Summary of the Geologic, Petrophysical, Reservoir Engineering and Production Forecast Studies at Bush Dome Reservoir

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Disclaimer

- All the simulations, history matching, predictions and forecast performed at Cliffside (Bush Dome) reservoir are based on the information received from BLM and using common reservoir and production engineering solutions. The forecasted values are based on current conditions. Change in reservoir management (especially after 2021), market conditions, operational issues, … could significantly change the results. Edge Geoscience Inc. doesn’t guarantee that the forecasted results will match the reservoir performance.

- Introduction
- Data Review
- Geologic and Petrophysical Studies
- Material Balance Analysis
- Simple and Complex History Matching
- Forecasts
- Conclusions and summary

Introduction

- In 2018, Edge Geoscience Inc. (EGI) was awarded by the Bureau of Land Management (BLM) to perform geologic, reservoir engineering and forecast studies for Bush Dome reservoir until 2023.
- Edge Geoscience Inc. and its staff have proven record of performing similar geologic, geomechanical and reservoir simulation studies for major oil and gas reservoirs globally.
- The previous version of the Geologic model built by Nitech was not accessible and EGI had to build a new geologic model from scratch. Many reservoir engineering models and production forecasts were unavailable/unclear.
- The current version built by EGI is much more detailed, follows common commercial format and has improved history matching and forecast quality.
- EGI was able to successfully rebuild the models in relatively short time frame

Data Review

Available: Old Well Logging Data, Inj. & Prod. Data

Unavailable:

- SCAL core data
- PVT lab data
- Seismic Data
- Digital 2D/3D Geologic Model
- Reservoir Fracture Characterization
- Rock Mechanical/ Geomechanical Data

GEOLOGIC AND PETROPHYSICAL STUDIES

Geologic and Petrophysical Model Generation

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1. Data Gathering and Validation √
2. Stratigraphic and Sequential Model √
3. 2D Structural Model √
4. 3D Structural Model √
5. Petrophysical Model √
6. Mapping (Net Pay/ Net to Gross) and Iso-Properties maps (porosity, permeability, volume of clay and water saturation) √
7. 3D Grid Generation √
8. Calculation of OGIP √

Permeability Summary

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Formation	Interpreted Geological Layer	Bi-A1	Bi-A2	Bi-A3	Bi-A4	Bi-A5	Bi-A6	Bi-A7	Bi-A9	Bi-A10	Bi-A11	Bi-A13	Bi-A14	Bi-A15	Bi-B1	Bi-B2	Bu-A1	Bu-A2	Bu-A3	Bu-A4	Bu-A5	Bu-A6	Bu-A7	Bu-A8	Bu-A9	Bu-A10	Bu-A11	Bu-B1	Bu-B2	Fu-1	Fu-A1	Fu-A2	Fu-A3
Panhandle	P-1																																
	P-2																																
	P-3																																
	P-4																																
	P-5		---	---	1.646	19.13	---	12	---	0.349	---	1.356	---	---	---	---	1.2	---	---	12.45	---	2.5	3.59	---	2.984	---	---	1.2	41.6	---	6.25	3.94	---
	P-6	---	---	0.852	---	12.48	---	9	---	0.825	---	1.211	---	---	---	---	10	---	47.3	45.15	---	4.66	---	9.54	1.542	---	---		---	---	7.1	4.68	---
	P-7	---	1.105	0.376	---	---	---	---	---	1.011	---	1.632	---	---	---	---	5	---	3.3	---	2.49	3.36	3.6	---	3.593	---	---		---	---	12	36.9	---
FS BROWN DOLOMITE		2	2	1	1	2	1	2	2	2	1	2	2	2	1	1	2	3	2	1	2	1	2	2	2	1	2	2	2	2	2	2	1
Bronw Dolommite	L-1	0.84	---	1.83	---	79.74	---	50.00	1.41	1.24	---	1.432	---	---	---	---	3	4	0.74	---	20.50	3.19	7.23	---	3.37	---	---	2.00	21.15	---	1.00	37.7	3.26
	L-2	0.83	0.33	1.79	0.83	4.72	0.84	3.00		1.53	---	7.066	---	---	---	---	1	1	0.76	---	7.75	0.91	3.27	---	2.97	15.63	---	0.91	13.28	12.00	8.00	1.72	1.83
	L-3	1	3.44	---	1.69	7.58	0.83	3.00	0.74	---	0.05	6.412	---	13.8	---	---	12	9	2.52	13.05	3.58	1.44	4.48	---	2.48	3.64	0.51	1.42	16.53	3.64	6.00	3.21	---
	L-4	14	15.17	0.20	5.10	13.75	1.04	14.00	22.05	0.37	1.40	14.245	0.57	13.9	8.21	---	5	3	3.09	17.74	32.38	---	4.64	14.31	1.11	8.84	16.89	---	11.73	8.84	0.83	1.19	0.74
	L-5	20	5.84	0.80	2.65	21.78	1.95	22.00	16.64	0.67	3.43	11.005	11.1	5.42	6.12	11	10	5	13.10	7.36	23.87	5.66	11.37	9.77	4.13	1.58	46.97	4.66	19.57	1.58	8.00	1.5	2.06
	L-6	1	2.00	4.30	3.01	1.08	5.88	1.00	49.40	---	1.02	2.457	9.436	4.91	3.43	0.57	8.2	3.2	9.10	8.20	43.40	24.08	---	52.25	5.81	1.67	12.50	24.08	7.21	1.67	30.50	5.63	28.55
	L-7	---	3.60	4.29	5.15	---	20.54	---	73.39	1.81	1.38	2.230	14.87	7.72	5.84	0.23	12	15	0.50	---	---	23.69	---	5.74	3.61	---	11.17	23.69	14.57	---	60.00	7.1	80.87
	L-8		---	55.62	---	---	---	---	---	---	1.66	21.559	10.95	42.1	23.2	---	---	---	---	---	---	---	---	35.51	---	---	5.75	3.00	---	---	1.00	---	---

Samples of Petrophysical Interpretations at each layer (Here:L01)

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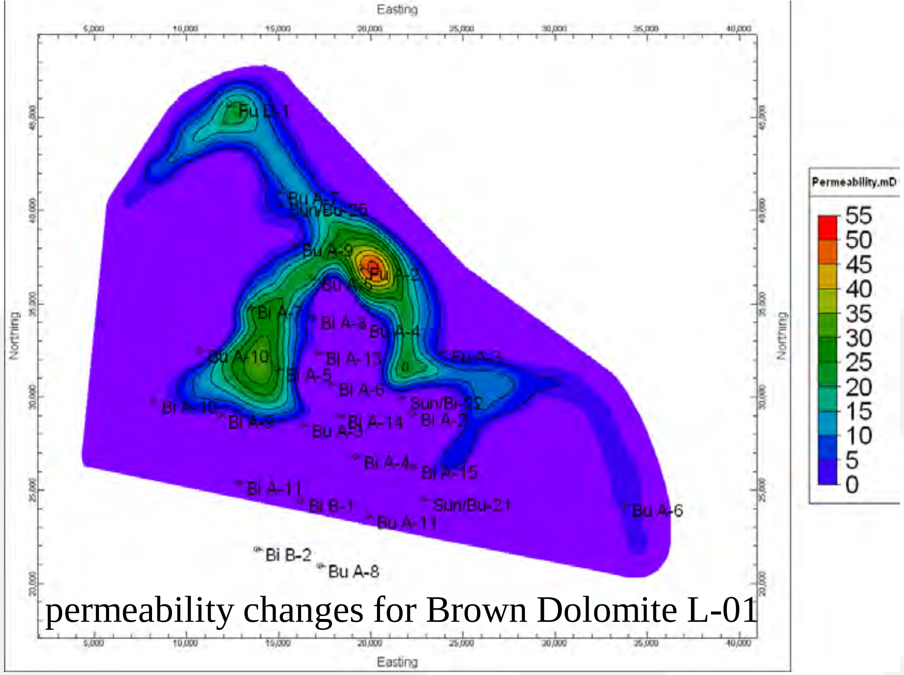
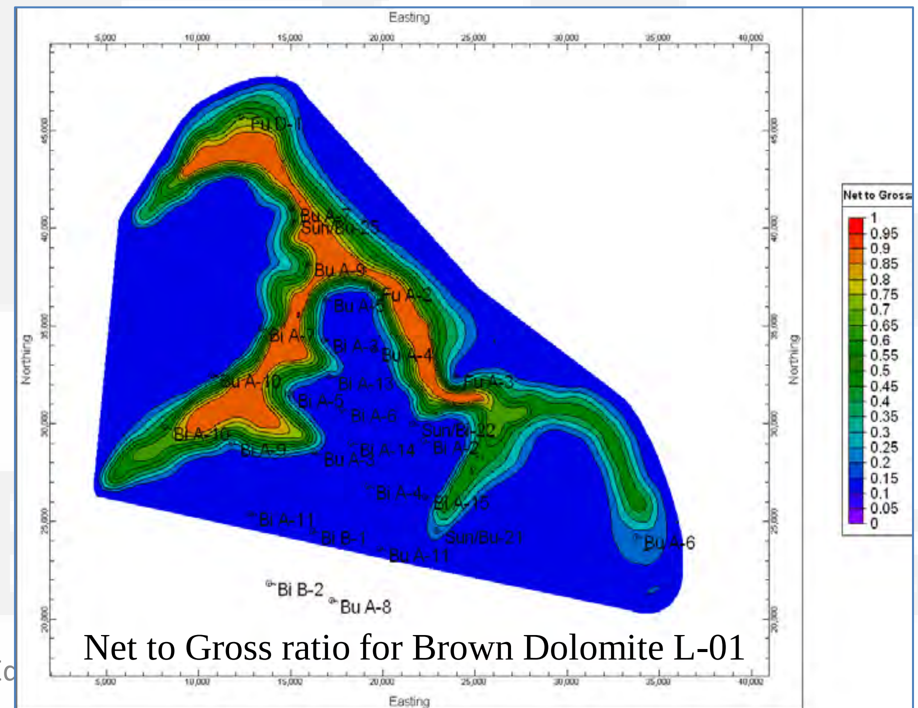
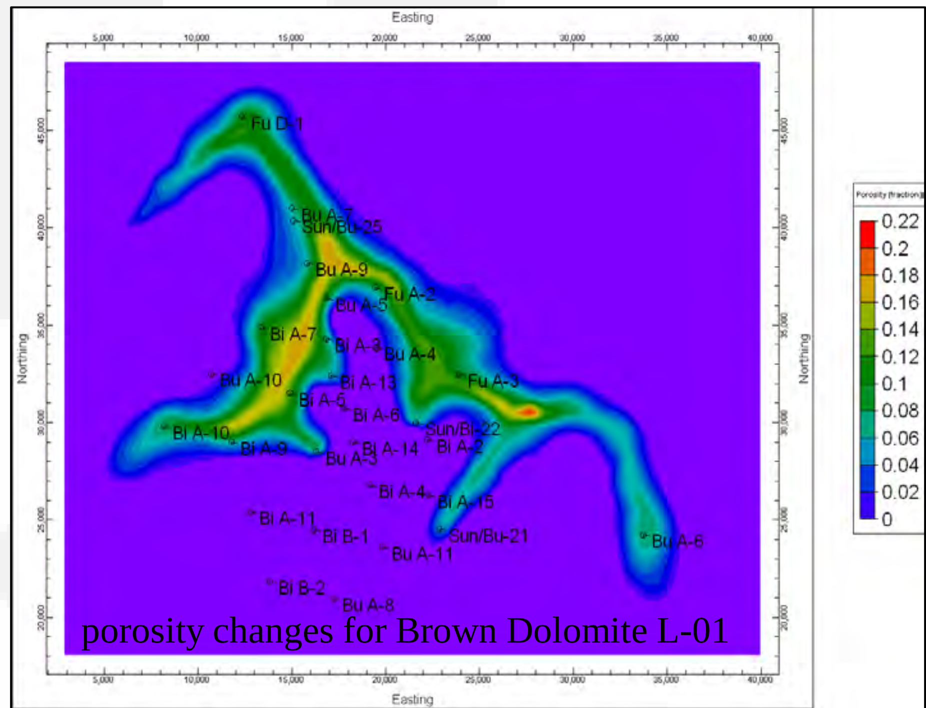


permeability changes for Brown Dolomite L-01



Net to Gross ratio for Brown Dolomite L-01



porosity changes for Brown Dolomite L-01

Building the New Geologic Model (Structural Model)

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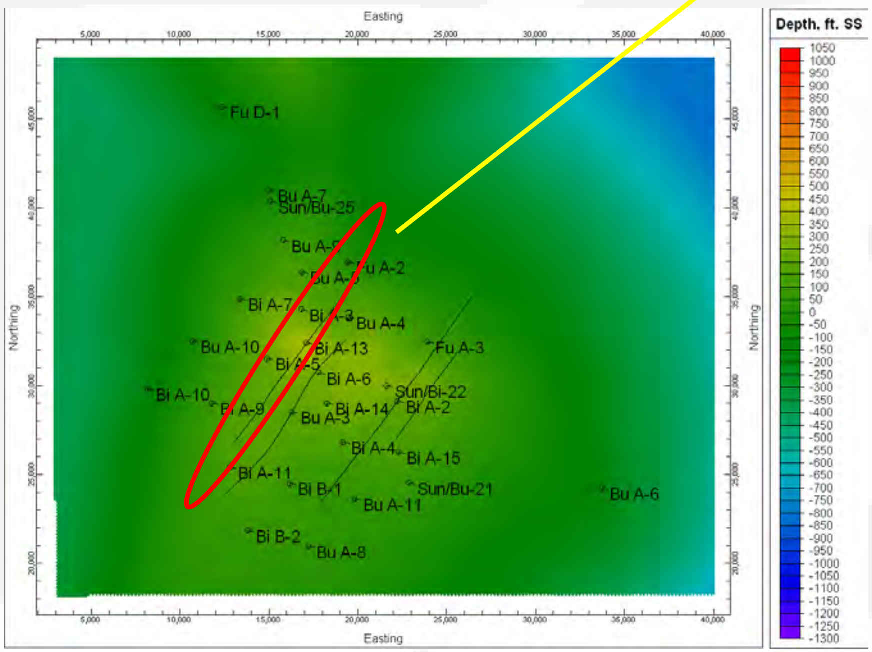
Structural Pattern: Anticline (Dome)

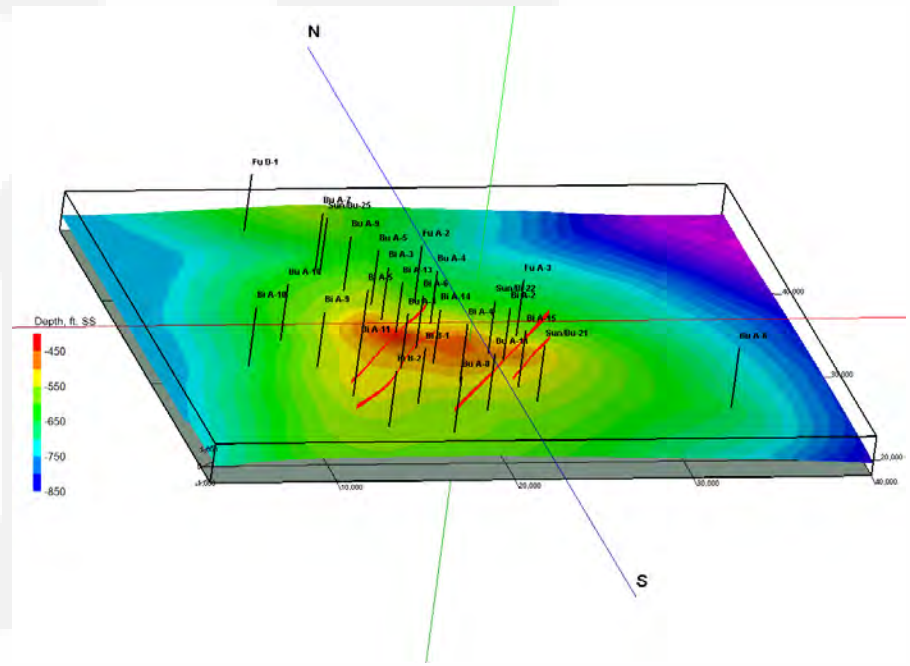
New Fault interpreted

2D Model



Top of Layer L-01_Brown Dolomite

3D Model



Top of Layer L-01_Brown Dolomite

17 Surfaces:

1 Surface Red - Cave.

7 Surfaces P-01 to P-07 (Panhandle Limestone).

9 Surfaces L-01 to L-09 (Brown Dolomite).

12 Horizons:

3 Surfaces P-05 to P-07 (Panhandle Limestone).

9 Surfaces L-01 to L-09 (Brown Dolomite).

4 faults (2 Normal and 2 reverse).

3D View of the Geologic Model

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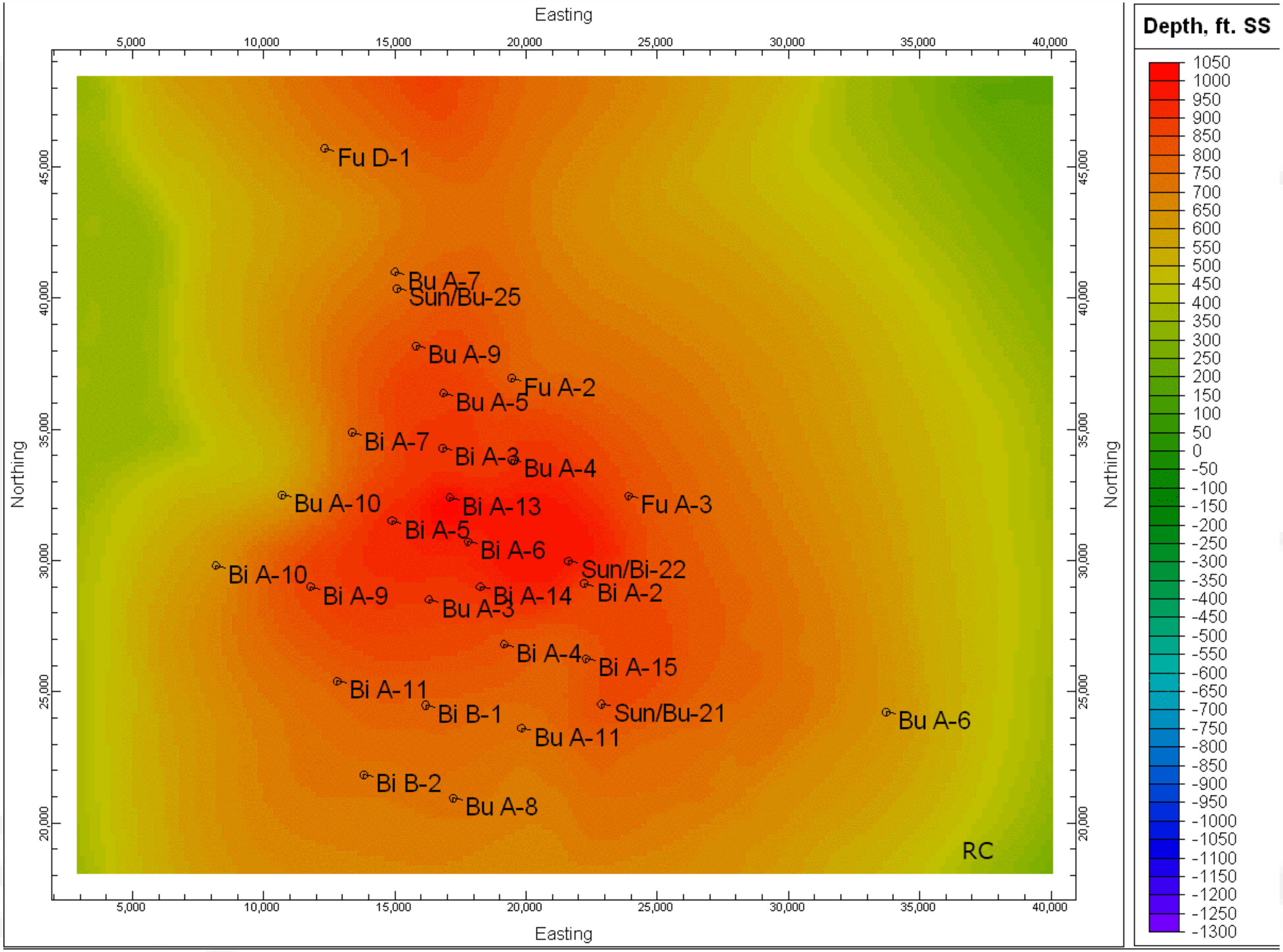
Formation Tops (Animated)



Gridding of Geologic Model for Application in Reservoir Simulator (Animated)

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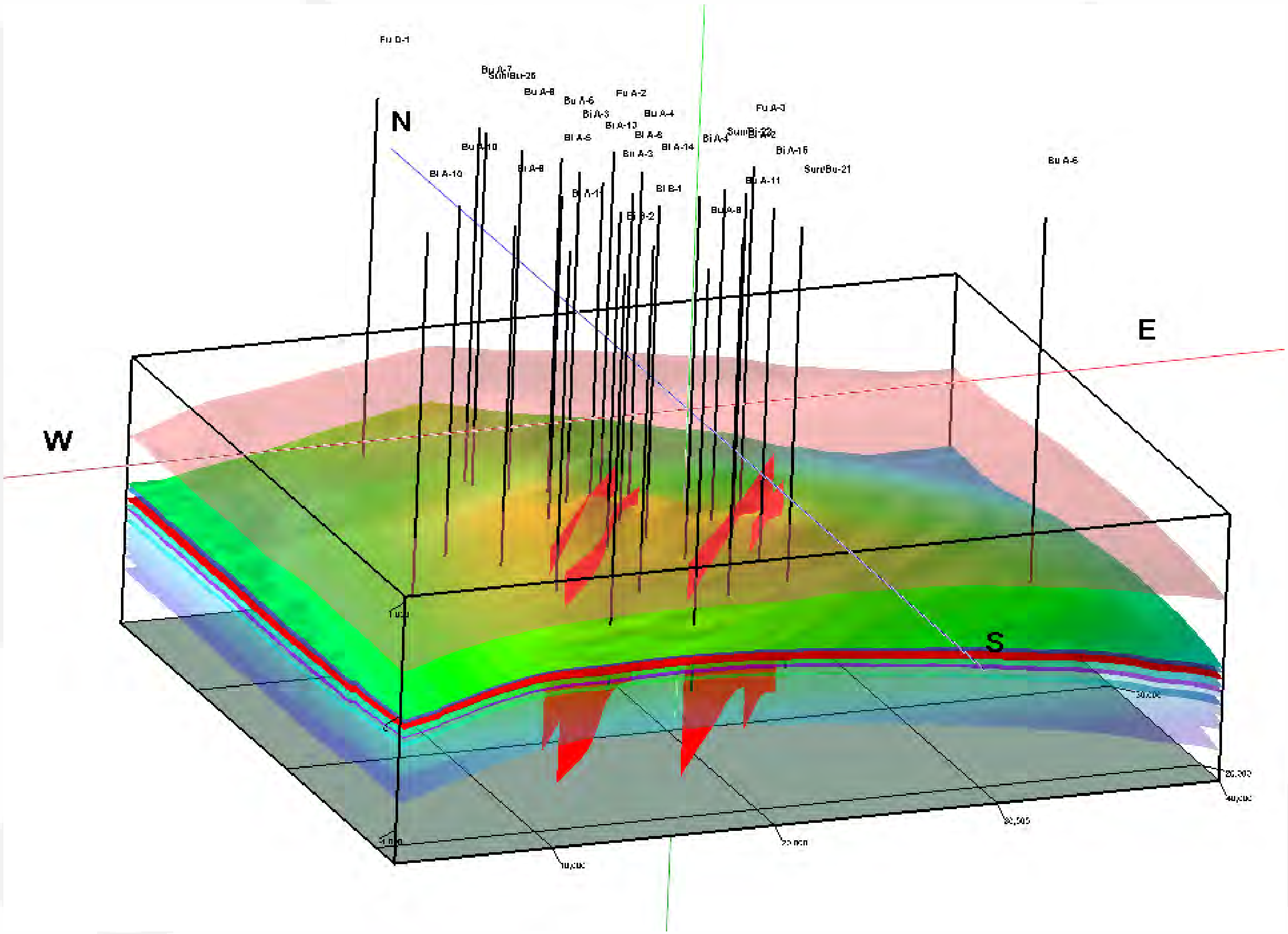
3D view of the Geologic Model



MATERIAL BALANCE ANALYSIS

Material Balance Analysis

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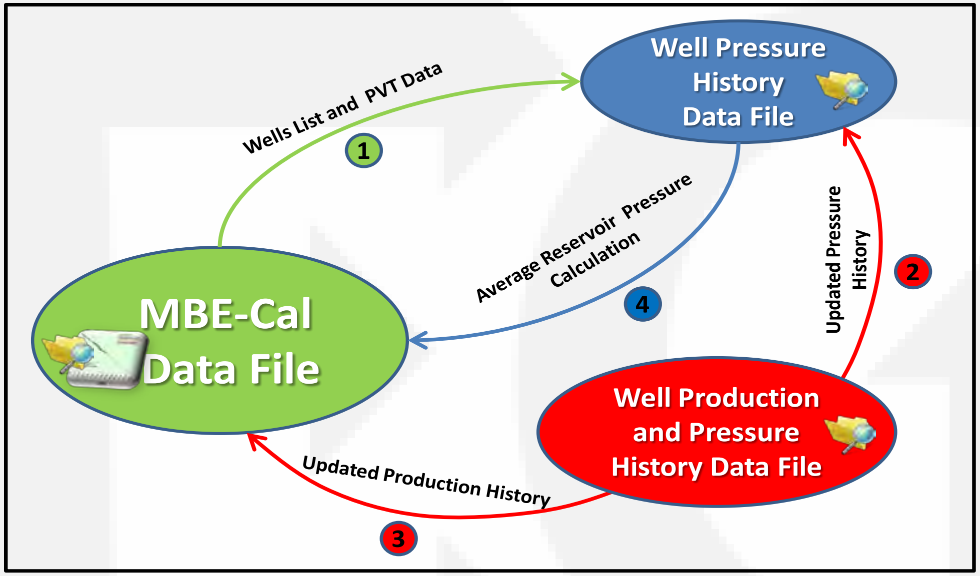
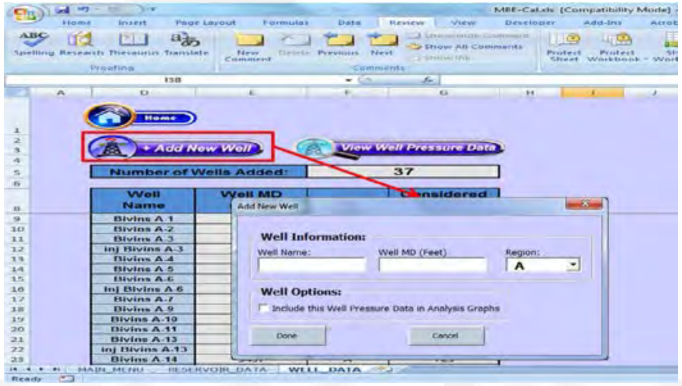
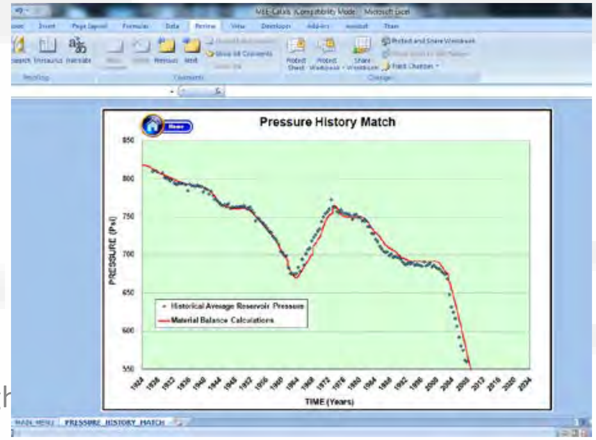


Well Pressure History File (Pressure Correction to Datum and Quality Control Procedure).
Well Pressure History and Production file
Reservoir Data, PVT, Pressure and Production data file. Material Balance Calculation are performed in this file





Material Balance
Performing Material Balance Analysis

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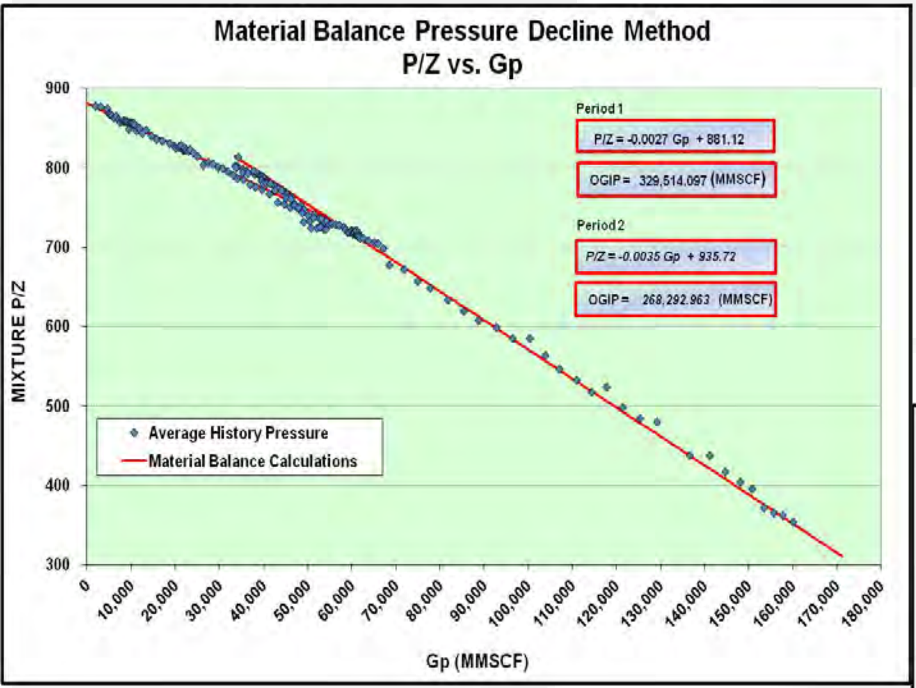

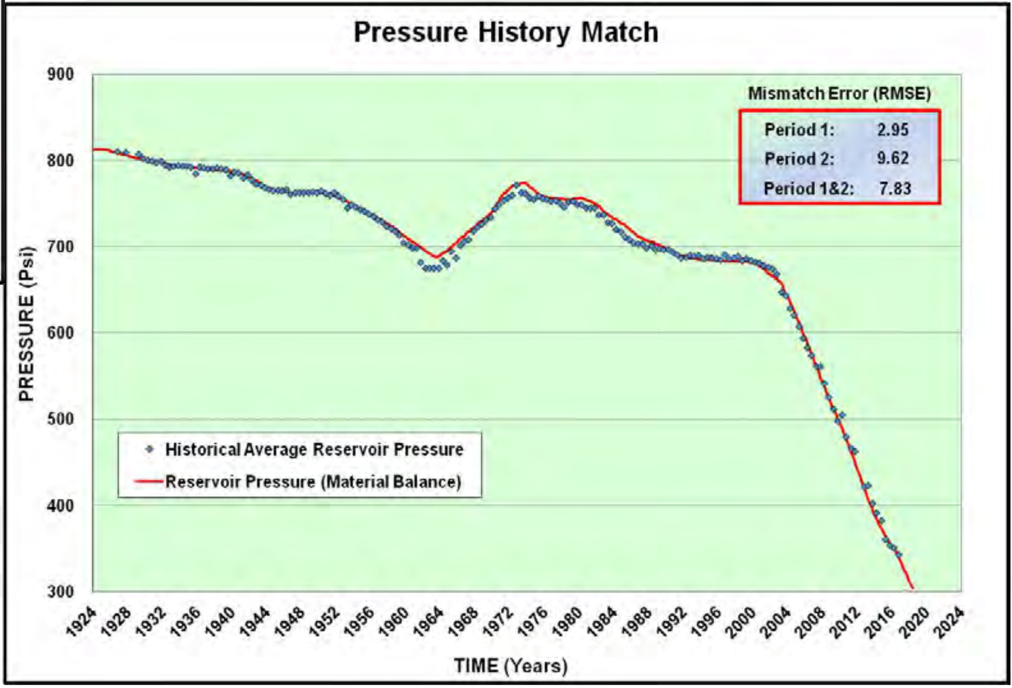

Material Balance
Aquifer Support Analysis

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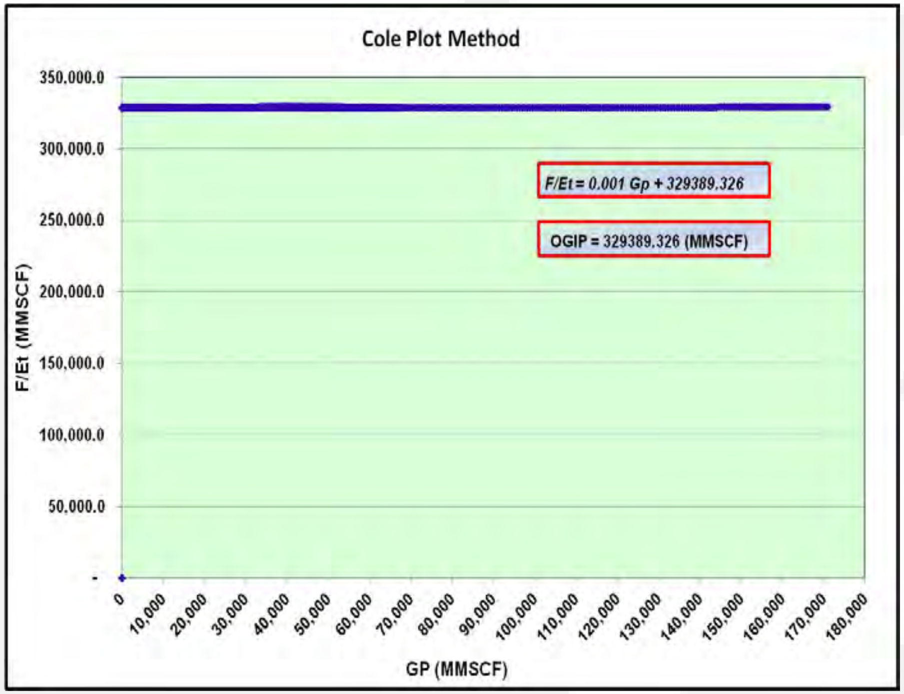
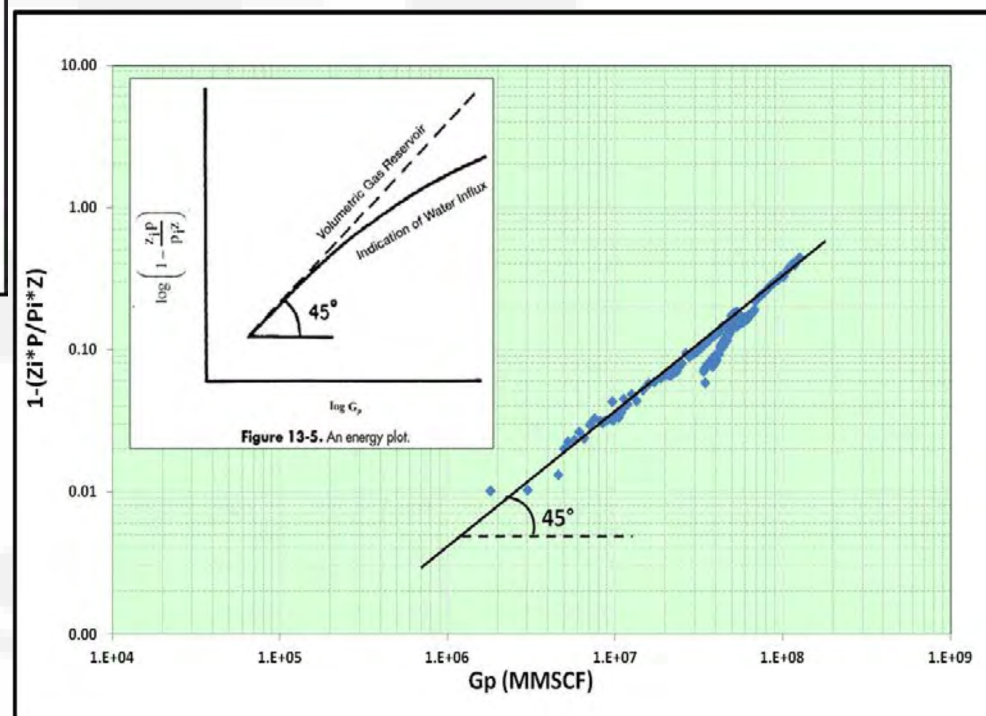


Based on results of 2 different analyses, there is no aquifer support for Bush Dome reservoir



Water Production at Bush Dome Reservoir

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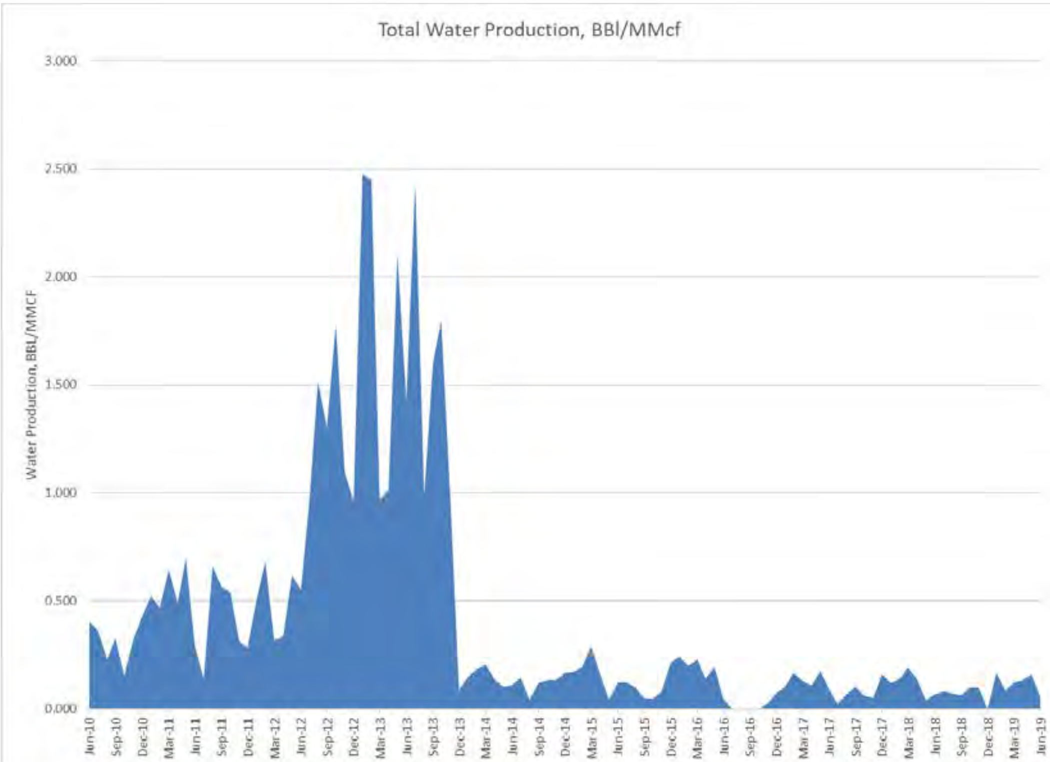

Month	liquid production: BBLs/MMcf
Jul-17	0.024
Aug-17	0.068
Sep-17	0.103
Oct-17	0.062
Nov-17	0.049
Dec-17	0.159
Jan-18	0.117
Feb-18	0.139
Mar-18	0.192
Apr-18	0.135
May-18	0.040
Jun-18	0.068
Average 2017-18	**0.096**

Month	liquid production: BBLs/MMcf
Jul-18	0.080
Aug-18	0.071
Sep-18	0.065
Oct-18	0.099
Nov-18	0.098
Dec-18	0.000
Jan-19	0.167
Feb-19	0.086
Mar-19	0.121
Apr-19	0.133
May-19	0.158
Jun-19	0.058
Average 2018-19	**0.080**

- Compared to the common water production scales in O&G industry, water production is less of an issue at Cliffside.

- Average water production has reduced ~16.6%

Simple and Complex History Matching

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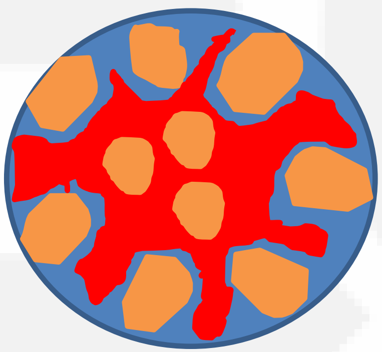
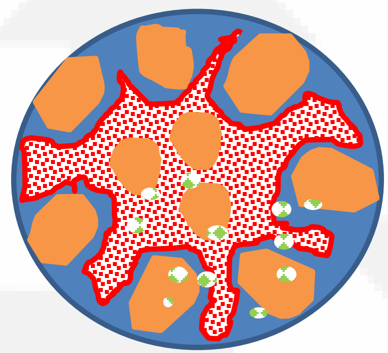
Adjusting reservoir model variables until it closely reproduces the past (historical) behavior for the entire field and each individual well:

Simple HM: Matching reservoir <u>pressure</u> and produced <u>gas volume</u> with time

Complex HM: Matching observed Helium <u>composition</u> with time





Gas Mixture
(one single phase: gas)

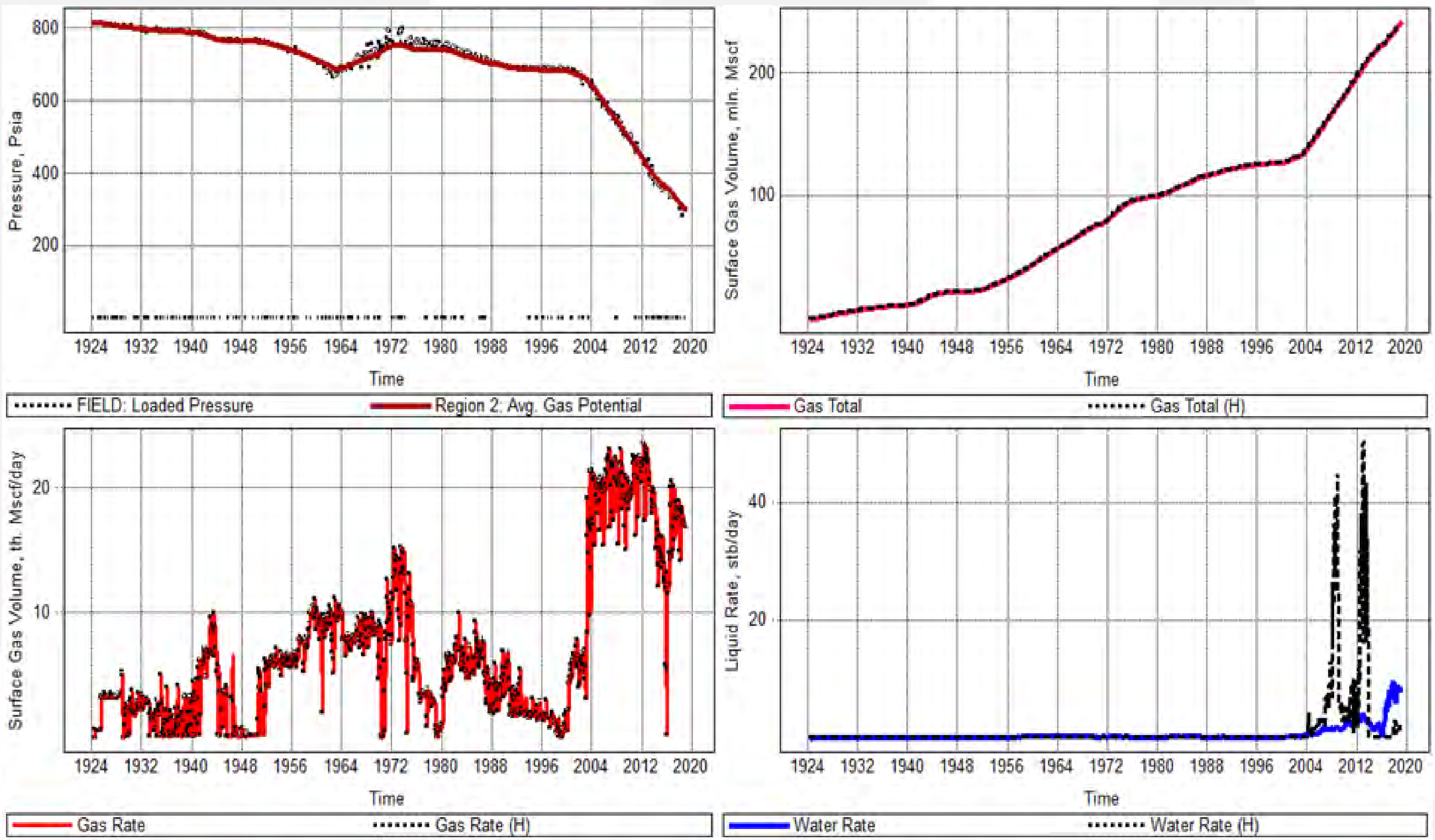
Gas Mixture
Compositional approach
(C1, C2, C3, C4, C5, C6, N2, CO2, Arg)

Helium

Simple History Match:
Pressure and Gas Flow rate is matched

Complex History Match:
Helium Composition and rate are matched

Simple History Match, Pressure and Volume History Match Results in FIELD SCALE



Complex History Match, Helium History Match Results in FIELD SCALE

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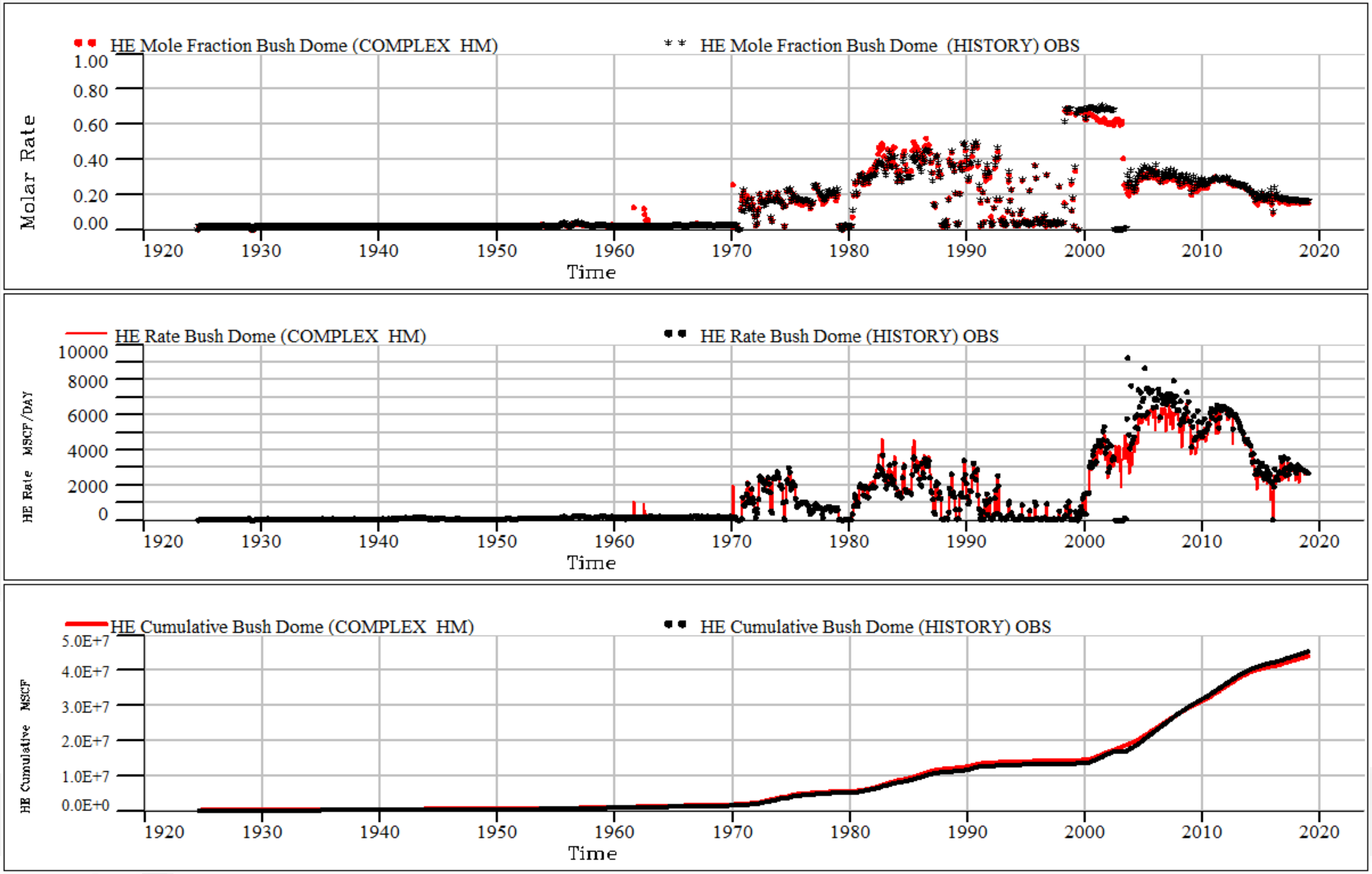

SIMPLE AND COMPLEX HM FOR A FEW MAJOR GAS PRODUCERS

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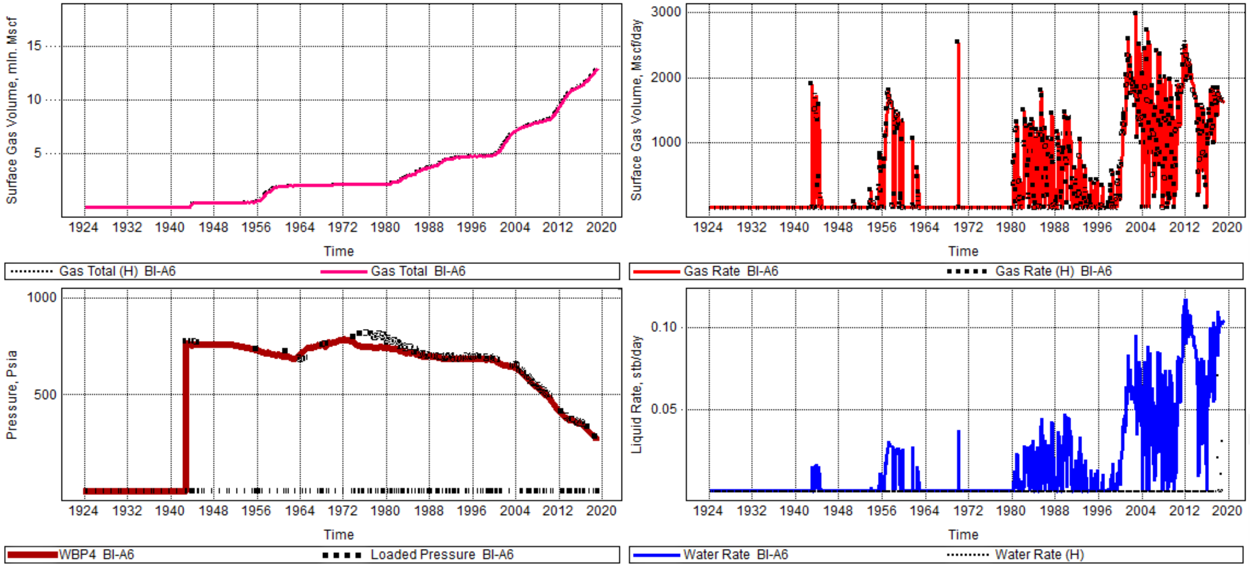
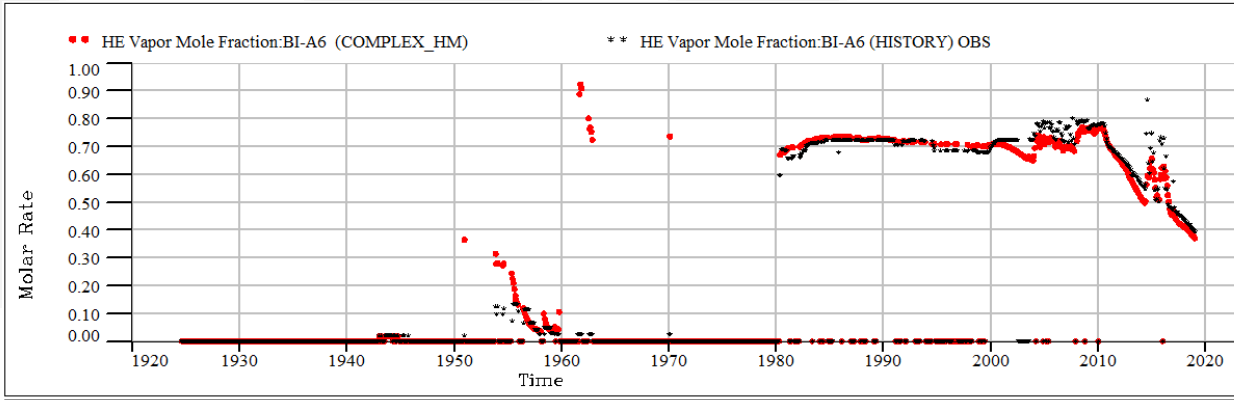
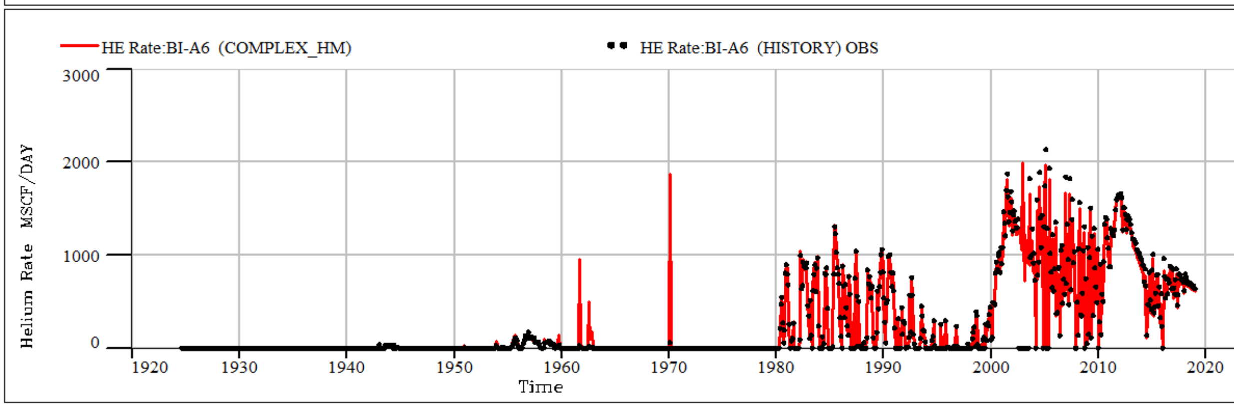


Well Bi-A6 History matching





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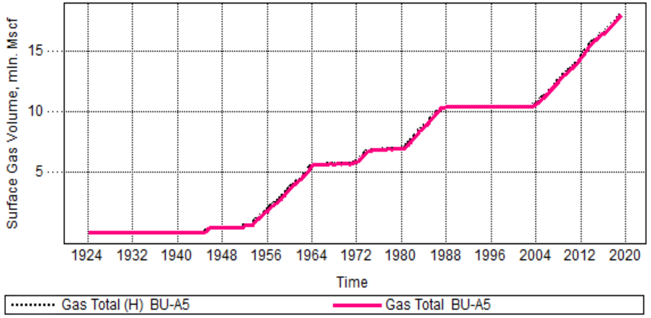
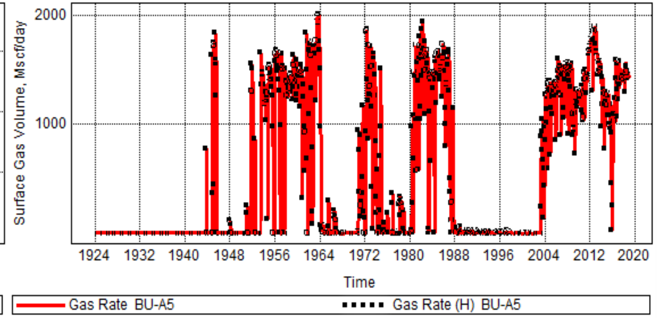
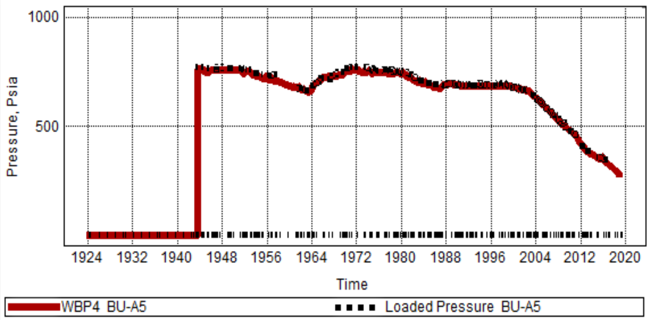
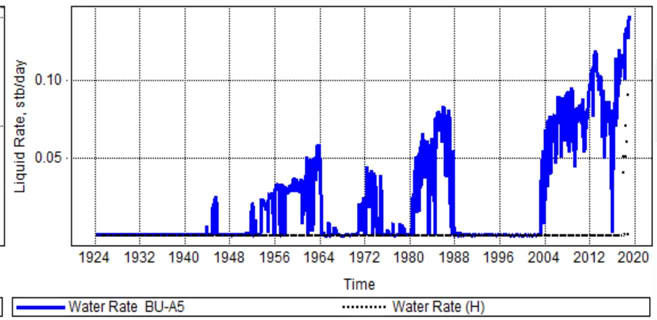
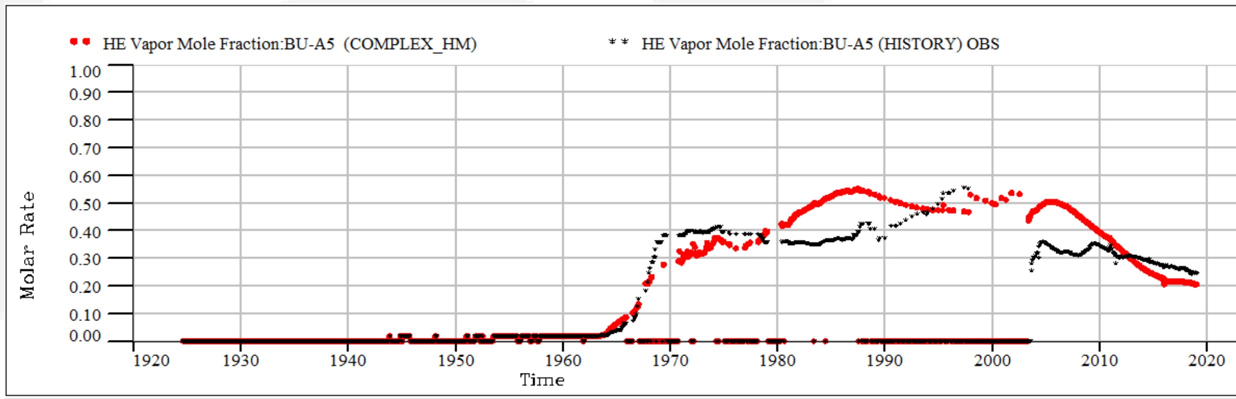


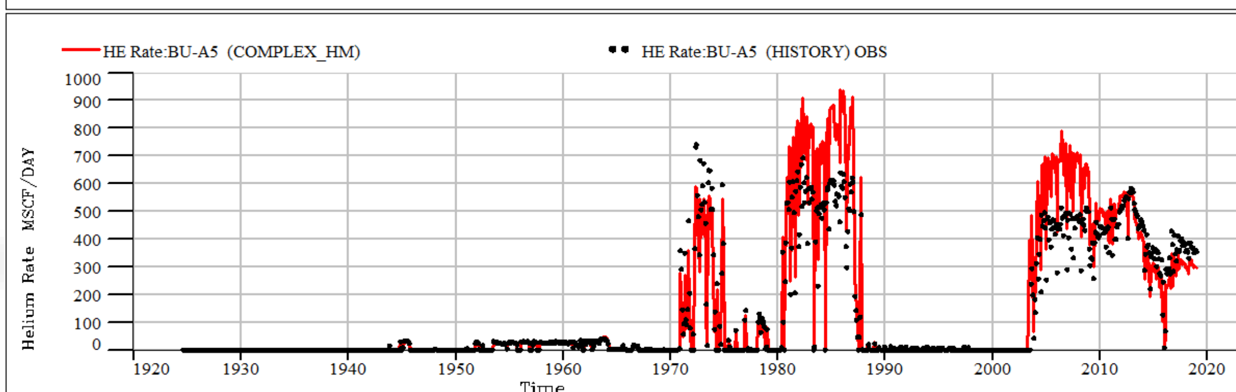


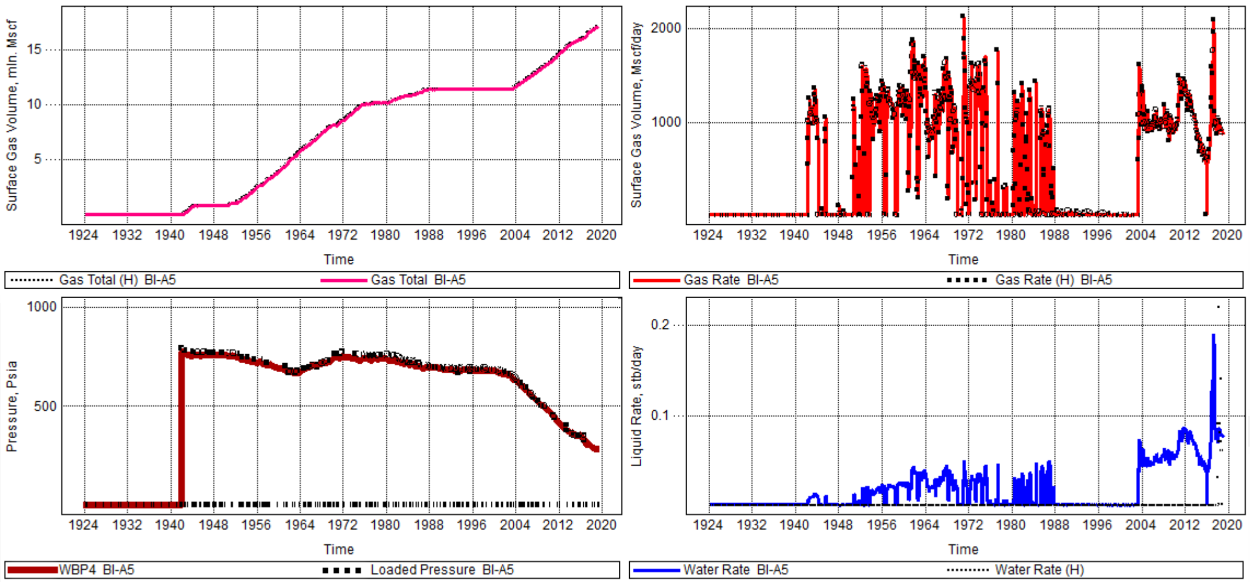




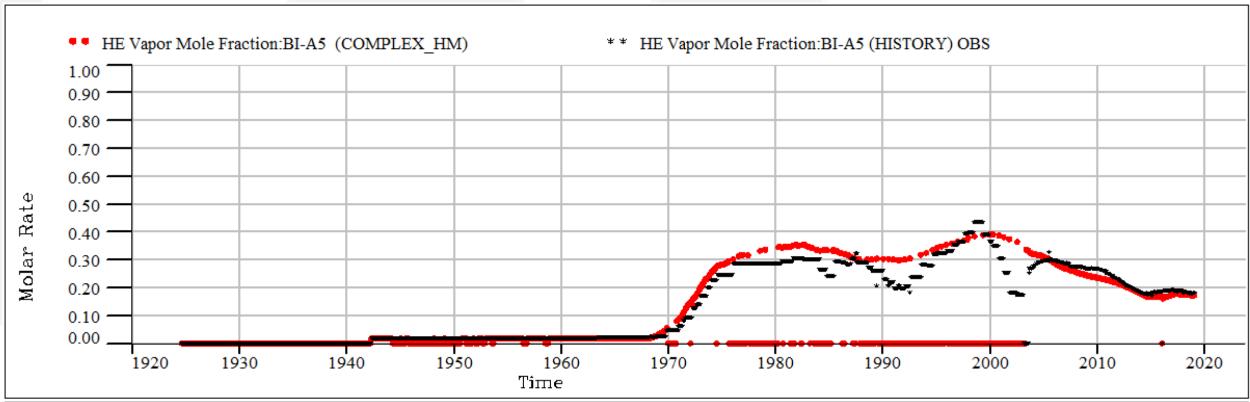
Well Bu-A5 History matching

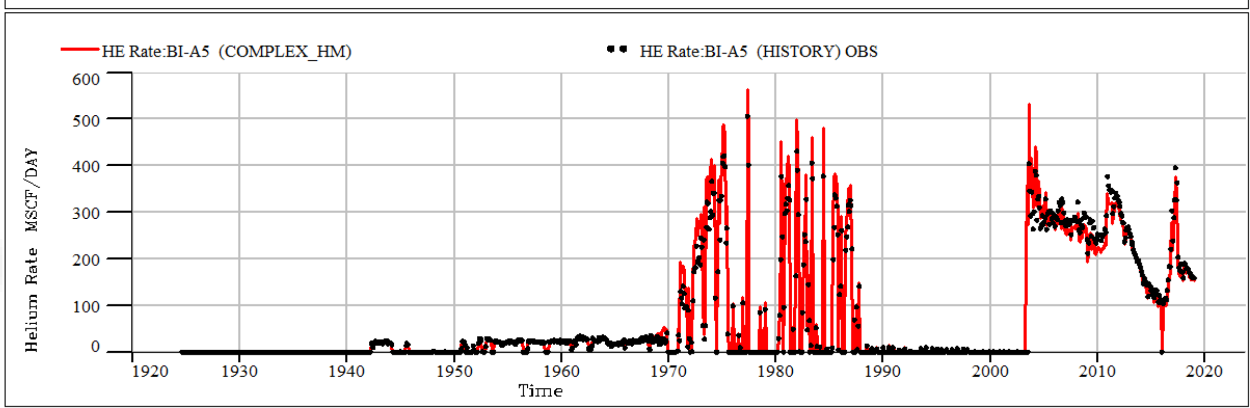




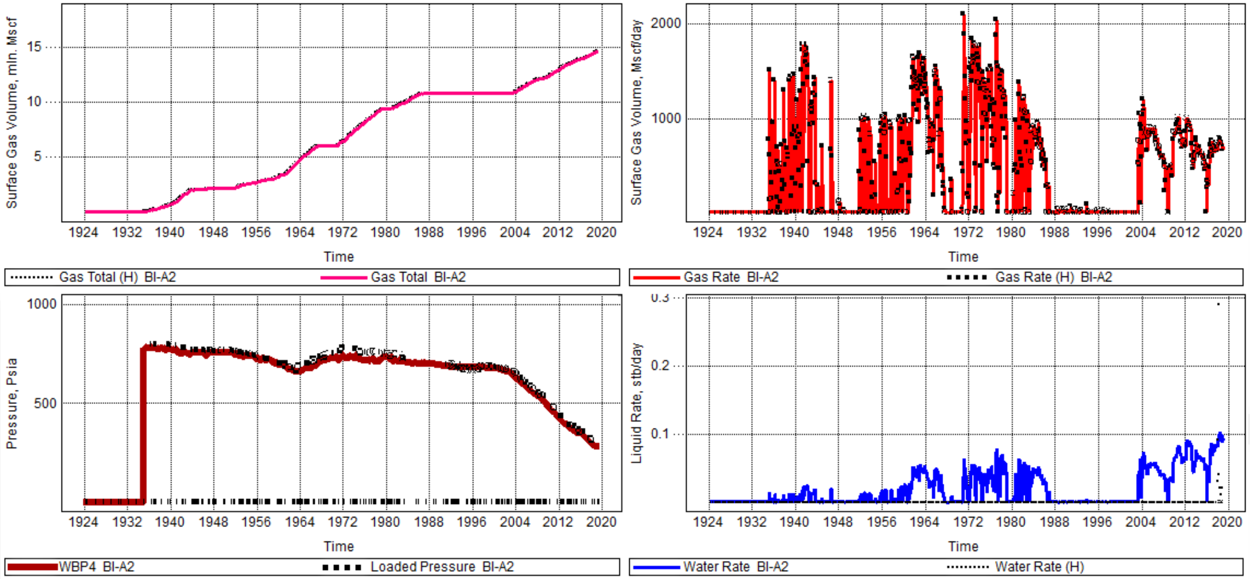


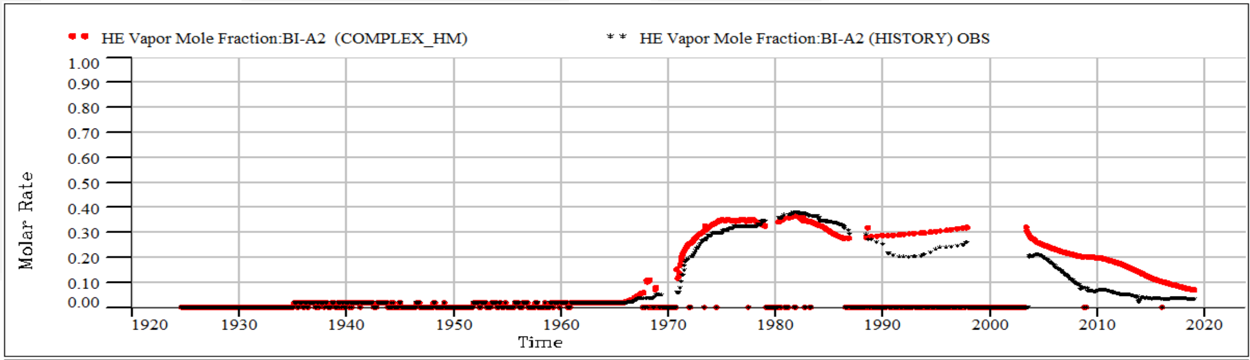
Well Bi-A5 History matching

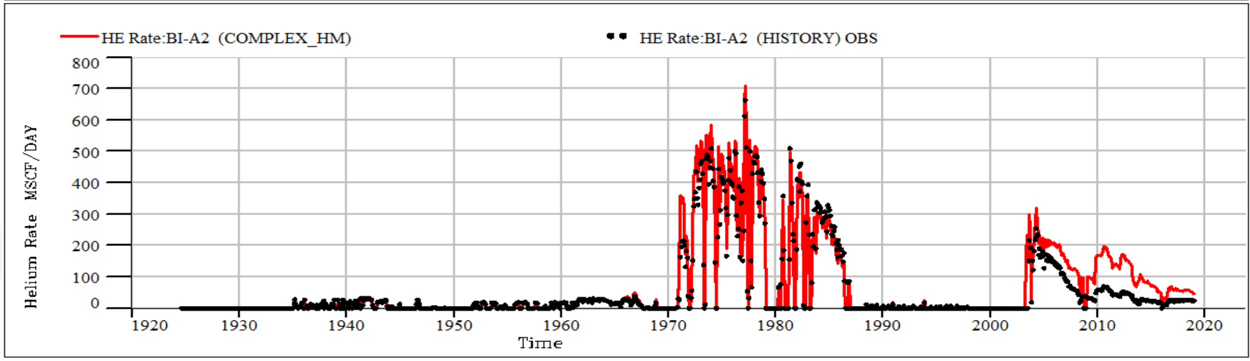




Well Bi-A2 History matching







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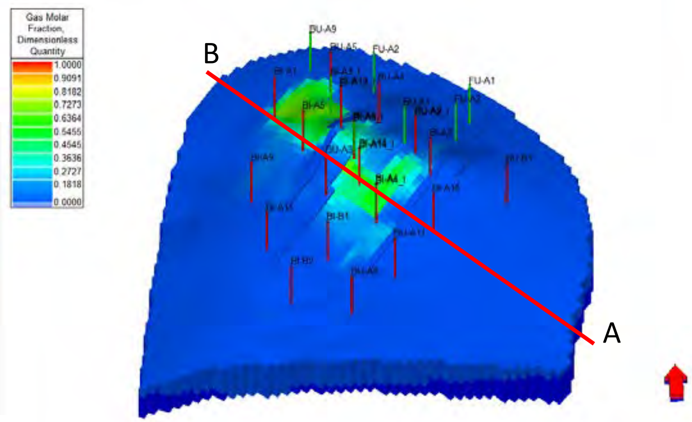
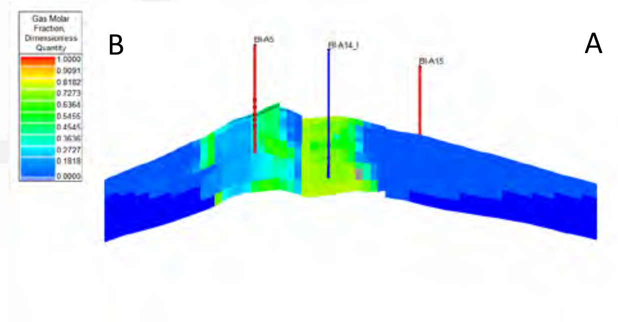
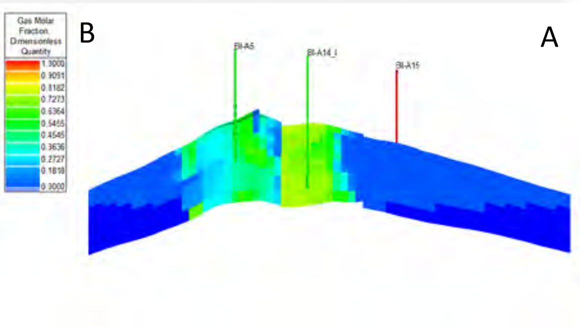
Helium Mole Fraction Distribution. Cross Section Analysis-Brown Dolomite

a. HE mole Fraction Cross Section . Dec-40

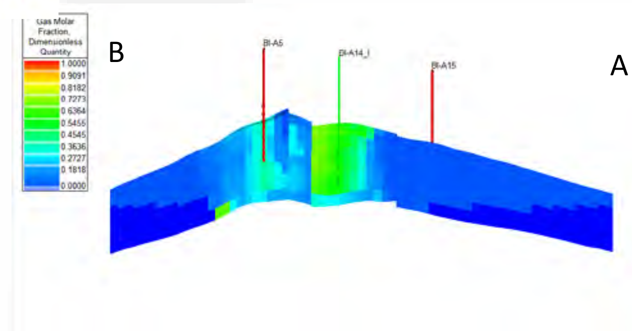




b. HE mole Fraction Cross Section. Dec-73



c. HE mole Fraction Cross Section . Dec-83



d. HE mole Fraction Cross Section . Dec-18

Helium Mole Fraction Distribution. Cross Section Analysis-Brown Dolomite

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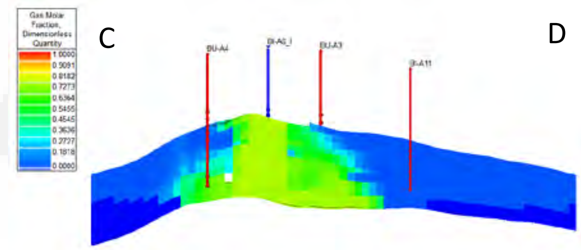
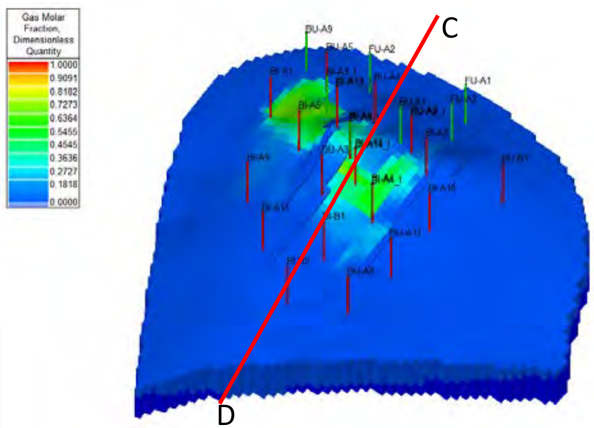
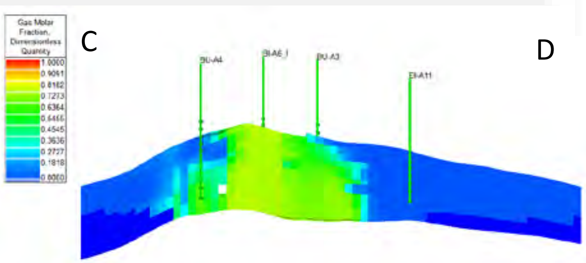
a. HE mole Fraction Cross Section . Dec-40

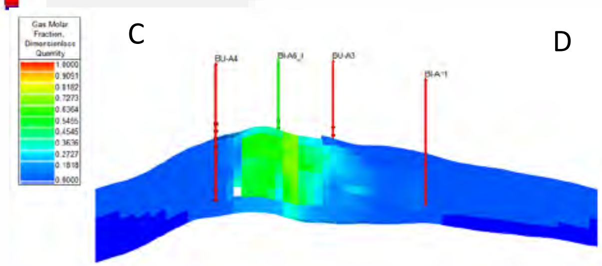


b. HE mole Fraction Cross Section. Dec-73





c. HE mole Fraction Cross Section . Dec-83



d. HE mole Fraction Cross Section . Dec-18

Helium Fraction Flux at the bottom of BD

Bush Dome Forecast

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- Good History Matching is required for predictions. However, just after History Matching, the numerical reservoir model can not be used to perform predictions

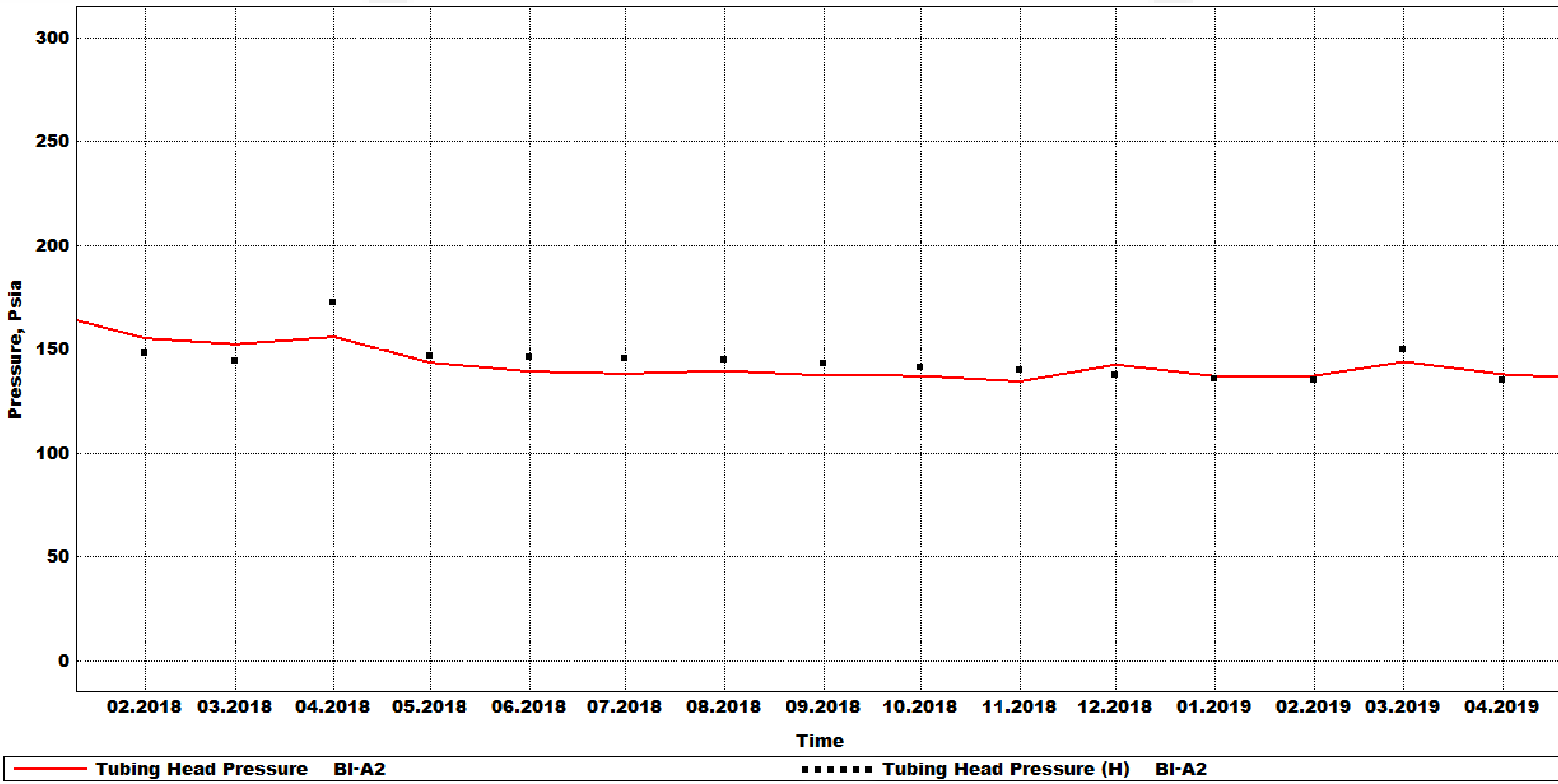
- During History Matching reservoir pressure and flow rates are calculated after adjusting reservoir model parameters. Pressure drop along completion from reservoir to well head is not considered during History Matching.

- During History Matching, well head pressure (WHP) is not matched. In order to match the well head pressure, pressure drop calculations across completion is generated using correlations. Vertical Flow Performance curves (VLP) or Vertical Lift Performance curves (VLP) are calibrated with actual well tests.

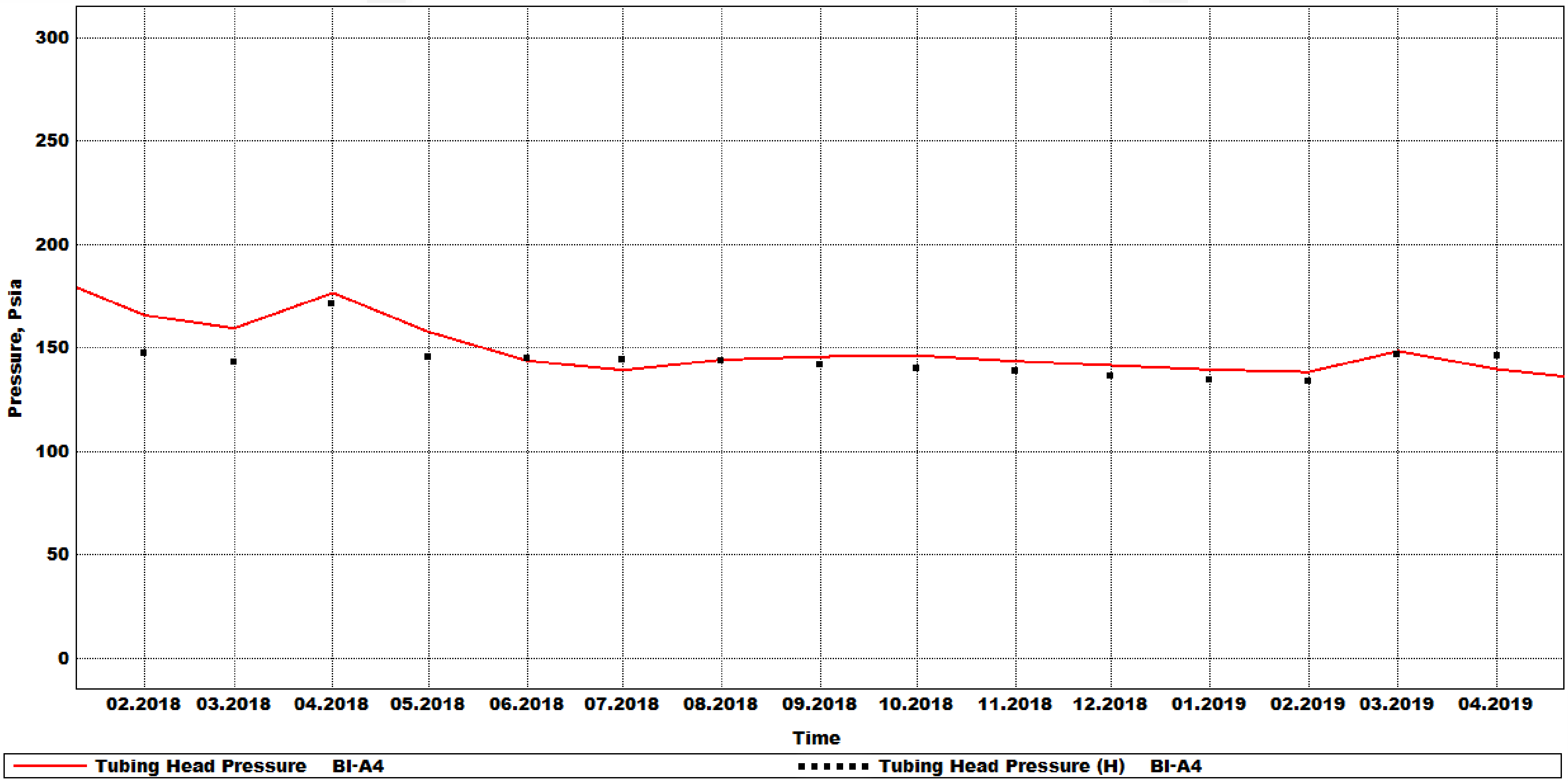
- Then, the first step prior to Forecasting any production scenario is to perform VLP calculations.

WELL-HEAD HISTORY MATCHING FOR A FEW GAS PRODUCERS

Well Bi-A2, Tubing Head Pressure History Match

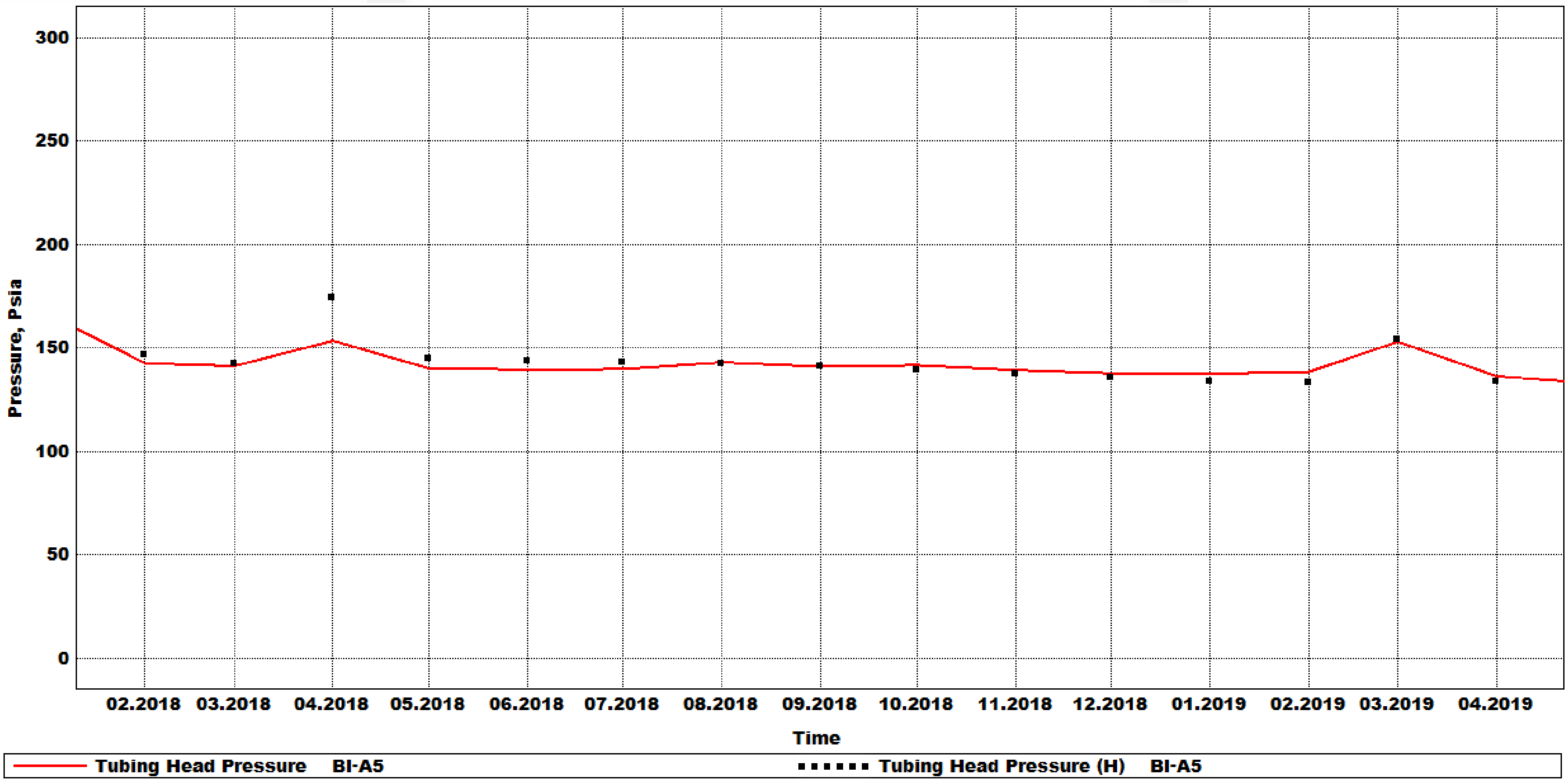


Well Bi-A4, Tubing Head Pressure History Match

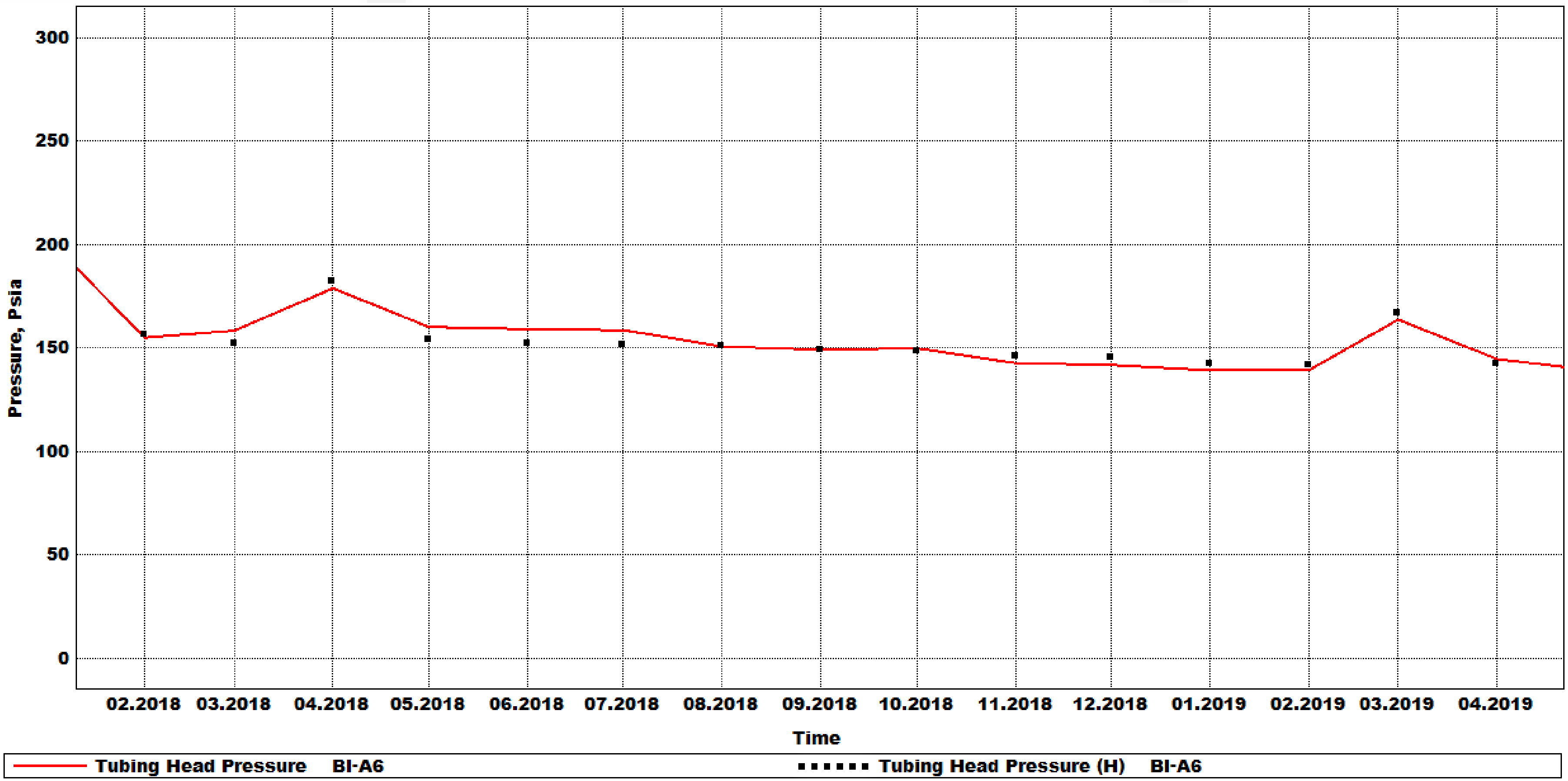


Well Bi-A5, Tubing Head Pressure History Match

Edge Geoscience Inc.



Well Bi-A6, Tubing Head Pressure History Match



Summary

- New Geologic model was developed and some geologic features such as new discovered faults were included in the model
- The results of the material balance analysis shows the lack of aquifer support at Bush Dome reservoir.
- Several rounds of history matching was performed to match the Gas and Helium production rates, production volume and well head pressure.
- Compared to previously developed model, this model uses more flow boundaries and has improved accuracy.

2019 FY STATISTICAL RESULTS AND THEIR COMPARISON WITH LAST YEAR

Comparison of Annual <u>Cumulative Gas Production</u> with Last Year

Edge Geoscience Inc.

Well Name	2018-19 Gas Production (MMSCF)	2017-18 Gas Production (MMSCF)	YoY change,%
Bivins A-6	549.45	587.93	-6.55
Bush A-5	492.57	516.36	-4.61
Bivins A-14	444.72	490.51	-9.34
Bivins A-15	399.70	422.78	-5.46
Bivins A-13	392.08	421.92	-7.07
Bivins B-1	378.75	397.13	-4.63
Bivins A-4	374.45	448.51	-16.51
Bivins A-9	347.16	396.29	-12.40
Bush A-3	343.48	374.00	-8.16
Bivins B-2	330.42	362.79	-8.92
Bivins A-5	301.95	344.93	-12.46
Bush A-4	273.84	250.51	9.31
Bivins A-2	235.42	255.26	-7.77
Bivins A-11	229.79	269.24	-14.65
Bush A-11	204.93	168.03	21.96
Bush A-8	197.36	233.63	-15.53
Bivins A-7	179.68	139.00	29.26
Bush A-2	96.85	295.22	-67.19
Bush B-1	51.24	51.65	-0.78
Bivins A-3	0.00	0.00	
Bush A-9	0.00	0.00	
Fuqua A-1	0.00	0.00	
Fuqua A-3	0.00	0.00	
Bush Dome	**5823.82**	**6425.71**	**-9.37**

- Top 8 wells contribute in ~60% of Gas Production
- The annual gas production in these 8 wells has declined ~8.3% year over year (YoY).
- In reservoir scale, annual gas production has decreased from 6.42 BCF to 5.82 BCF (YoY)
- This shows a ~9.4% year over year decline

Comparison of Average Daily Gas Rate with Last Year

Edge Geoscience Inc.

Average Daily Gas Rate (Mscf/d)			
Well Name	July2018-Jun2019	July2017-Jun2018	YoY Change %
BI-A6	1,503.3	1,612.4	-6.8
BU-A5	1,347.7	1,415.6	-4.8
BI-A14	1,216.5	1,345.5	-9.6
BI-A15	1,094.3	1,159.4	-5.6
BI-A13	1,072.5	1,157.4	-7.3
BI-B1	1,037.2	1,088.8	-4.7
BI-A4	1,025.1	1,229.3	-16.6
BI-A9	950.2	1,086.5	-12.5
BU-A3	939.4	1,026.2	-8.5
BI-B2	904.3	995.1	-9.1
BI-A5	826.0	946.0	-12.7
BU-A4	749.7	687.7	9.0
BI-A2	644.2	699.9	-8.0
BI-A11	628.9	738.2	-14.8
BU-A11	561.0	461.6	21.5
BU-A8	540.3	640.2	-15.6
BI-A7	491.5	382.1	28.6
BU-A2	265.4	805.9	-67.1
BU-B1	140.4	141.4	-0.8
BI-A1	0.0	0.0	
BI-A3	0.0	0.0	
BU-A1	0.0	0.0	
BU-A9	0.0	0.0	
FU-A1	0.0	0.0	
FU-A2	0.0	0.0	
FU-A3	0.0	0.0	
BUSH DOME	**15,937.9**	**17,619.1**	**-9.5**

- In reservoir scale, Average Daily Gas production rate has decreased from 17.6 MMSCF to 15.9 MM SCF year over year (YoY)
- This shows a 9.5% year over year decline

Comparison of Average Helium Fraction with Last Year

Edge Geoscience Inc.

HE Mole Fraction			
Well Name	**July2018-Jun2019**	**July2017-Jun2018**	**YoY Change %**
BI-A6	0.388	0.434	-10.50
BI-A13	0.313	0.325	-3.49
BU-A3	0.313	0.326	-4.06
BI-A7	0.297	0.290	2.46
BI-A14	0.253	0.282	-10.04
BU-A5	0.244	0.256	-4.87
BI-A5	0.178	0.184	-3.37
BI-A4	0.100	0.110	-8.35
BU-A4	0.083	0.087	-5.29
BU-A2	0.044	0.065	-32.44
BI-A2	0.032	0.034	-6.09
BI-A11	0.030	0.029	1.83
BI-A9	0.028	0.026	8.49
BI-B1	0.023	0.023	0.64
BU-A11	0.022	0.022	1.18
BI-B2	0.019	0.019	0.64
BU-A8	0.018	0.018	-0.34
BU-B1	0.017	0.017	-0.72
BI-A15	0.017	0.017	-1.28
BI-A1	0.000	0.000	
BI-A3	0.000	0.000	
BU-A1	0.000	0.000	
BU-A9	0.000	0.000	
FU-A1	0.000	0.000	
FU-A2	0.000	0.000	
FU-A3	0.000	0.000	
BUSH DOME	**0.149**	**0.162**	**-7.99**

- In reservoir scale, Helium Mole Fraction has decreased from 16.2% to 14.9% (YoY)
- This shows an 8% year over year decline

Comparison of Annual **Helium Production** with Last Year

Edge Geoscience Inc.

Well Name	2018-19 He Production (MMSCF)	2017-18 He Production (MMSCF)	YoY change,%
Bivins A-6	214.79	255.08	-15.79
Bivins A-13	123.14	136.89	-10.05
Bush A-5	120.30	132.38	-9.13
Bivins A-14	113.14	138.18	-18.12
Bush A-3	107.63	122.05	-11.82
Bivins A-5	53.82	63.53	-15.29
Bivins A-7	53.30	39.93	33.48
Bivins A-4	37.71	49.28	-23.49
Bush A-4	22.75	21.88	3.97
Bivins A-9	9.70	10.23	-5.16
Bivins B-1	8.88	9.24	-3.98
Bivins A-2	7.64	8.79	-13.09
Bivins A-11	6.84	7.88	-13.21
Bivins A-15	6.77	7.25	-6.71
Bivins B-2	6.21	6.77	-8.26
Bush A-11	4.49	3.68	22.17
Bush A-2	4.29	21.29	-79.86
Bush A-8	3.58	4.27	-15.97
Bush B-1	0.89	0.90	-1.41
Bivins A-3	0.00	0.00	
Bush A-9	0.00	0.00	0.00
Fuqua A-1	0.00	0.00	0.00
Fuqua A-3	0.00	0.00	0.00
Bush Dome	**905.85**	**1039.50**	**-12.86**

- The cumulative helium production between July 2018-June2019 was ~.905 BCF (Compared to ~1.04 BCF the year before)
- Top 8 wells contribute in ~90% of Helium Production
- The annual Helium production in top 8 wells has declined ~8.78% year over year (YoY).
- This shows a 12.86% year over year decline

Comparison of Annual Helium Production with Last Year

Edge Geoscience Inc.

Top Helium Producers		
Rank	**2018-19 year**	**2017-18 year**
1	BI-A6	BI-A6
2	BI-A13	BI-A14
3	BU-A5	BI-A13
4	BI-A14	BU-A5
5	BU-A3	BU-A3
6	BI-A5	BI-A5
7	BI-A7	BI-A4
8	BI-A4	BI-A7

- Top 8 wells contribute in ~90% of Helium Production.
- Bi-A6 is still the biggest Helium Producer
- Compared to last year, the wells' ranking has changed slightly but overall, they are still the top 8 Helium producers and still contribute in 90% of He production.

(Average Wellhead Pressure (WHP) changes in the past 10 years)

Edge Geoscience Inc.

Beginning from July of	2009	2010	2011	2012	2013	2014	2015	2016	2017	**2018**
Ending on July of	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
Beginning WHP (psi)	362	334	310	278	287	277	255	232	197	**158**
Ending WHP (psi)	334	303	278	251	277	255	232	197	158	**133**
Change,%	-7.7	-9.3	-10.3	-9.7	-3.5	-7.9	-9.0	-15.1	-19.8	**-15.8**

- WHP has been on a decline in the past 10 years
- The WHP decline has been accelerated in the past few years with this year as the most severe decline in 10 years

(Helium Production changes in the past 10 years)

Edge Geoscience Inc.

Beginning from July of	2009	2010	2011	2012	2013	2014	2015	2016	2017	**2018**
Ending on July of	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
Helium Production (BCF)	1.817	2.123	2.263	1.97	1.428	0.916	0.751	1.059	1.042	**0.906**
Helium Injection (BCF)	-0.163	0	0	0	-0.015	-0.06	-0.074	-0.007	0	**0**
Net Helium Production (BCF)	1.654	2.123	2.263	1.970	1.413	0.856	0.677	1.052	1.042	**0.906**
Year over Year Change,%		28.36	6.59	-12.95	-28.27	-39.42	-20.91	55.39	-0.95	**-13.05**

The total Helium production in 2018-19 has declined ~13% compared to the year before.

(Total Gas Production changes in the past 10 years)

Edge Geoscience Inc.

Beginning from July of	2009	2010	2011	2012	2013	2014	2015	2016	2017	**2018**
Ending on July of	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
Gas Production (BCF)	7.155	7.279	8.154	7.797	6.669	5.322	4.272	6.353	6.426	**5.823**
Gas Injection (BCF)	-0.209	0	0	0	-0.021	-0.08	-0.1	-0.01	0	**0**
Net Gas Production (BCF)	6.946	7.279	8.154	7.797	6.648	5.242	4.172	6.343	6.426	**5.823**
Year over Year Change,%		4.79	12.02	-4.38	-14.74	-21.15	-20.41	52.04	1.31	**-9.38**

The total gas production in 2018-19 has declined ~9.4% compared to the year before.

Review of Last year's Predictions

For Scenario #1, (current conditions) :

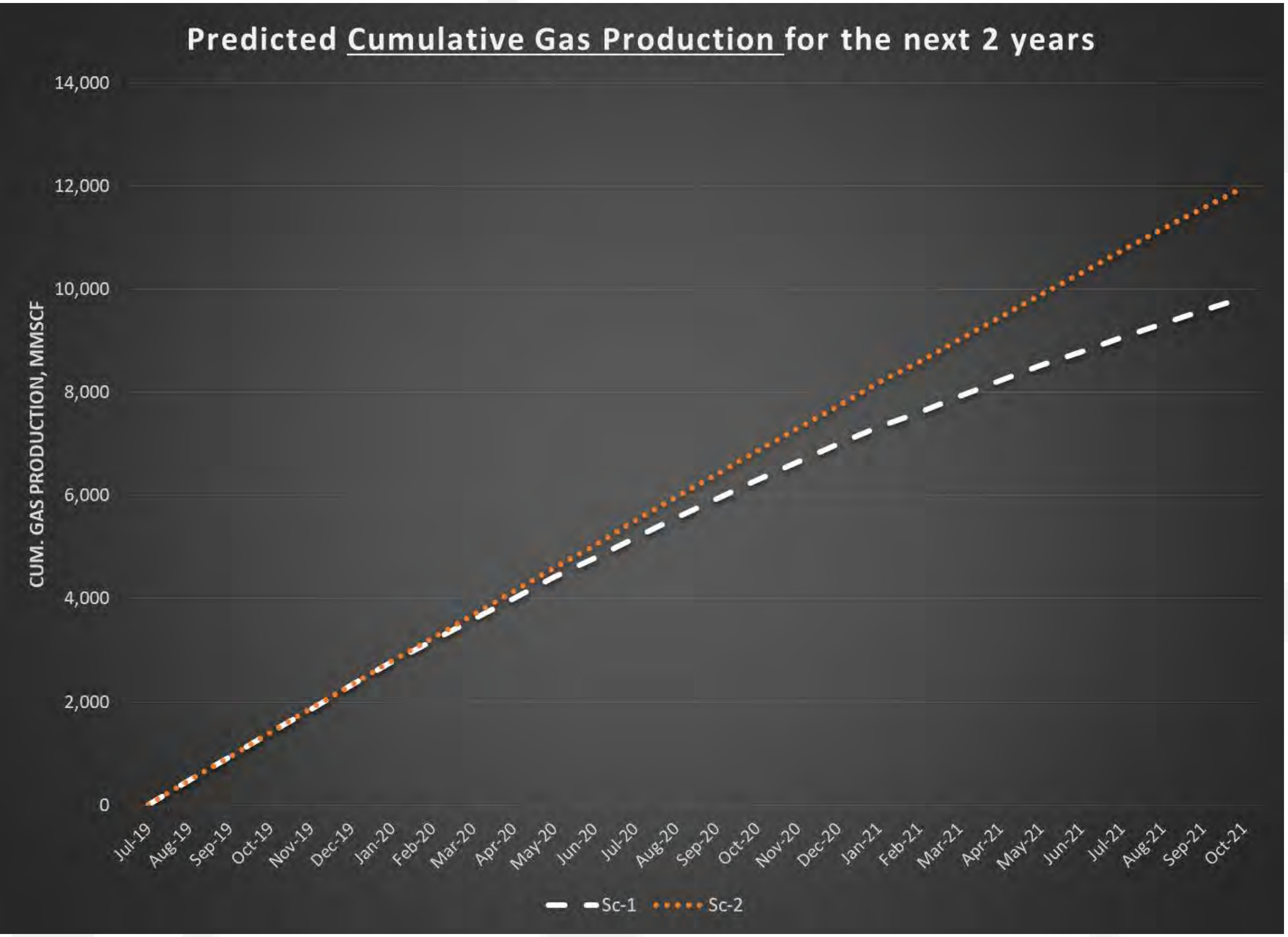
From July 1st 2018- October 1st 2018:
Model prediction: 0.236 BCF
Actual Production: 0.255 BCF

Prediction From October 1st 2018- October 1st 2019 : 0.767 BCF
Actual from July 1st 2018-July 1st 2019 : 0.905 BCF

Although it is not the same time interval, but considering the actual production vs. predictions for 3rd quarter of 2018, it seems last year's model has under-predicted the production.

Cumulative Gas Production Forecast

Edge Geoscience Inc.



Scenario Number	Scenario Name
1	Base Case
2	Base Case + New Compressor

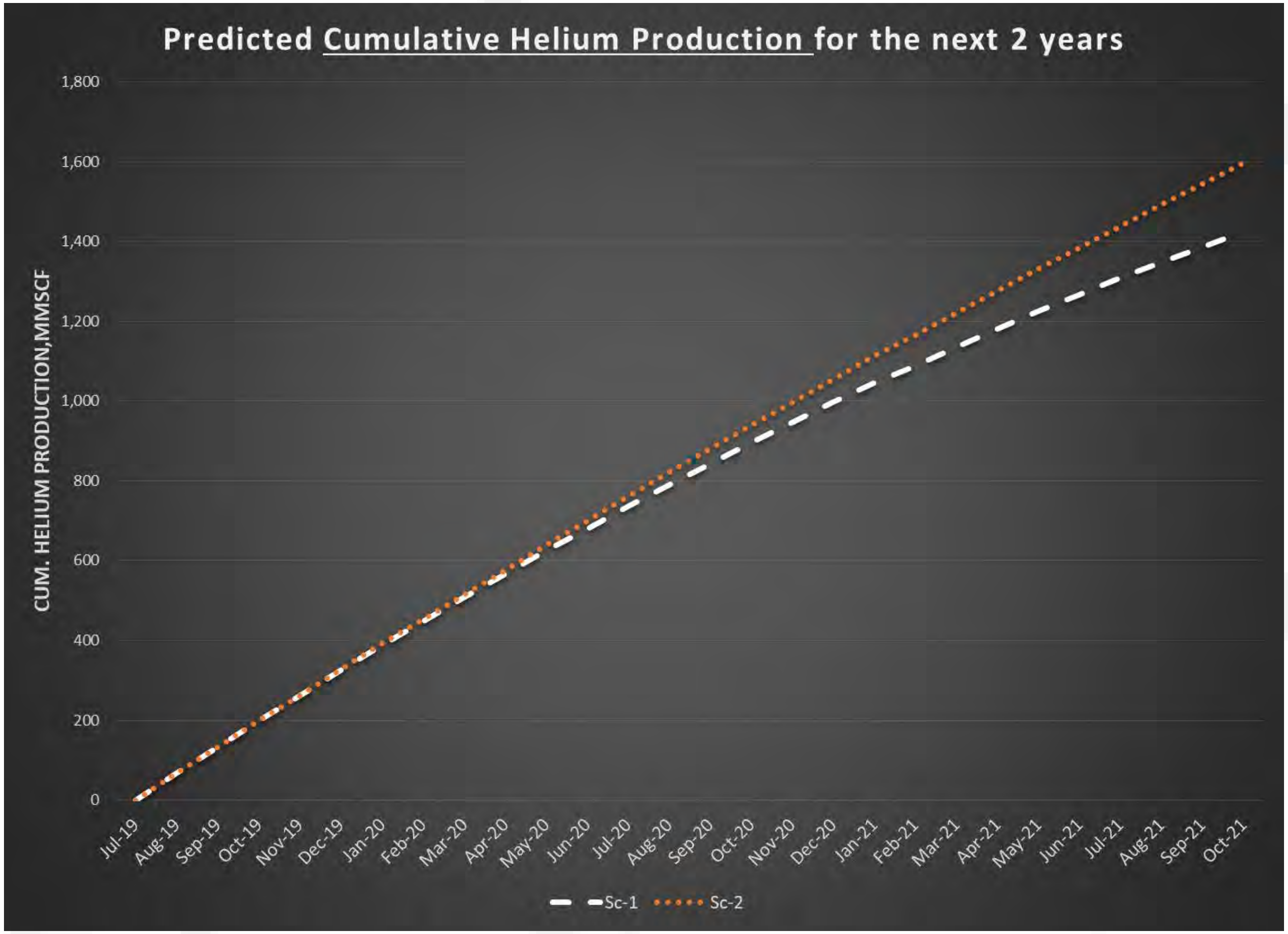
Predicted Gas Production (BCF)

	Sce-1	Sce-2
1 July-1 Oct 2019	1.397	1.399
FY 2020	4.89	5.45
FY 2021	3.55	5.12

Scenario 2 assumes the new compressor will be operational in July!

Cumulative Helium Production Forecast

Edge Geoscience Inc.



Scenario Number	Scenario Name
1	Base Case
2	Base Case + New Compressor

Predicted He Production (MMCF)

	Sce-1	Sce-2
1 July-1 Oct 2019	198.0	198.4
FY 2020	697.1	740.2
FY 2021	528.2	656.1

Summary

- By comparing the production rates and volumes in 2018-19 with the year before, it is evident that almost all the production indices have declined.
- Last year's model had under predicted the production values and the actual production exceeded the predictions.
- To mitigate the production decline, Edge Geoscience Inc. has evaluated several scenarios to increase the production from Bush Dome reservoir.

Opportunity Index

Opportunity Index Objective: it is a variable that can help us to select the best reservoir zones to place new wells, do well stimulations or carry out sidetrack wells

Opportunity Index Formulation

$$Opportunity\_Index = HeliumFraction \times \text{Perm} \times \text{Poro} \times \text{Pressure} \times (1\text{-Sw})$$

$$Opportunity\_Index\_Normalized = Opportunity\_Index / \left(Opportunity_{Index}\right)_{max}$$

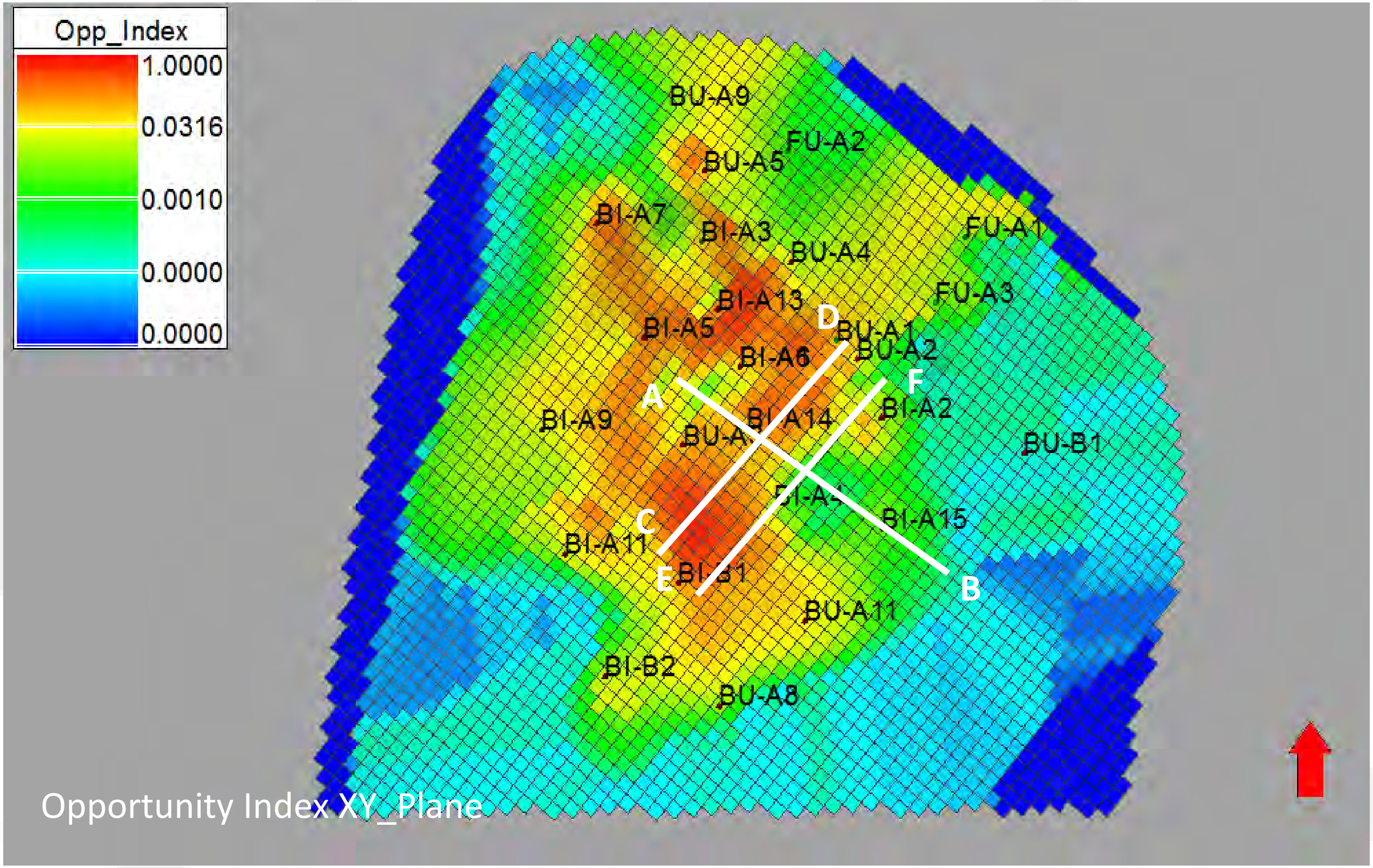
Interpretation: Normalized Opportunity index varies from 0 to 1

Interpretation: Normalized Opportunity index close to 1 is related with the best zones to drill new wells or perform workover operations

Bush Dome Forecast

Opportunity Index

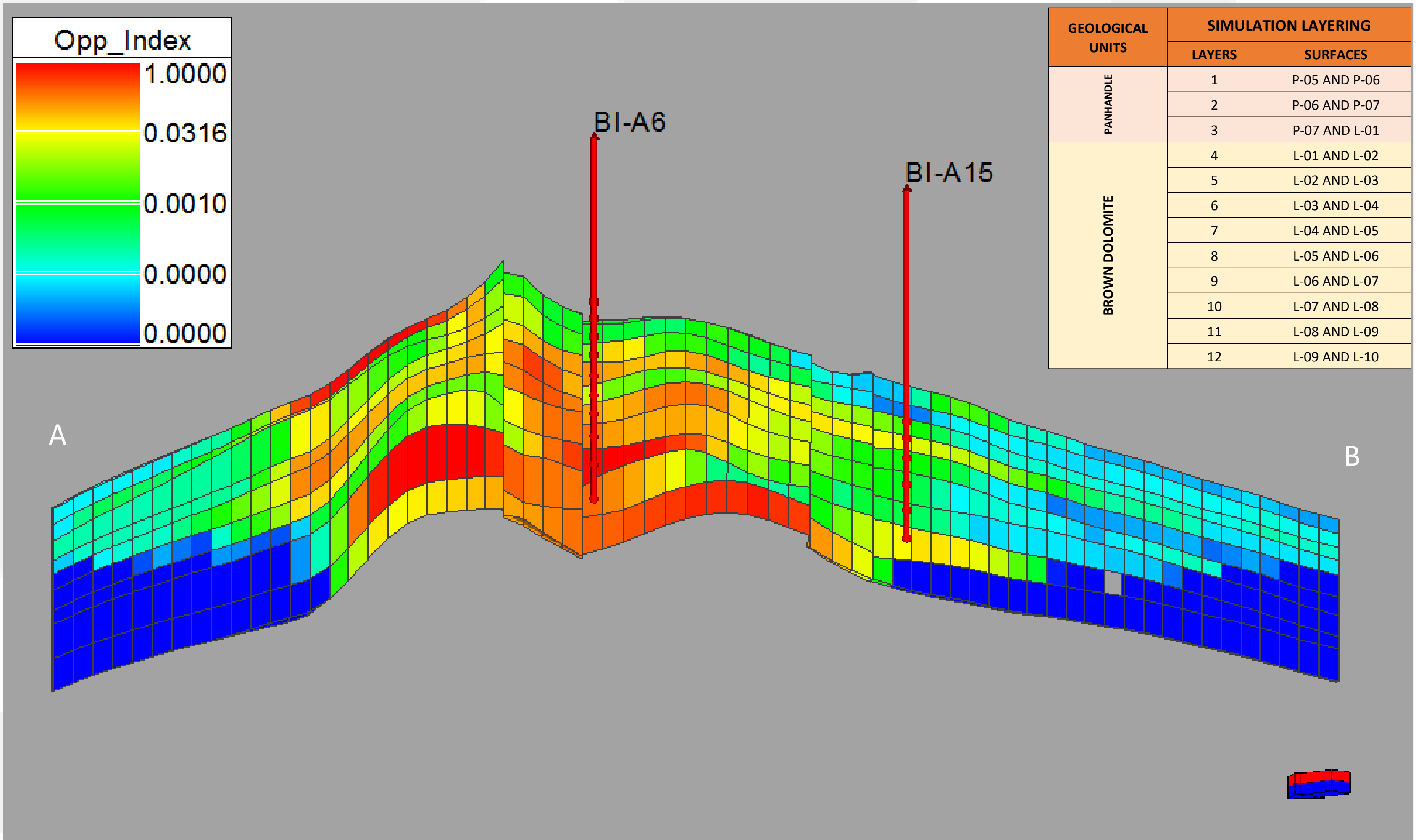
Cross sections at A-B, C-D, and D-E at layer L-05.



Bush Dome Forecast

Edge Geoscience Inc.

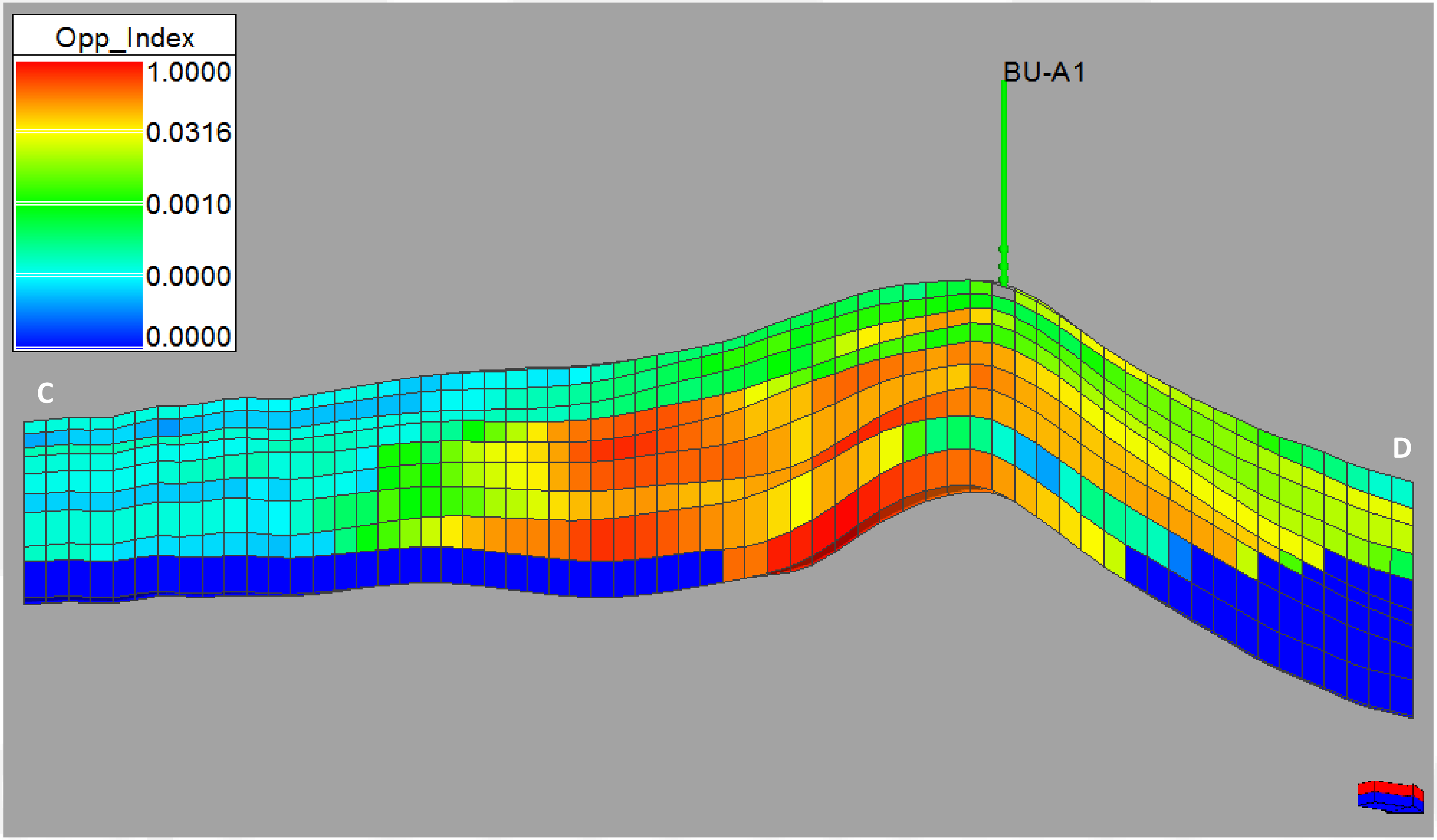
Cross sections A-B



GEOLOGICAL UNITS	SIMULATION LAYERING	
	LAYERS	SURFACES
PANHANDLE	1	P-05 AND P-06
	2	P-06 AND P-07
	3	P-07 AND L-01
BROWN DOLOMITE	4	L-01 AND L-02
	5	L-02 AND L-03
	6	L-03 AND L-04
	7	L-04 AND L-05
	8	L-05 AND L-06
	9	L-06 AND L-07
	10	L-07 AND L-08
	11	L-08 AND L-09
	12	L-09 AND L-10

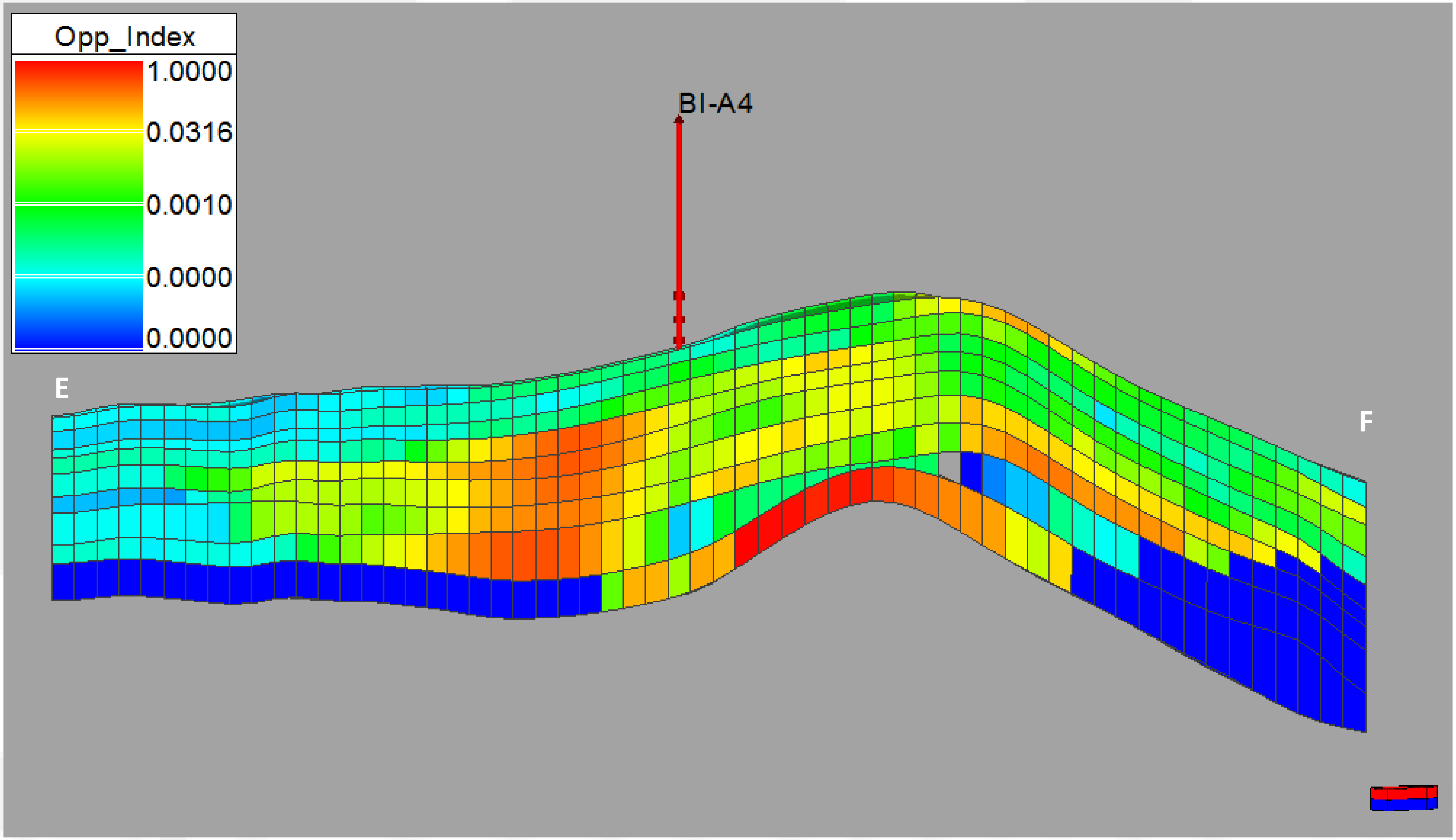
Bush Dome Forecast

Cross sections C-D



Bush Dome Forecast

Cross sections at E-F



Scenarios Definition

Bush Dome Forecast

Edge Geoscience Inc.

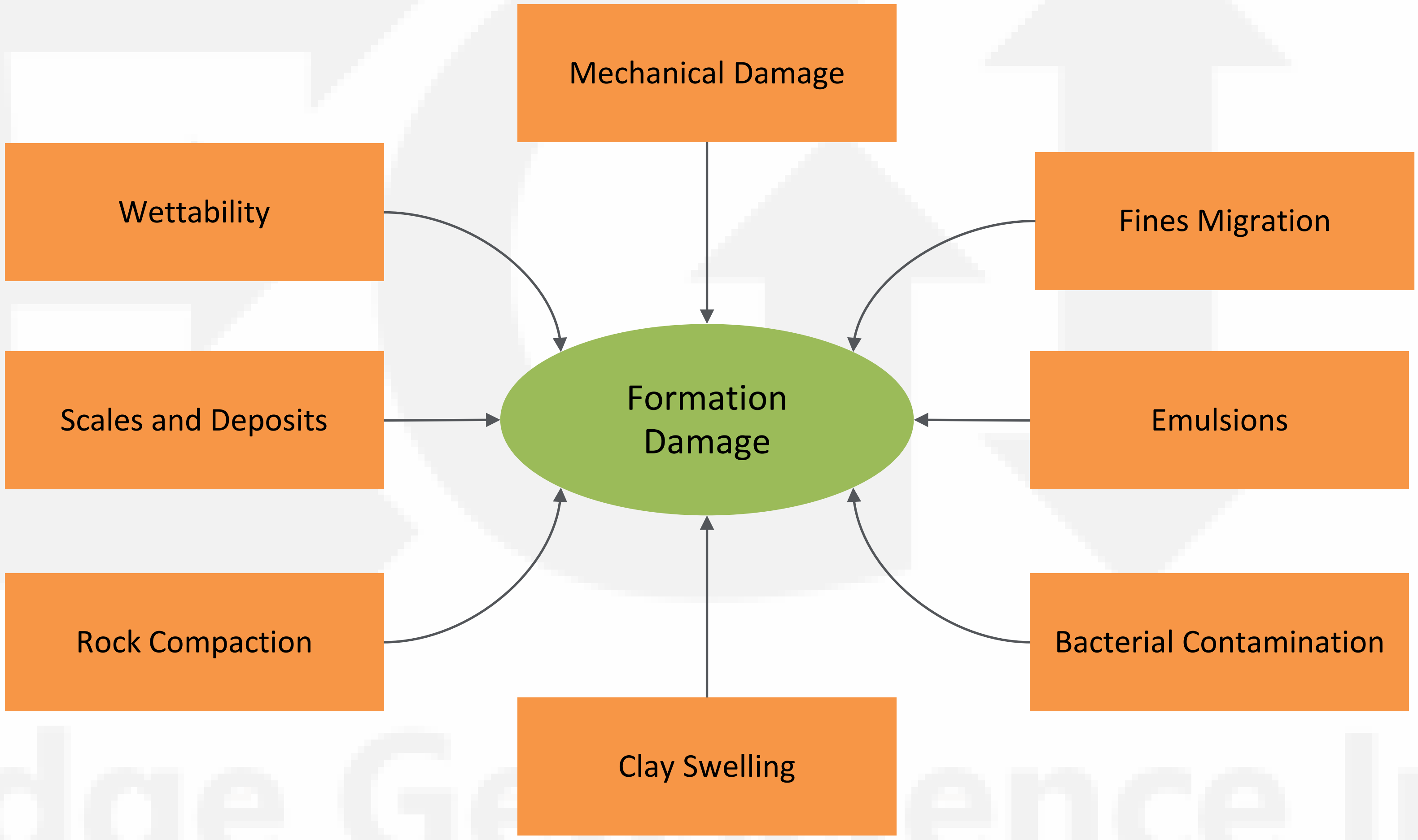
Scenario Number	Scenario Name	Scenario Description	Upstream compressor pressure (psi)	Simulated Starting Date
1	Base Case	Depletion of current producing wells with existing Compression system	132	July 2019
2	Base Case + New Compressor	Depletion of current wells with two Compressors in series, no well stimulation	75	July 2019
3	Well stimulation Sce-1	Depletion of current wells with two Compressors in series+19 wells under stimulation. Skin factor is reduced 50%	75	Feb 2020
4	Well stimulation Sce-2	Depletion of current wells with two Compressors in series+19 well under stimulation. Skin factor is reduced 75%	75	Feb 2020
5	Well stimulation Sce-3	Depletion of current wells with two Compressors in series+19 well under stimulation. Skin factor is reduced 100%	75	Feb 2020
6	Base Case + New Compressor+Constant N2 inj.	Constant Nitrogen reinjection. Well conditions of scenario 2 are considered	75	Nov 2019
7	Base Case + New Compressor +N2 Stepwise inj.	Variable stepwise Nitrogen Reinjection. Well conditions of scenario 2 are considered	75	Nov 2019
8	Base Case + New Compressor+ Bivins 22 Sidetrack	Depletion of current wells with two Compressors in series + Bivins 22 sidetrack(check new drainage point)	75	March 2020

Scenario definition is for pre-screening purpose only. Defining scenarios doesn't necessarily mean the possibility of performing the technique in the field. Economic and further feasibility studies are needed for final decisions.

Well Stimulation
(Scenarios 3,4,5)

Bush Dome Forecast

Formation Damage and Well Skin Factor



Bush Dome Forecast

Well Stimulation

Skin Factor is a dimensionless factor that can help understand the severity of formation damage (and thus, pressure loss) near the wellbore

Results of our analyses show that a well stimulation job can increase the production from the wells in short time before October 2021.

Welltest analysis is recommended before performing the actual stimulation job at the field

Advantage: Fast, short down time, relatively cheap, production boost in short time

Therefore, well stimulation methods (including but not limited to acidizing) is recommended due to its low costs and productivity boosting advantages.

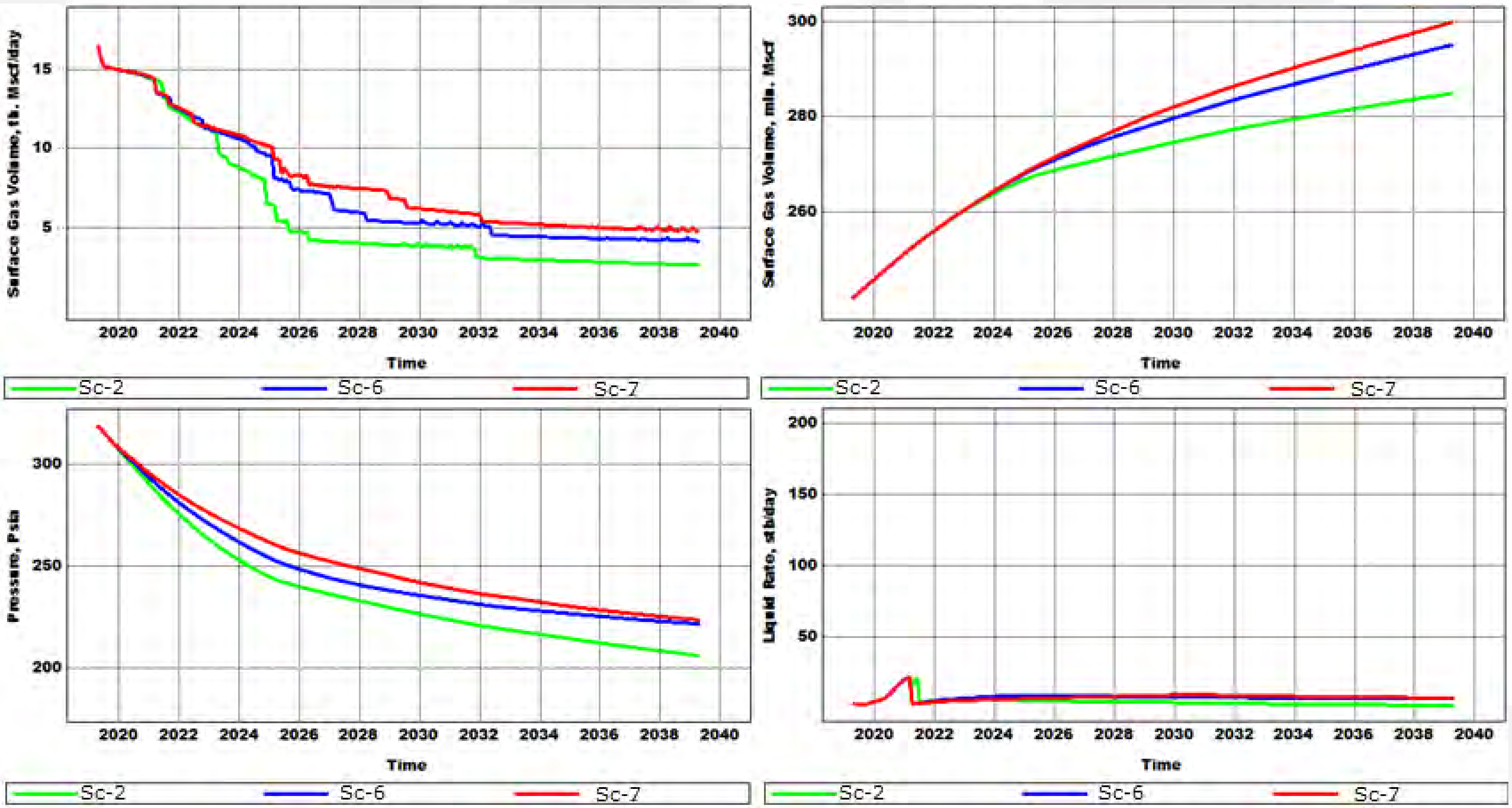
Edge Geoscience Inc.

N2 Injection Cases
(Scenario 6&7)

Forecast Scenarios. Final N_2 Injection Scenario(Case_6 and Case_7) Vs Case_2

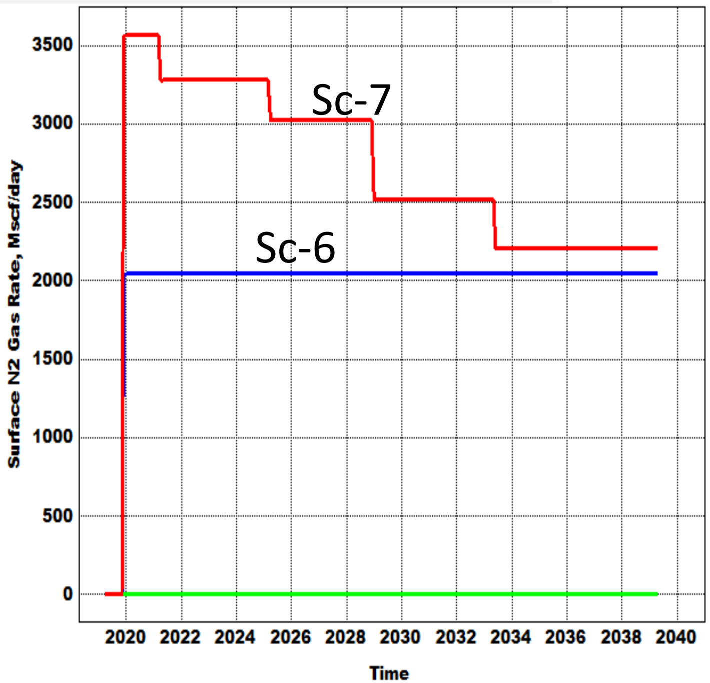
Edge Geoscience Inc.

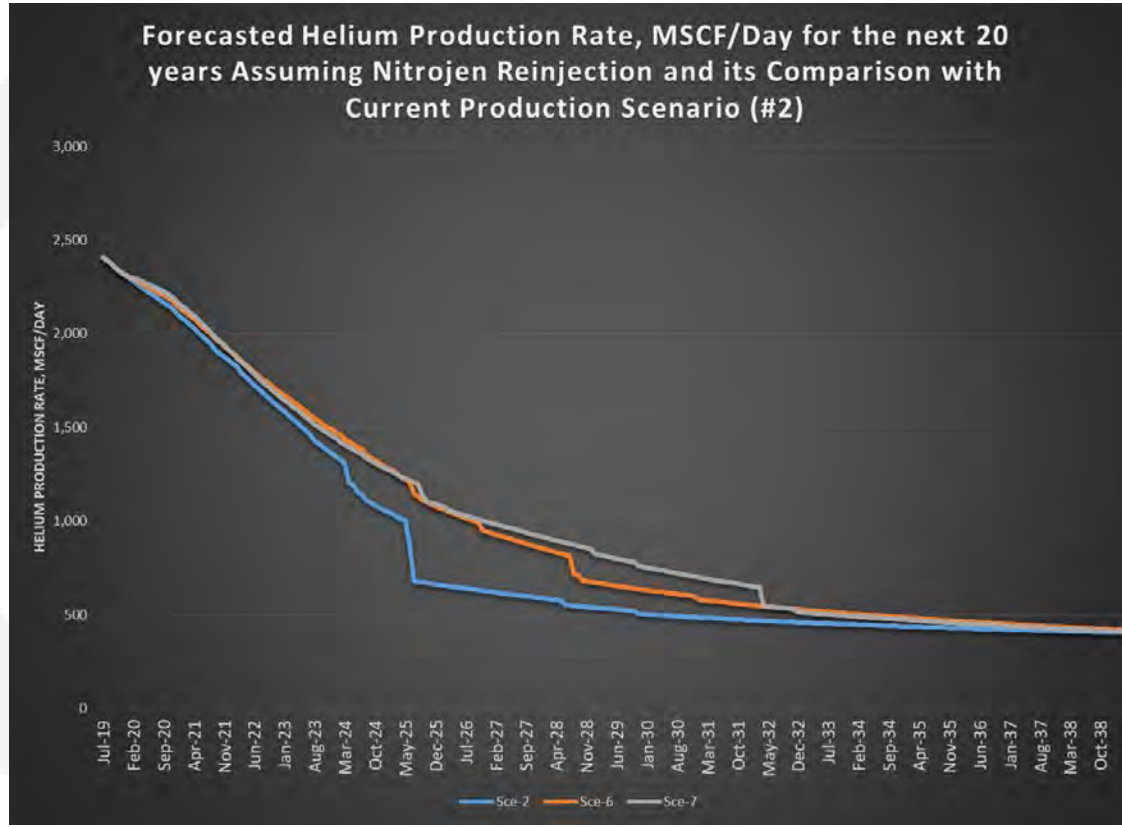
- Once reservoir response under N_2 injection is understood, final scenarios of N2 injection should be defined.
  - Case_6_Q2150 means constant N2 injection of 2.15 MMSCF/D
  - Case_7_Qinj_Opt is an optimized scenario based on a stepwise injection scheme



Surface Gas Volume, th, Mscf/day= Production Rate at tubing head, Million SCF/day
Surface Gas Volume, Mln.Mscf = Cumulative Gas Production BCF

Effect of N_2 injection on Helium gas production rate

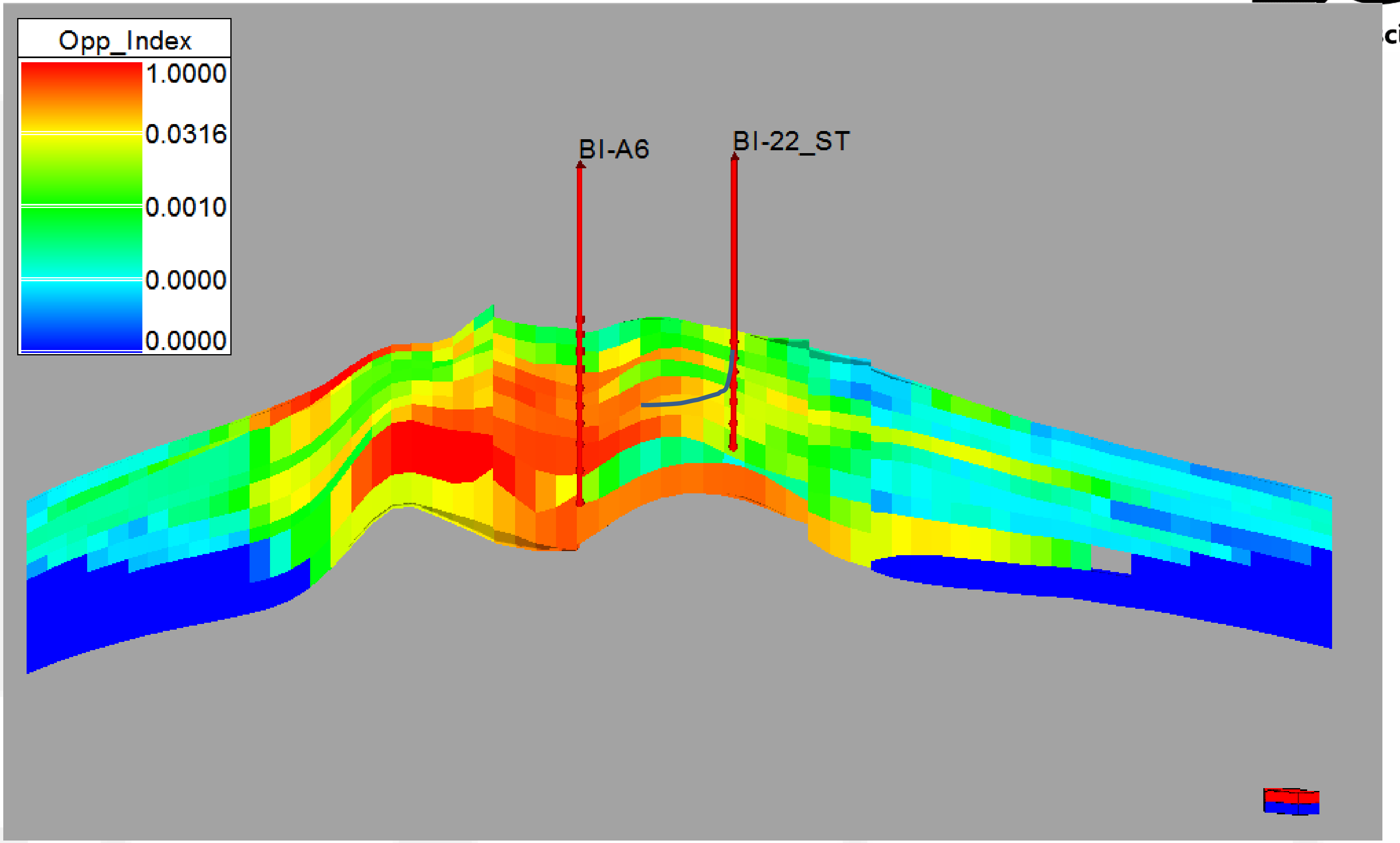




- Notice: The higher the N_2 injection rate the higher the He gas production rate
- Disadvantage of N2 injection is that its results won’t be noticed until Mid-2024. It is costly and requires plant configuration change

WELL Bi-22 SIDETRACK
(Scenario 8)

Forecast Scenario: sidetrack Bi-22_ST

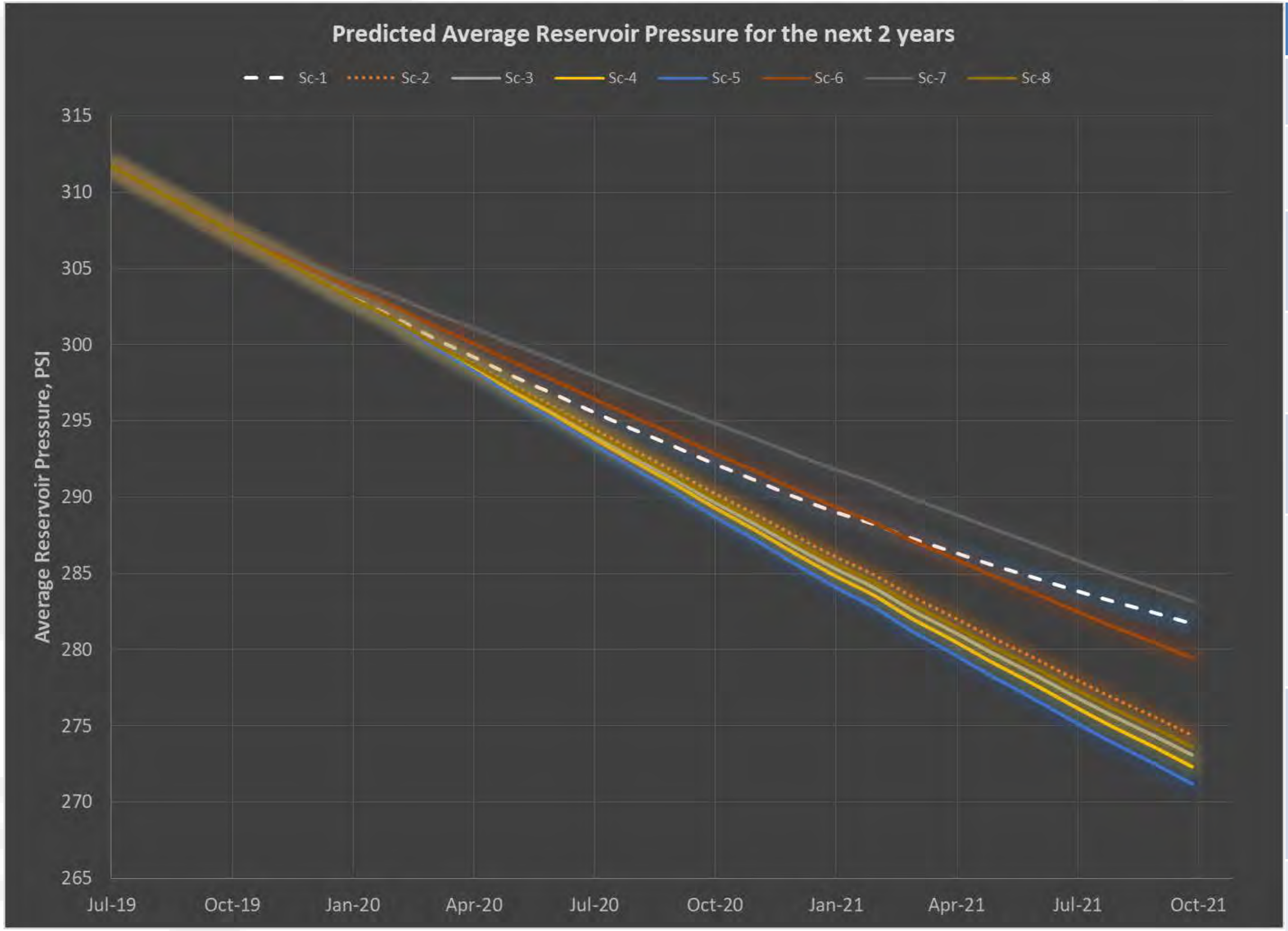


Disadvantage: Expensive, not located in a good net pay, needs long horizontal section

COMPARISON OF PRODUCTION FORECASTS FOR DEFINED SCENARIOS

Average Reservoir Pressure Forecast

Edge Geoscience Inc.



Scenario Number	Scenario Name
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2	Base Case + New Compressor
3	Well stimulation Sce-1
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5	Well stimulation Sce-3
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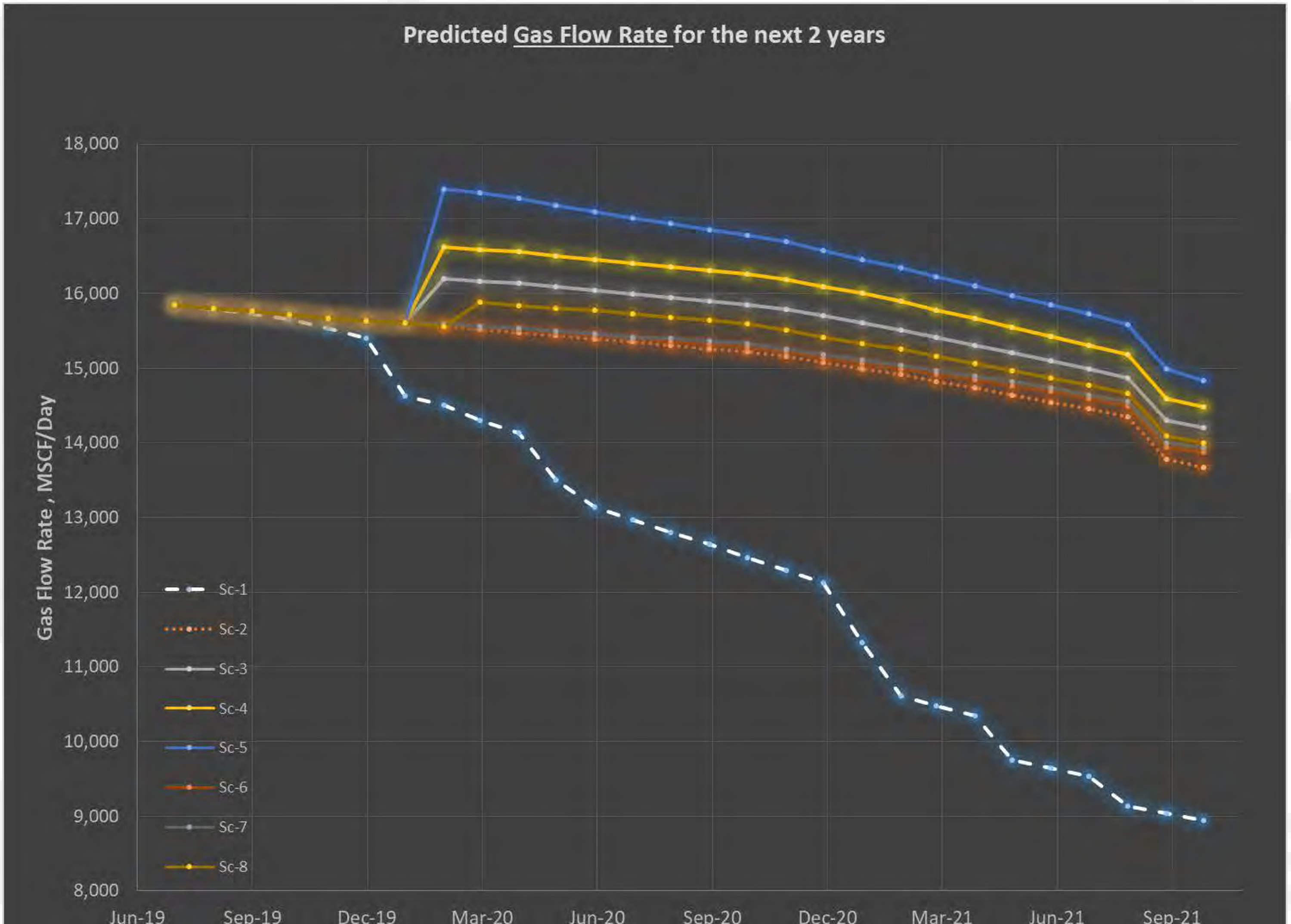
7	Base Case + New Compressor +N2 Stepwise inj.
8	Base Case + New Compressor+ Bivins 22 Sidetrack

Gas Flow Rate Forecast



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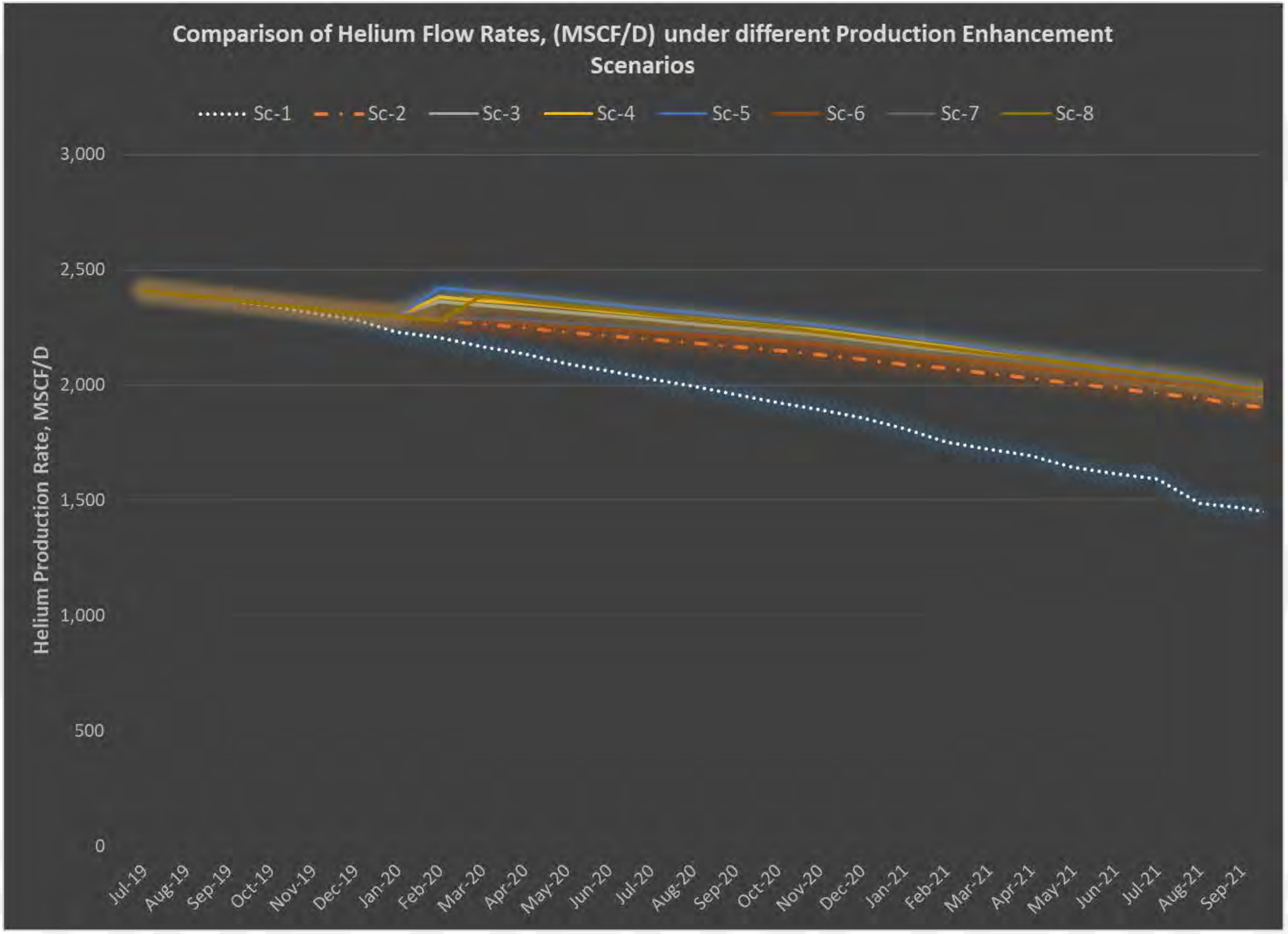
Helium Flow Rate Forecast



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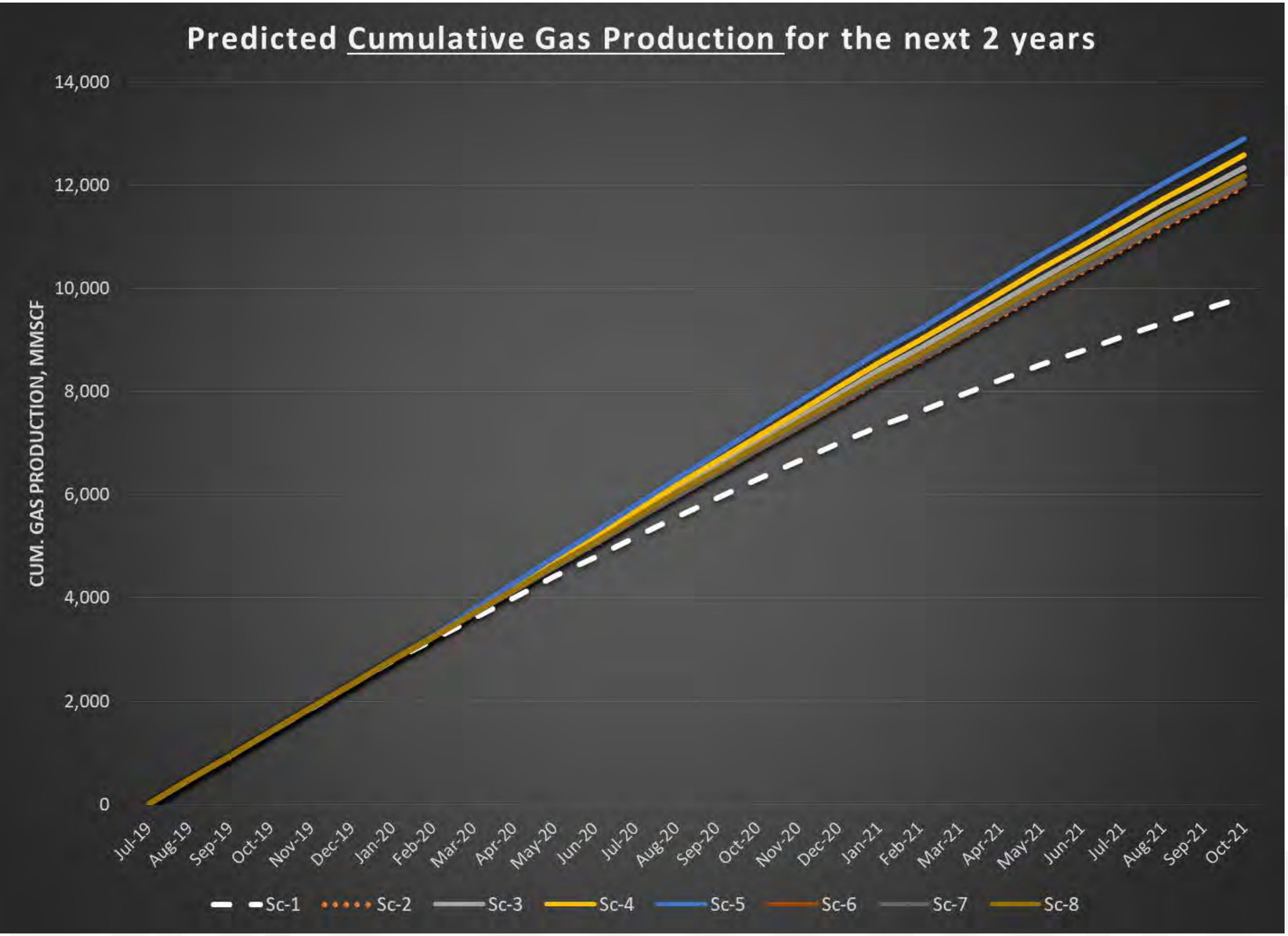
Cumulative Gas Production Forecast

Edge Geoscience Inc.



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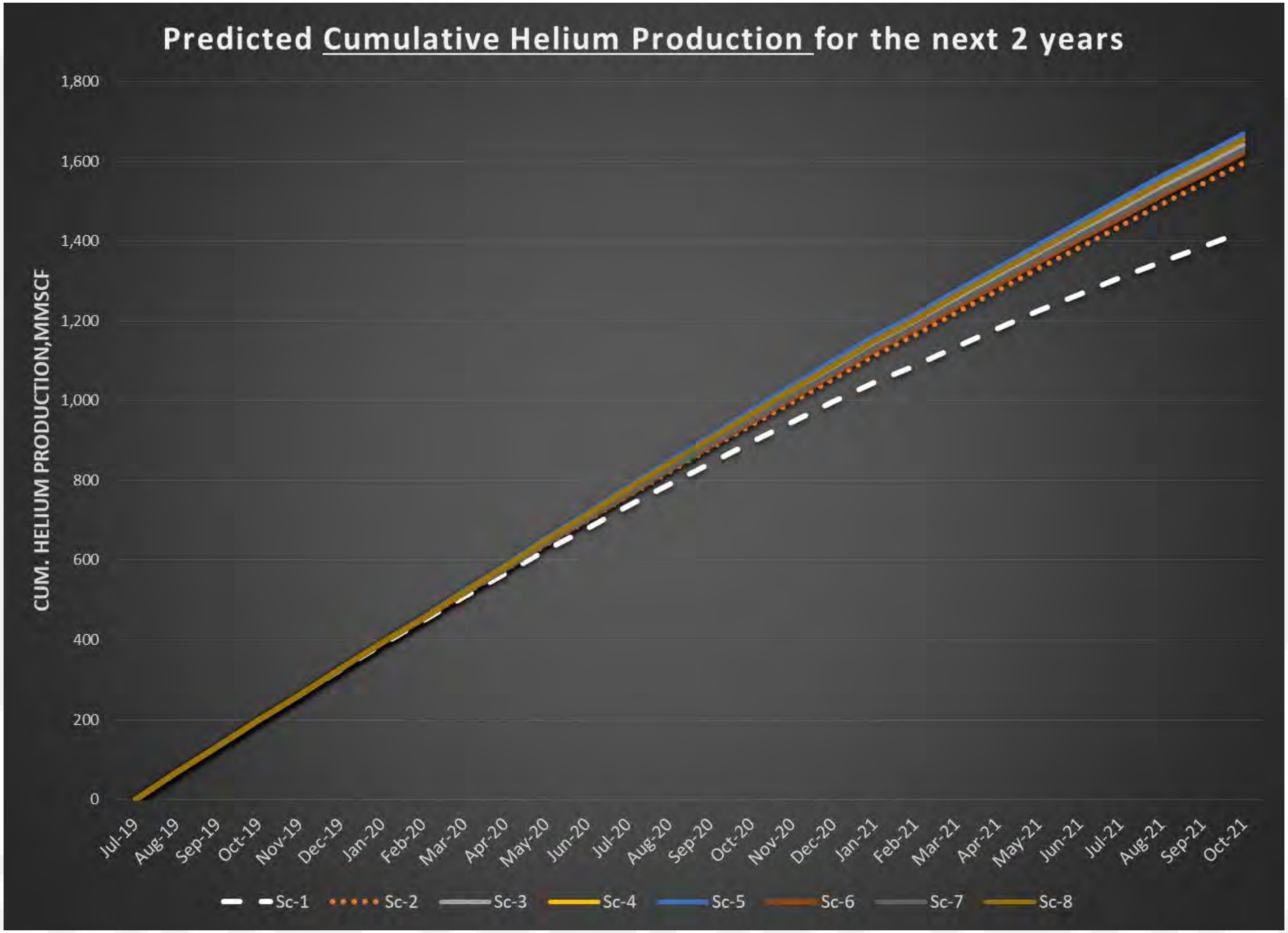
Cumulative Helium Production Forecast

Edge Geoscience Inc.



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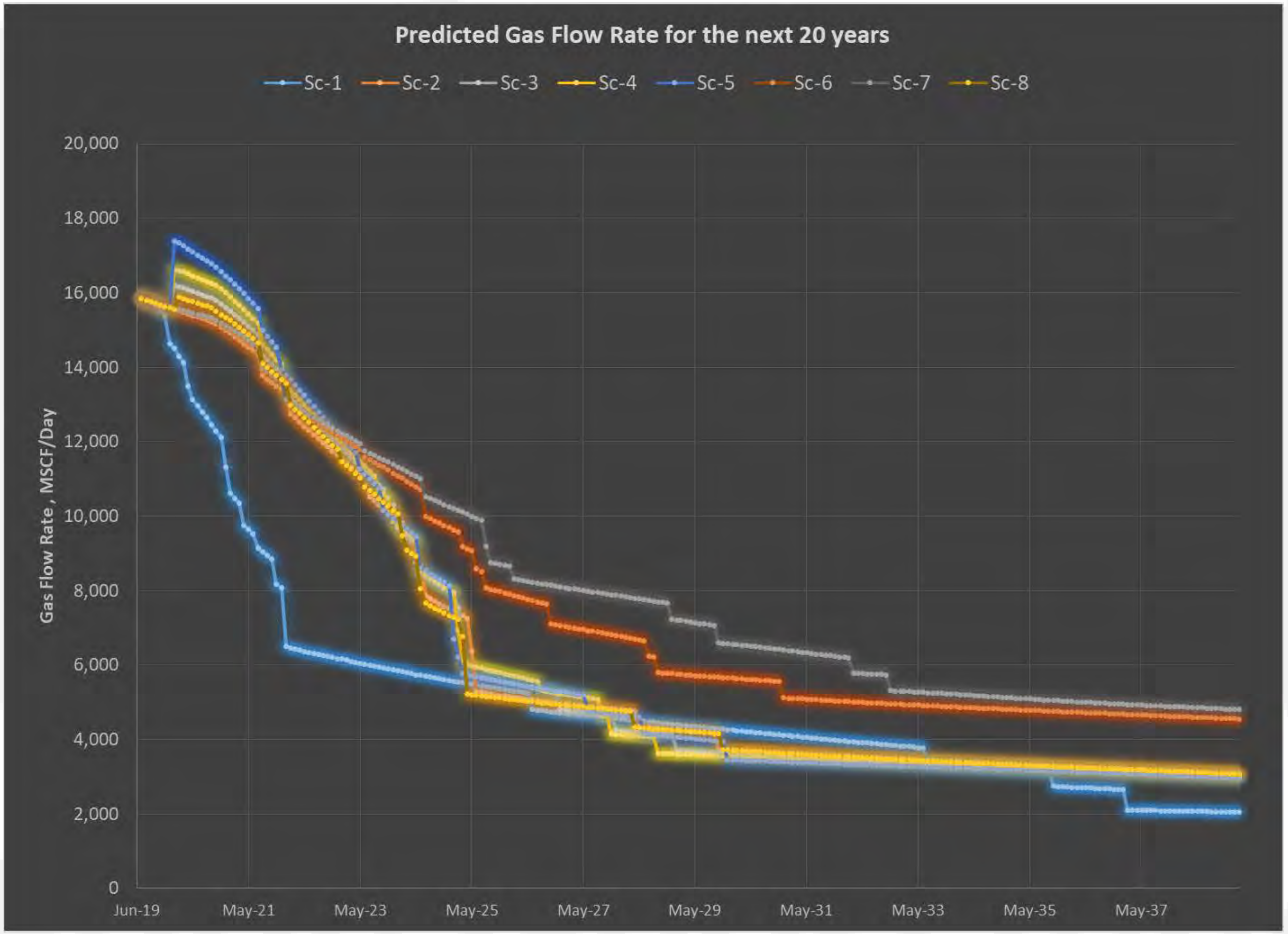
Long Term Forecast for Bush Dome

Forecast, all scenarios (95% uptime)



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7	Base Case + New Compressor +N2 Stepwise inj.
8	Base Case + New Compressor+ Bivins 22 Sidetrack

Note: The estimated rates are based on current conditions. Change in reservoir management (especially after 2021), starting date of production enhancement methods, market conditions,… could significantly change the results

Cumulative Helium Production Forecasts for Different Scenarios from July 2019 to July 2021

Edge Geoscience Inc.

Scenario Number	Scenario Name	Cumulative He production (MMSCF) Forecast Jul 2019-July 2020	Cumulative He production (MMSCF) Forecast Jul 2020-July 2021
1	Base Case	734.8	574.07
2	Base Case + New Compressor	759.3	678.93
3	Well stimulation Sce-1	773.6	706.61
4	Well stimulation Sce-2	777.2	713.39
5	Well stimulation Sce-3	782.9	721.42
6	Base Case + New Compressor +Constant N2 inj.	763.2	695.12
7	Base Case + New Compressor +Stepwise N2 inj.	765.8	701.98
8	Base Case + New Compressor+ Bi 22 Sidetrack	777.2	712.52

- Due to accelerated Production decline, performing Production Enhancement (PE) methods are highly suggested.
- If no PE method is implemented, the estimated cumulative helium production will be close to scenario 2 (~760 MMcf)
- The production can significantly change if production enhancement methods get implemented ASAP.
- Some of the scenarios will show their effect in 2-3 years. So, it is natural not to see major production boost at first year.

Cumulative Gas Production Forecasts for Different Scenarios from July 2019 to July 2020

Edge Geoscience Inc.

Scenario Number	Scenario Name	Cumulative Gas production (BCF) Forecast Jul 2019-July 2020	Cumulative Gas production (BCF) Forecast Jul 2020-July 2021
1	Base Case	5.179	3.884
2	Base Case + New Compressor	5.498	5.244
3	Well stimulation Sce-1	5.607	5.463
4	Well stimulation Sce-2	5.677	5.600
5	Well stimulation Sce-3	5.793	5.773
6	Base Case + New Compressor +Constant N2 inj.	5.504	5.275
7	Base Case + New Compressor +Stepwise N2 inj.	5.508	5.293
8	Base Case + New Compressor+ Bi 22 Sidetrack	5.555	5.369

Conclusions and Summary

- 2D & 3D Geologic, Stratigraphic and Petrophysical models were developed for Bush Dome reservoir with higher precision and less inconsistency and more geologic discoveries.
- The geological complexity of Bush Dome reservoir is higher than the one we can characterize today by using available data and there are structural and stratigraphic barriers that cannot be identified by conventional geological analysis but they exist in the reservoir. New seismic acquisition can help to improve structural framework, identify faults, compartments, sand distribution and rock quality.
- There is no aquifer support at Bush Dome reservoir. Limited water produced from Bush Dome reservoir is due to rock and fluid expansion. The rapid pressure decline for the last depletion period supports the assumptions. Cumulative water production is less than 5% which means that produced water is connate water.
- So far Bush Dome reservoir has been exploited as a conventional gas reservoir. Completion history showed low contacted area (low perforation density), conservative (low volume) acid stimulation jobs, no hydraulic fracture implementation, and production tubing that limited gas production.

Conclusions and Summary

- The reservoir pressure is declining relatively fast and so is the production rate. To increase the production rate, several production enhancement scenarios were studied and analyzed. The results of the studies show the fastest and cheapest production enhancement scenario in short term is well stimulation and N2 re-injection or drilling new vertical wells in long term. Although decision about long-term production enhancement methods depend on the next reservoir owners.