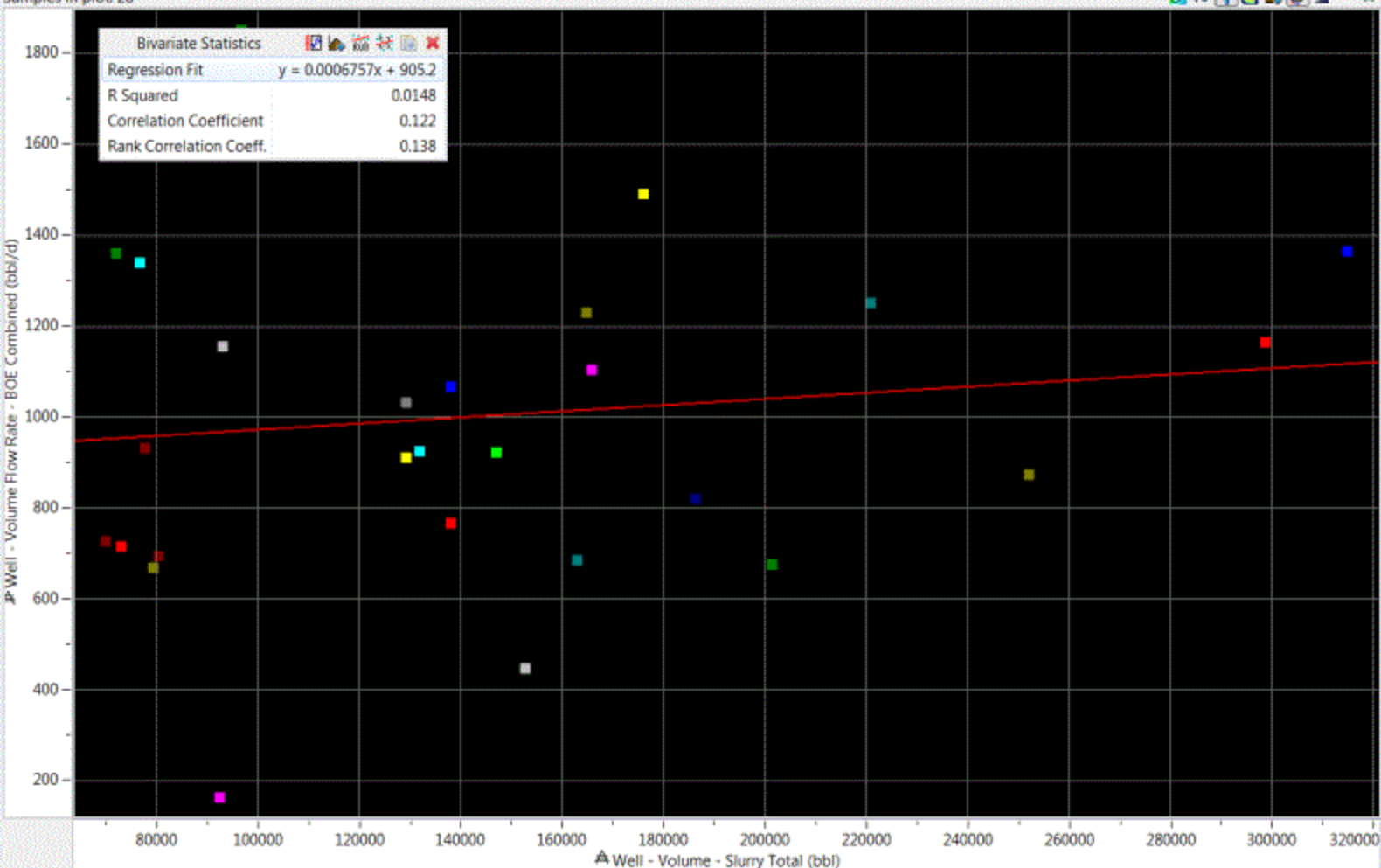
Samples in plot: 103



Production versus Total Fluid Volume

Plot 3

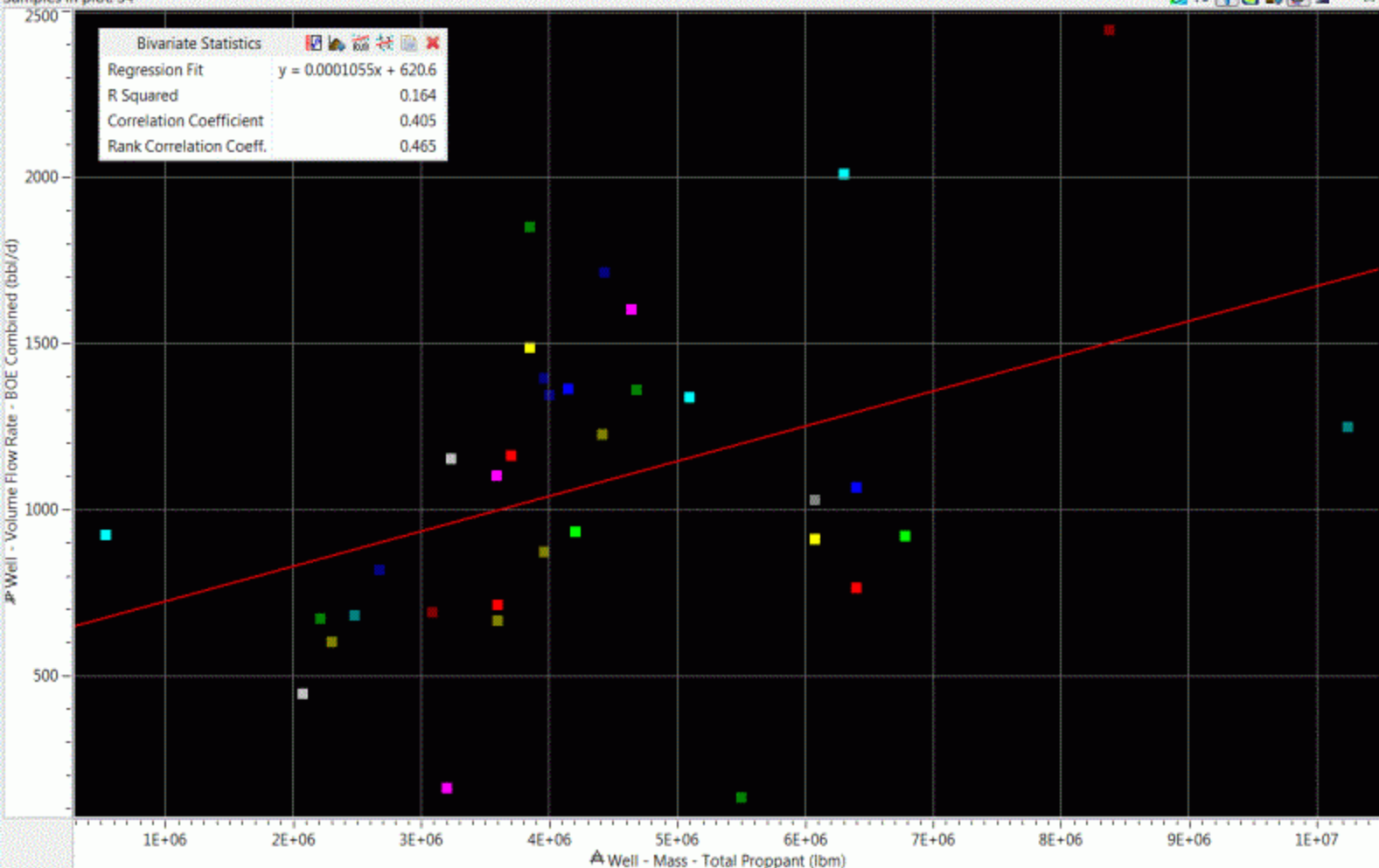
Samples in plot: 28



Production versus Total Proppant

Plot 3

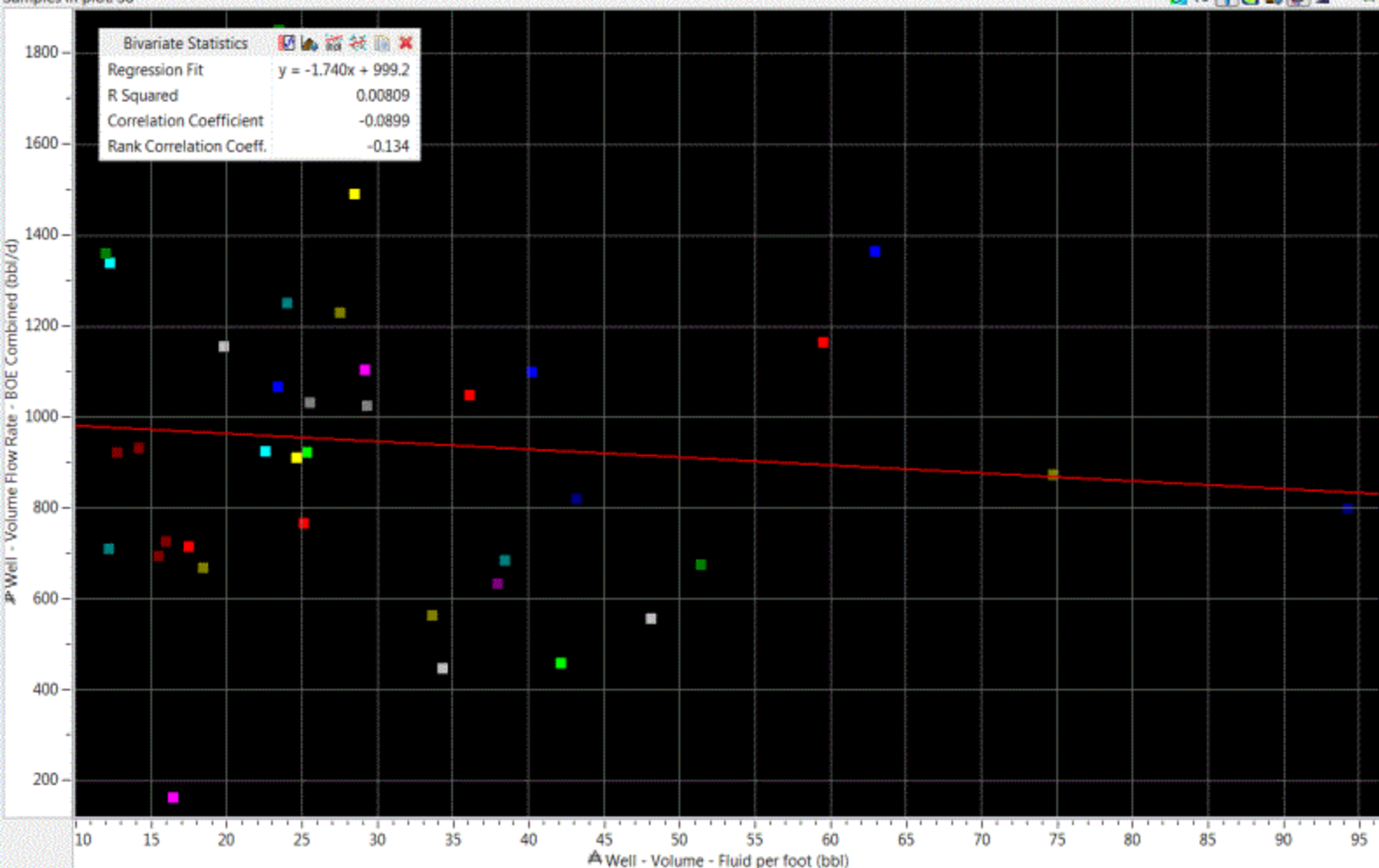
Samples in plot: 34



Production versus fluid/foot

Plot 3

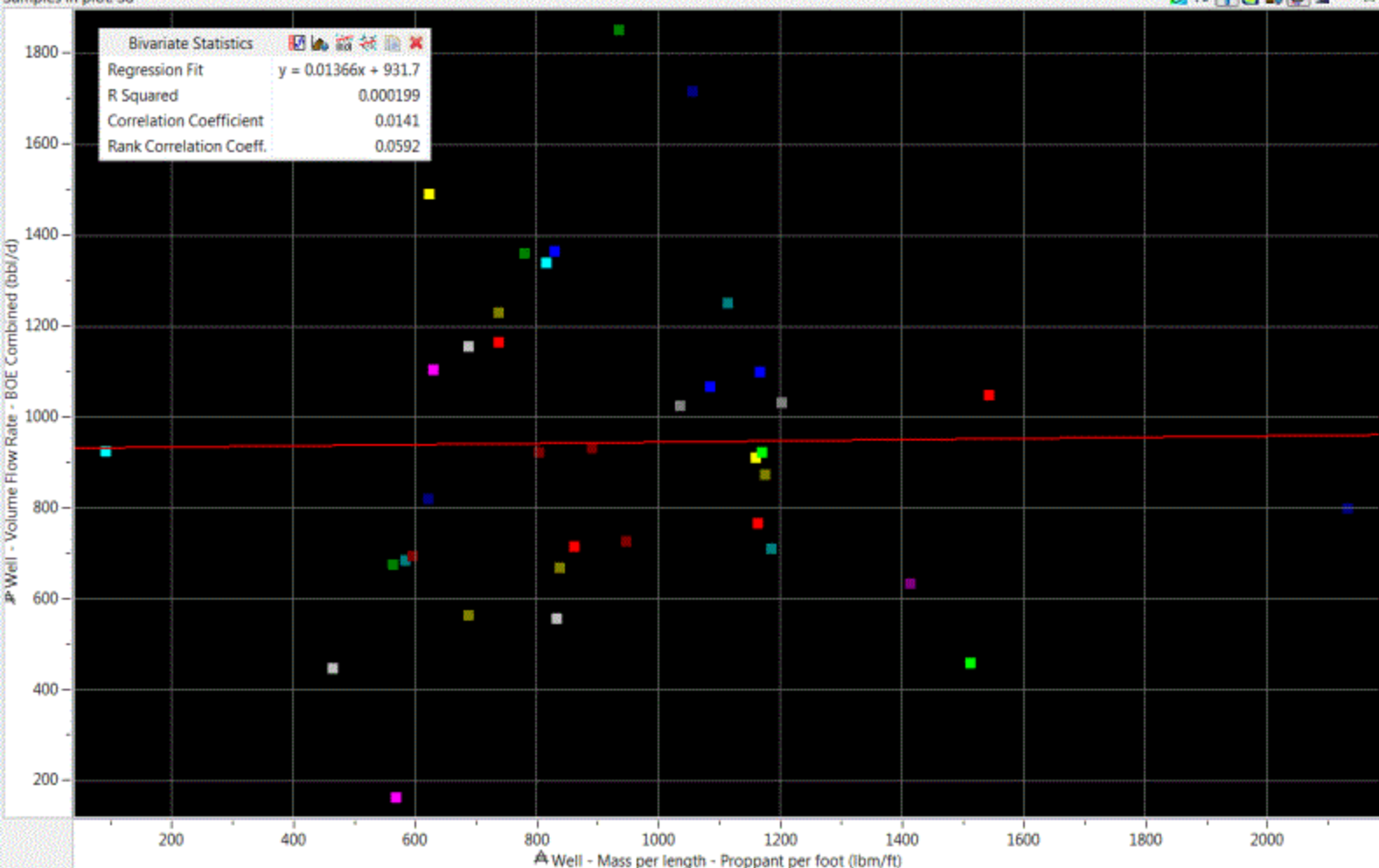
Samples in plot: 38



Production versus Proppant/foot

Plot 3

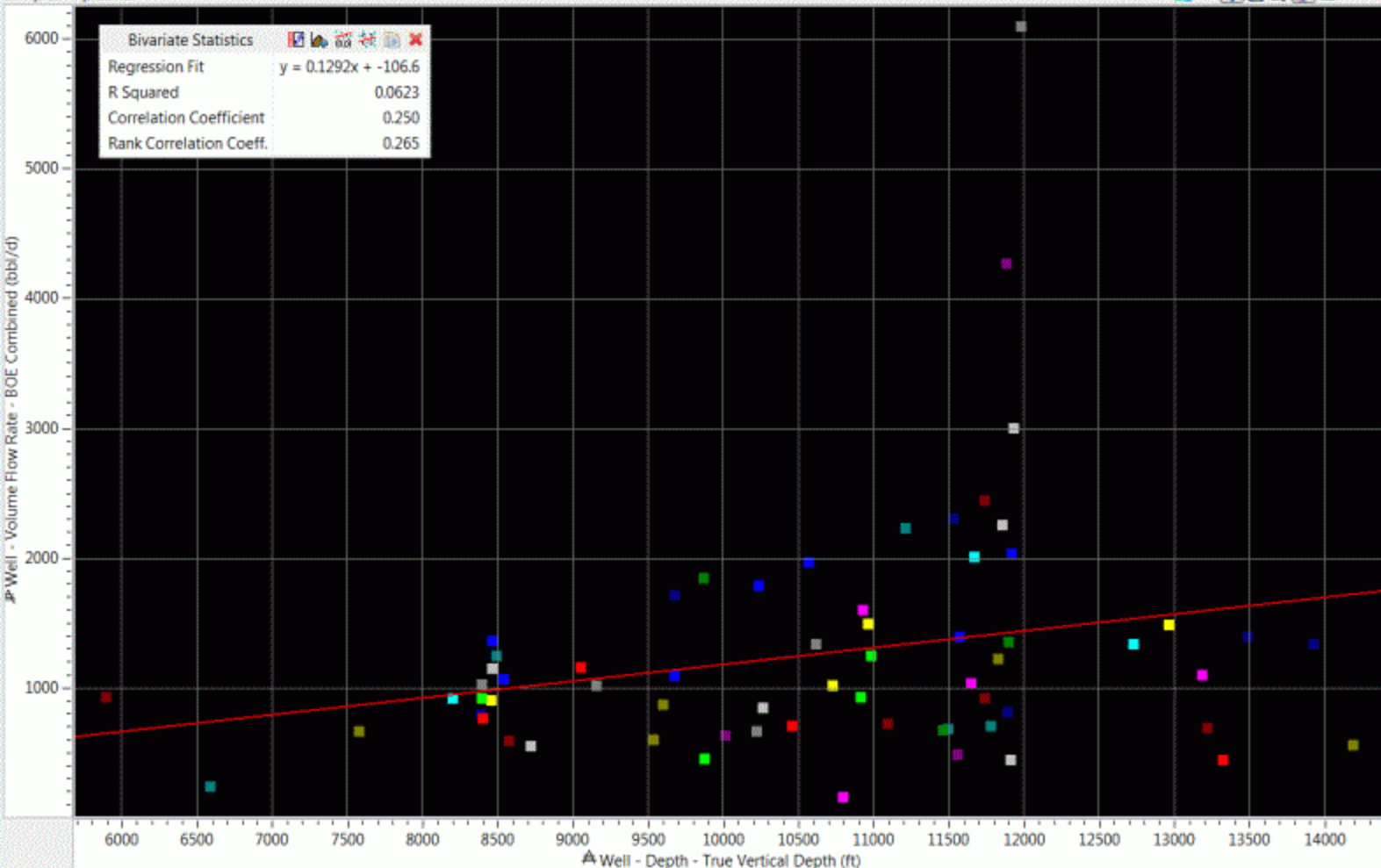
Samples in plot: 38



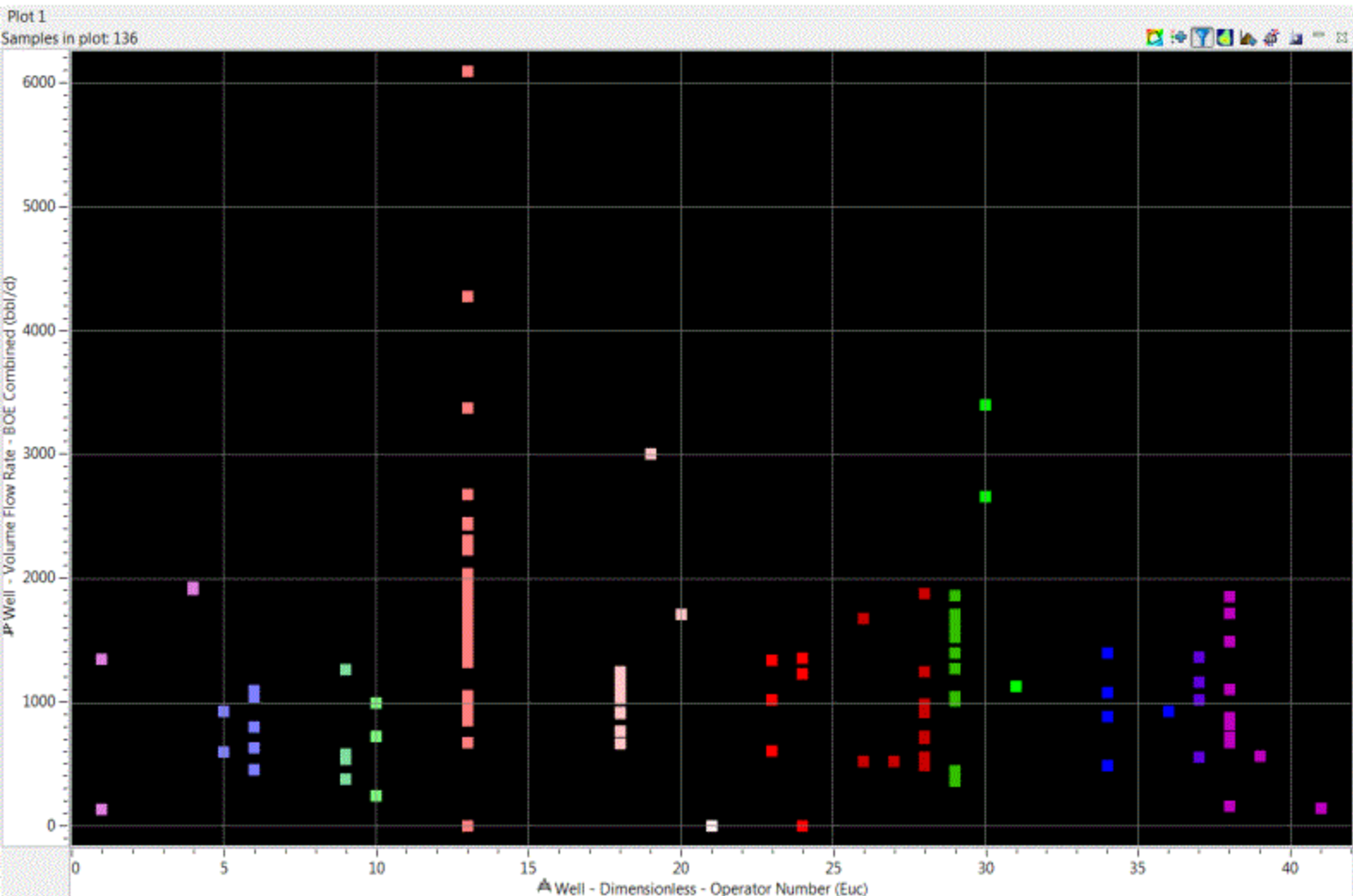
Prediction versus Depth

Plot 3

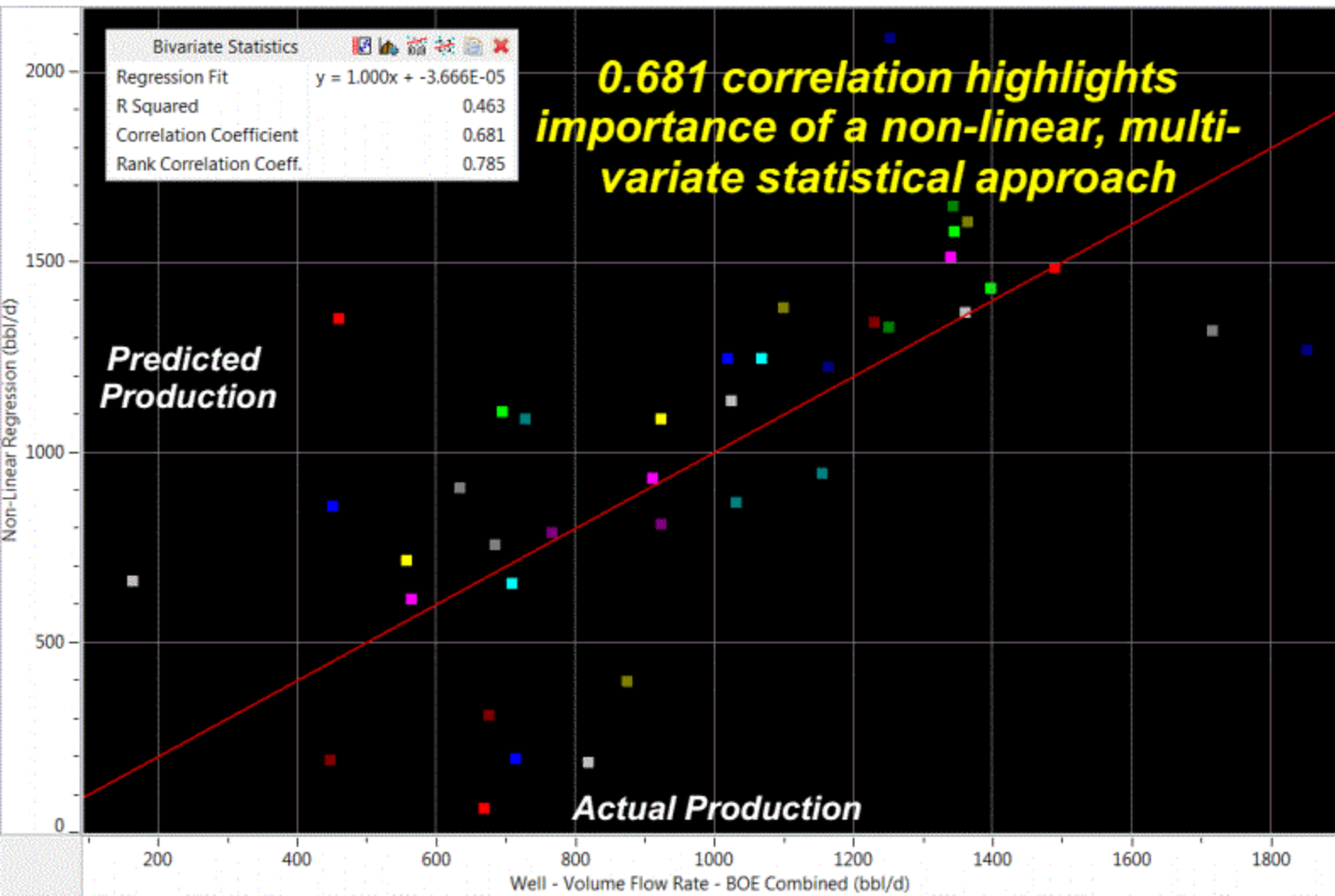
Samples in plot: 65



Production versus Operator



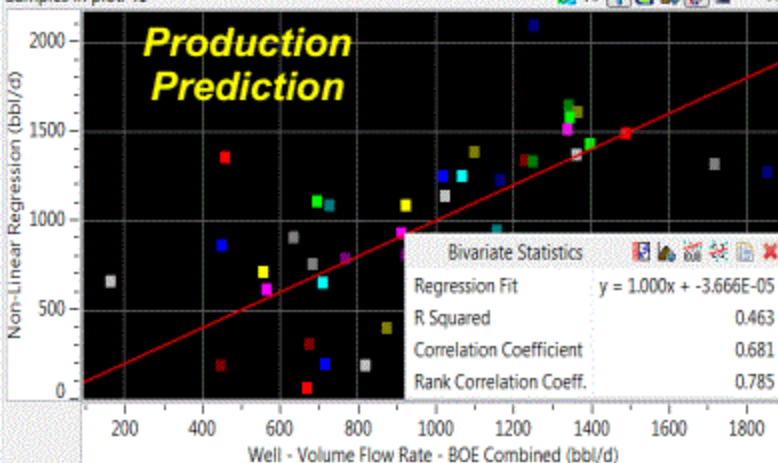
Non-linear Production Prediction Model



Influence of Well Engineering on Production

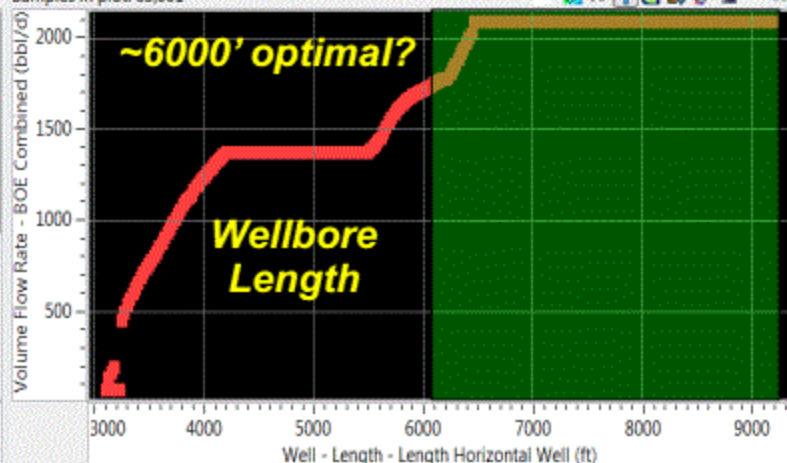
Well - Volume Flow Rate - BOE Combined vs Non-Linear Regression

Samples in plot: 41



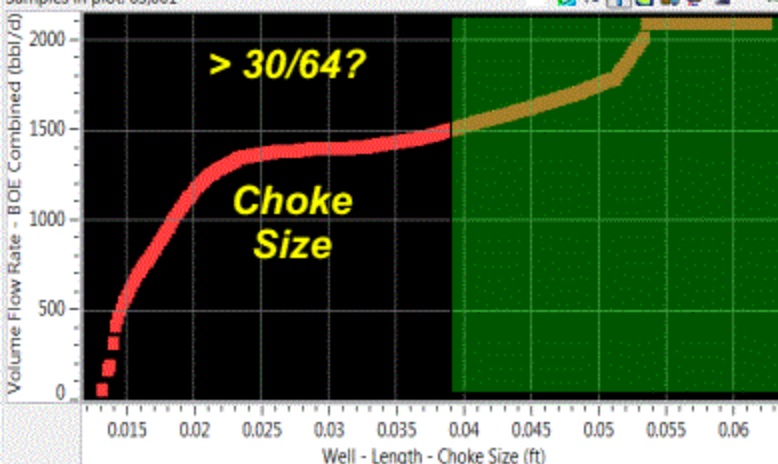
Well - Length - Length Horizontal Well impact on Well - Volume Flow Rate - BOE Combined

Samples in plot: 63,001



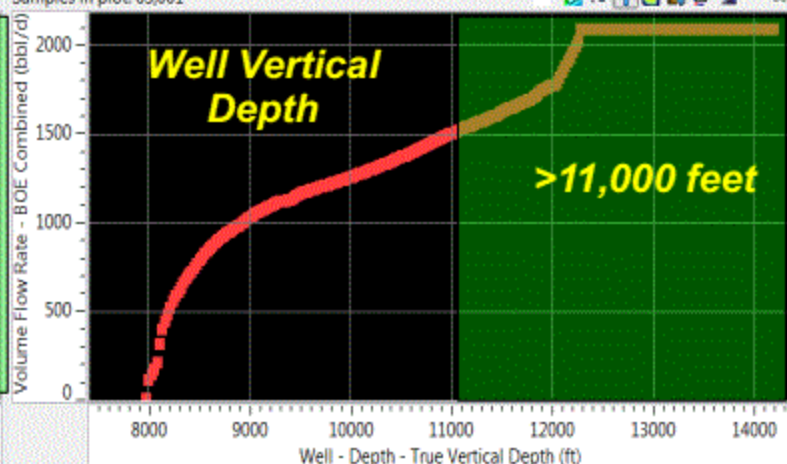
Well - Length - Choke Size impact on Well - Volume Flow Rate - BOE Combined

Samples in plot: 63,001

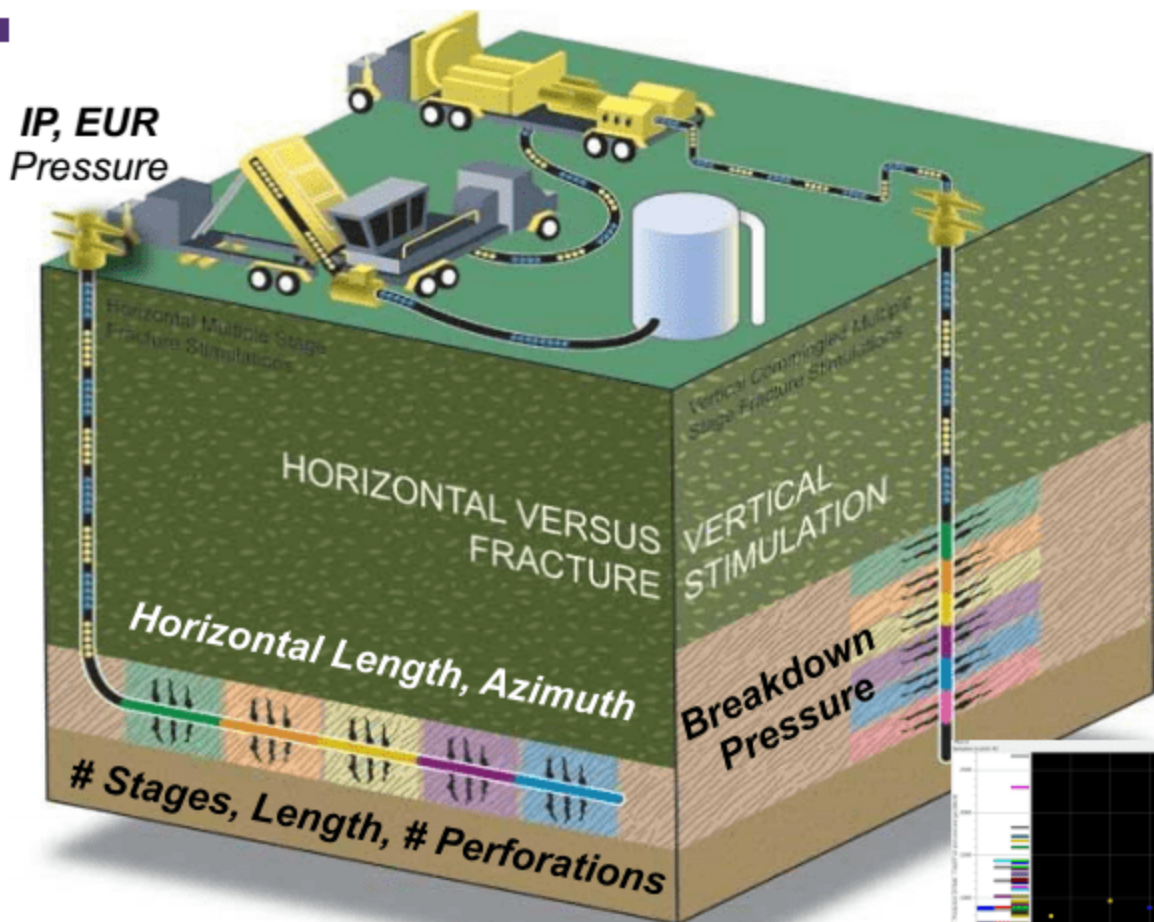


Well - Depth - True Vertical Depth impact on Well - Volume Flow Rate - BOE Combined

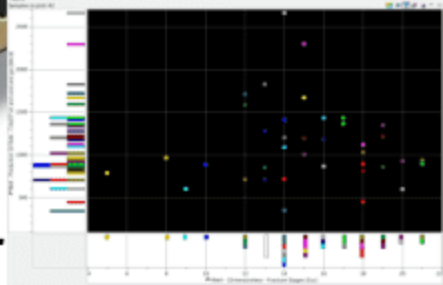
Samples in plot: 63,001



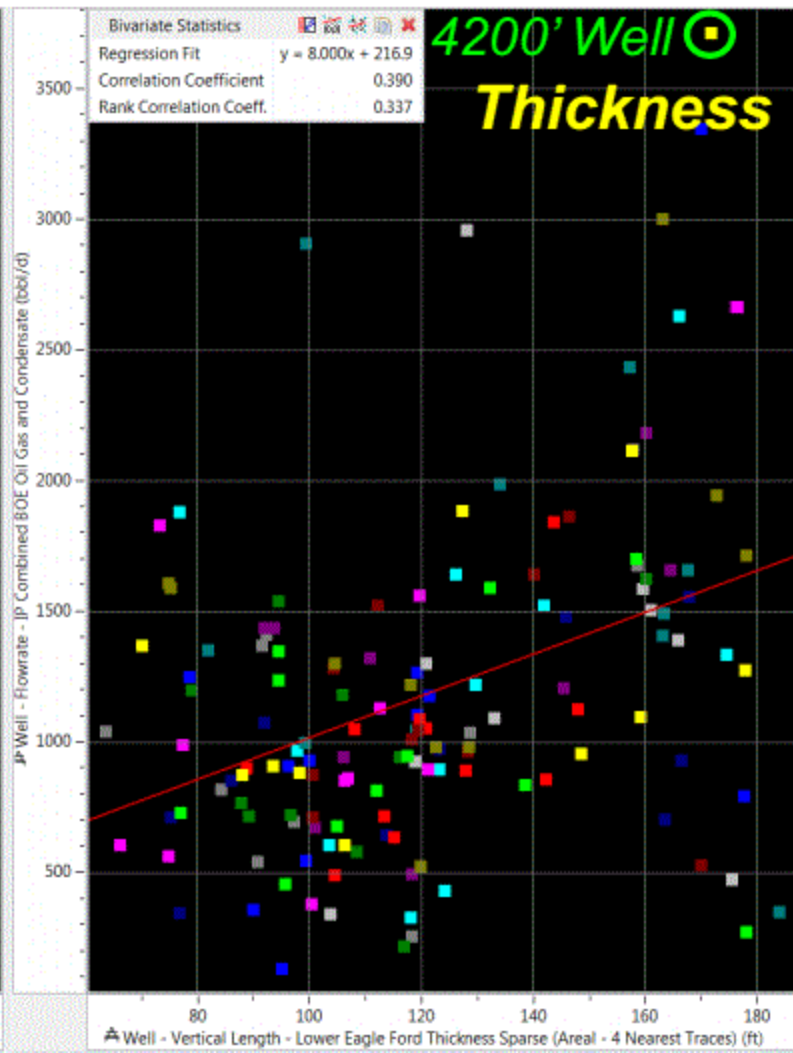
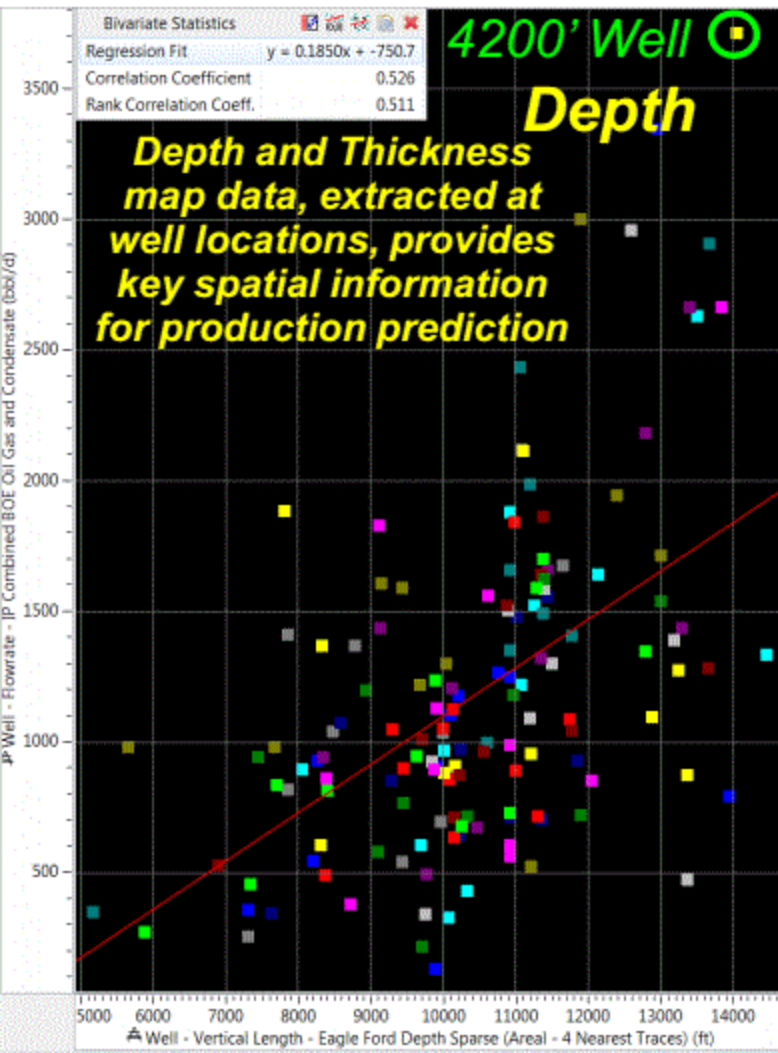
Completions drive Production!



But much more than completions...



Production and Extracted Depth and Thickness



Engineering and Geology Production Prediction

Select the type of statistical analysis

☐ Unsupervised Classification ☐ Hierarchical Classification ☐ Supervised Classification ☐ Linear Regression ☒ Non-Linear Regression

Regression Modeling Parameters

Variable Selection and Transforms

Use	Variable	Property Type	Linear	Monotonic	Higher Or...	Period
☒	Well - Flow...	Flowrate	☒	☒	☐	☐
☒	Well - Leng...	Length	☒	☒	☐	☐
☒	Well - Leng...	Length	☒	☒	☐	☐
☒	Well - Leng...	Length	☒	☒	☐	☐
☒	Well - Verti...	Vertical Length	☒	☒	☐	☐
☒	Well - Verti...	Vertical Length	☒	☒	☐	☐

Improved correlation (0.804) and better prediction of high producers highlights the importance of combining engineering and geologic data for production prediction.

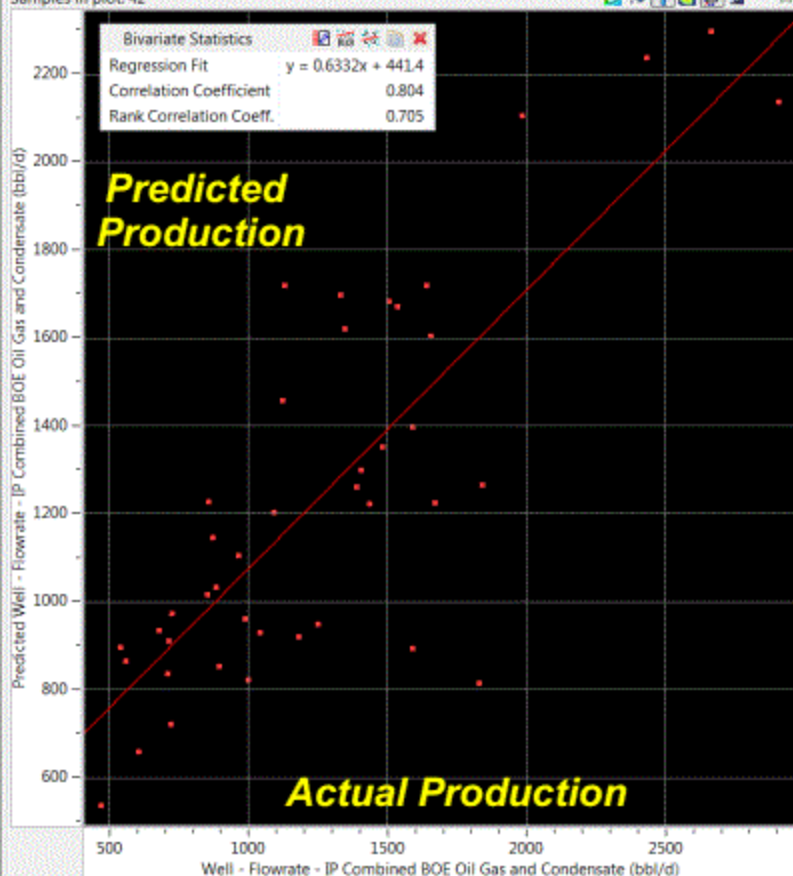
Opportunity for further increasing prediction accuracy with detailed spatial information, using seismic data

Variable	Sensitivity
Well - Length - Choke Size	0.2995
Well - Vertical Length - Eagle Ford Depth Sparse (Areal - 4 Nearest Traces)	0.0725
Well - Vertical Length - Lower Eagle Ford Thickness Sparse (Areal - 4 Nearest Traces)	0.0208
Well - Length - HORIZONTAL WELLBORE LENGTH (Cal)	0.0153
Well - Length - SEG Average Stage Length	0.0076

Find (Ctrl+F)

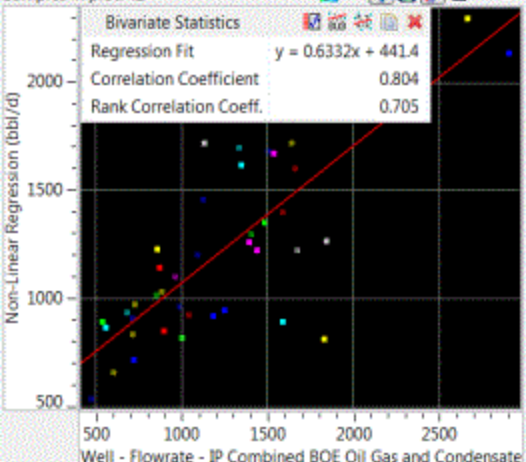
Cross-Validation Options

Well - Flowrate - IP Combined BOE Oil Gas and Condensate vs Predicted Well - IP Combined BOE Oil Gas and Condensate
Samples in plot: 42

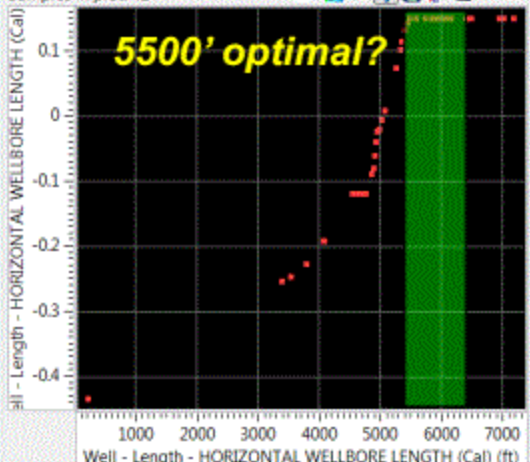


Engineering and Geology Parameter Optimization

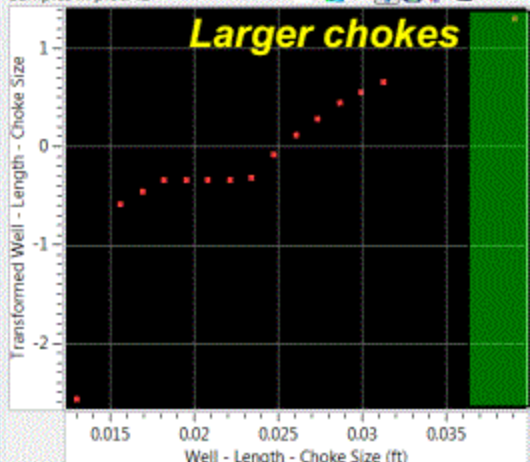
Well - Flowrate - IP Combined BOE Oil Gas and Condensate vs Non-Linear Regression (bbl/d)
Samples in plot: 42



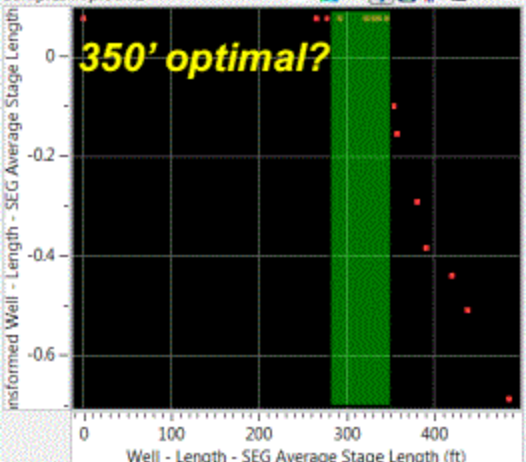
Well - Length - HORIZONTAL WELLBORE LENGTH (Cal) vs Transform
Samples in plot: 42



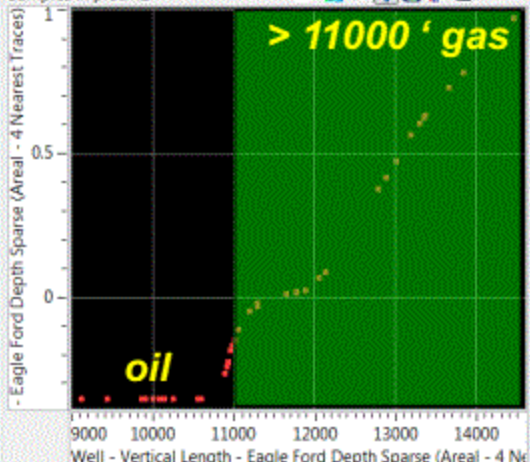
Well - Length - Choke Size vs Transformed Well - Length - Choke Size
Samples in plot: 42



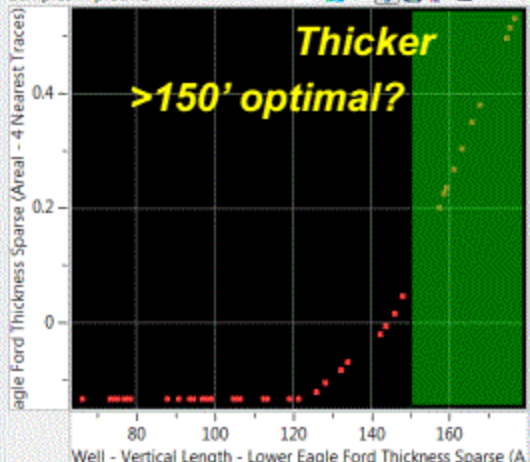
Well - Length - SEG Average Stage Length vs Transformed Well - Length - SEG Average Stage Length
Samples in plot: 42



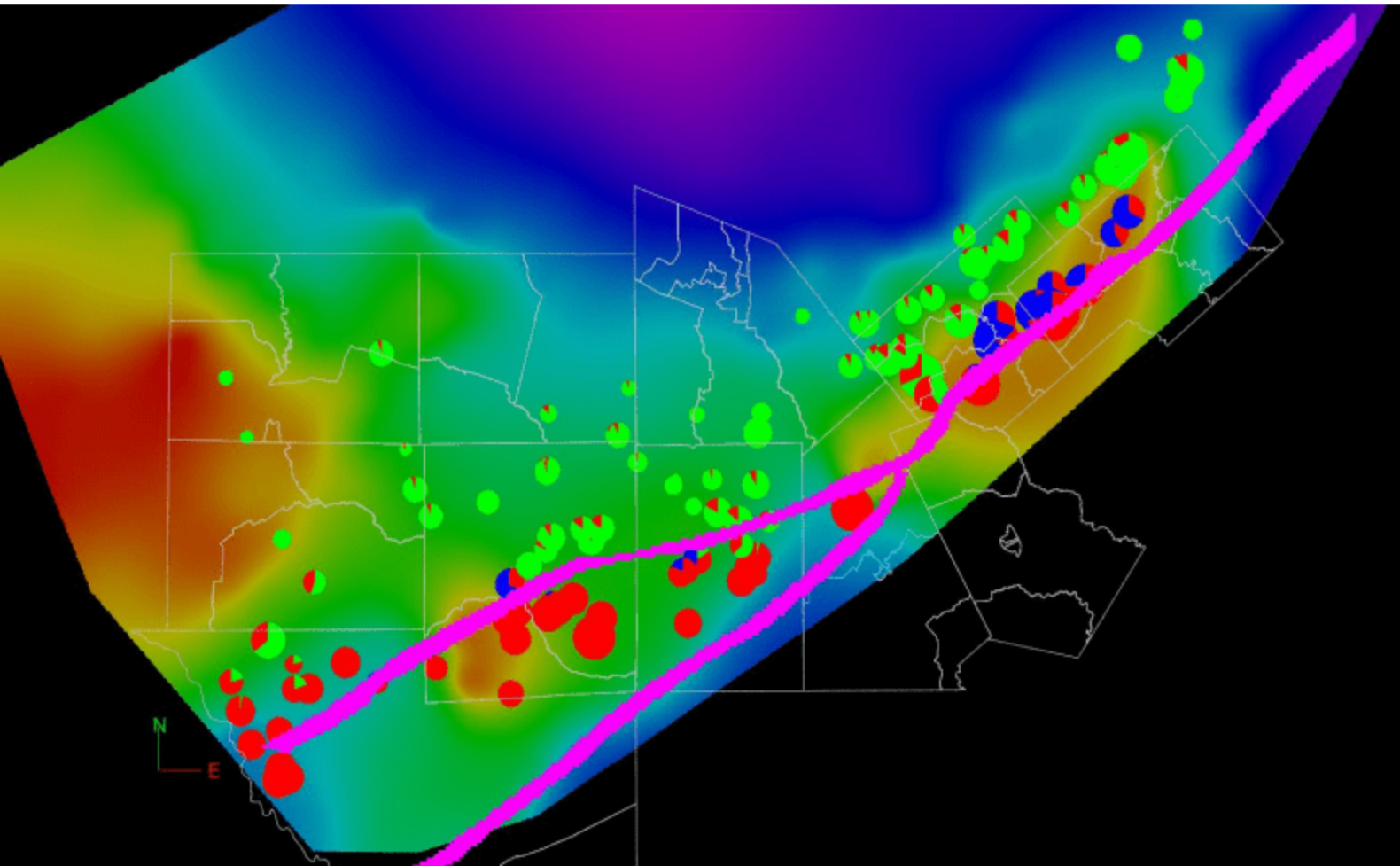
Well - Vertical Length - Eagle Ford Depth Sparse (Areal - 4 Nearest Tr
Samples in plot: 42



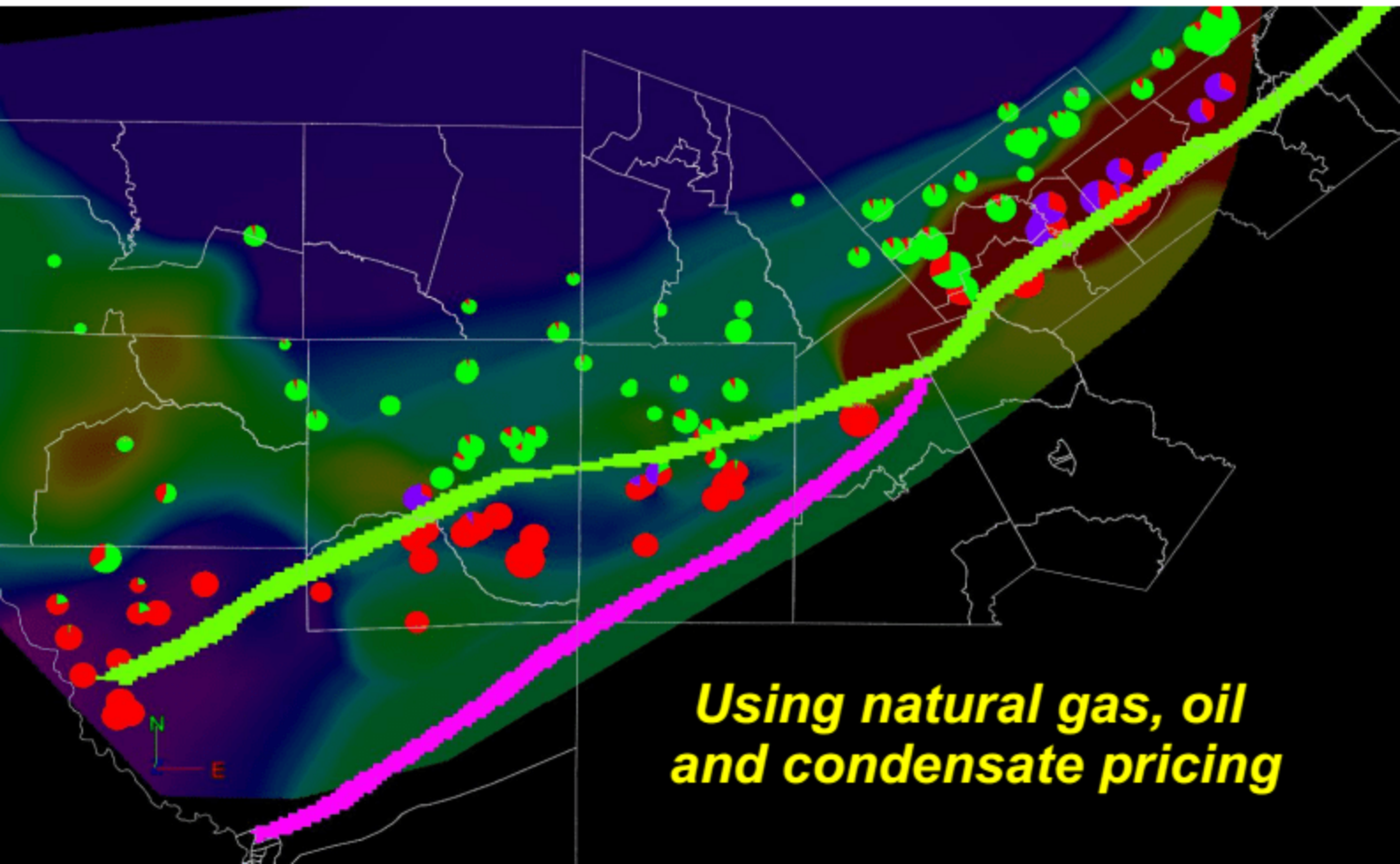
Well - Vertical Length - Lower Eagle Ford Thickness Sparse (Areal - 4
Samples in plot: 42



Production Prediction – Eng/Geology

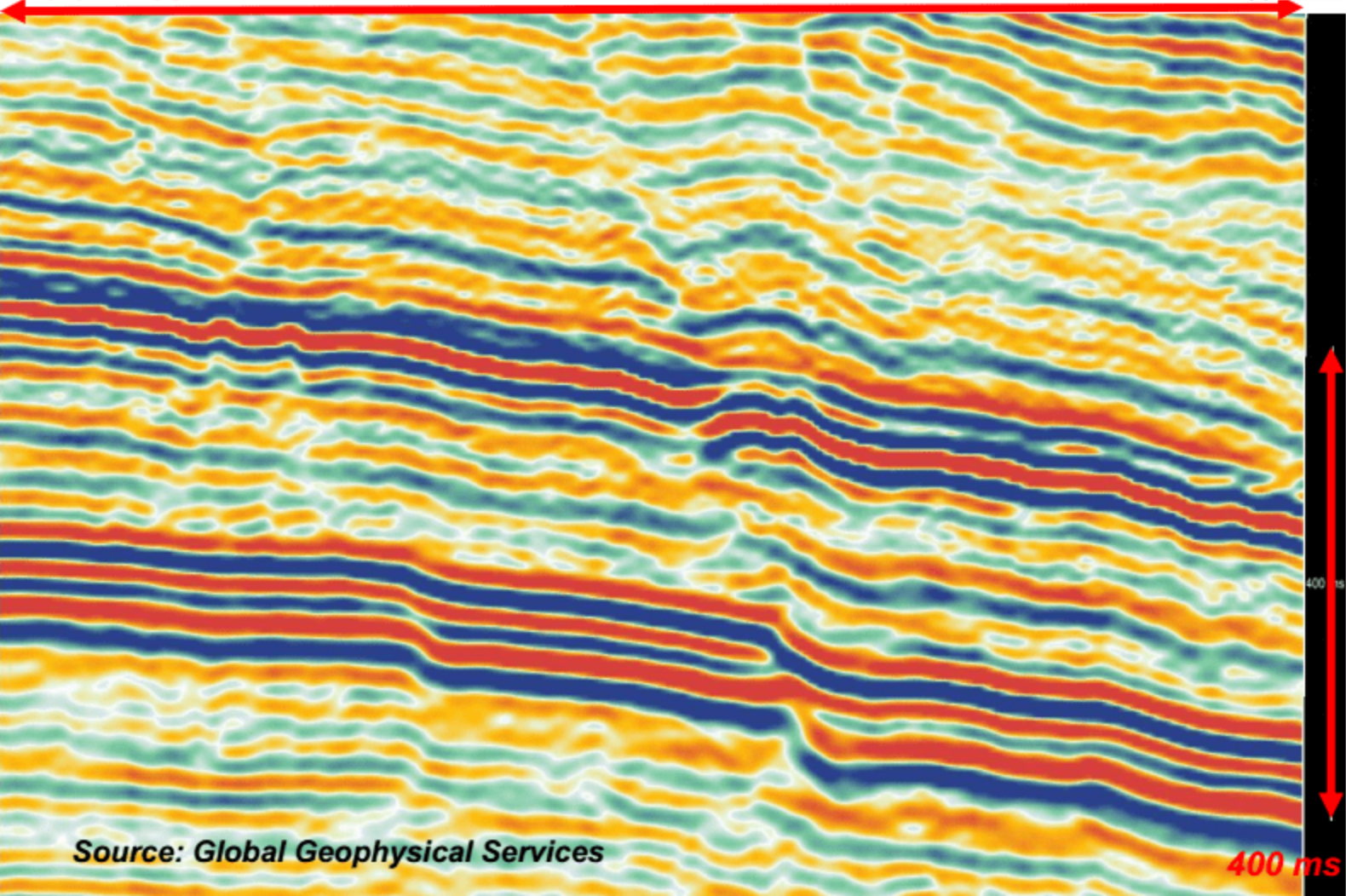


Eagle Ford Economic Sweetspot Map



Eagle Ford Seismic

5.0 miles

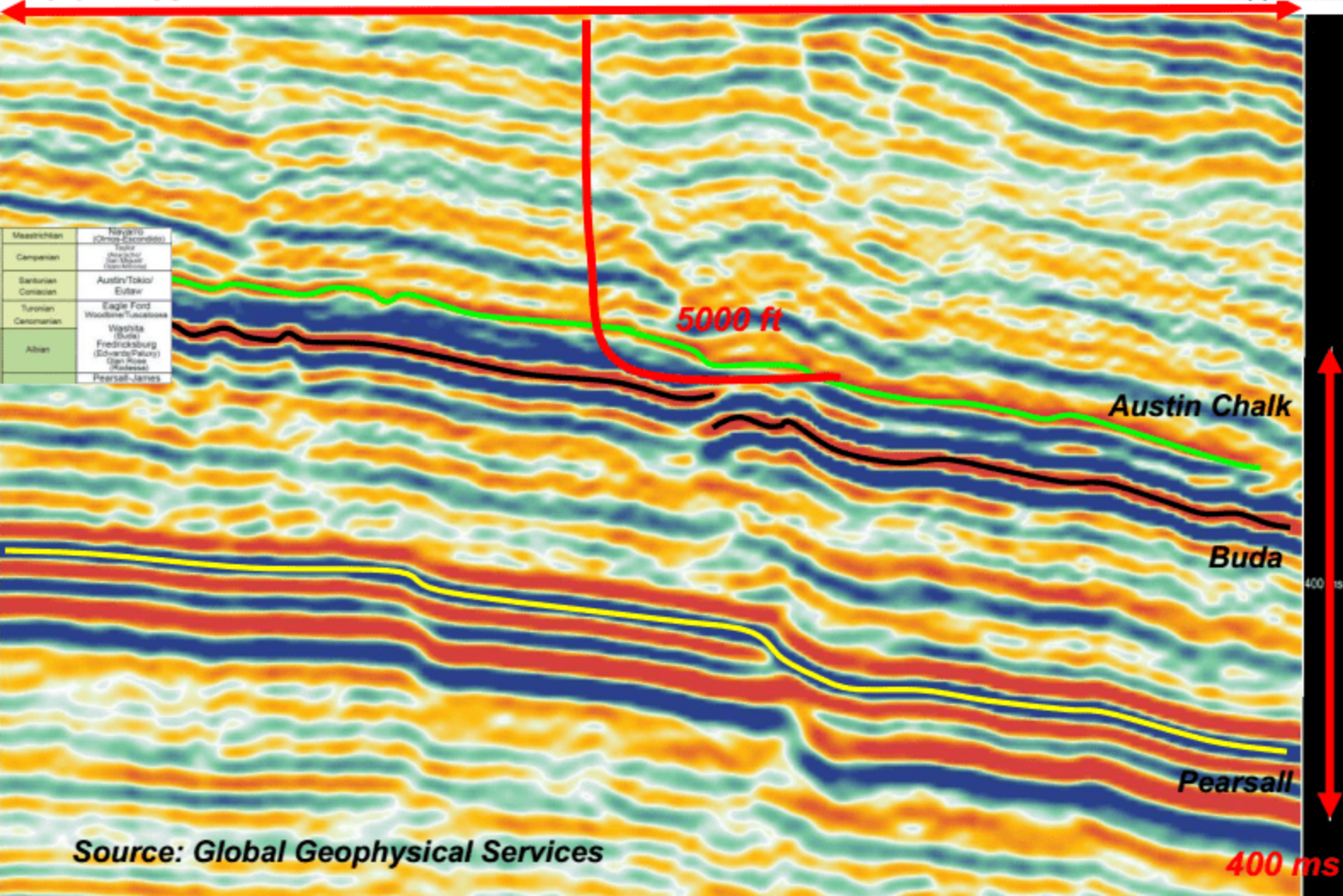


Source: Global Geophysical Services

400 ms

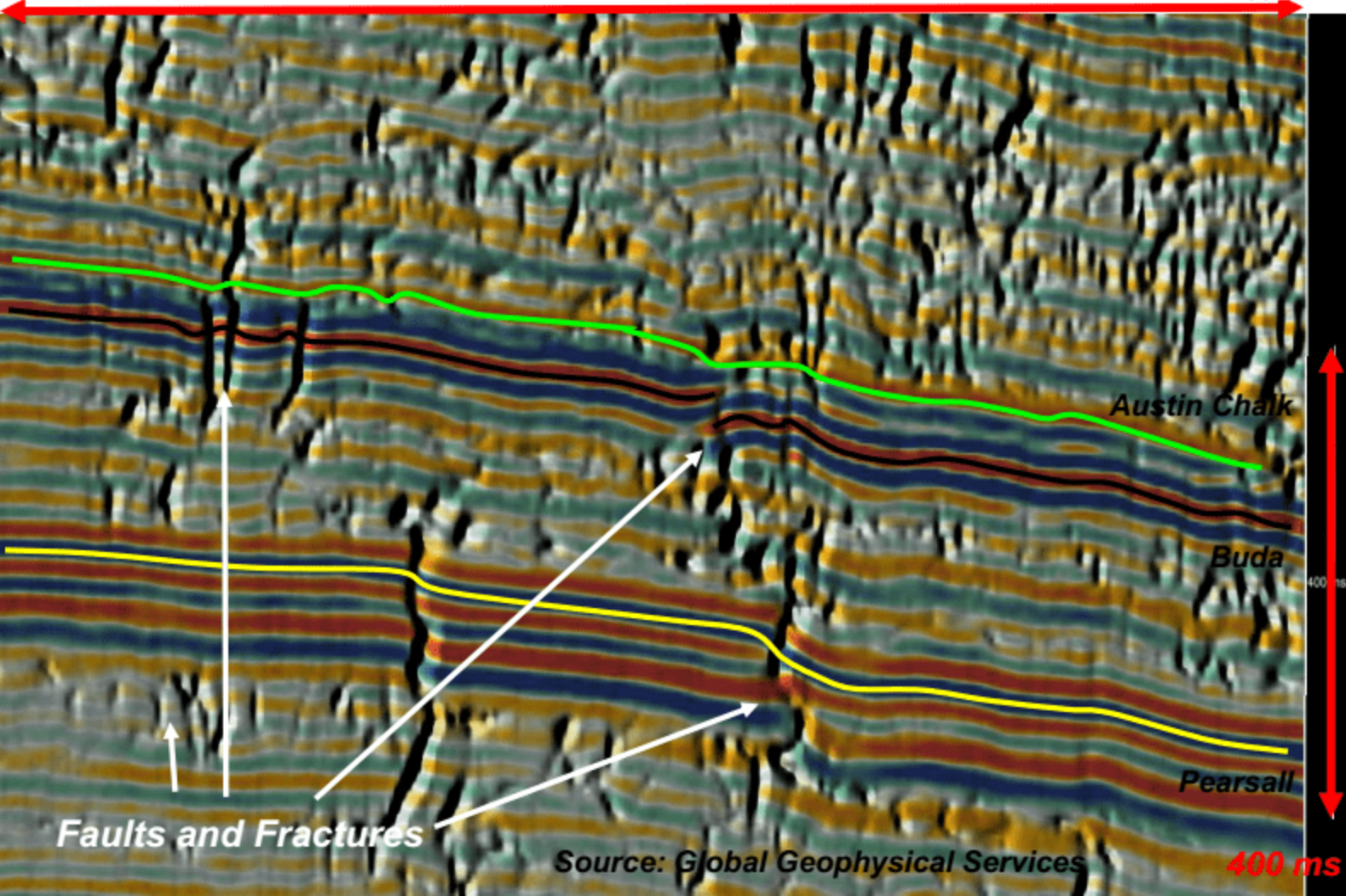
Eagle Ford Seismic

5.0 miles

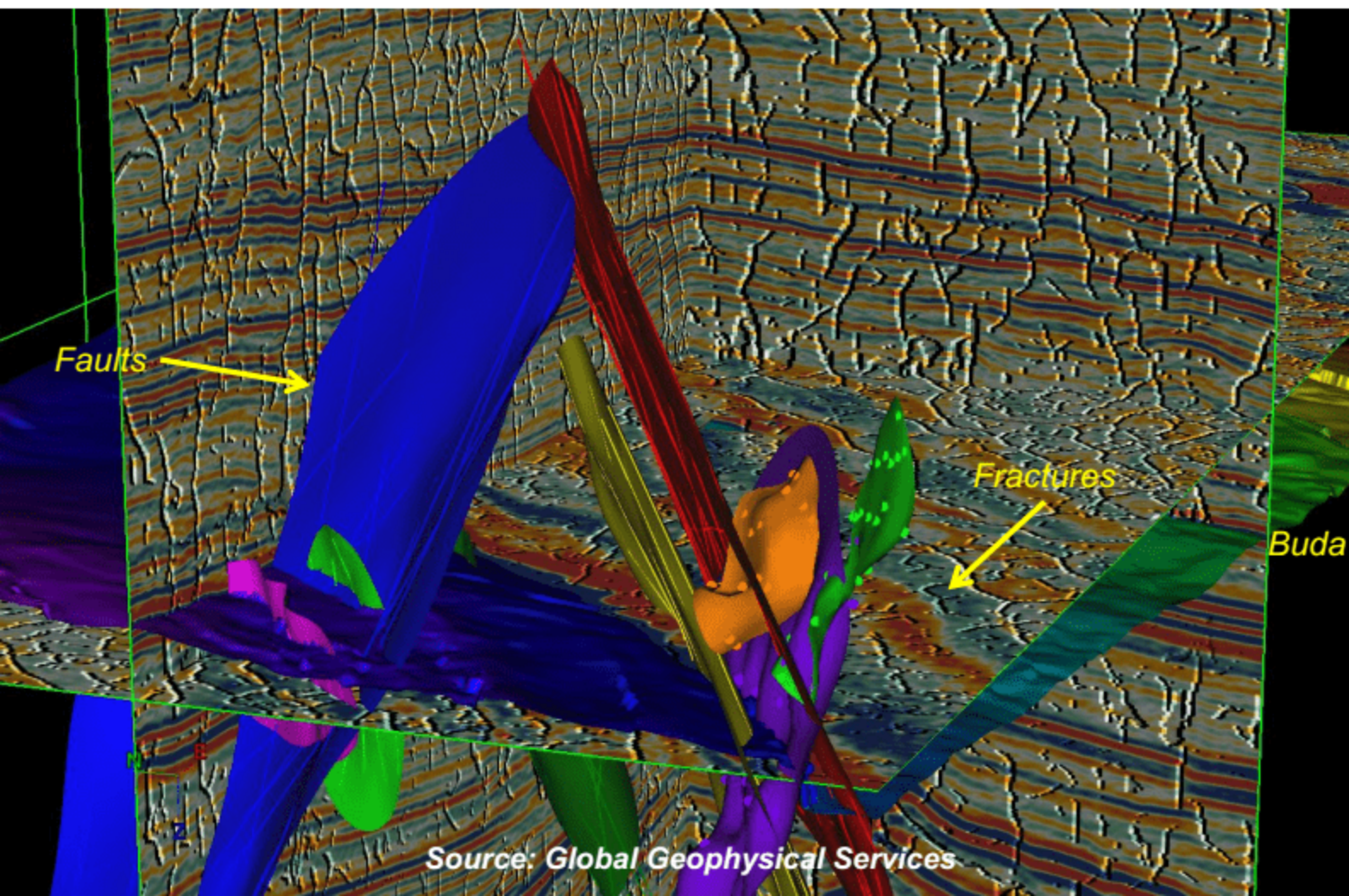


Eagle Ford Seismic

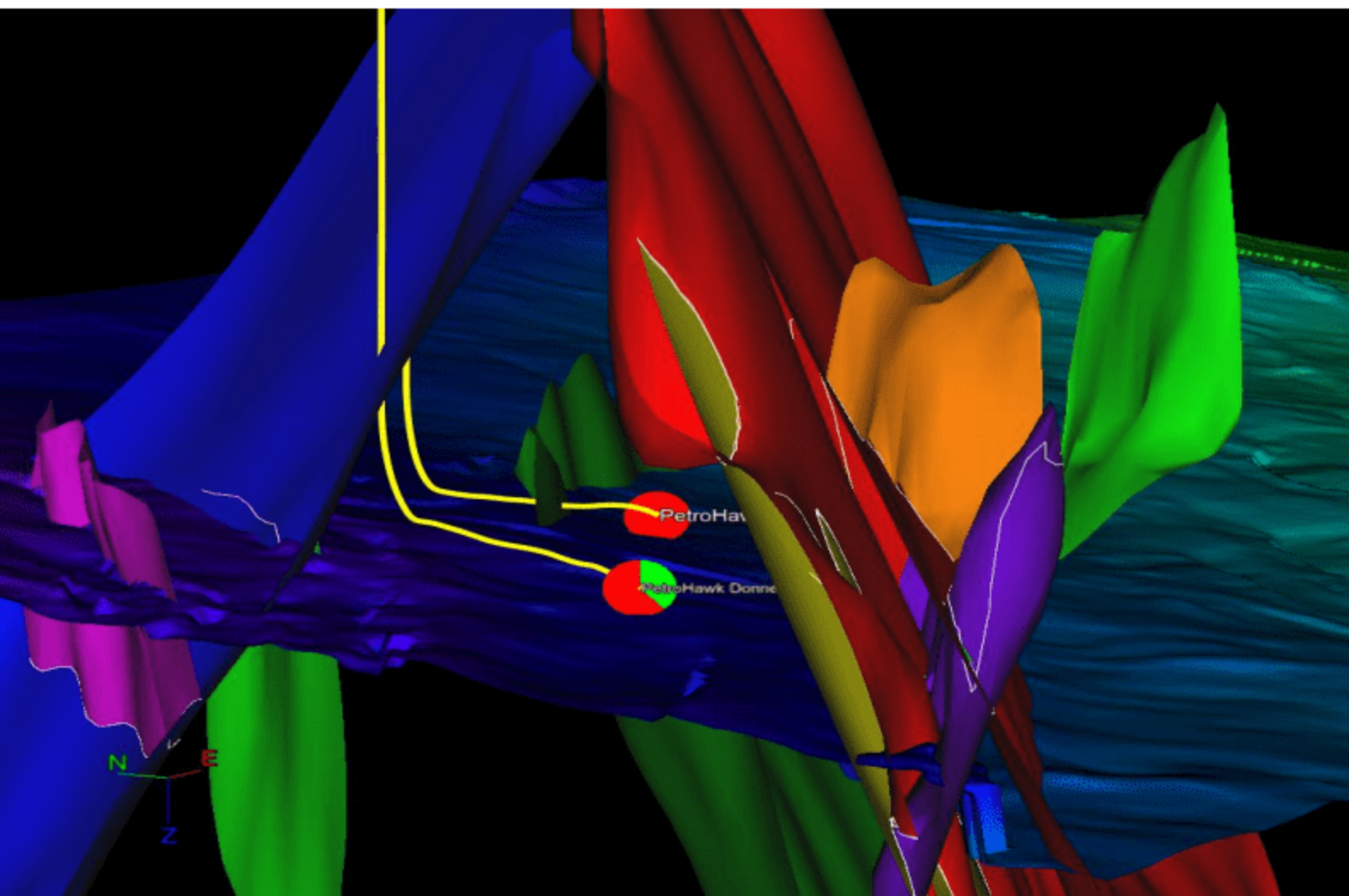
5.0 miles



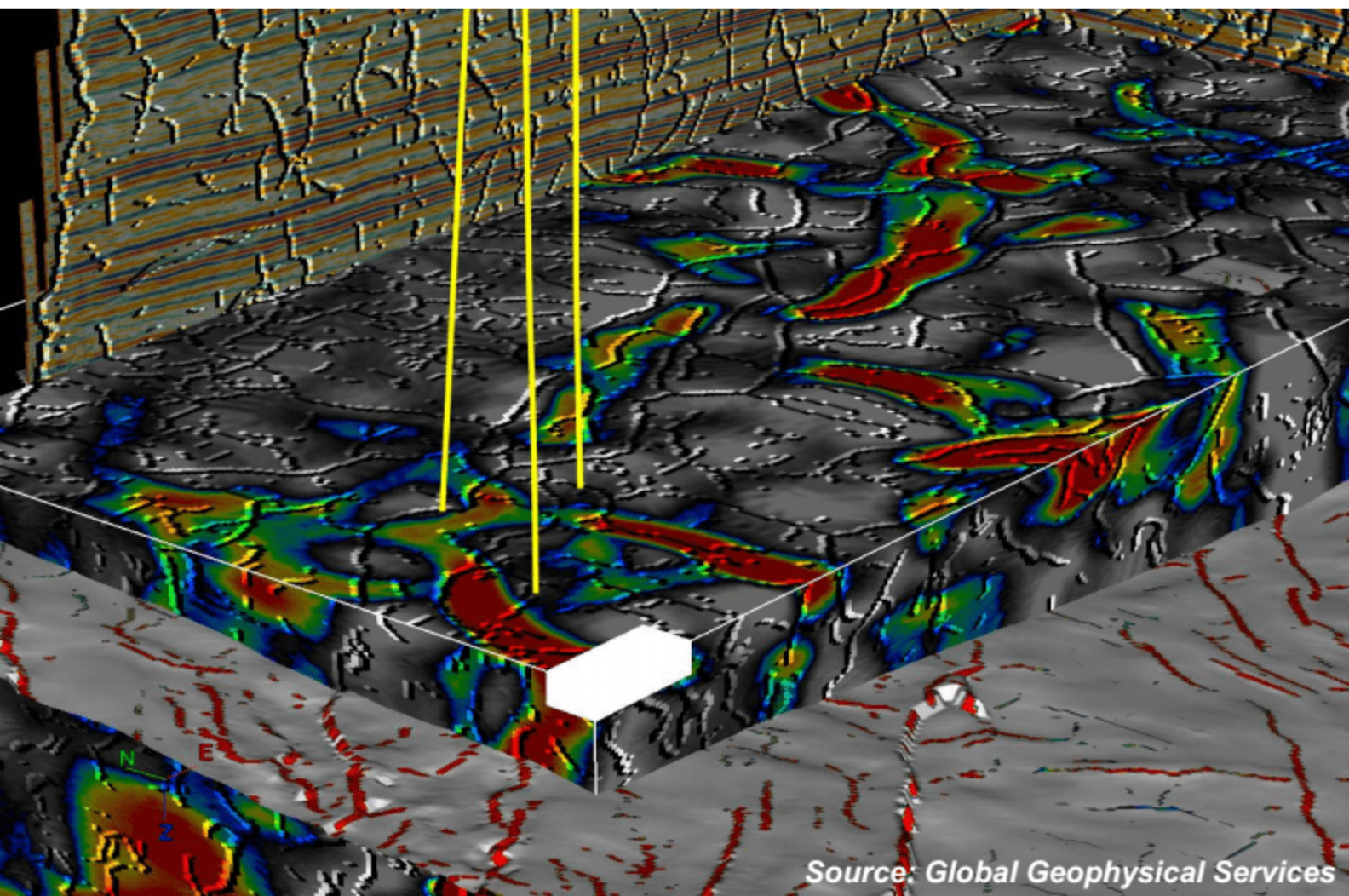
Eagle Ford Fault/Fracture Attributes



Fault Hazards



Eagle Ford Fault/Fracture Attributes

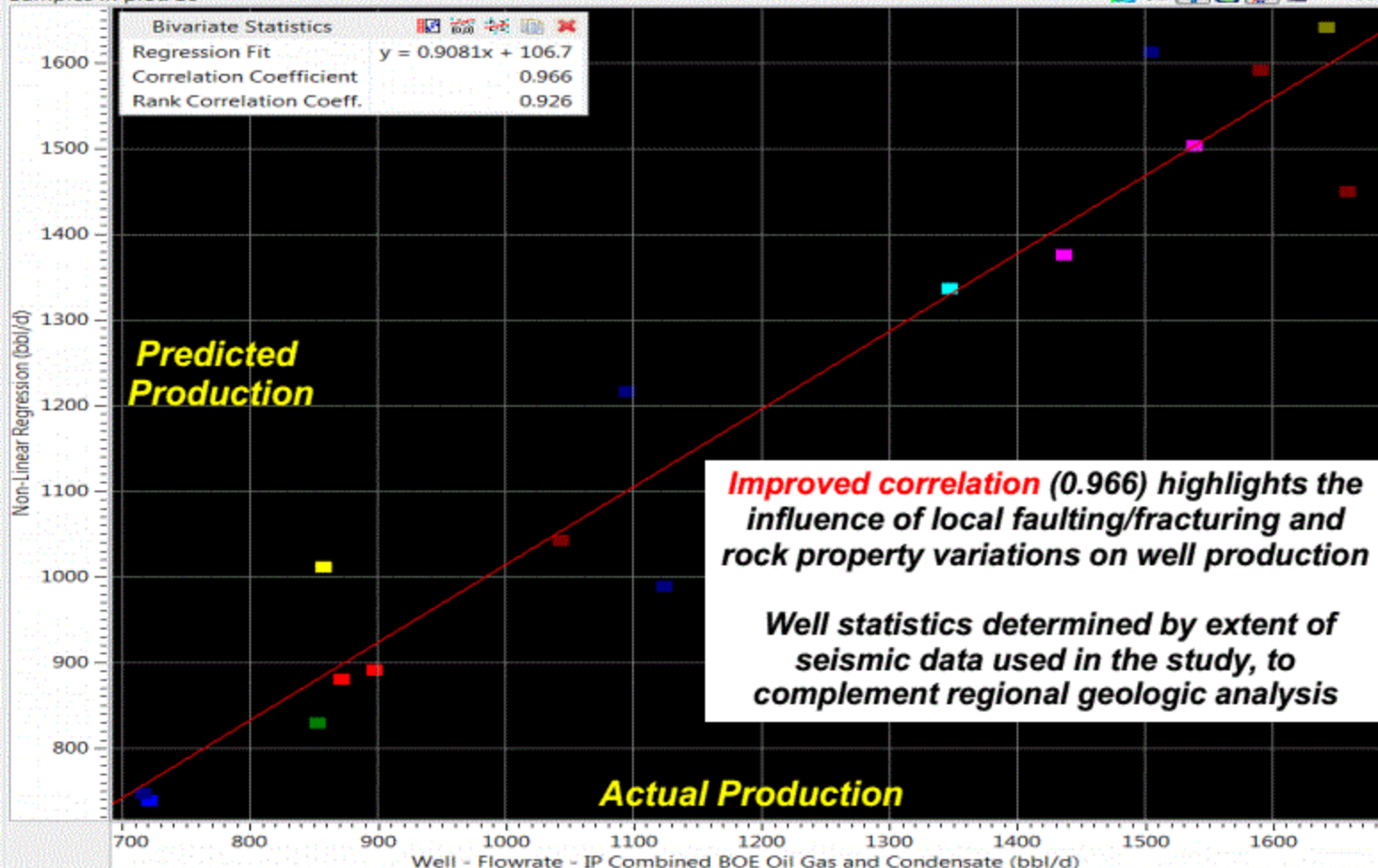


Source: Global Geophysical Services

Production: Engineering/Geology(+Seismic)

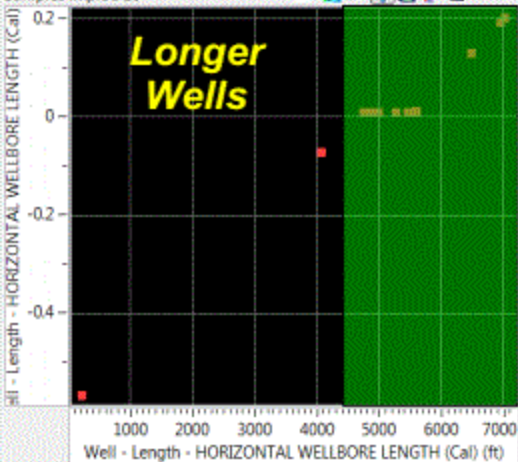
Well - Flowrate - IP Combined BOE Oil Gas and Condensate vs Non-Linear Regression

Samples in plot: 16

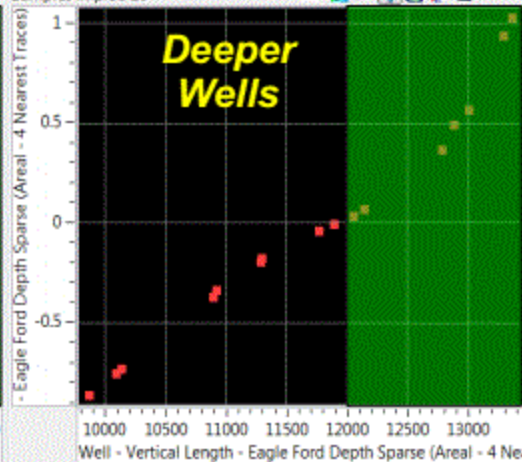


Engineering + Geology + Seismic

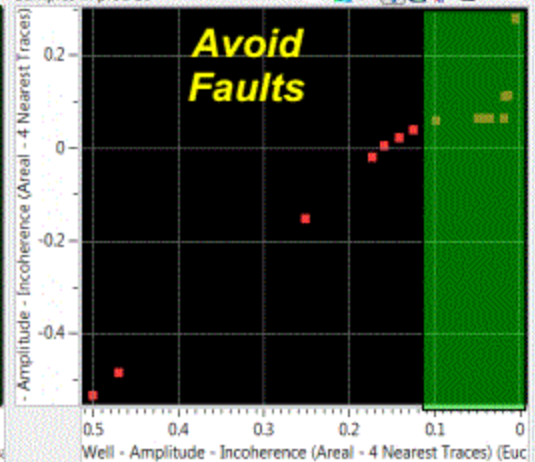
Well - Length - HORIZONTAL WELLBORE LENGTH (Cal) vs Transformed
Samples in plot: 16



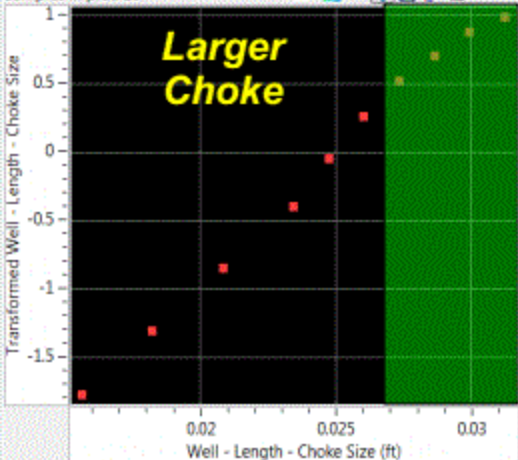
Well - Vertical Length - Eagle Ford Depth Sparse (Areal - 4 Nearest Traces)
Samples in plot: 16



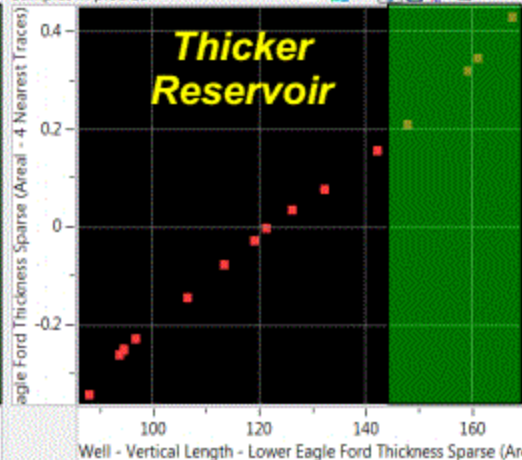
Well - Amplitude - Incoherence (Areal - 4 Nearest Traces) vs Transform
Samples in plot: 16



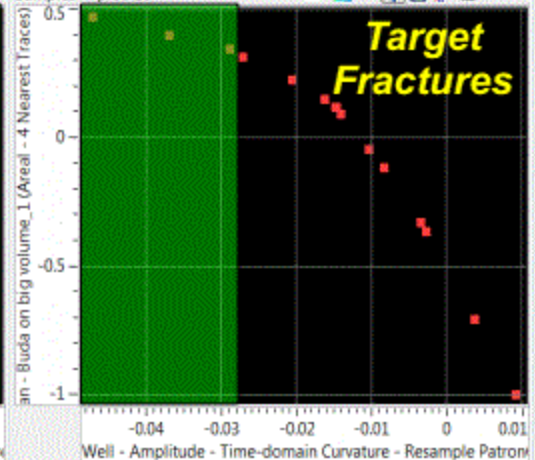
Well - Length - Choke Size vs Transformed Well - Length - Choke Size
Samples in plot: 16



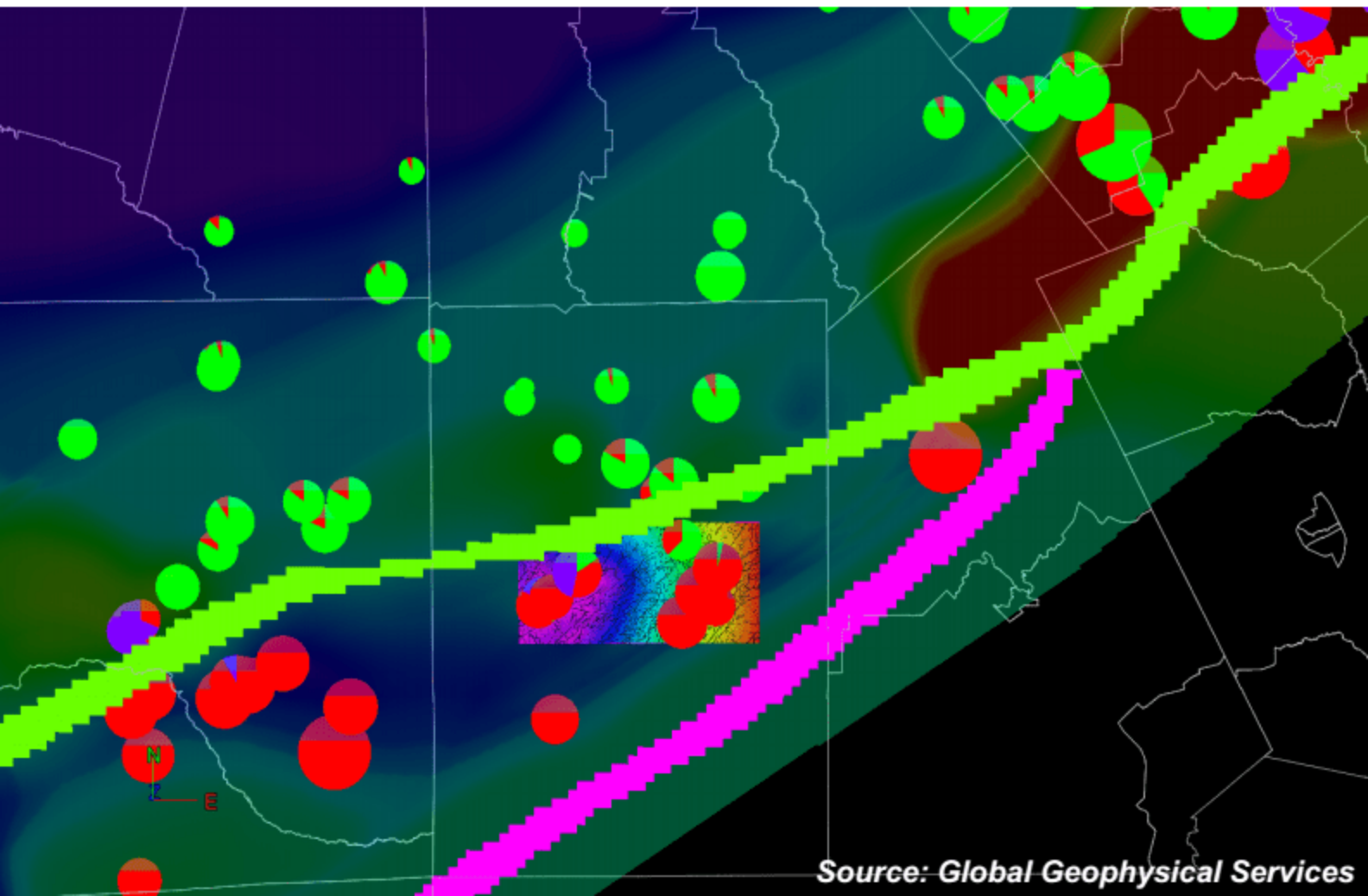
Well - Vertical Length - Lower Eagle Ford Thickness Sparse (Areal - 4 Ne
Samples in plot: 16



Well - Amplitude - Time-domain Curvature - Resample PatronGrande3D
Samples in plot: 16



Eagle Ford Economic Sweetspot Map



Source: Global Geophysical Services

Eagle Ford Summary

Using crossplots to optimize engineering parameters is not feasible due to the number and subtle interactions

We propose using non-linear, multi-variate statistics to create sweetspot maps and estimates of best engineering parameters

Better production in the Eagle Ford correlates with (using public and Global seismic data):

- *Deeper parts of the play*
 - *(oil 8000-11,500 feet/gas >11,500 feet gas)*
- *Thicker zones (~150 feet)*
- *Avoiding faults, targeting fractures*
- *Nominal wellbores of ~5500 feet*
- *Frac stage spacing ~ 350 feet*

ESSCA

TM

阿什卡集团

北京市朝阳区
亚运村北苑路170号
凯旋中心27层
邮政编码100101

www.essca.com

姚同云

Transform产品经理

阿什卡软件解决方案与增值服务事业部

电话: 010 5823 6996 转8014分机

传真: 010 5823 6077

手机: 132 6031 9180

[Tongyun.yao @essca.com](mailto:Tongyun.yao@essca.com)

ESSCA

总部地址邮编：北京市朝阳区北苑路170号凯旋中心27层（100101）

北京:010-5823-6996 大庆:0459-5923-315 盘锦:0427-7830-315 西安:029-86594-315 克拉玛依:0990-6227-315

ess@essca.com ecs@essca.com ees@essca.com evc@essca.com hr@essca.com

www.essca.com

ESS软件解决方案与增值服务 | ECS油气勘探开发技术咨询服务 | EES油气田工程服务与工具仪器 | EVC风险投资与合作

TemisFlow 多维盆地模拟与资源远景评价

Dionisos 地层沉积演化模拟

CobraFlow 属性模拟与粗化

FracaFlow 裂缝描述与建模

InterWell 叠前同时反演

Transform 非常规勘探开发解释平台

CougarFlow 辅助自动历史拟合

PumaFlow 一体化油藏数值模拟解决方案

Enable 不确定性分析与历史拟合

Tempest 油藏数值模拟

Saphir Emeraude Topaze Rubis Amethyste Diamant 试井 生产测井 生产动态分析 井组数模 井筒节点分析 数据管理

WellWired 随钻实时数据传输

INT 勘探开发软件图形组件库

Essca Consulting & Service 油气勘探开发技术咨询服务

具有社会责任感的、不断进步的学习型团队，为您提供全球业界最好的技术、产品和服务，
以帮助您和客户不断提高生产力与投资回报！

精诚合作 互助共赢

Together Everyone Achieves More®