APPENDIX E FIGURES

Figure E- 1: North Texas Case Study Regional Area 1
Figure E- 2: Barnett Shale, E-W Generalized Cross-Section (Bruner and Smosna, 2011) 2
Figure E- 3: Barnett Shale, N-S Generalized Cross-Section (Bruner and Smosna, 2011) 3
Figure E- 4: Top Ellenburger Karst Features from 3D 4
Figure E- 5: DFW Fault Location (Frohlich et al., 2011) 1
Figure E- 6: DFW Focus Area Seismicity Map 1
Figure E- 7: Relocated DFW events (Figure 5 of Janská and Eisner, 2012) 2
Figure E- 8: DFW Seismometer Deployment (Figure 1 of Janská and Eisner, 2012) 3
Figure E- 9: DFW Focus Area Seismicity Timeline 4
Figure E- 10: DFW C1De Operational Data Overvview Plot 5
Figure E- 11: DFW North A1DM Operational Data Overview Plot 5
Figure E- 12: DFW C1DE Operational Pressure Gradient Plot 6
Figure E- 13: DFW North A1DM Operational Pressure Gradient Plot 6
Figure E- 14: DFW C1DE Tandem Plot of Hall Integral with Derivative and Seismic Events 7
Figure E- 15: DFW North A1DM Hall Integral and Derivative Plot 7
Figure E- 16: Cleburne Focus Area Seismicity Map 8
Figure E- 17: Cleburne Focus Area Seismicity Timeline 9
Figure E- 18: Cleburne Seismometer Deployment and Event Relocation (Figure 4 of Howe-Justinic et al., 2013) 9
Figure E- 19: Hanna Operational Data Overview Plot 10
Figure E- 20: Johnson Salty III Operational Data Overview Plot 10
Figure E- 21: Rose Operational Data Overview Plot 11
Figure E- 22: Vortex Operational Data Overview Plot 11
Figure E- 23: Mann Operational Data Overview Plot 12
Figure E- 24: Sparks Drive Operational Data Overview Plot 12
Figure E- 25: Johnson County Operational Data Overview PLot 13
Figure E- 26: SoutH Cleburne Operational Data Overview Plot 13
Figure E- 27: Cleburne Yard Operational Data OVerview Plot 14
Figure E- 28: Johnson Salty II Operational Data OVerview Plot 14
Figure E- 29: Hanna Operating Pressure Gradient Plot 15
Figure E- 30: Johnson Salty III Operational Pressure Gradient Plot 15
Figure E- 31: Rose Operational Pressure Gradient Plot 16
Figure E- 32: Vortex Operational Pressure Gradient Plot 16
Figure E- 33: Mann Operational Pressure Gradient Plot 17
Figure E- 34: Sparks Drive Operational Pressure Gradient Plot 17
Figure E- 35: Johnson County Operational Pressure Gradient Plot 18
Figure E- 36: South Cleburne Operational Gradient Pressure Plot 18
Figure E- 37: Cleburne Yard Operational Pressure Gradient Plot 19
Figure E- 38: Johnson Salty II Operational Pressure Plot 19

Figure E- 39: Hanna Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 20
Figure E- 40: Johnson Salty III Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 20
Figure E- 41: Rose Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative .. 21
Figure E- 42: Vortex Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 21
Figure E- 43: Mann Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 22
Figure E- 44: Sparks Drive Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 22
Figure E- 45: Johnson County Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 23
Figure E- 46: South Cleburne Tandem Plot Of Cumulative Earthquakes and Hall Integral with Derivative 23
Figure E- 47: Cleburn Yard Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 24
Figure E- 48: Johnson Salty II Tandem Plot of Cumulative Earthquakes and Hall Integral with Derivative 24
Figure E- 49: 2005 Sparks Falloff Test Overview Plot 25
Figure E- 50: 2006 Sparks Falloff Test Overview Plot 25
Figure E- 51: 2005 SParks Falloff Test Log-log Plot 26
Figure E- 52: 2006 Sparks Falloff Test Log-log Plot 26
Figure E- 53: 2005 Sparks Type Curve Match 27
Figure E- 54: 2006 Sparks Type Curve Match 27
Figure E- 55: 2006 Sparks Type Curve Match of Late Time Data 28
Figure E- 56: 2008 Sparks Falloff Test Overview Plot 28
Figure E- 57: 2008 Sparks Log-log Plot 29
Figure E- 58: 2008 Sparks Type Curve Match – Homogeneous Model 29
Figure E- 59: 2008 Sparks Type Curve Match 30
Figure E- 60: 2009 Sparks Falloff Test Overview Plot 30
Figure E- 61: 2009 Sparks Log-log Plot and Type Curve Match 31
Figure E- 62: 2010 Sparks Falloff Test Overview Plot 31
Figure E- 63: 2010 Sparks Log-log Plot and Type Curve Match 32
Figure E- 64: 2010 SParks Type Curve Match of Late time Data 32
Figure E- 65: 2011 Sparks Falloff Test Overview Plot 33
Figure E- 66: 2011 Sparks Type Curve Match 33

FIGURE E- 1: NORTH TEXAS CASE STUDY REGIONAL AREA

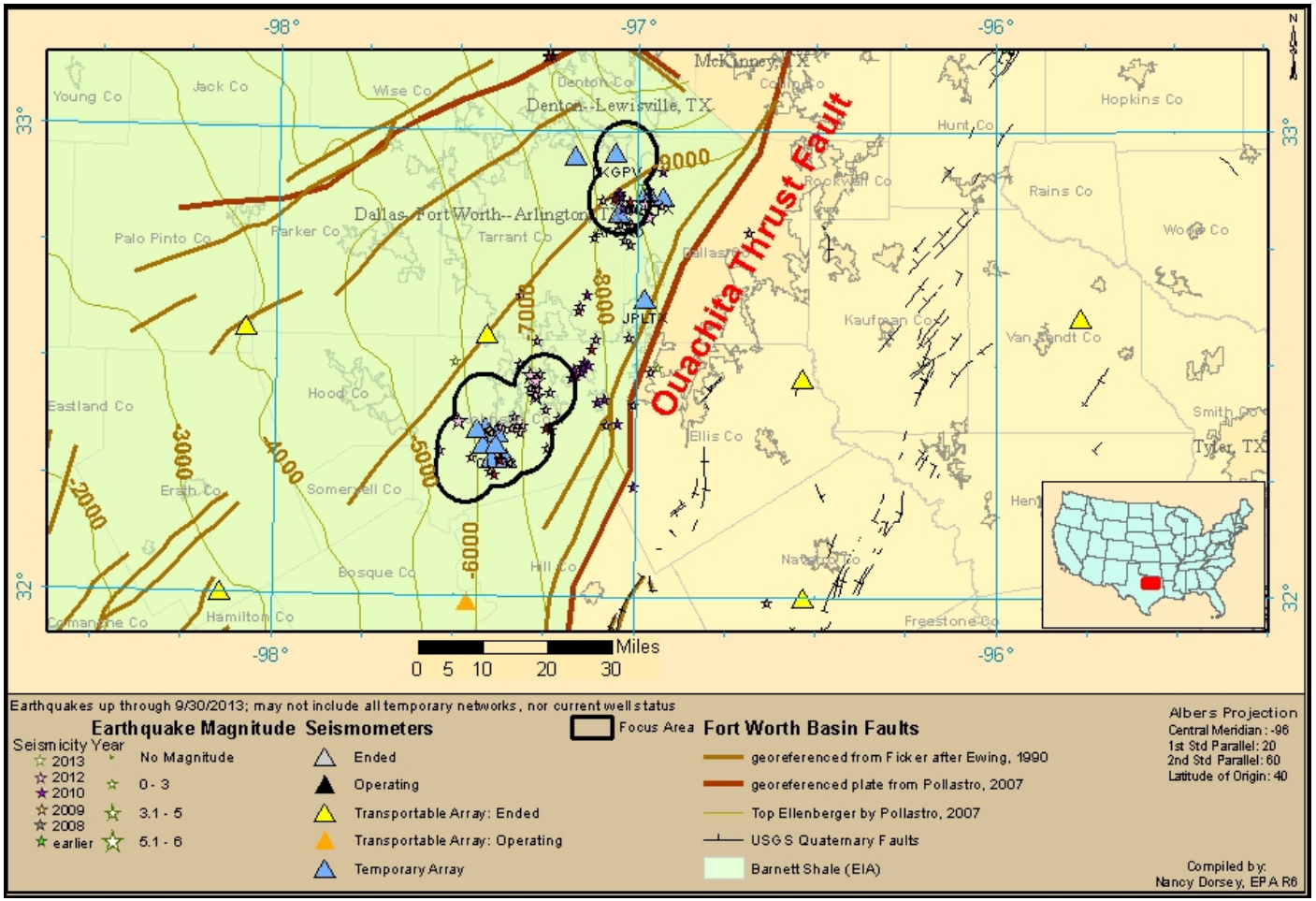
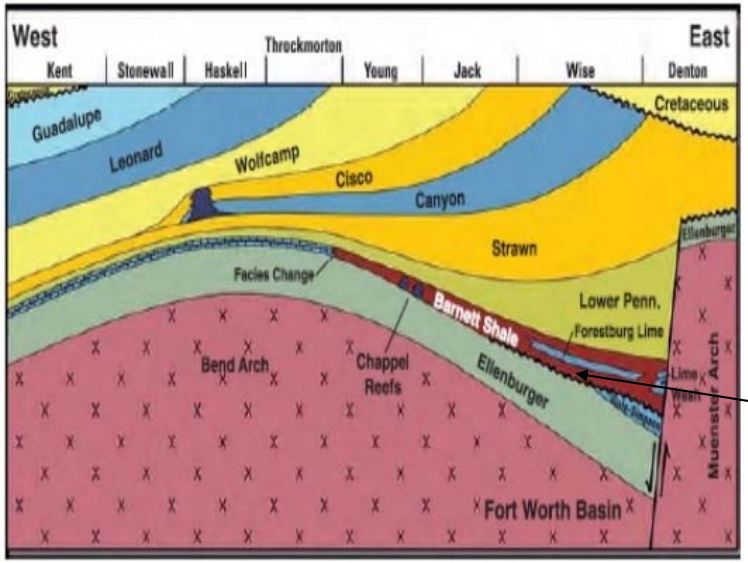


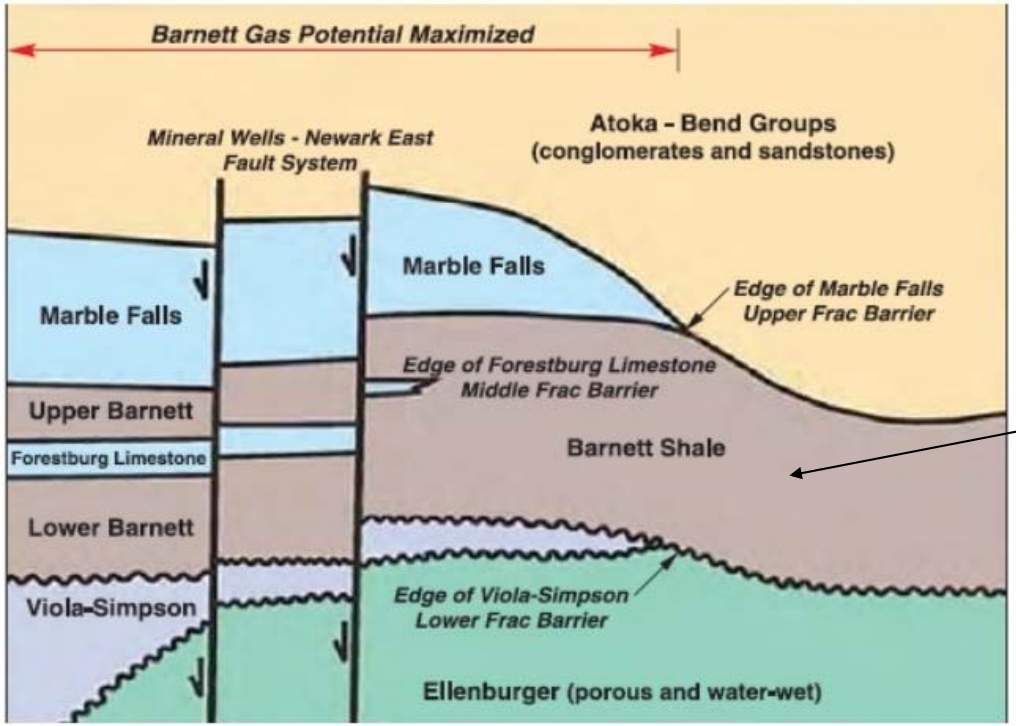
FIGURE E- 2: BARNETT SHALE, E-W GENERALIZED CROSS-SECTION (BRUNER AND SMOSNA, 2011)



Barnett shale overlying the Ellenburger formation

Bruner, K. R., and Smosna, R., 2011, A comparative study of the Mississippian Barnett Shale, Fort Worth Basin, and Devonian Marcellus Shale, Appalachian Basin: US Department of Energy, National Energy Technology Laboratory.

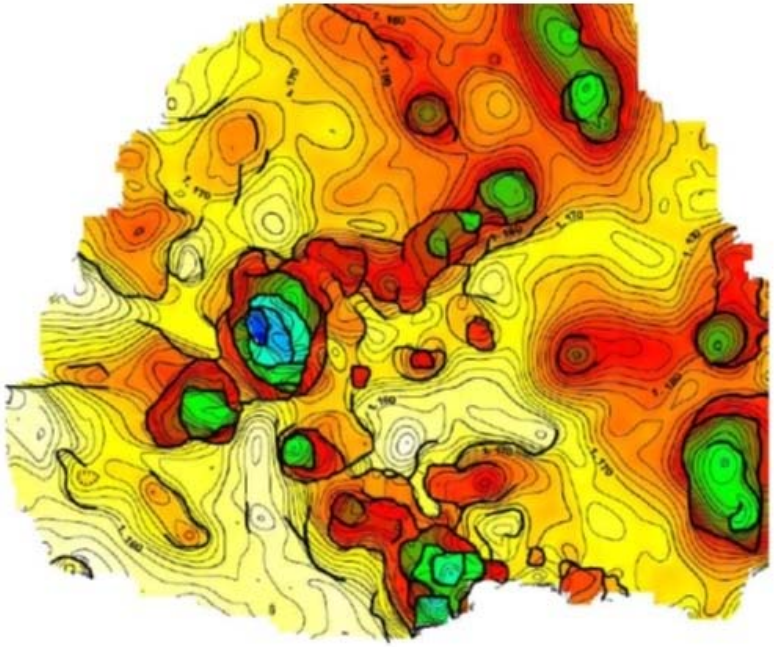
FIGURE E- 3: BARNETT SHALE, N-S GENERALIZED CROSS-SECTION (BRUNER AND SMOSNA, 2011)



Barnett shale overlying the Ellenburger formation

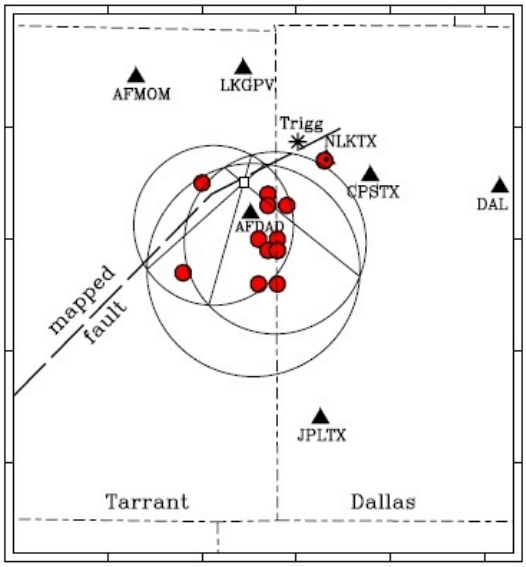
Bruner, K. R., and Smosna, R., 2011, A comparative study of the Mississippian Barnett Shale, Fort Worth Basin, and Devonian Marcellus Shale, Appalachian Basin: US Department of Energy, National Energy Technology Laboratory.

FIGURE E- 4: TOP ELLENBURGER KARST FEATURES FROM 3D



Steward, D. B., 2011, The Barnett Shale oil model of North Texas, Article #110151, Search and Discovery, AAPG/Datapages, Inc., posted June 13, 2011.

FIGURE E- 5: DFW FAULT LOCATION (FROHLICH ET AL., 2011)



Frohlich, C. et al., 2011, Dallas-Fort Worth earthquake sequence: October 2008 through May 2009: Bulletin of the Seismological Society of America, v. 101, p. 327-340.

FIGURE E- 6: DFW FOCUS AREA SEISMICITY MAP

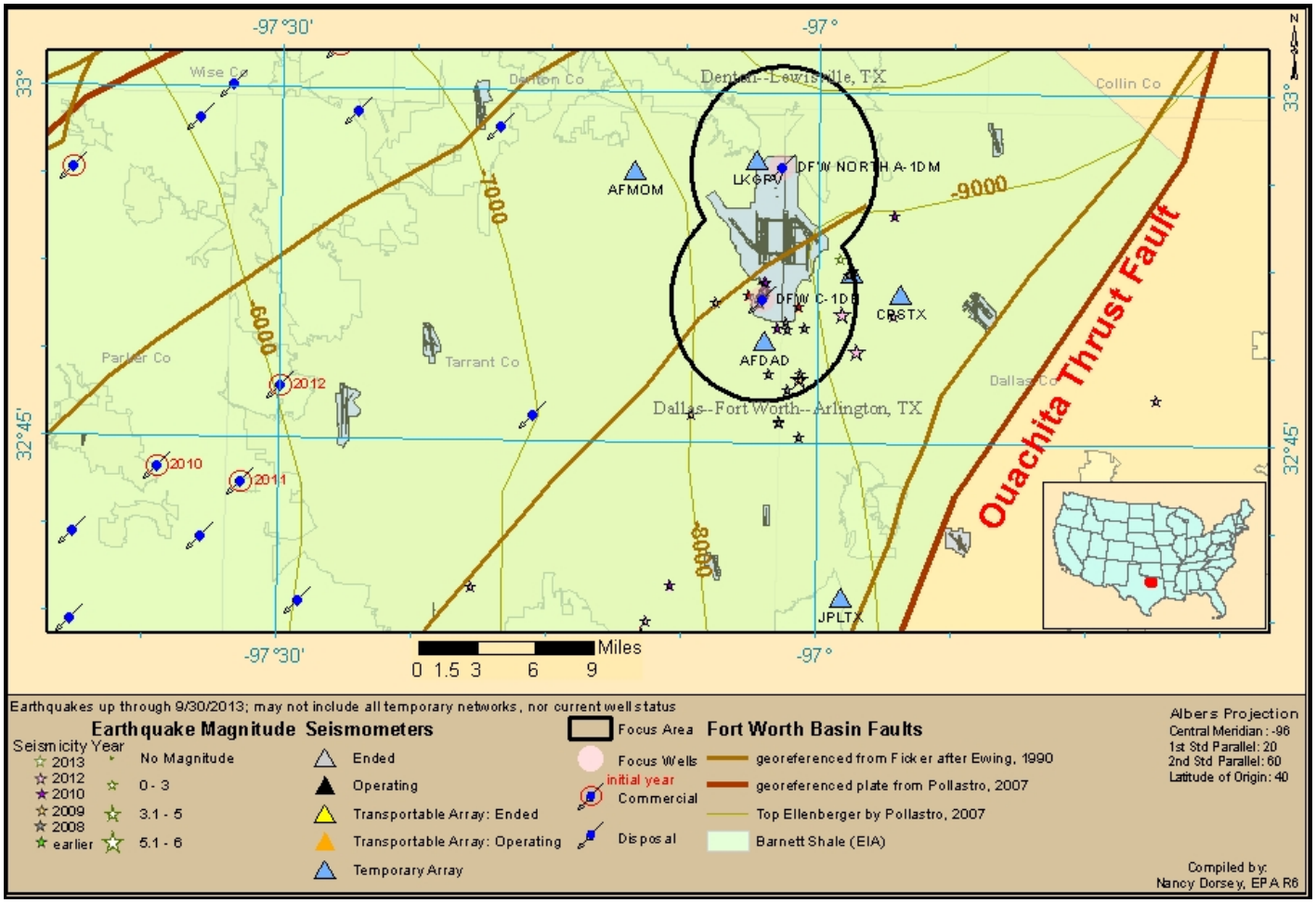


FIGURE E- 7: RELOCATED DFW EVENTS (FIGURE 5 OF JANSKÁ AND EISNER, 2012)

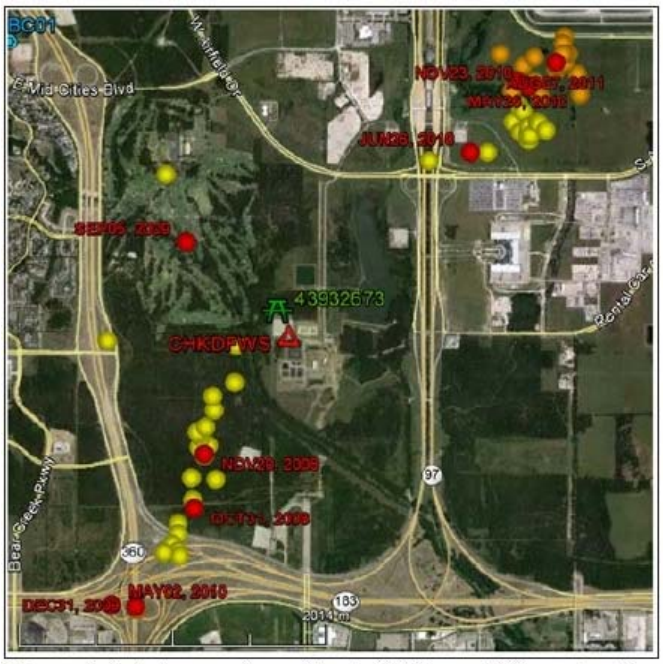


Figure 5. *Seismic events located in the DFW area. Yellow points show epicenters of events located by 2D relative location, orange points by 3D relative location. Red points refer to the detection masters. The CHKDFWS station is on the site of the SWD well (*API *43932673).*

Janská, E. and L. Eisner, 2012, Ongoing Seismicity in the Dallas-Fort Worth Area: The Leading Edge, v. 31, p. 1462-1468.
http://dx.doi.org/10.1190/tle31121462.1

FIGURE E- 8: DFW SEISMOMETER DEPLOYMENT (FIGURE 1 OF JANSKÁ AND EISNER, 2012)

Figure 1. *Dallas-Fort Worth (DFW) area and regional seismic WMOK and TA.135A stations in lower right inset. Red and green triangles represent currently recording stations. Yellow triangles represent temporary stations operated by South Methodist University (SMU). The picnic table symbol stands for the injection well (API 43932673).*

Janská, E. and L. Eisner, 2012, Ongoing Seismicity in the Dallas-Fort Worth Area: The Leading Edge, v. 31, p. 1462-1468.
http://dx.doi.org/10.1190/tle31121462.1

FIGURE E- 9: DFW FOCUS AREA SEISMICITY TIMELINE

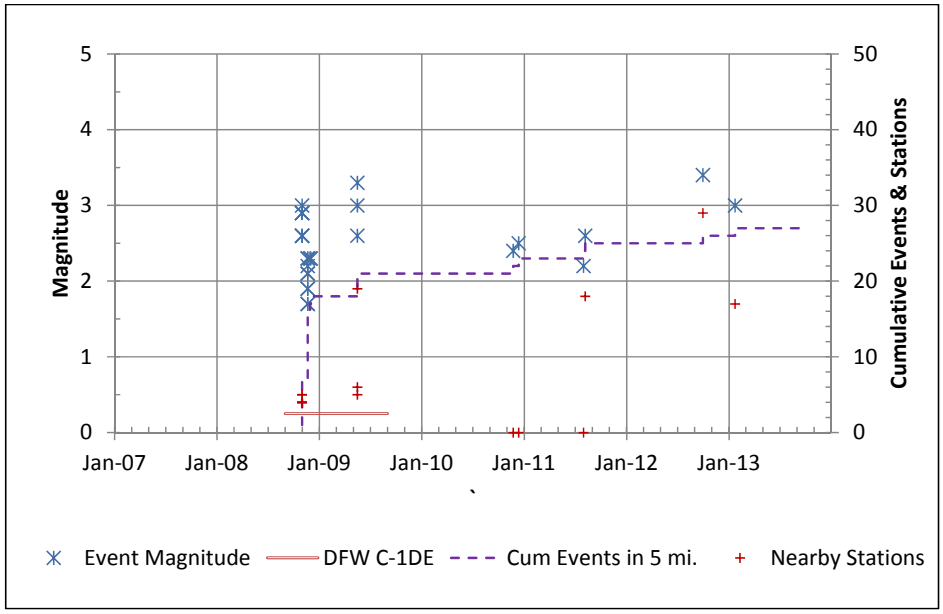


FIGURE E- 10: DFW C1DE OPERATIONAL DATA OVERVVIEW PLOT

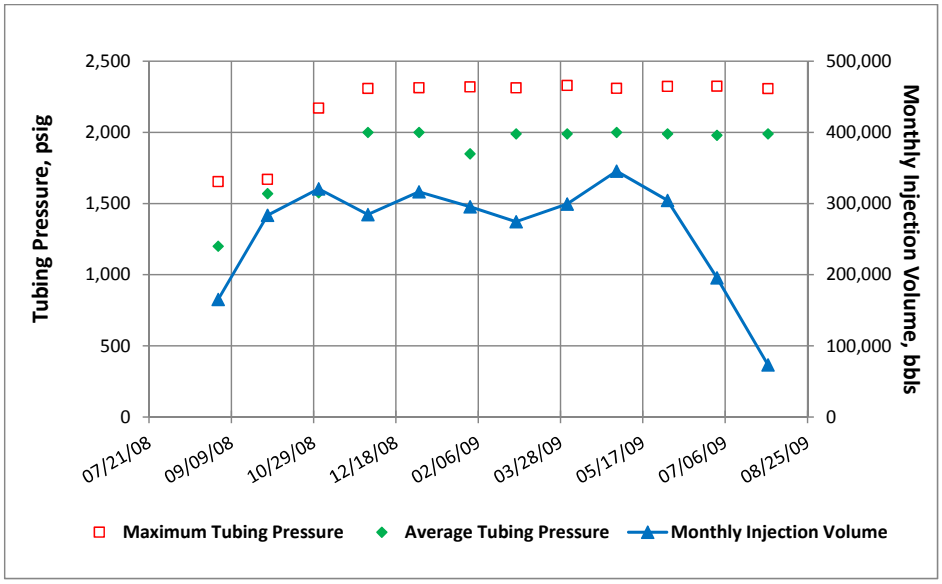


FIGURE E- 11: DFW NORTH A1DM OPERATIONAL DATA OVERVIEW PLOT

Commented [A1]: Wrong plot

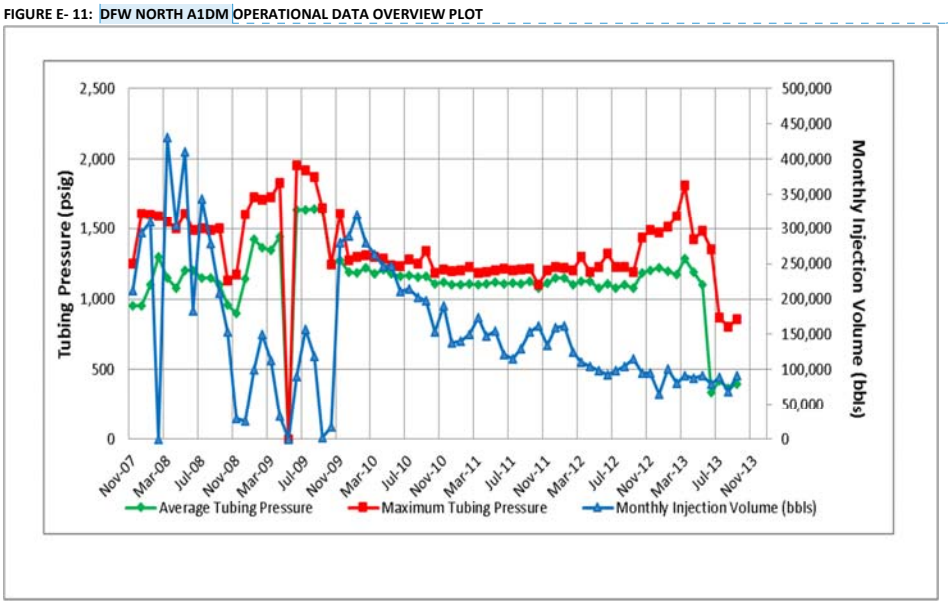


FIGURE E- 12: DFW C1DE OPERATIONAL PRESSURE GRADIENT PLOT

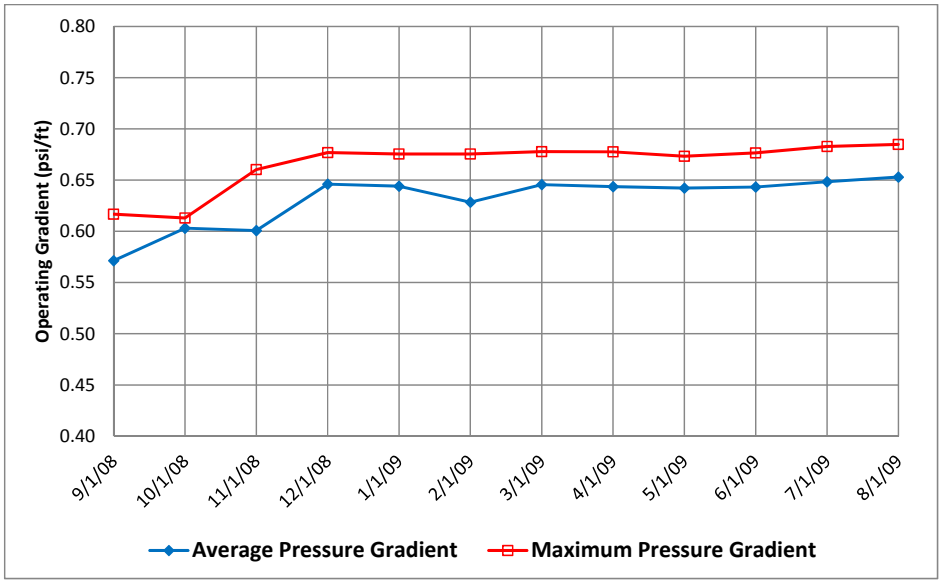


FIGURE E- 13: DFW NORTH A1DM OPERATIONAL PRESSURE GRADIENT PLOT

Commented [A2]: Wrong plot

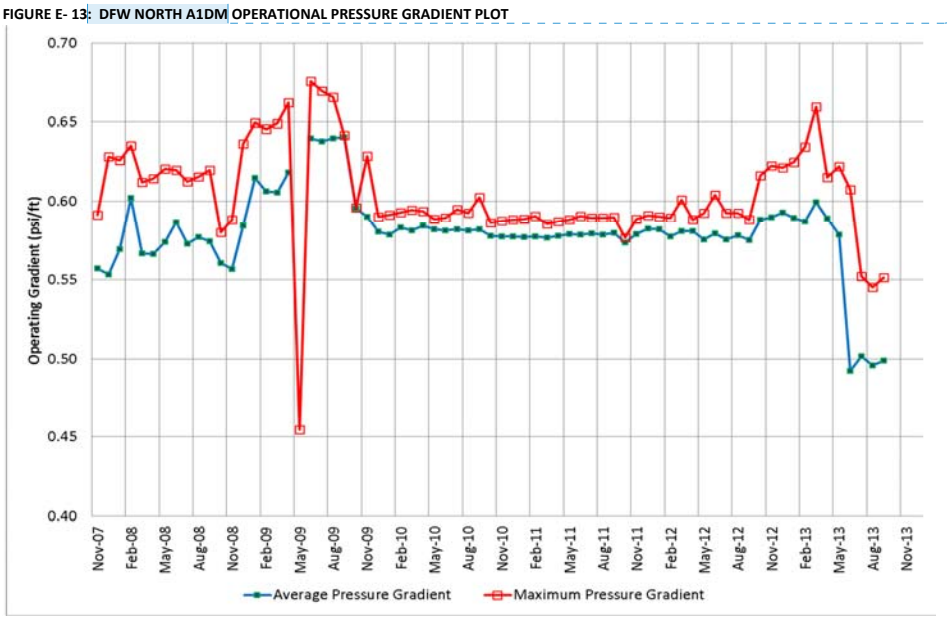


FIGURE E- 14: DFW C1DE TANDEM PLOT OF HALL INTEGRAL WITH DERIVATIVE AND SEISMIC EVENTS

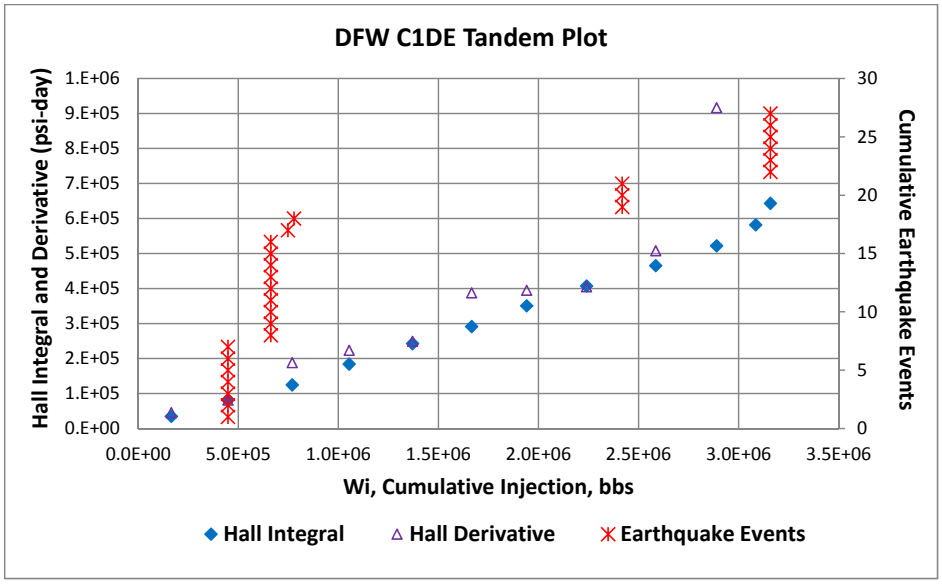


FIGURE E- 15: DFW NORTH A1DM HALL INTEGRAL AND DERIVATIVE PLOT

Commented [A3]: Revised plot

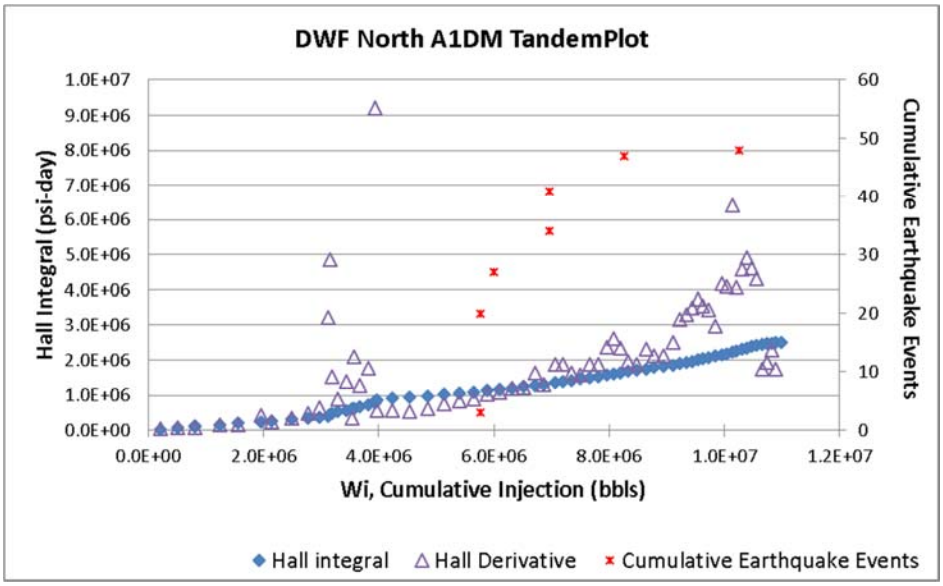


FIGURE E- 16: CLEBURNE FOCUS AREA SEISMICITY MAP

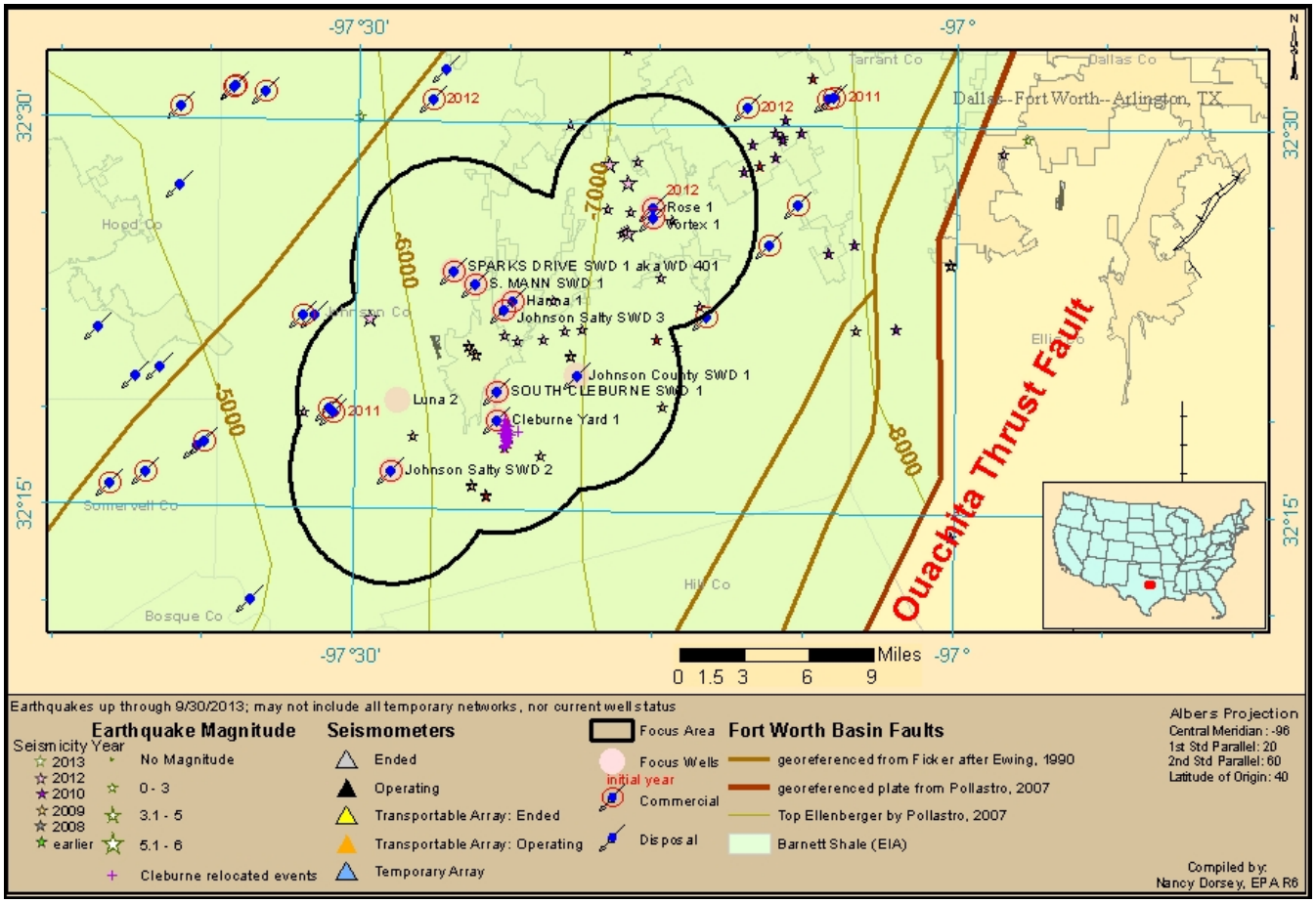


FIGURE E- 17: CLEBURNE FOCUS AREA SEISMICITY TIMELINE

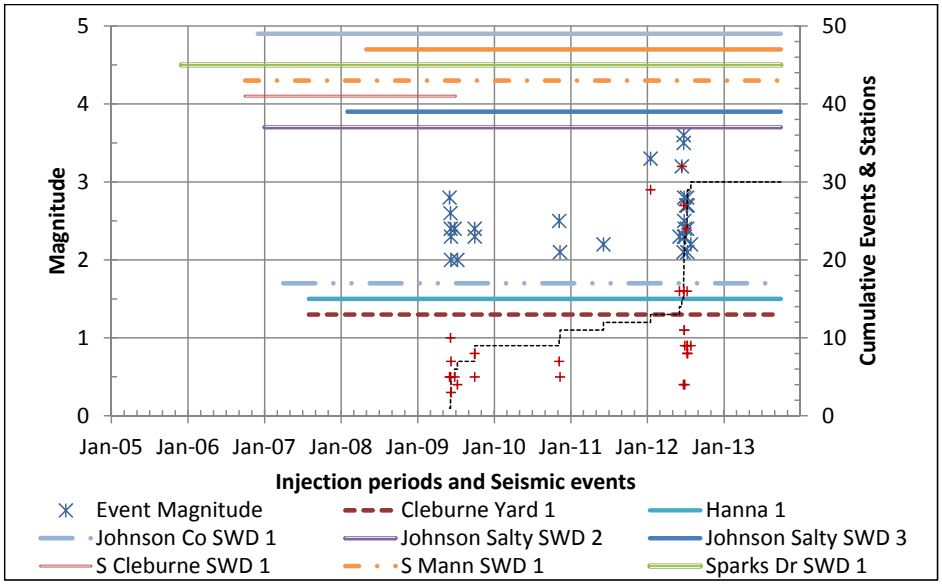


FIGURE E- 18: CLEBURNE SEISMOMETER DEPLOYMENT AND EVENT RELOCATION (FIGURE 4 OF HOWE-JUSTINIC ET AL., 2013)

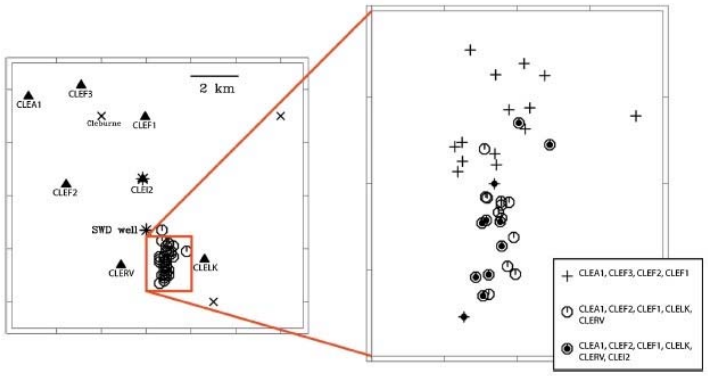


Figure 4. Final event locations determined from data recorded by the local network. Triangles are seismic stations; plus symbols, octagons; circles, earthquakes; and asterisks, injection disposal wells. Events located using data from the initial four stations (plus symbols) are more northward. Events locations using the final network configuration (circles) should be more reliable because stations surrounded the events. Note that locations form an approximate north–south trend about 2 km long, with a saltwater disposal well (API 42-251-31266) situated about 1.3 km from the trend.

Howe Justinic, A. M., B. S. Stump, C. Hayward, and C. Frohlich (2013). Analysis of the Cleburne earthquake sequence from June 2009 to June 2010: Bulletin of the Seismological Society of America, v. 103 n. 6, p. 3083-3093. doi: 10.1785/0120120336

FIGURE E- 19: HANNA OPERATIONAL DATA OVERVIEW PLOT

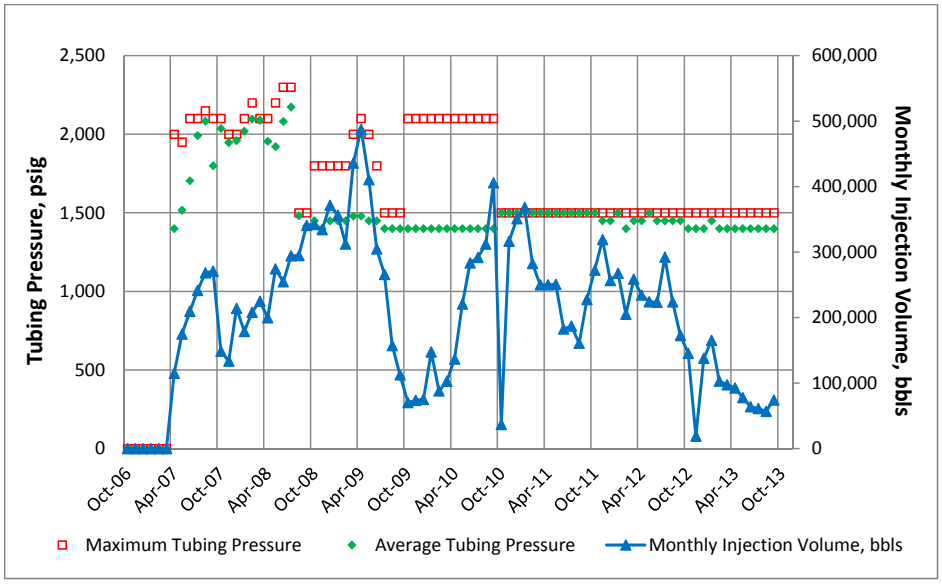


FIGURE E- 20: JOHNSON SALTY III OPERATIONAL DATA OVERVIEW PLOT

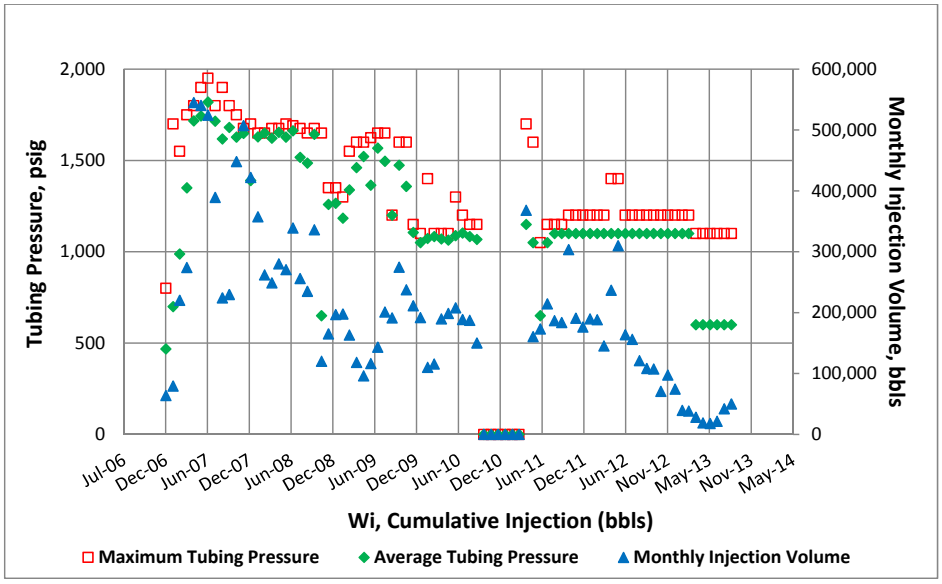


FIGURE E- 21: ROSE OPERATIONAL DATA OVERVIEW PLOT

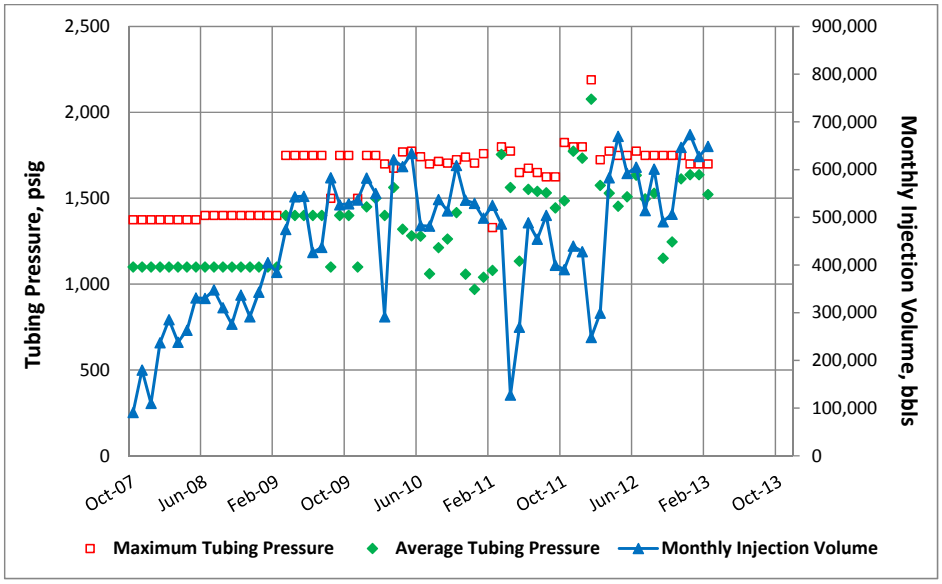


FIGURE E- 22: VORTEX OPERATIONAL DATA OVERVIEW PLOT

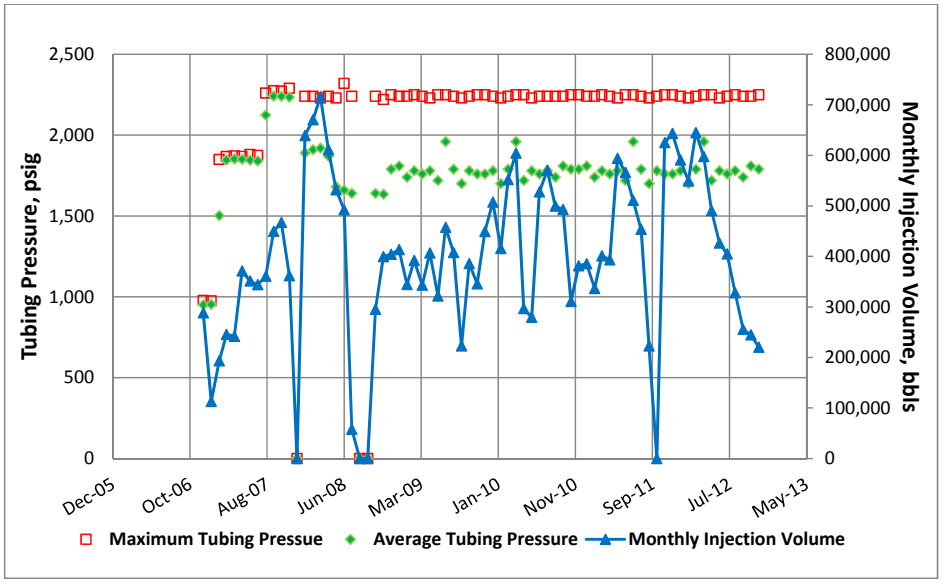


FIGURE E- 23: MANN OPERATIONAL DATA OVERVIEW PLOT

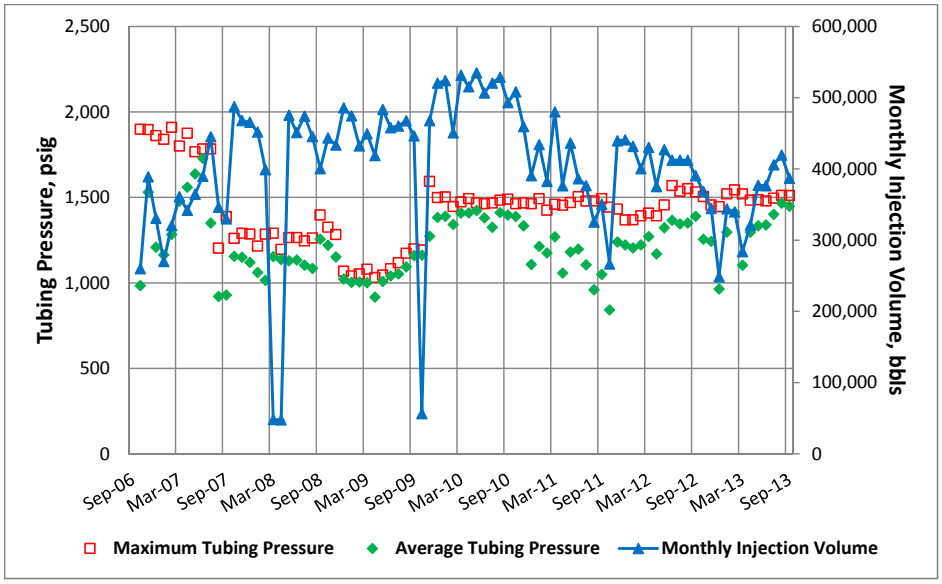


FIGURE E- 24: SPARKS DRIVE OPERATIONAL DATA OVERVIEW PLOT

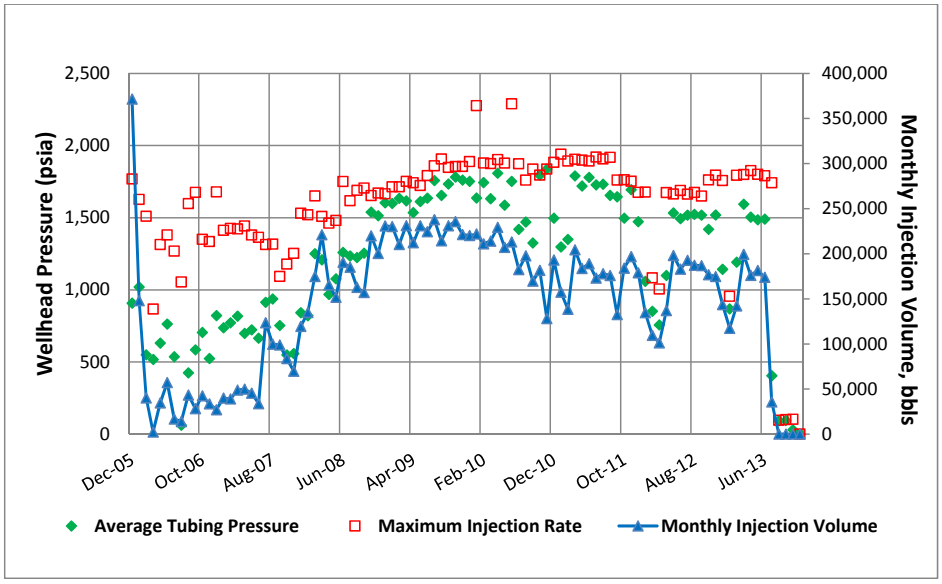


FIGURE E- 25: JOHNSON COUNTY OPERATIONAL DATA OVERVIEW PLOT

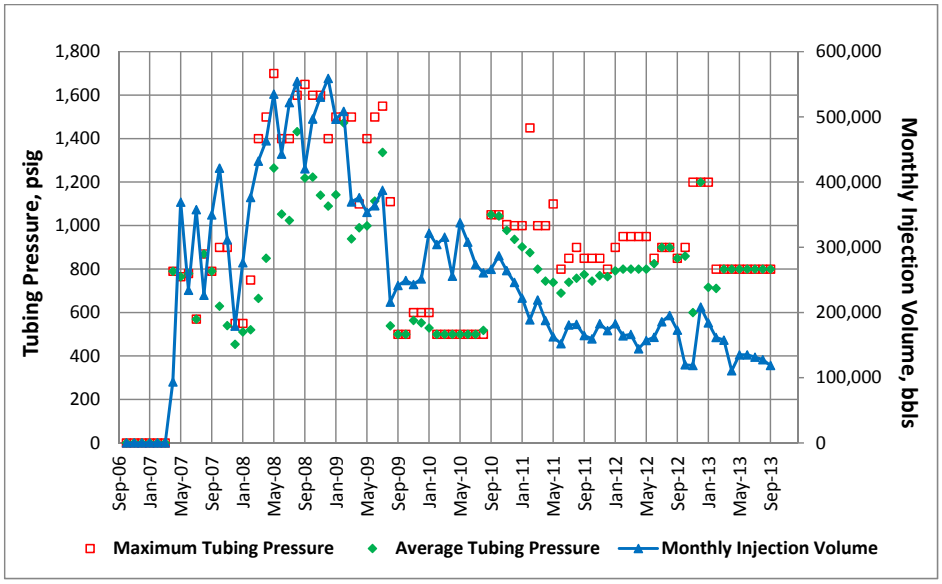


FIGURE E- 26: SOUTH CLEBURNE OPERATIONAL DATA OVERVIEW PLOT

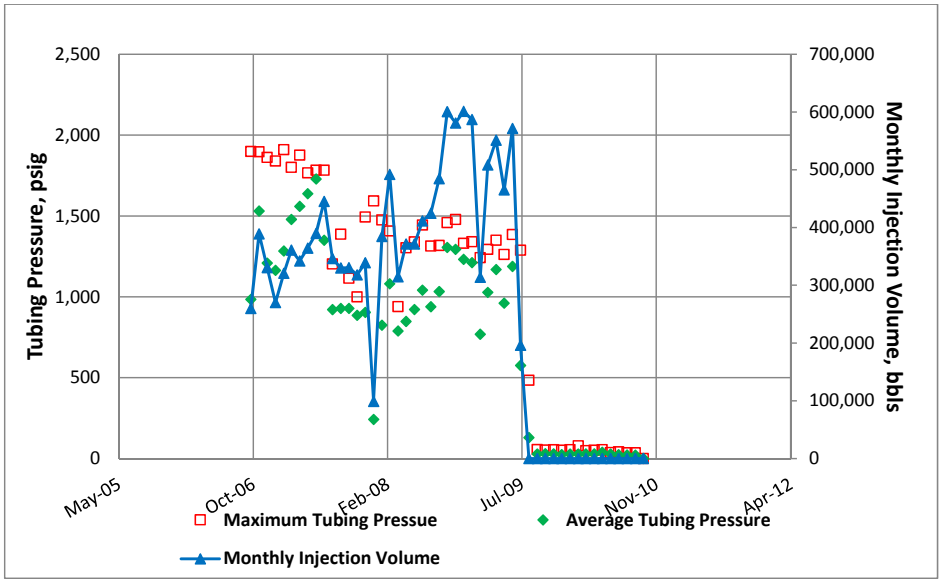


FIGURE E- 27: CLEBURNE YARD OPERATIONAL DATA OVERVIEW PLOT

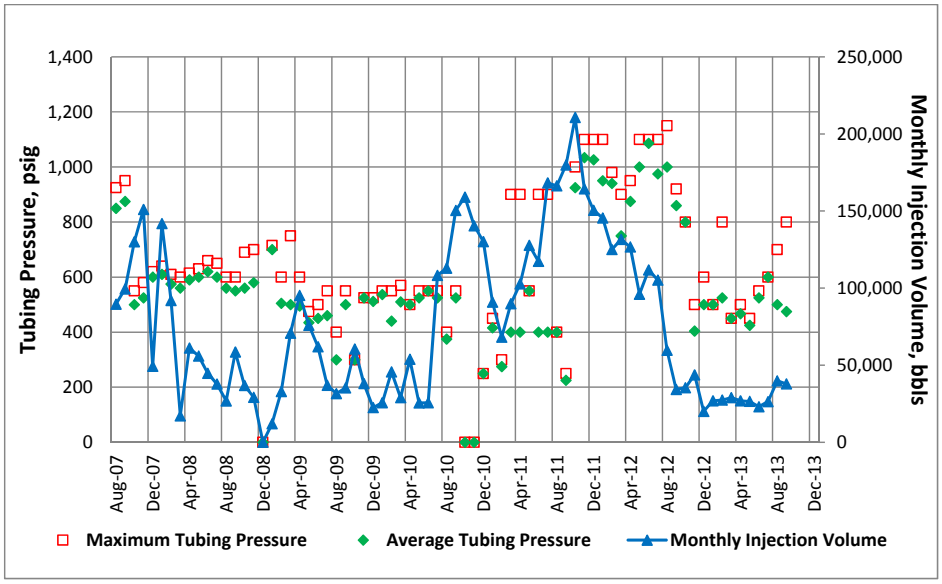


FIGURE E- 28: JOHNSON SALTY II OPERATIONAL DATA OVERVIEW PLOT

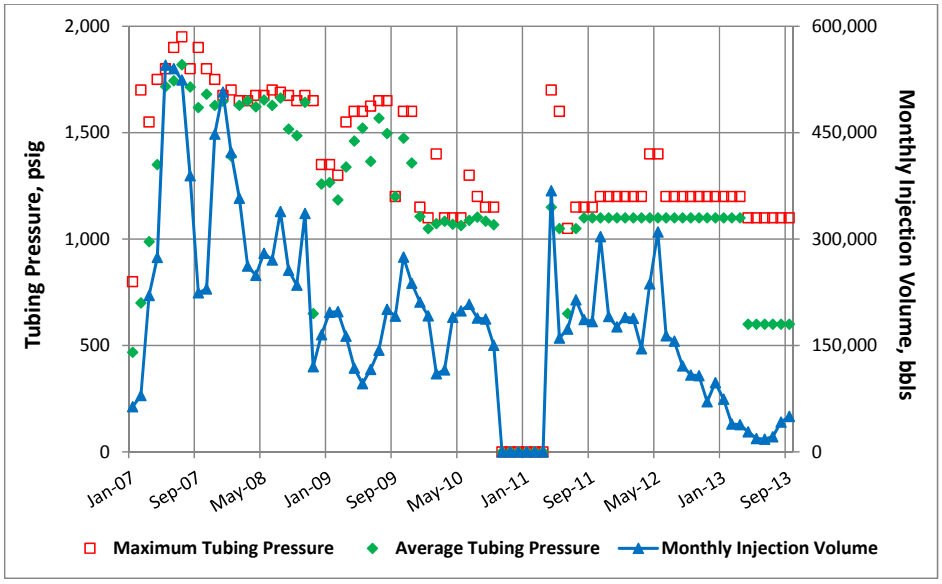


FIGURE E- 29: HANNA OPERATING PRESSURE GRADIENT PLOT

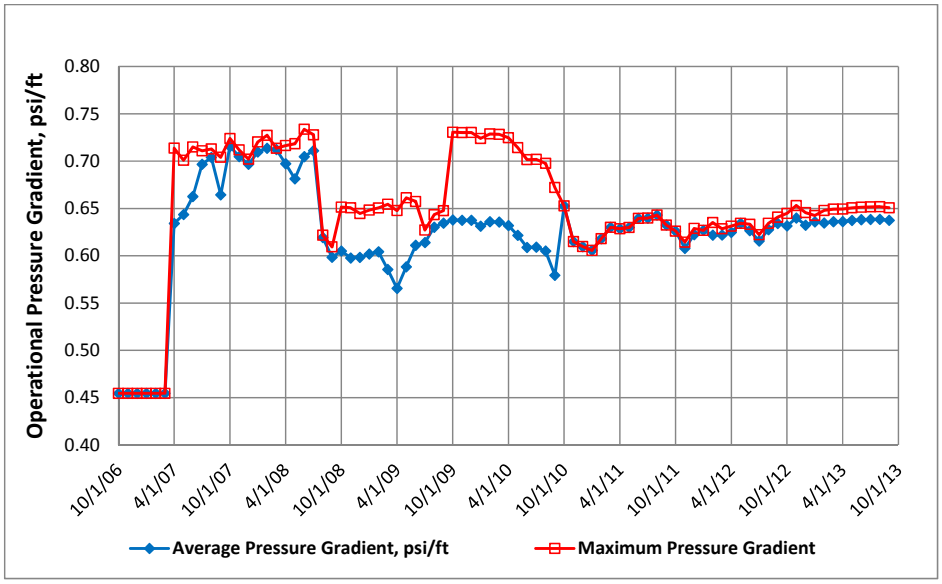


FIGURE E- 30: JOHNSON SALTY III OPERATIONAL PRESSURE GRADIENT PLOT

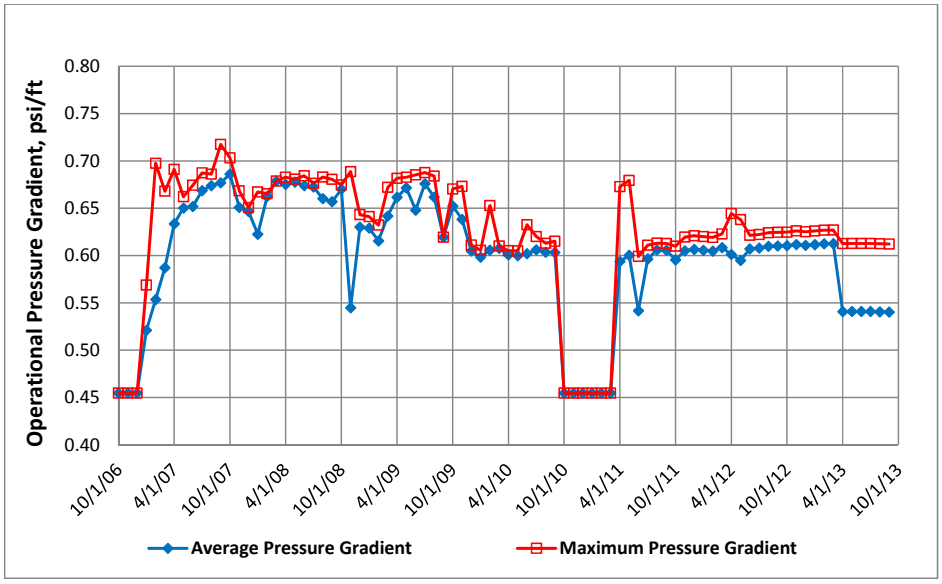


FIGURE E- 31: ROSE OPERATIONAL PRESSURE GRADIENT PLOT

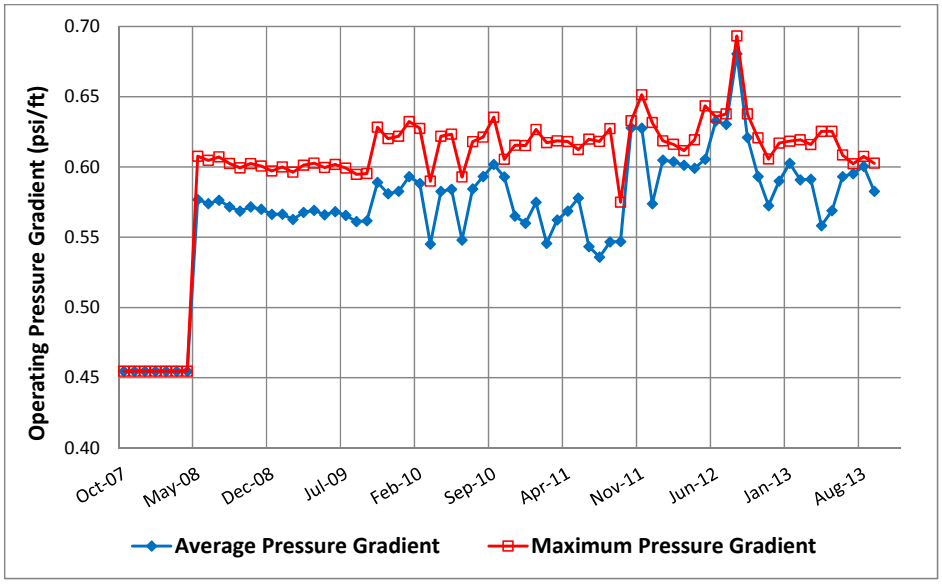


FIGURE E- 32: VORTEX OPERATIONAL PRESSURE GRADIENT PLOT

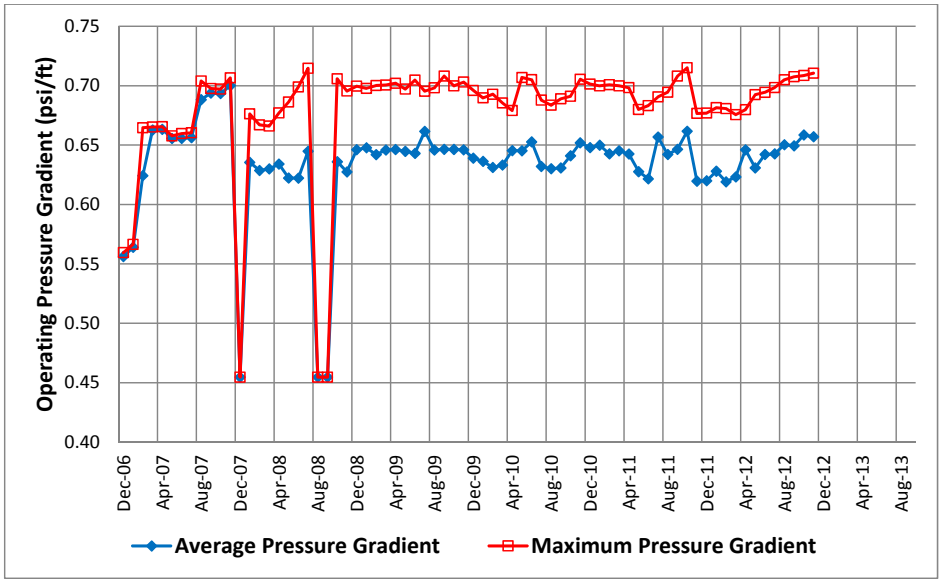


FIGURE E- 33: MANN OPERATIONAL PRESSURE GRADIENT PLOT

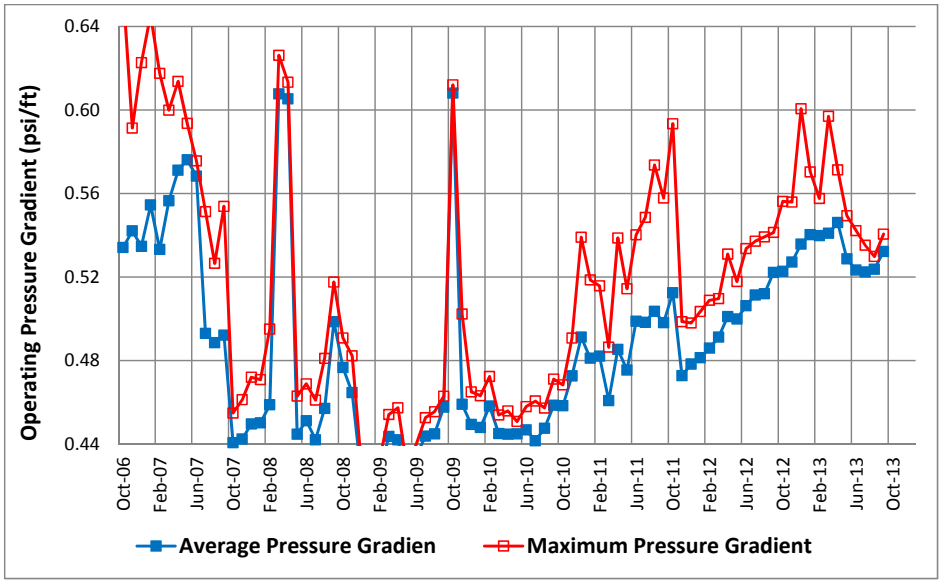


FIGURE E- 34: SPARKS DRIVE OPERATIONAL PRESSURE GRADIENT PLOT

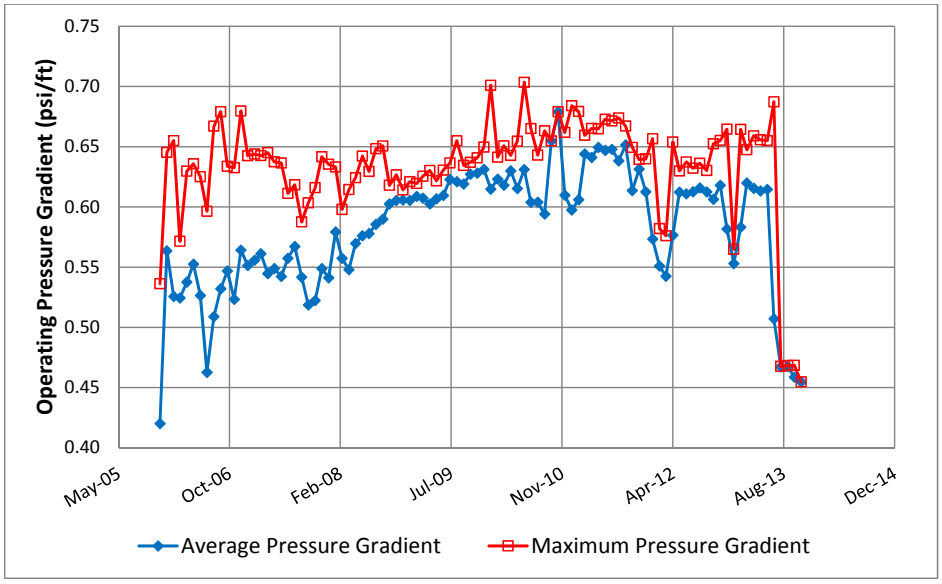


FIGURE E- 35: JOHNSON COUNTY OPERATIONAL PRESSURE GRADIENT PLOT

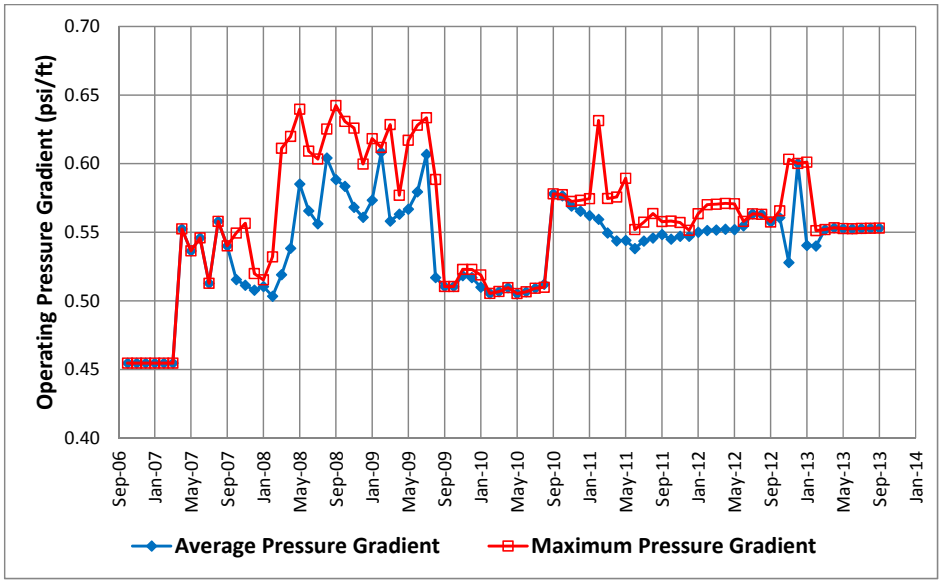


FIGURE E- 36: SOUTH CLEBURNE OPERATIONAL GRADIENT PRESSURE PLOT

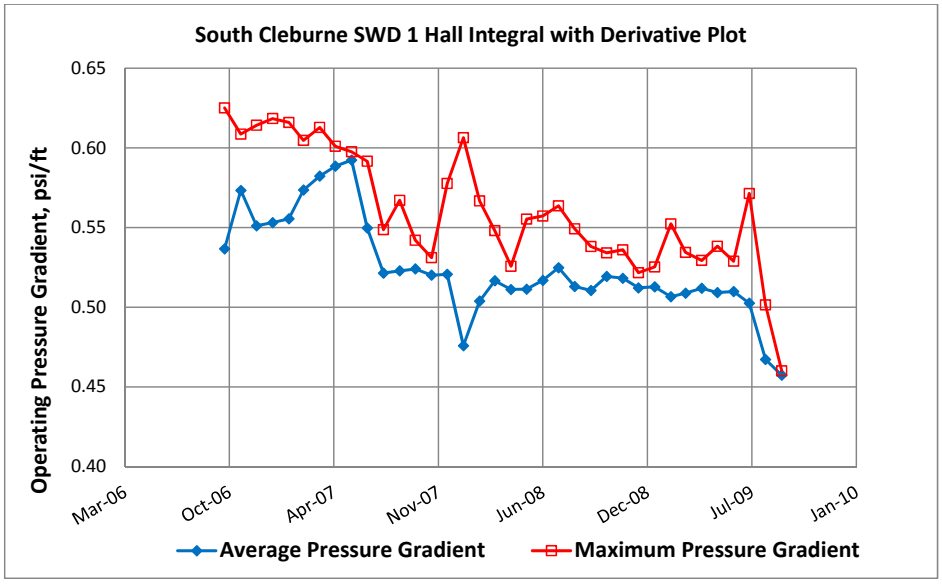


FIGURE E- 37: CLEBURNE YARD OPERATIONAL PRESSURE GRADIENT PLOT

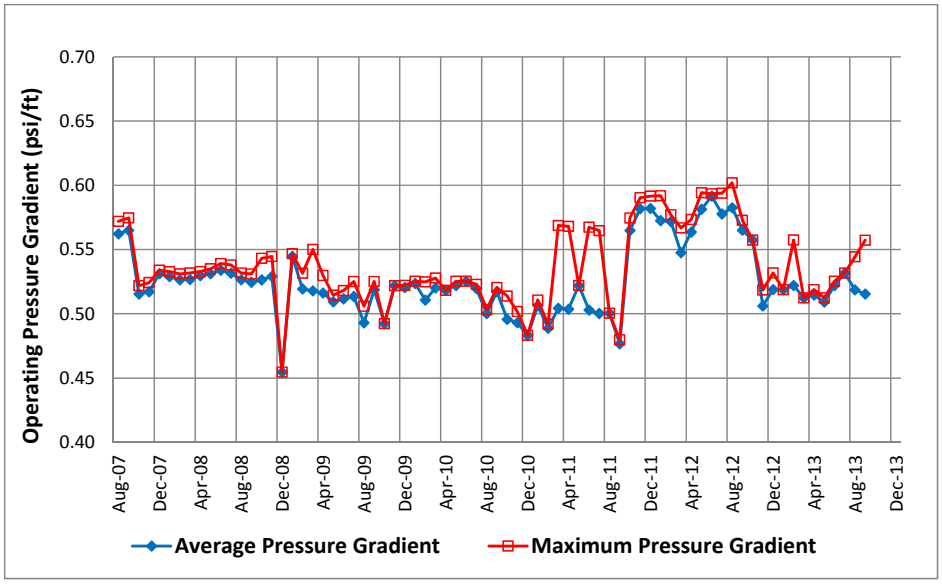


FIGURE E- 38: JOHNSON SALTY II OPERATIONAL PRESSURE PLOT

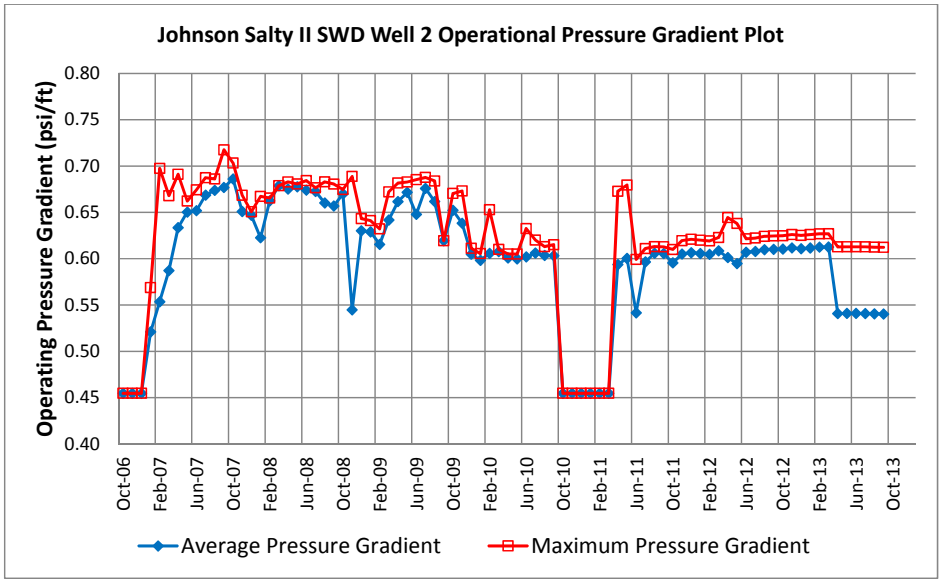


FIGURE E- 39: HANNA TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

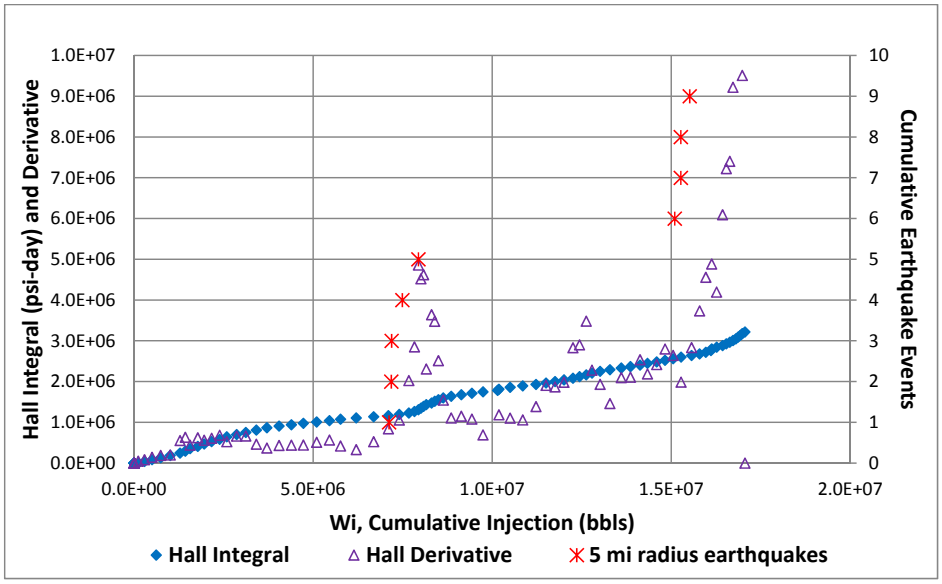


FIGURE E- 40: JOHNSON SALTY III TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

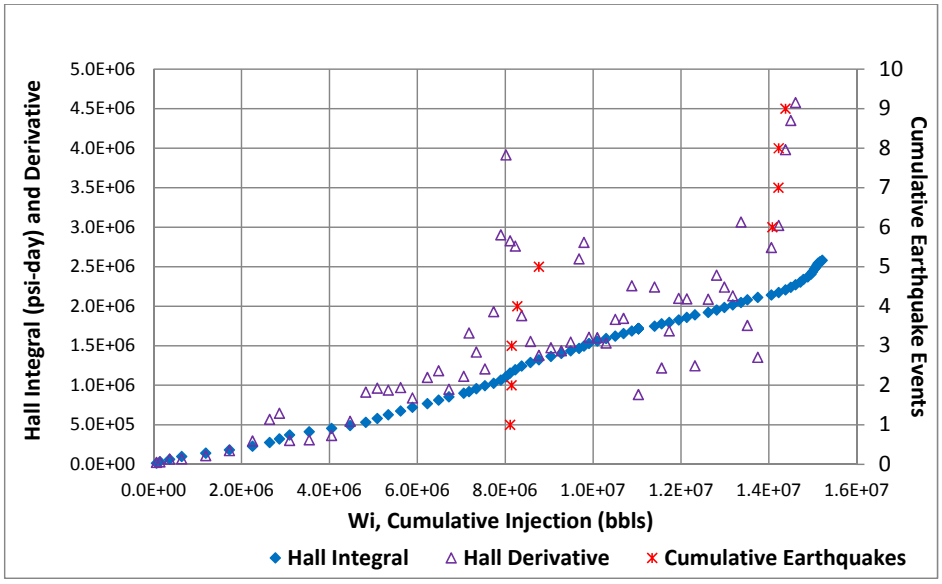


FIGURE E- 41: ROSE TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

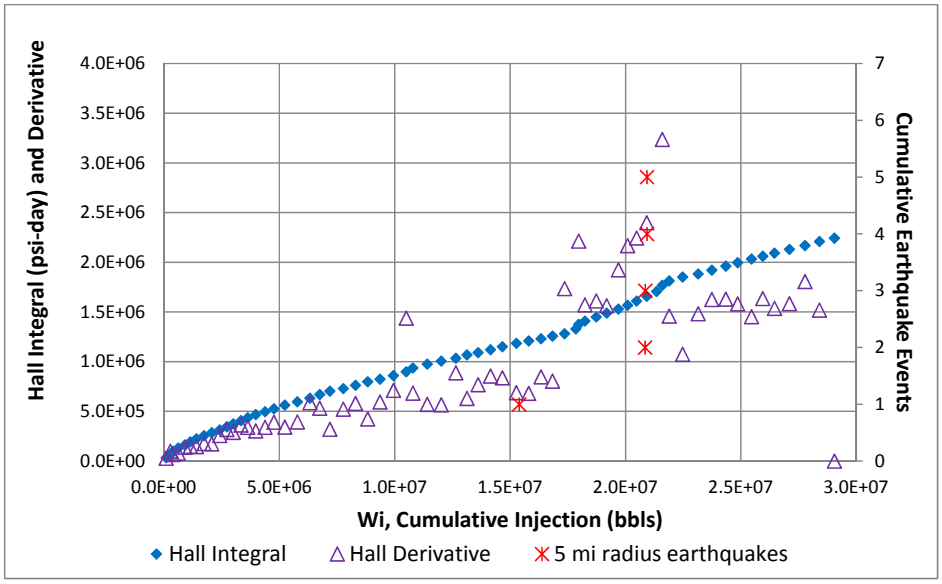


FIGURE E- 42: VORTEX TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

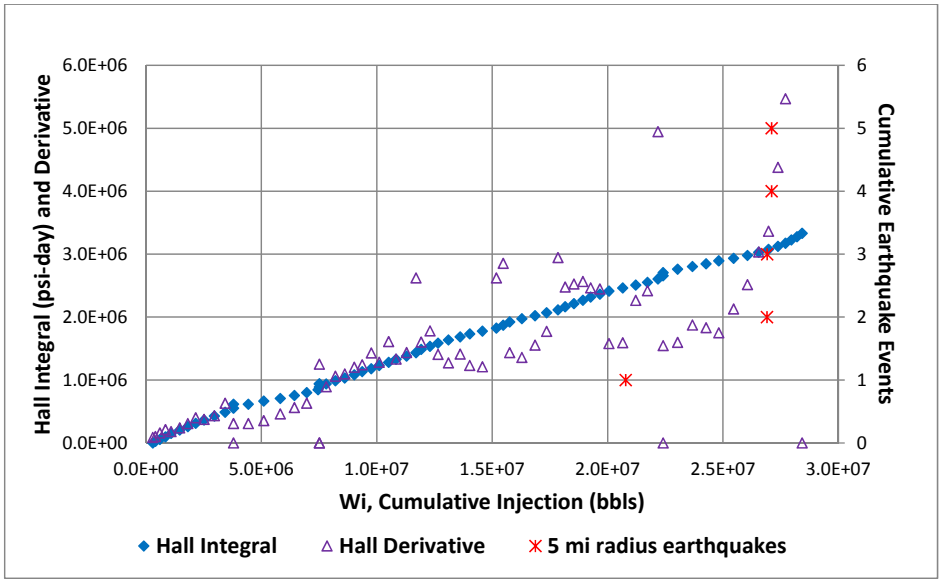


FIGURE E- 43: MANN TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

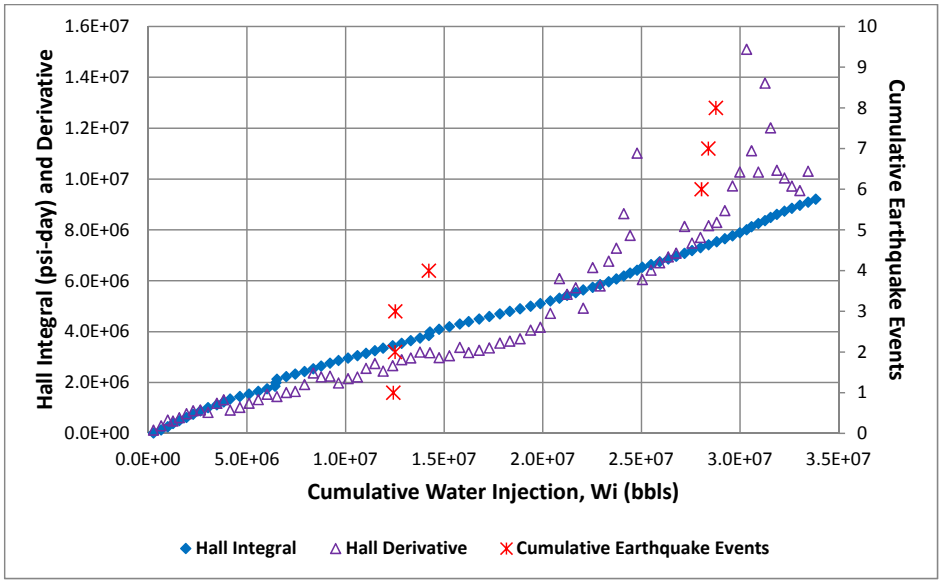


FIGURE E- 44: SPARKS DRIVE TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

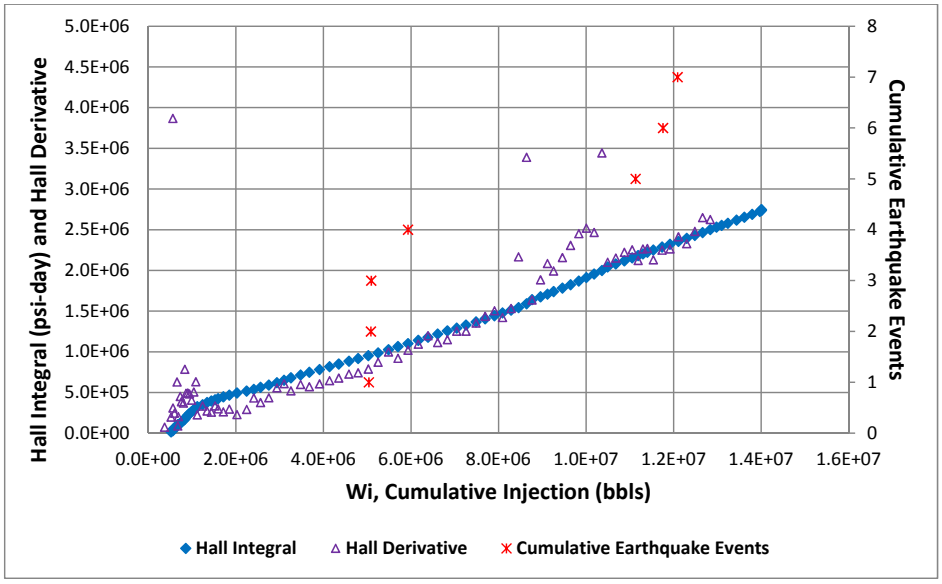


FIGURE E- 45: JOHNSON COUNTY TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

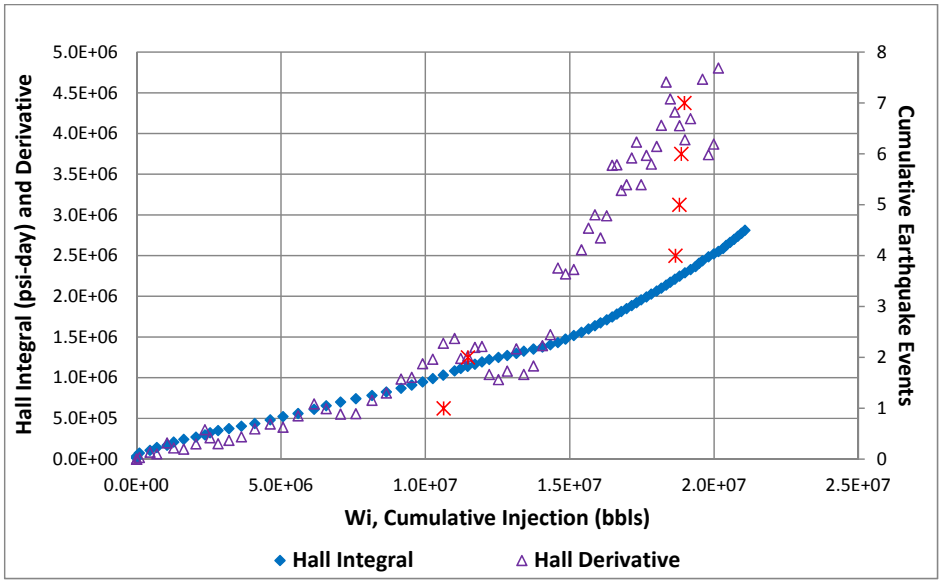


FIGURE E- 46: SOUTH CLEBURNE TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

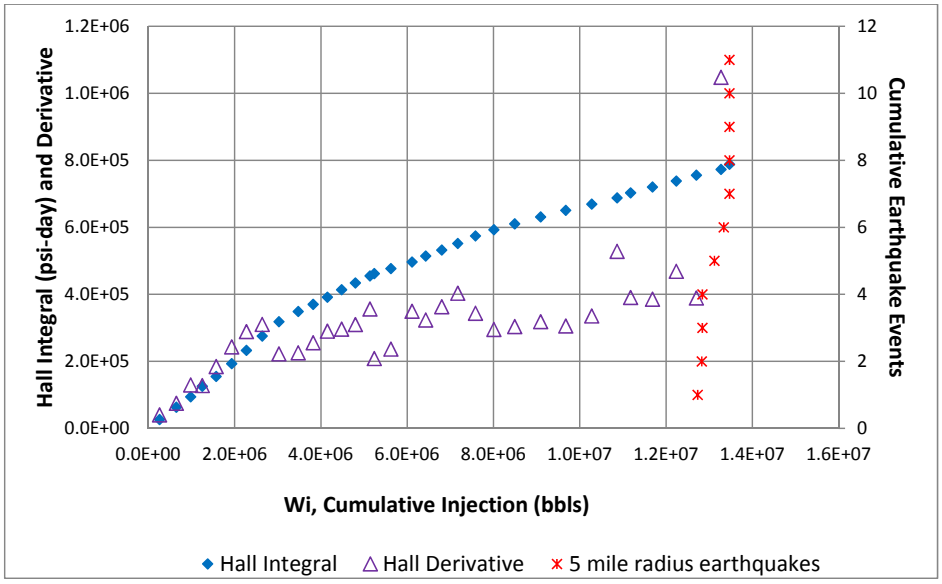


FIGURE E- 47: CLEBURN YARD TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

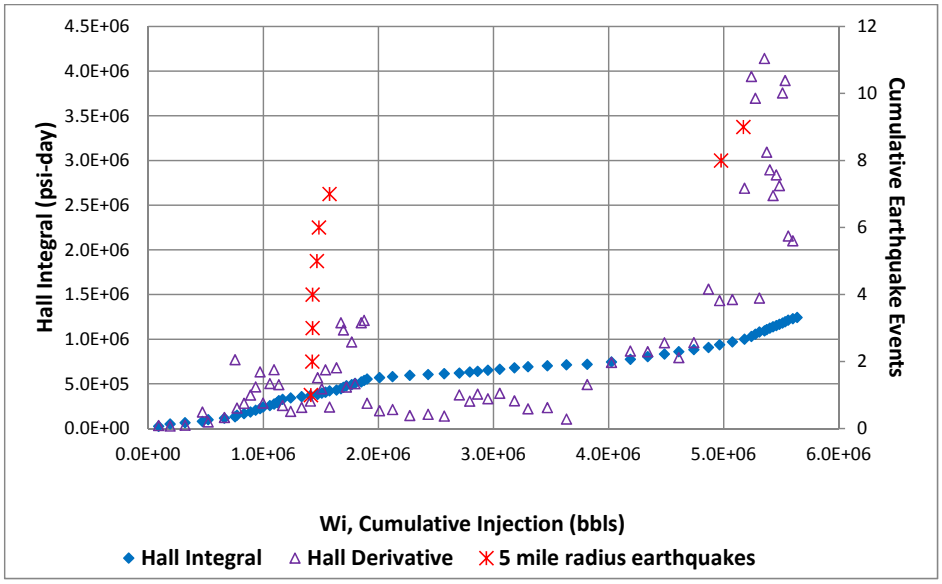


FIGURE E- 48: JOHNSON SALTY II TANDEM PLOT OF CUMULATIVE EARTHQUAKES AND HALL INTEGRAL WITH DERIVATIVE

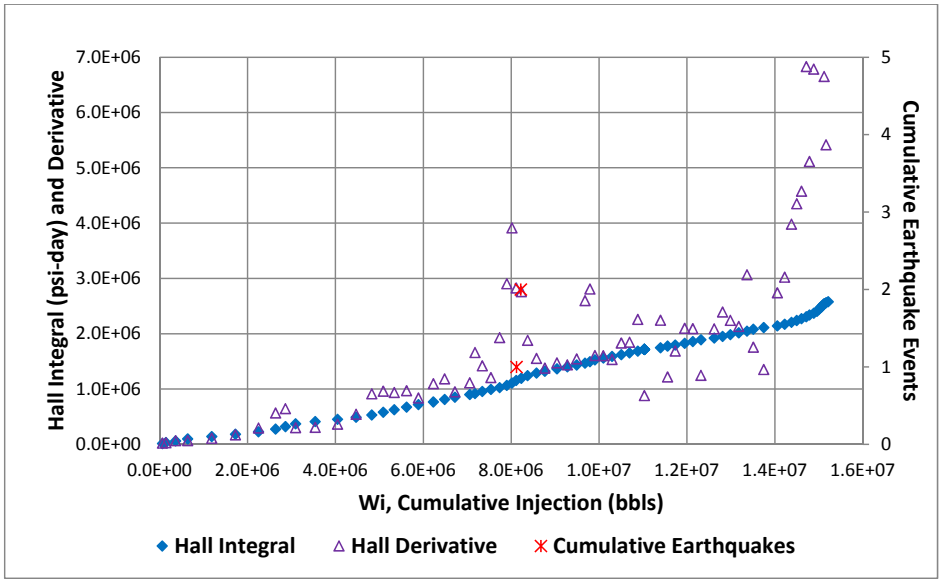


FIGURE E- 49: 2005 SPARKS FALLOFF TEST OVERVIEW PLOT

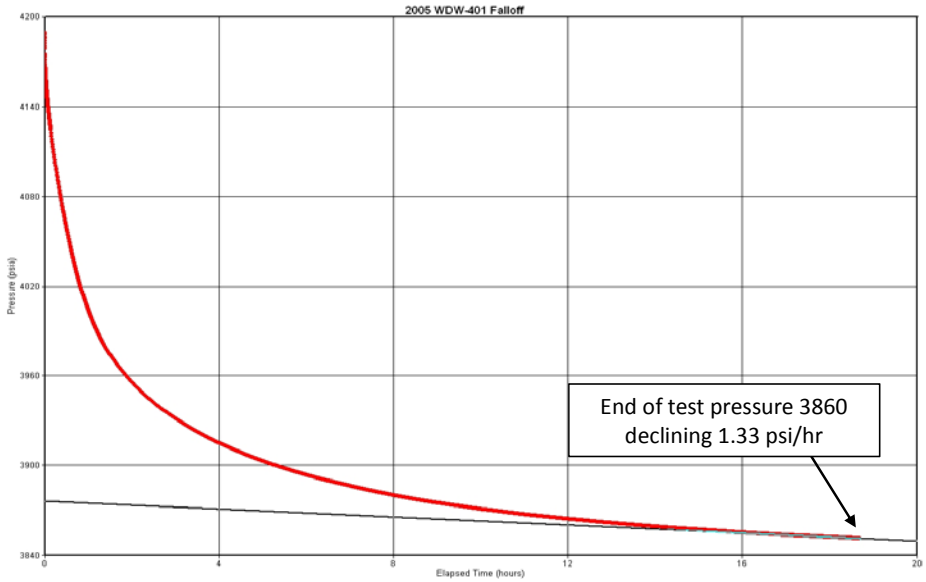


FIGURE E- 50: 2006 SPARKS FALLOFF TEST OVERVIEW PLOT

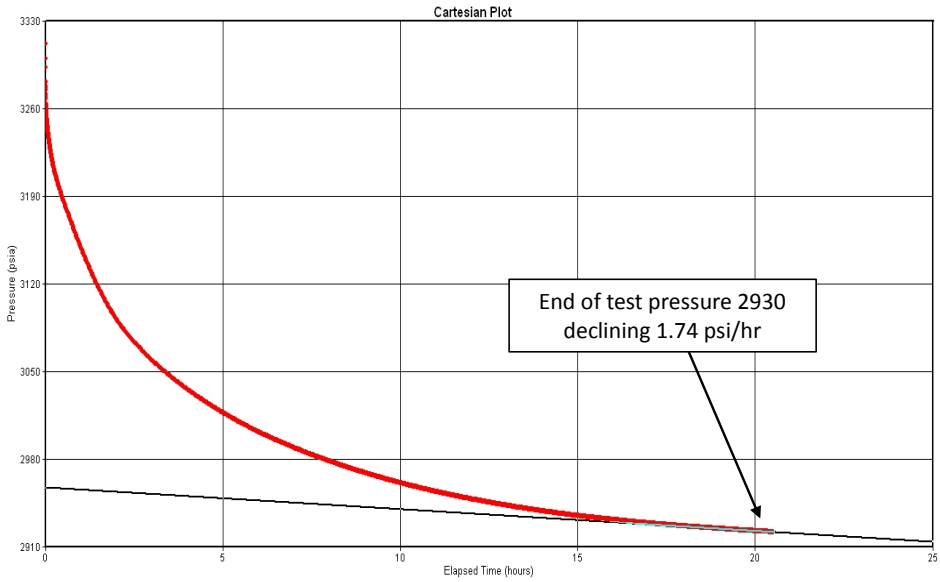


FIGURE E- 51: 2005 SPARKS FALLOFF TEST LOG-LOG PLOT

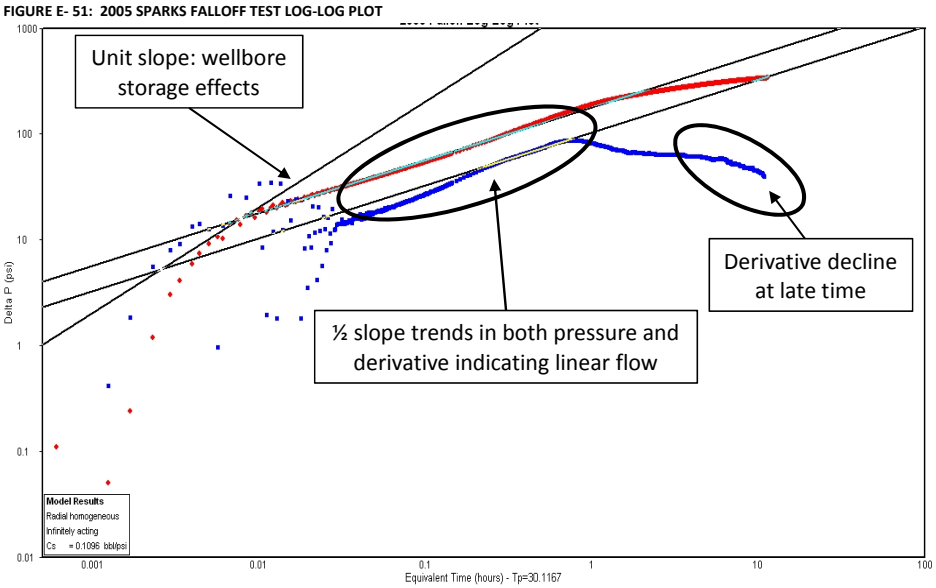


FIGURE E- 52: 2006 SPARKS FALLOFF TEST LOG-LOG PLOT

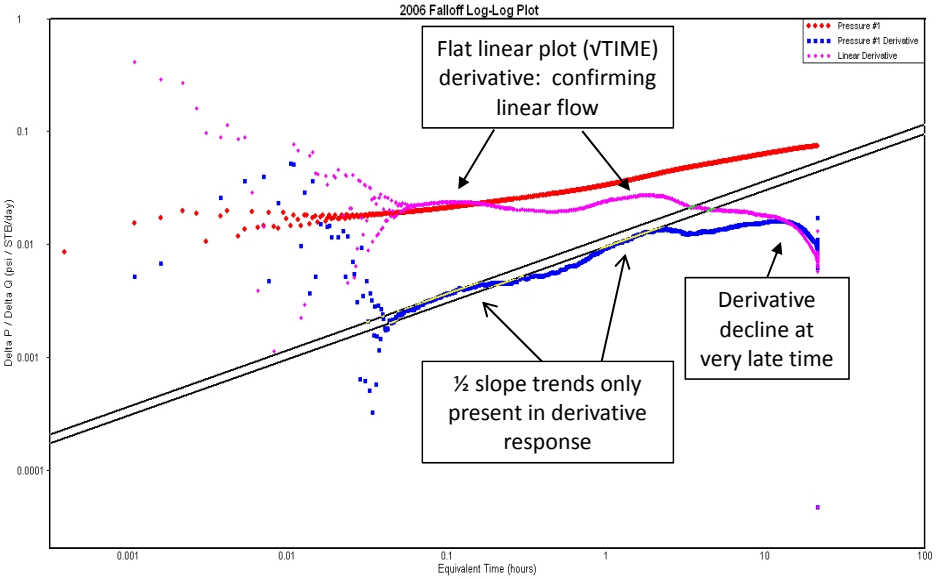


FIGURE E- 53: 2005 SPARKS TYPE CURVE MATCH

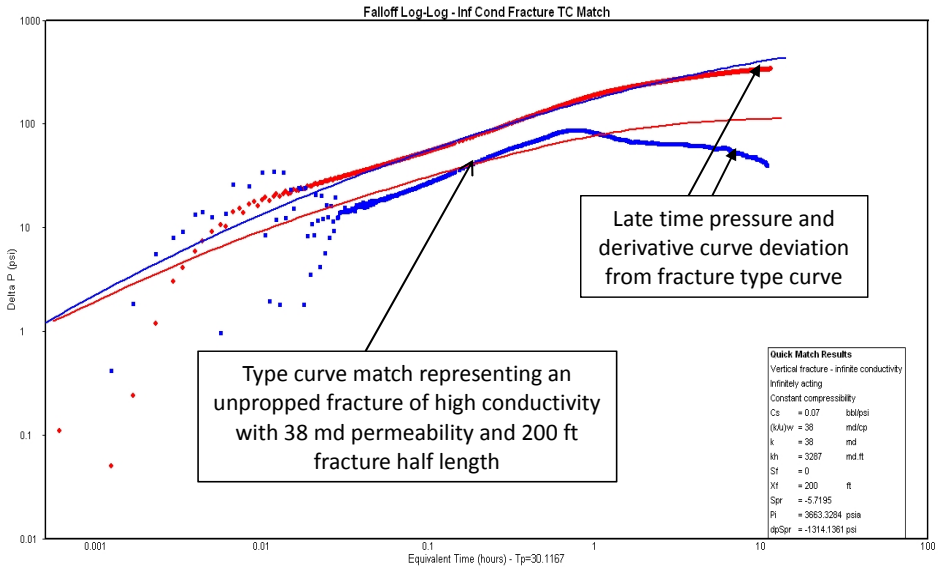


FIGURE E- 54: 2006 SPARKS TYPE CURVE MATCH

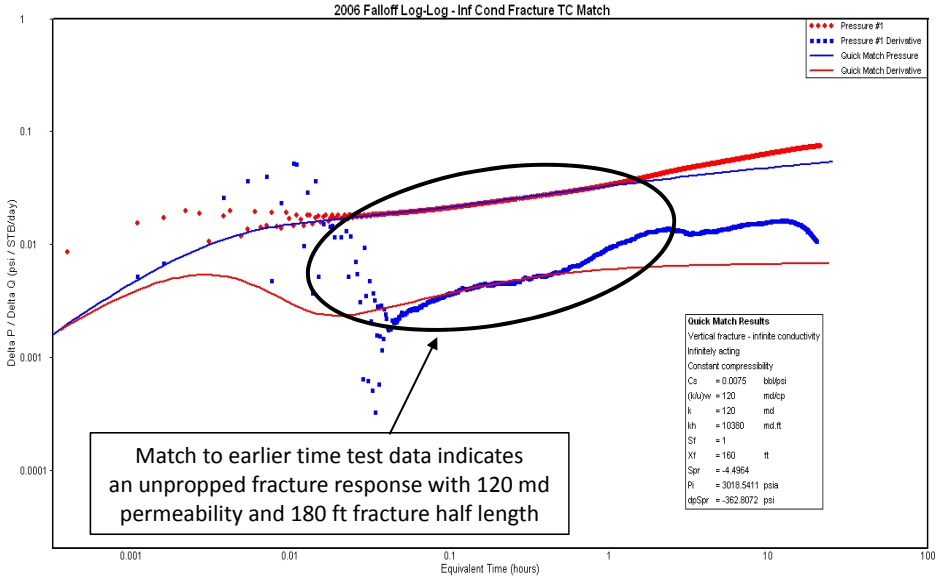


FIGURE E- 55: 2006 SPARKS TYPE CURVE MATCH OF LATE TIME DATA

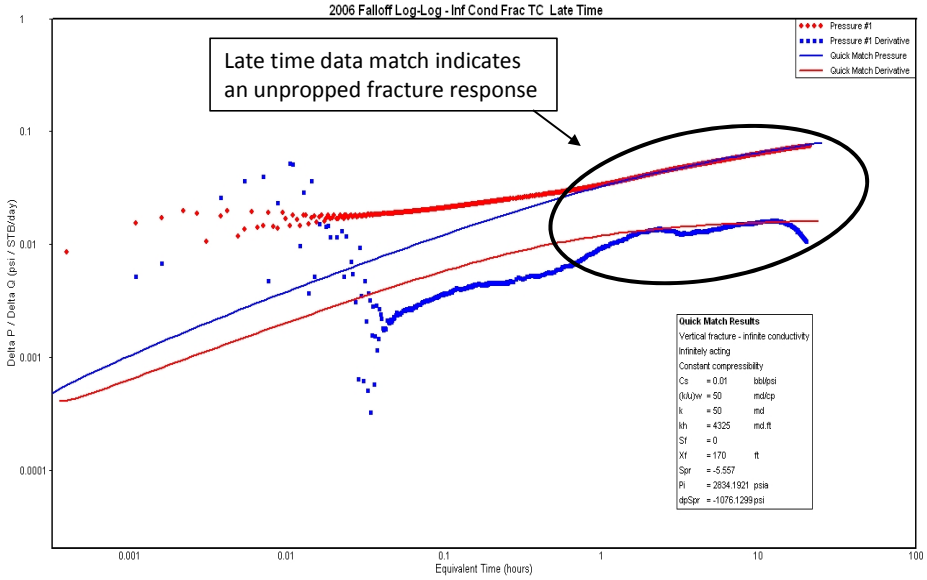


FIGURE E- 56: 2008 SPARKS FALLOFF TEST OVERVIEW PLOT

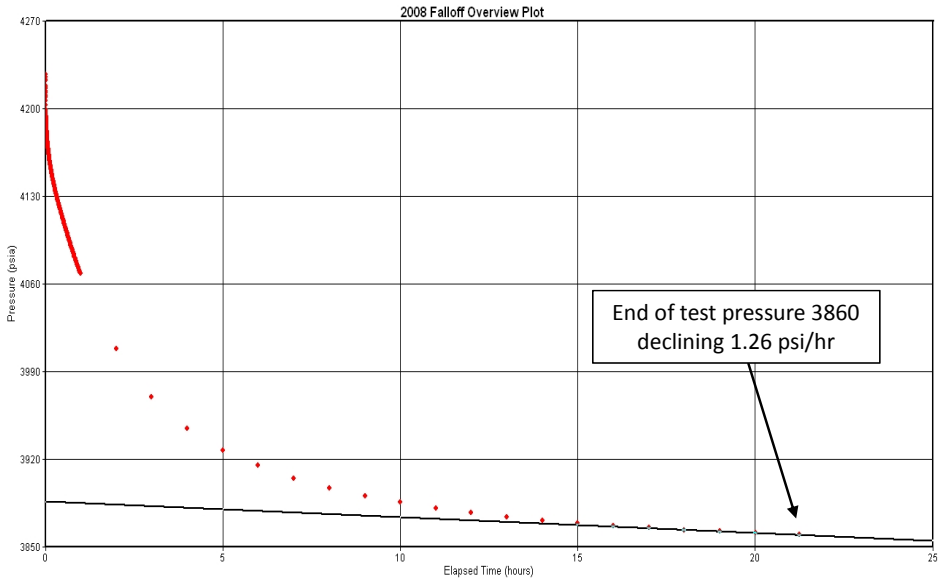


FIGURE E- 57: 2008 SPARKS LOG-LOG PLOT

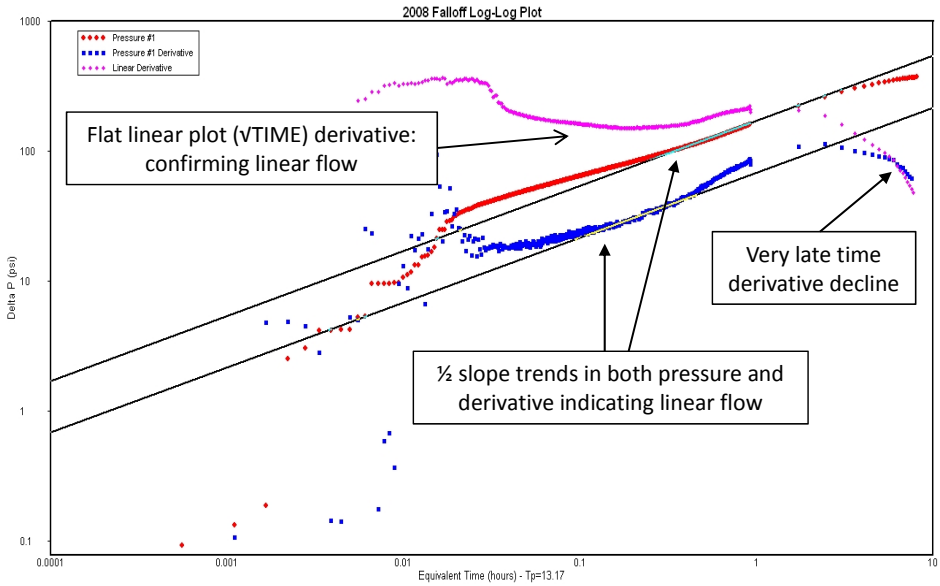


FIGURE E- 58: 2008 SPARKS TYPE CURVE MATCH – HOMOGENEOUS MODEL

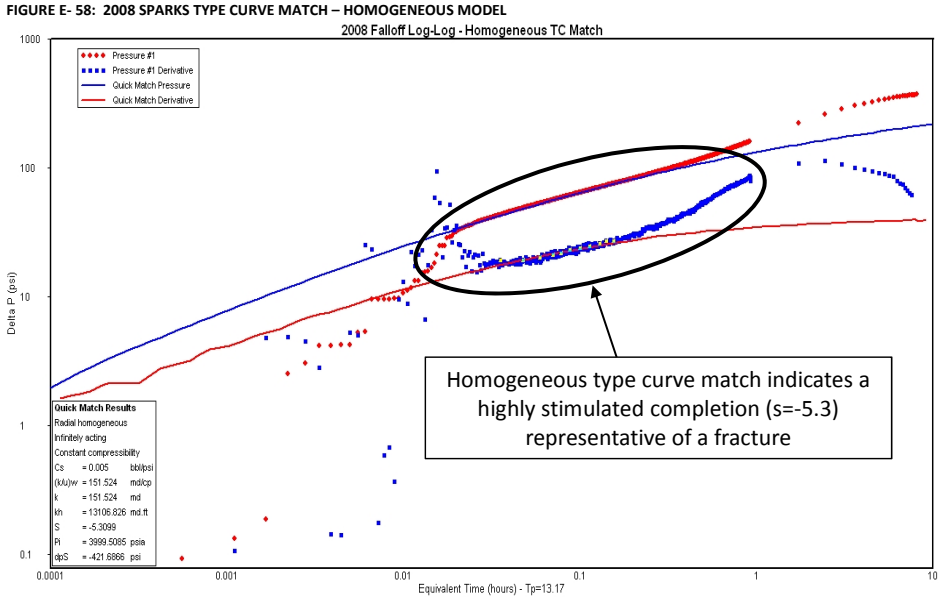


FIGURE E- 59: 2008 SPARKS TYPE CURVE MATCH

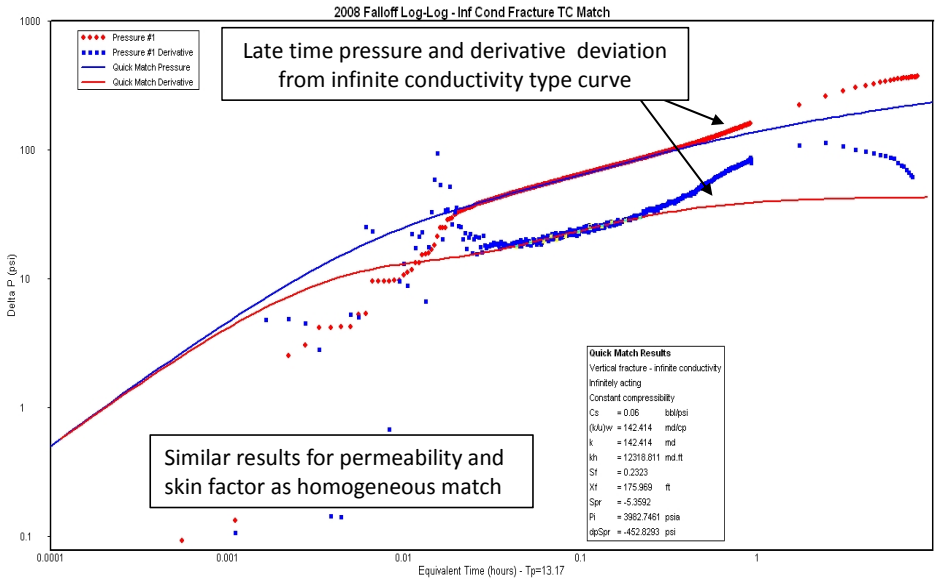


FIGURE E- 60: 2009 SPARKS FALLOFF TEST OVERVIEW PLOT

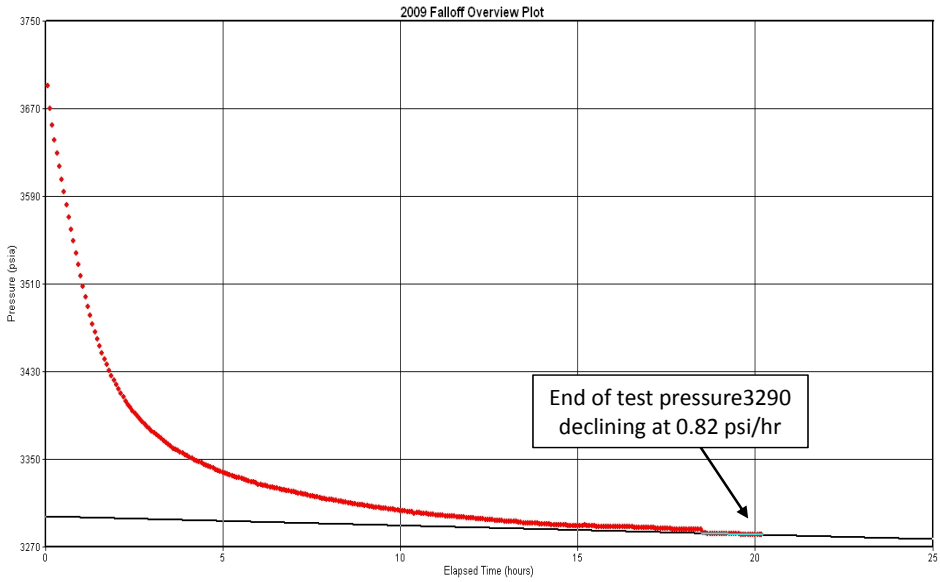


FIGURE E- 61: 2009 SPARKS LOG-LOG PLOT AND TYPE CURVE MATCH

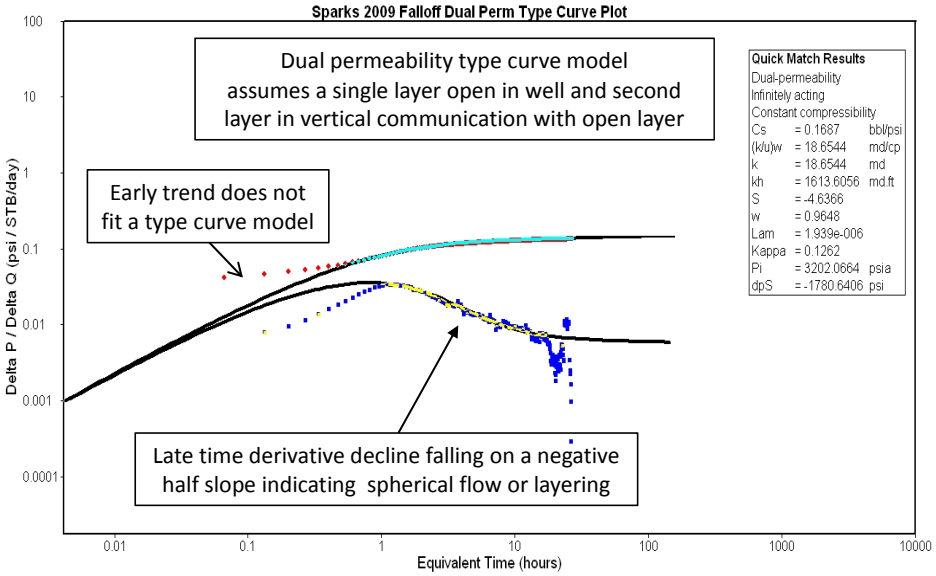


FIGURE E- 62: 2010 SPARKS FALLOFF TEST OVERVIEW PLOT

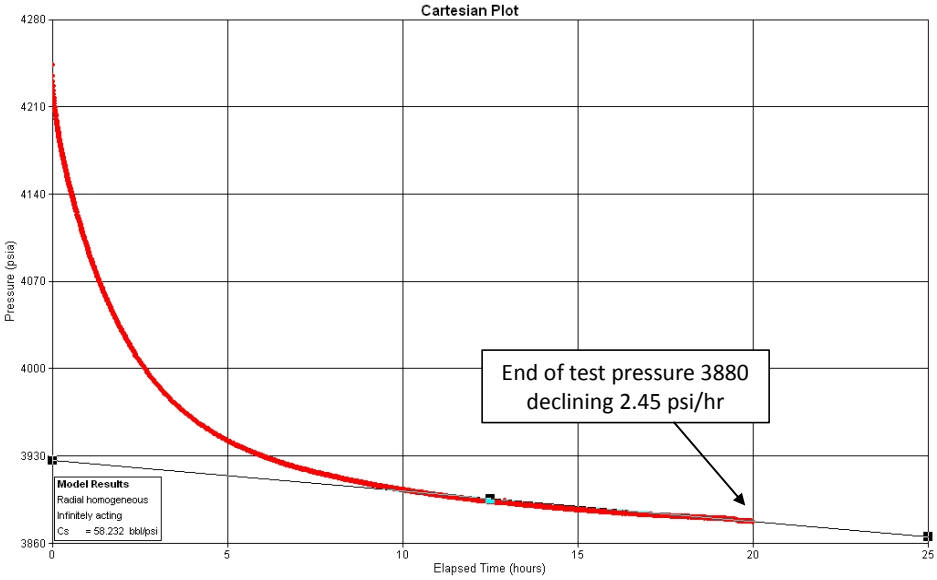


FIGURE E- 63: 2010 SPARKS LOG-LOG PLOT AND TYPE CURVE MATCH

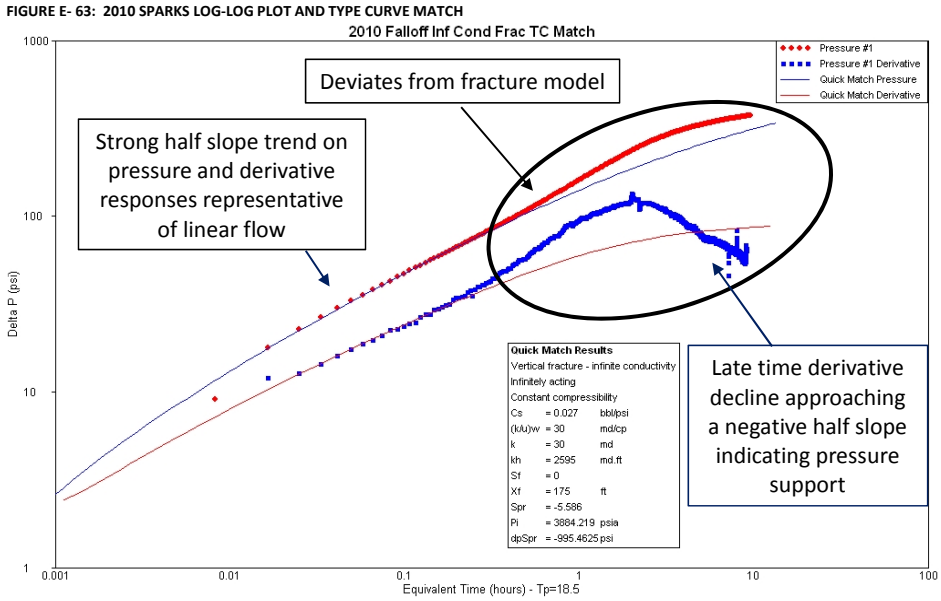


FIGURE E- 64: 2010 SPARKS TYPE CURVE MATCH OF LATE TIME DATA

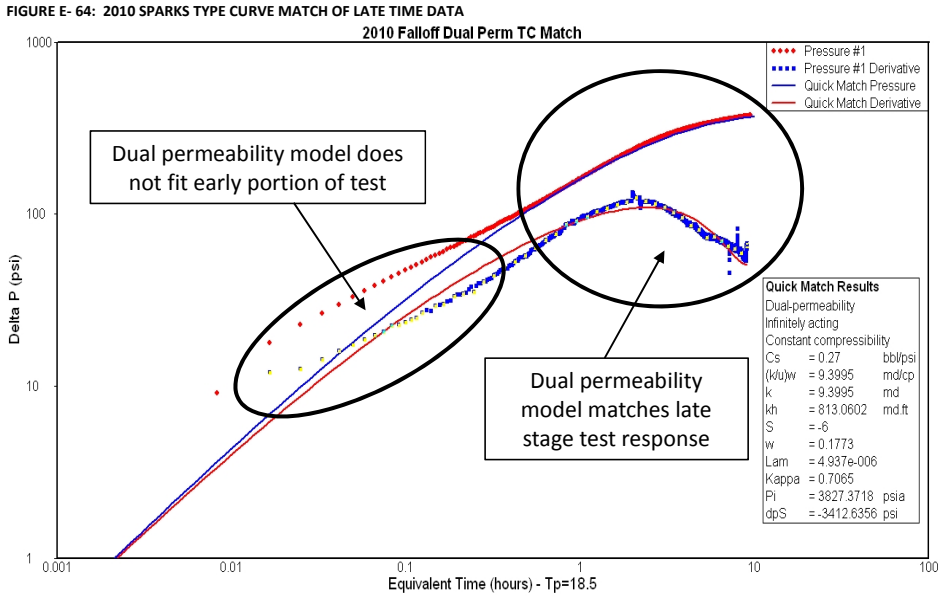


FIGURE E- 65: 2011 SPARKS FALLOFF TEST OVERVIEW PLOT

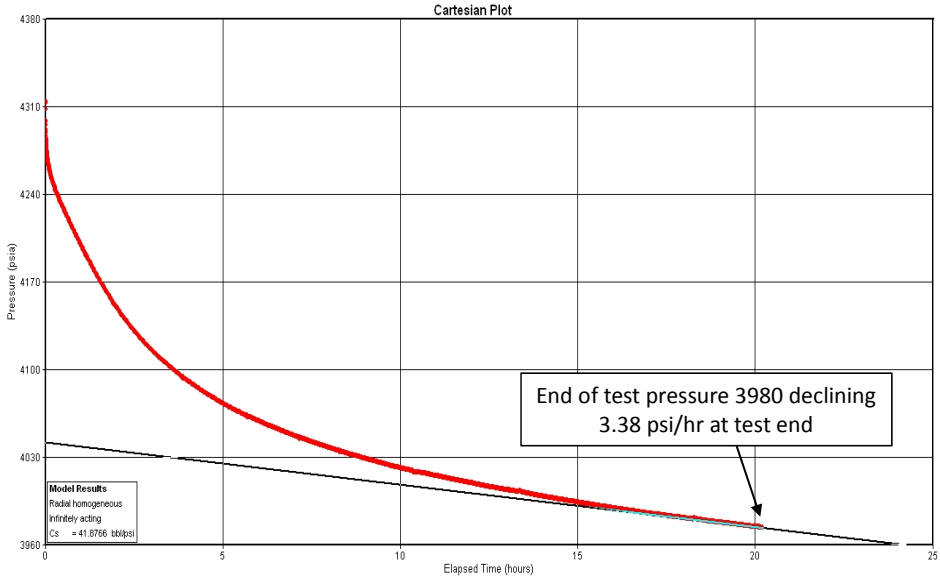
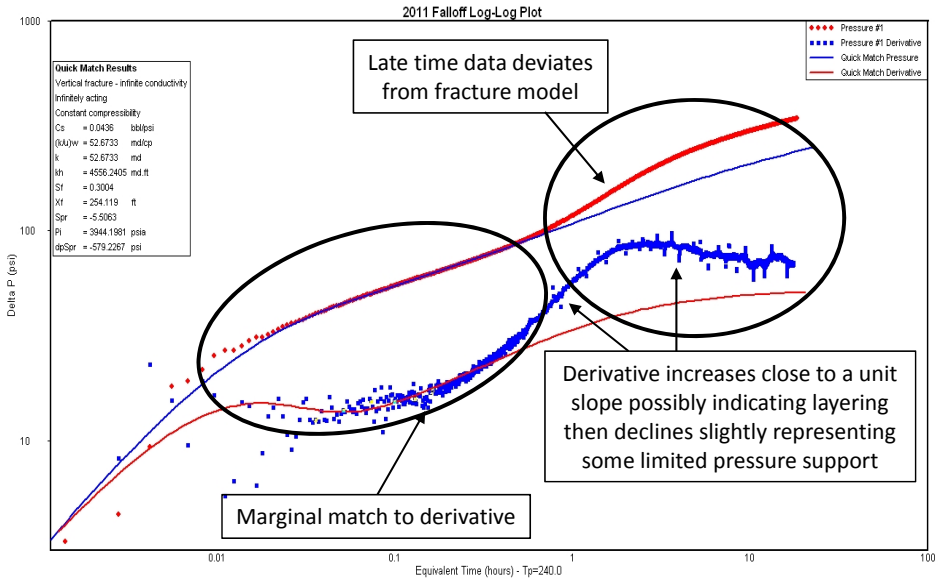



FIGURE E- 66: 2011 SPARKS TYPE CURVE MATCH