CPE 651 :Undergraduate Summer Research

CMG Simulation Modeling Learning

Presenter: Jason Zhang

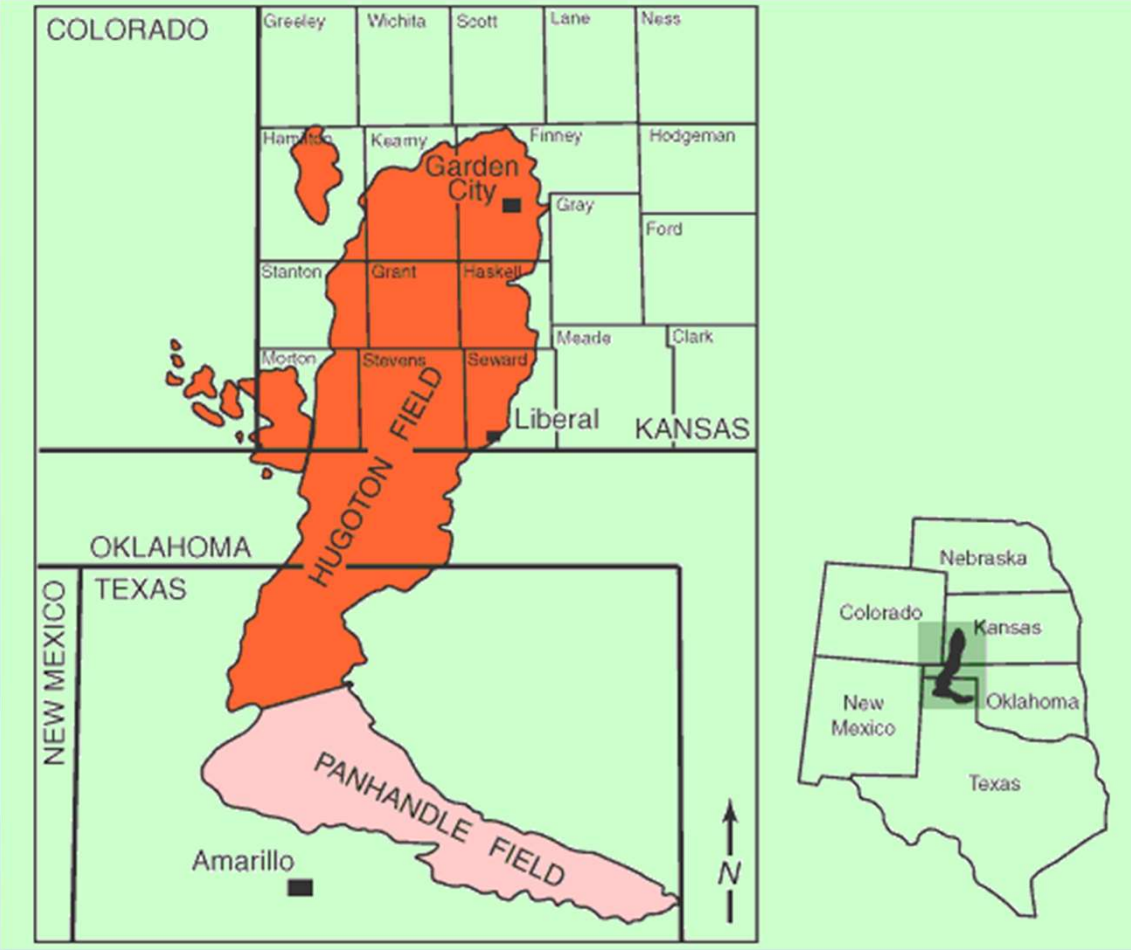
Project Outline

- ❑Project Objective
- ❑Raw Data
- ❑History Matching Procedures and Results
- ❑Future Forecast
- ❑Locations of New Wells to Optimize

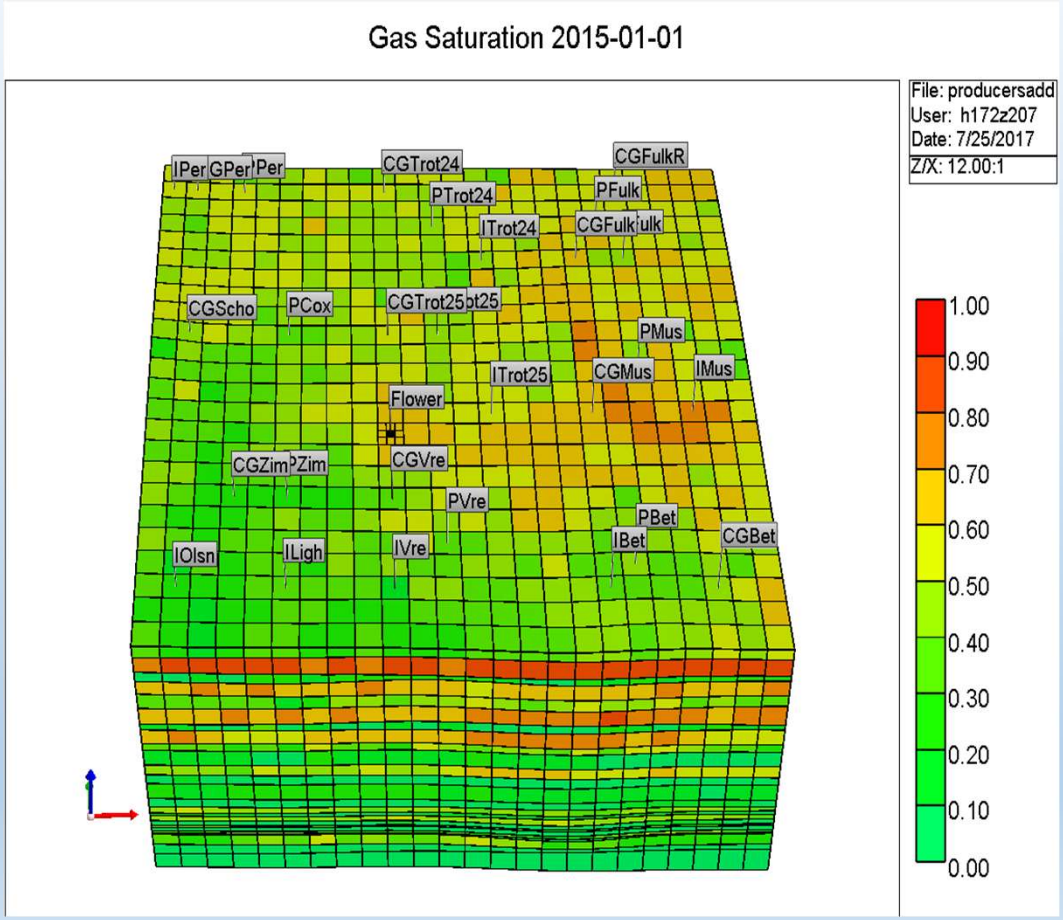
Project Objective

- History Matching for the Gas Field at Kansas Hugoton Flower Area.
- Future Prediction
- Determine the optimum locations for at least two new wells

Hugoton-Panoma **Gas Field**

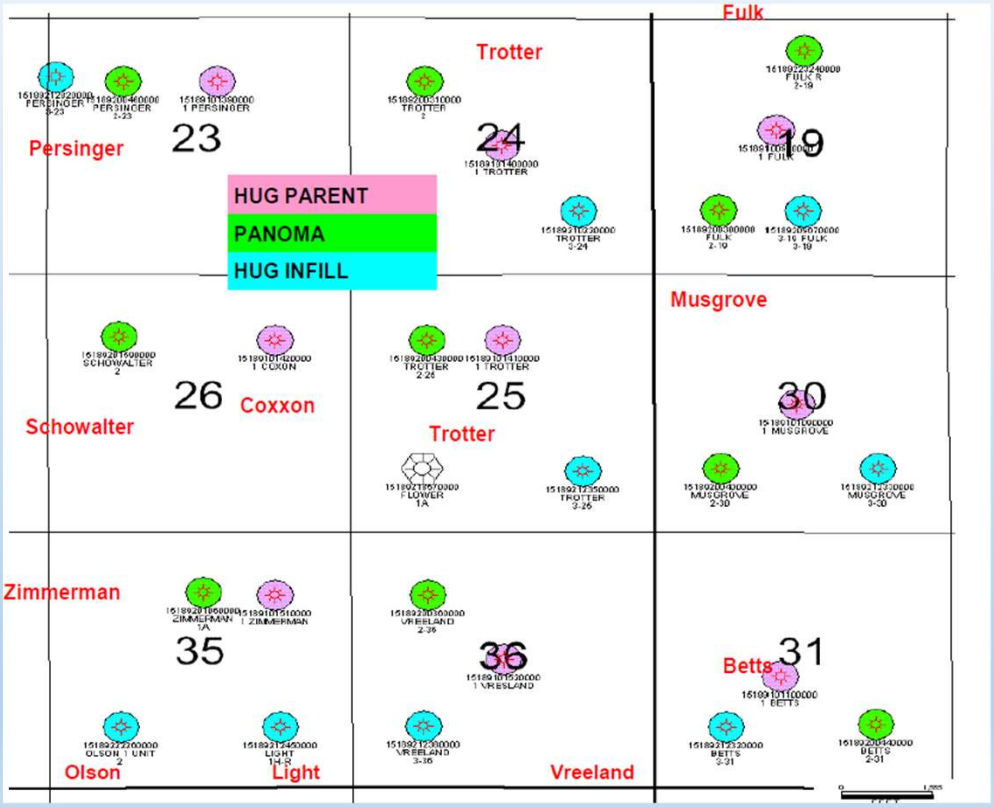


Initial Reservoir Condition



The reservoir interested has 24x24 blocks in the X and Y directions and has 25 layers, single porosity. There are 29 wells and had been perforated at different time.

Well Location



Group	Formation / Member	LAYER
Chase	HRNGTN	1
	KRIDER	2
	ODELL	3
	WINF	4
	GAGE	5
	TOWANDA	6
	HOLMESVILLE	7
	FT RILEY	8
	L/FT RILEY	9
	MATFIELD	10
	WREFORD	11
Council Grove	A1_SH	12
	A1_LM	13
	B1_SH	14
	B1_LM	15
	B2_SH	16
	B2_LM	17
	B3_SH	18
	B3_LM	19
	B4_SH	20
	B4_LM	21
	B5_SH	22
	B5_LM	23
	C_SH	24
	C_LM	25

Table 1: Chase and Council Grove settings

Data Given

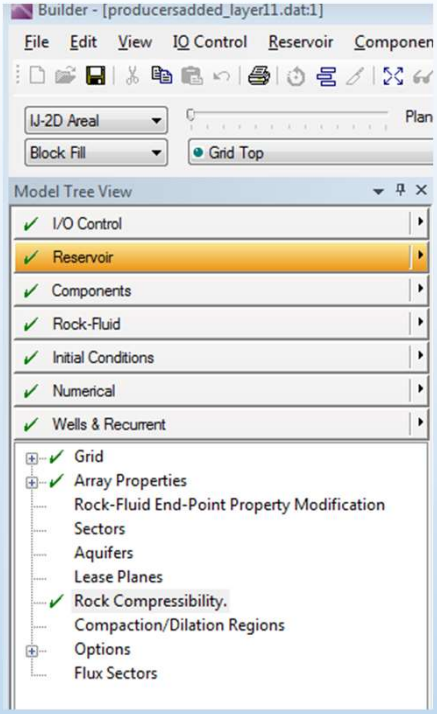
Builder 2014.10

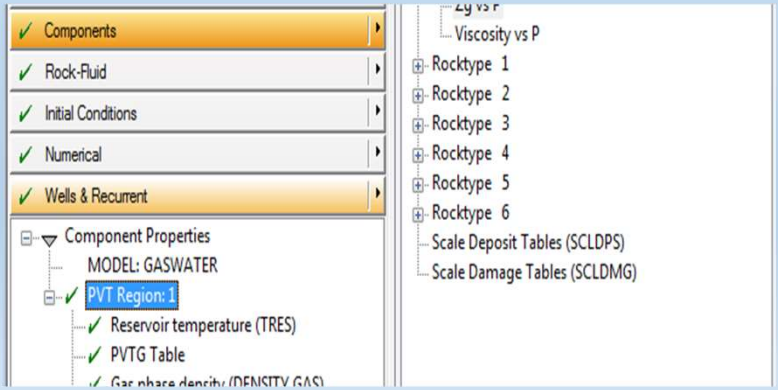
Table 2: Rock compressibility

Property	Value		
Reference pressure	465	psi	
Rock compressibility	0.000002	1/psi	(assumed)

Table 3: PVT properties of the Hugoton gas field

Property	Value	
Reference pressure	465	psi
Max Pressure	500	psi
Reservoir temp	90	F
Gas gravity (Air = 1.0)	0.715	
Water salinity	110,000	ppm





Data Given

A.

SW	KRW	KRG
0.25	0.0000	0.40
0.30	0.0000	0.31
0.35	0.0000	0.23
0.40	0.0000	0.16
0.45	0.0002	0.10
0.50	0.0006	0.06
0.55	0.0013	0.02
0.60	0.0024	0.00
0.65	0.0042	0.00
0.70	0.0068	0.00
0.75	0.0103	0.00
0.80	0.0152	0.00
0.85	0.0215	0.00
0.90	0.0296	0.00
0.95	0.0399	0.00
1.00	0.0526	0.00

Rock Type 1)

$K \leq 0.0001$ md

B.

SW	KRW	KRG
0.12	0.0000	0.69
0.15	0.0000	0.65
0.20	0.0000	0.54
0.25	0.0000	0.44
0.30	0.0001	0.35
0.35	0.0004	0.27
0.40	0.0010	0.19
0.45	0.0020	0.13
0.50	0.0036	0.08
0.55	0.0060	0.05
0.60	0.0093	0.02
0.65	0.0140	0.00
0.70	0.0202	0.00
0.75	0.0283	0.00
0.80	0.0386	0.00
0.85	0.0515	0.00
0.90	0.0673	0.00
0.95	0.0866	0.00
1.00	0.1096	0.00

Rock Type 2)

$0.0001 < K < 0.001$ md

C.

SW	KRW	KRG
0.06	0.0000	0.97
0.10	0.0000	0.88
0.15	0.0000	0.76
0.20	0.0000	0.65
0.25	0.0003	0.54
0.30	0.0009	0.44
0.35	0.0019	0.35
0.40	0.0037	0.26
0.45	0.0065	0.19
0.50	0.0106	0.13
0.55	0.0165	0.08
0.60	0.0244	0.04
0.65	0.0350	0.02
0.70	0.0486	0.00
0.75	0.0658	0.00
0.80	0.0873	0.00
0.85	0.1136	0.00
0.90	0.1455	0.00
0.95	0.1836	0.00
1.00	0.2288	0.00

Rock Type 3)

$0.001 < K < 0.01$ md

D.

SW	KRW	KRG
0.01	0.0000	0.9803
0.05	0.0000	0.9331
0.10	0.0000	0.8632
0.15	0.0000	0.7913
0.20	0.0000	0.7182
0.25	0.0000	0.6449
0.30	0.0000	0.5723
0.35	0.0000	0.5012
0.40	0.0002	0.4323
0.45	0.0005	0.3666
0.50	0.0013	0.3045
0.55	0.0029	0.2470
0.60	0.0061	0.1944
0.65	0.0119	0.1475
0.70	0.0220	0.1066
0.75	0.0390	0.0721
0.80	0.0667	0.0444
0.85	0.1104	0.0235
0.90	0.1774	0.0095
0.95	0.2780	0.0019
1.00	0.4255	0.0000

Rock Type 4)

$0.01 < K < 0.1$ md

SW	KRW	KRG
0.01	0.0000	0.9803
0.05	0.0000	0.9331
0.10	0.0000	0.8632
0.15	0.0000	0.7913
0.20	0.0000	0.7182
0.25	0.0000	0.6449
0.30	0.0000	0.5723
0.35	0.0000	0.5012
0.40	0.0002	0.4323
0.45	0.0006	0.3666
0.50	0.0015	0.3045
0.55	0.0034	0.2470
0.60	0.0072	0.1944
0.65	0.0140	0.1475
0.70	0.0258	0.1066
0.75	0.0459	0.0721
0.80	0.0784	0.0444
0.85	0.1297	0.0235
0.90	0.2085	0.0095
0.95	0.3266	0.0019
1.00	0.4999	0.0000

Rock Type 5)

$K > 0.1$ md

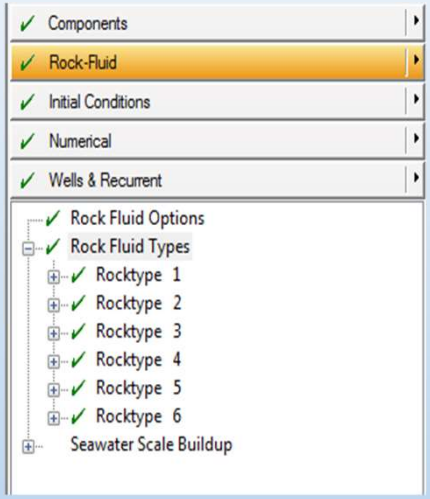
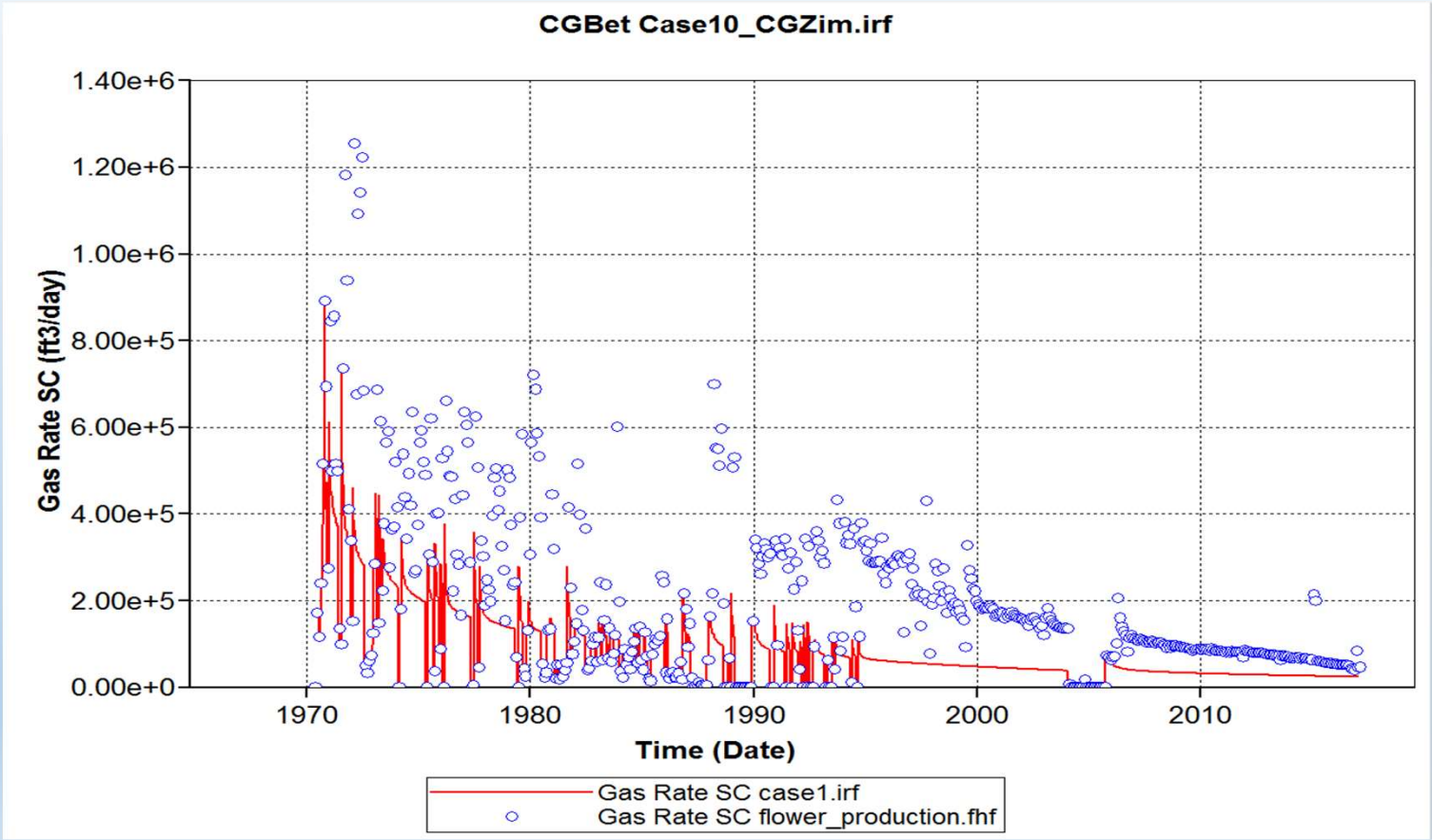
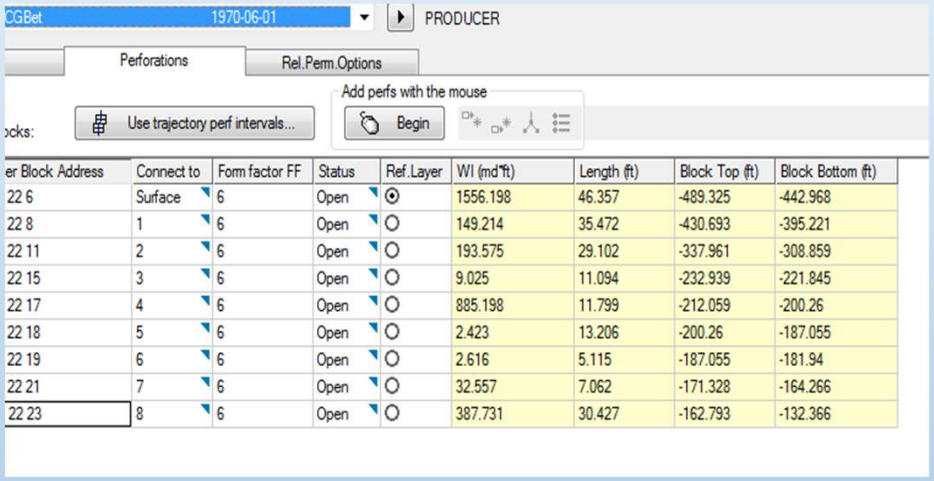


Table 4: Relative-permeability tables for respective rock-types used in single- and multi-section simulation studies.

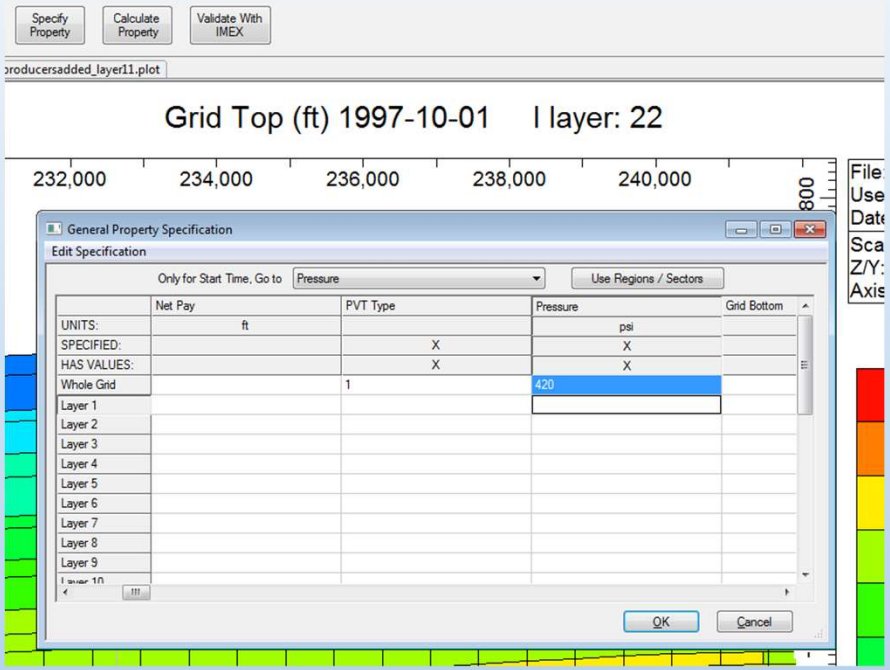
History Matching



History Matching

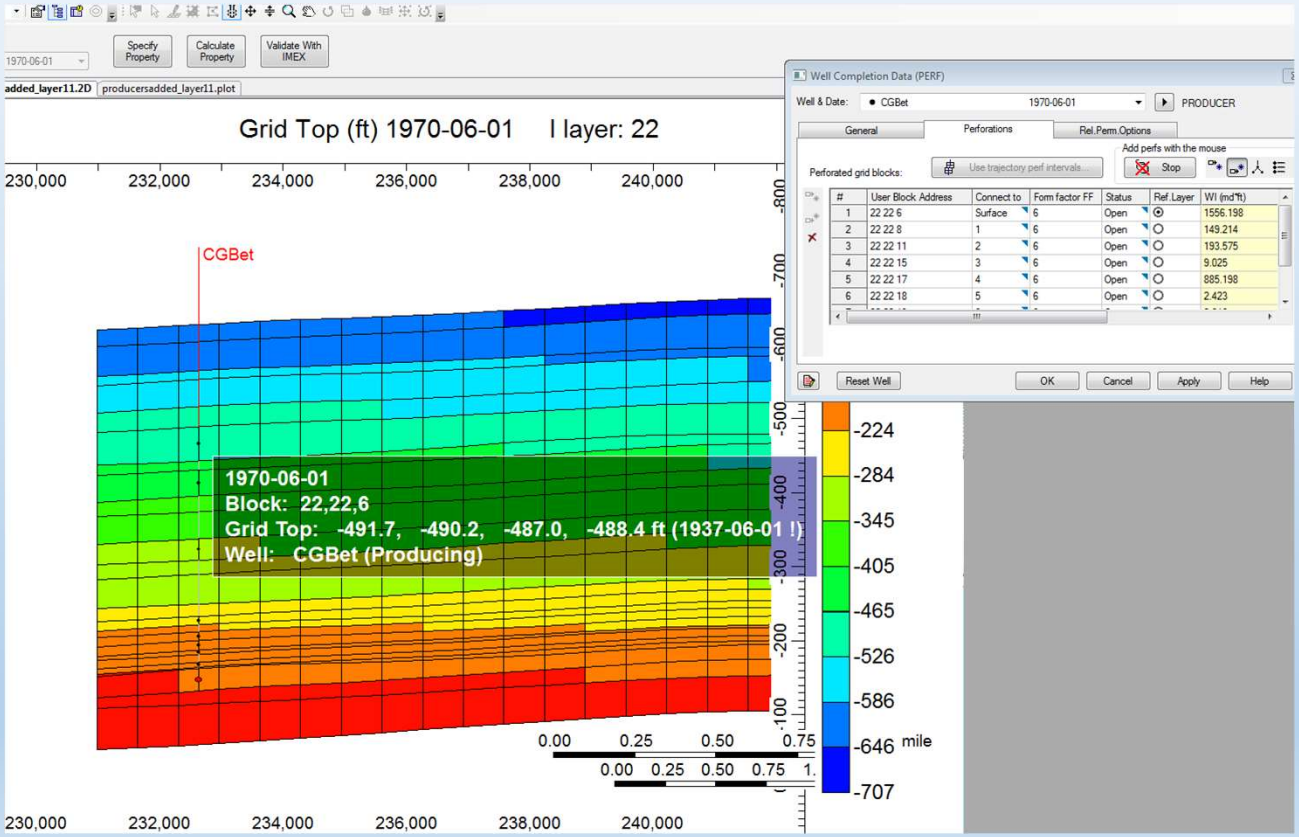


er Block Address	Connect to	Form factor FF	Status	Ref.Layer	WI (md*ft)	Length (ft)	Block Top (ft)	Block Bottom (ft)
22 6	Surface	6	Open	⊙	1556.198	46.357	-489.325	-442.968
22 8	1	6	Open	○	149.214	35.472	-430.693	-395.221
22 11	2	6	Open	○	193.575	29.102	-337.961	-308.859
22 15	3	6	Open	○	9.025	11.094	-232.939	-221.845
22 17	4	6	Open	○	885.198	11.799	-212.059	-200.26
22 18	5	6	Open	○	2.423	13.206	-200.26	-187.055
22 19	6	6	Open	○	2.616	5.115	-187.055	-181.94
22 21	7	6	Open	○	32.557	7.062	-171.328	-164.266
22 23	8	6	Open	○	387.731	30.427	-162.793	-132.366



The ff-factor = 1 represents unfeatured well and ff>1 represents a well had been hydraulic fractured.
the initial reservoir pressure is 460 and can vary between 400-500psi.

History Matching



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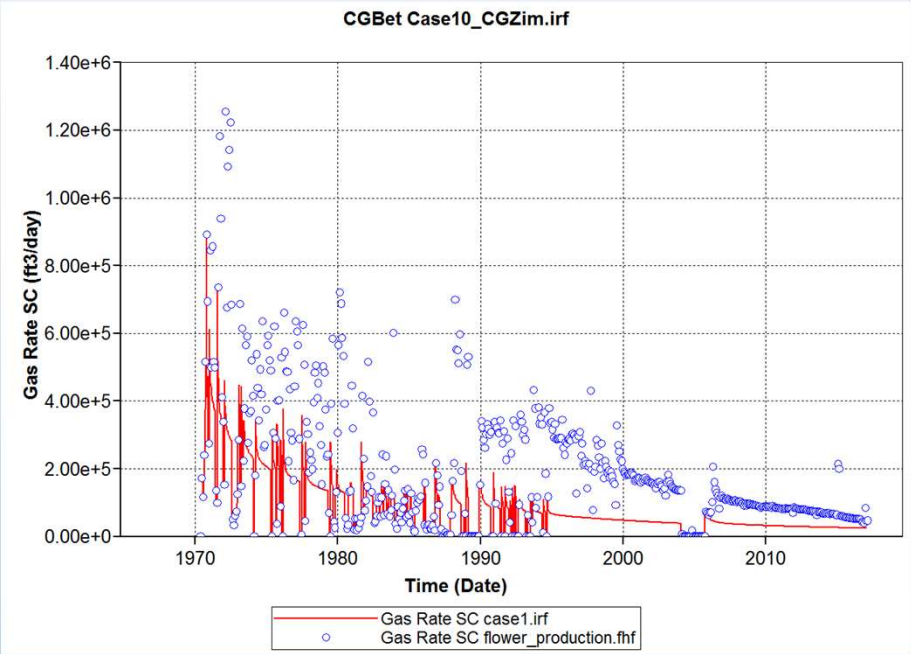
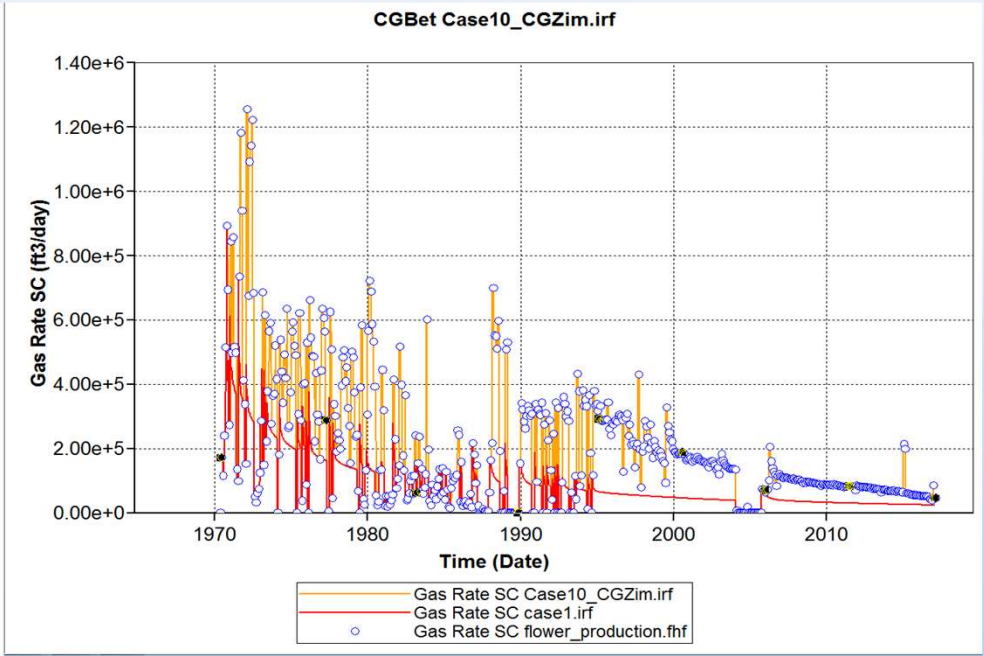


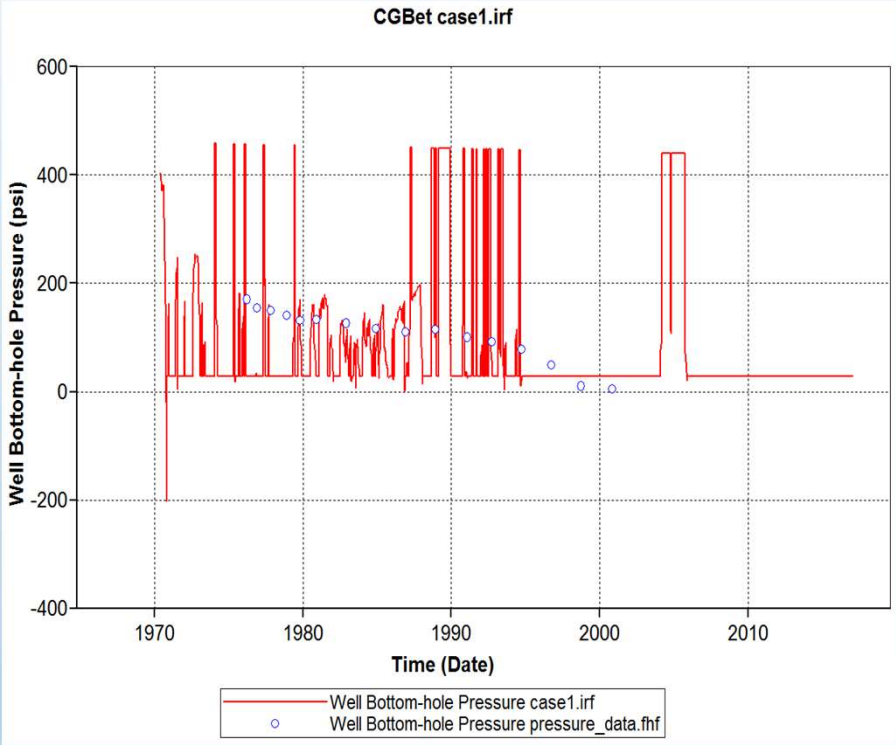
Initial State



History Matched

CGBet

History Matching



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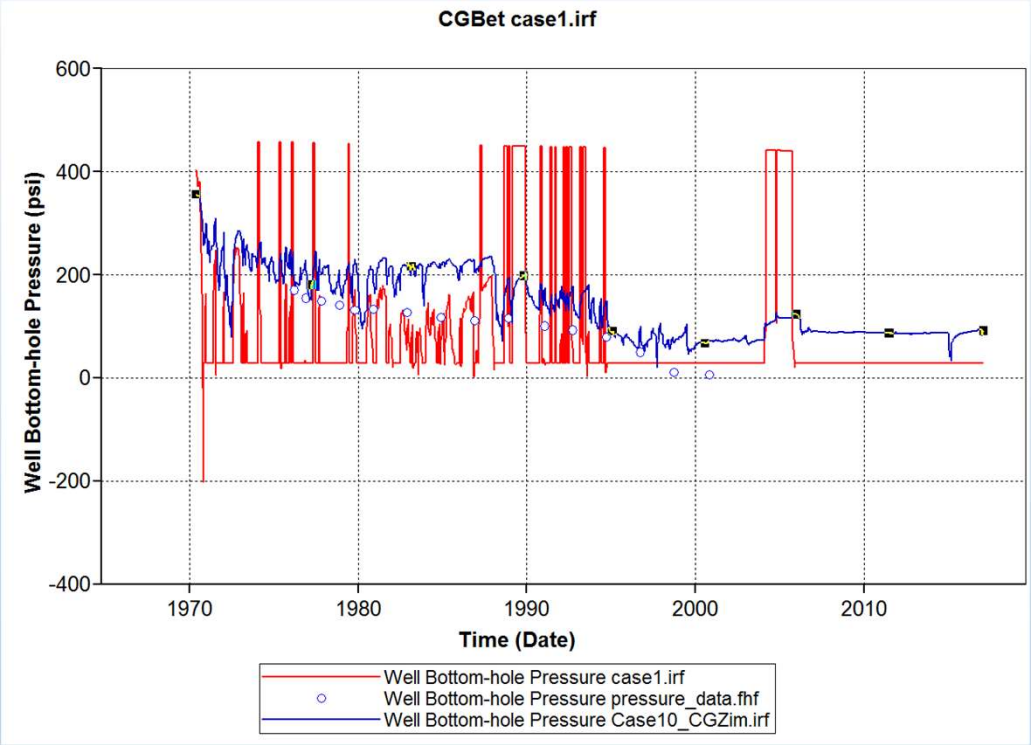
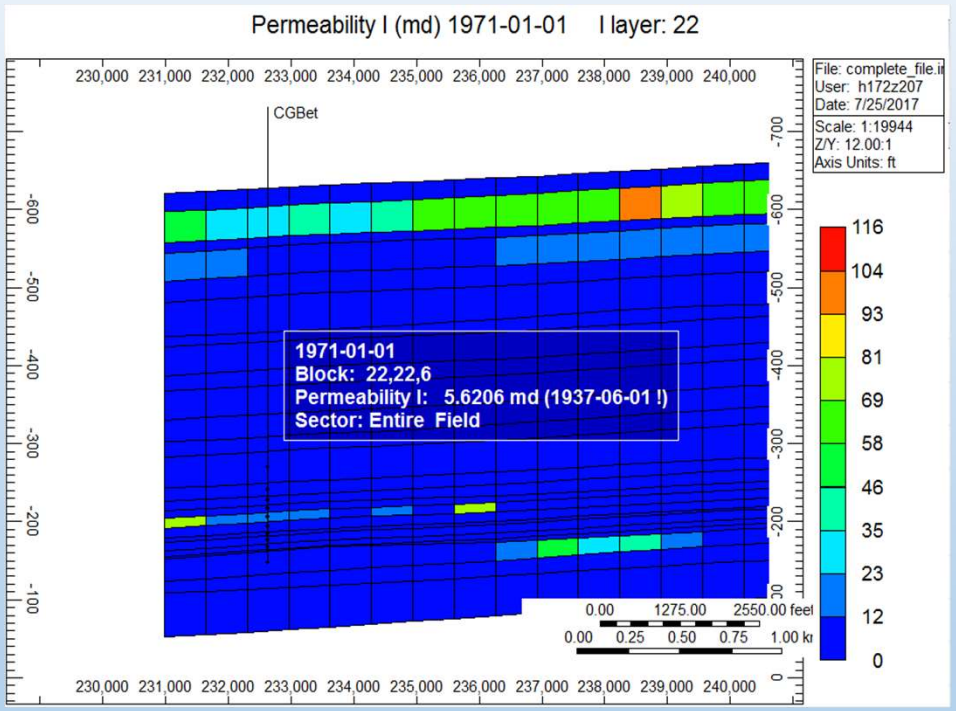
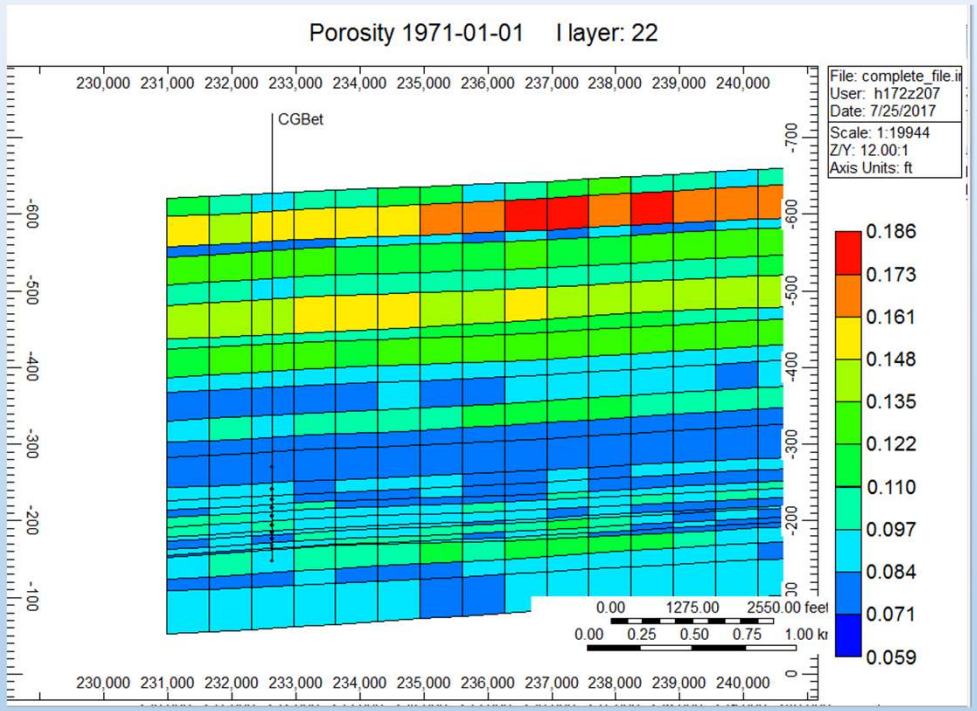


History Matched

History Matching





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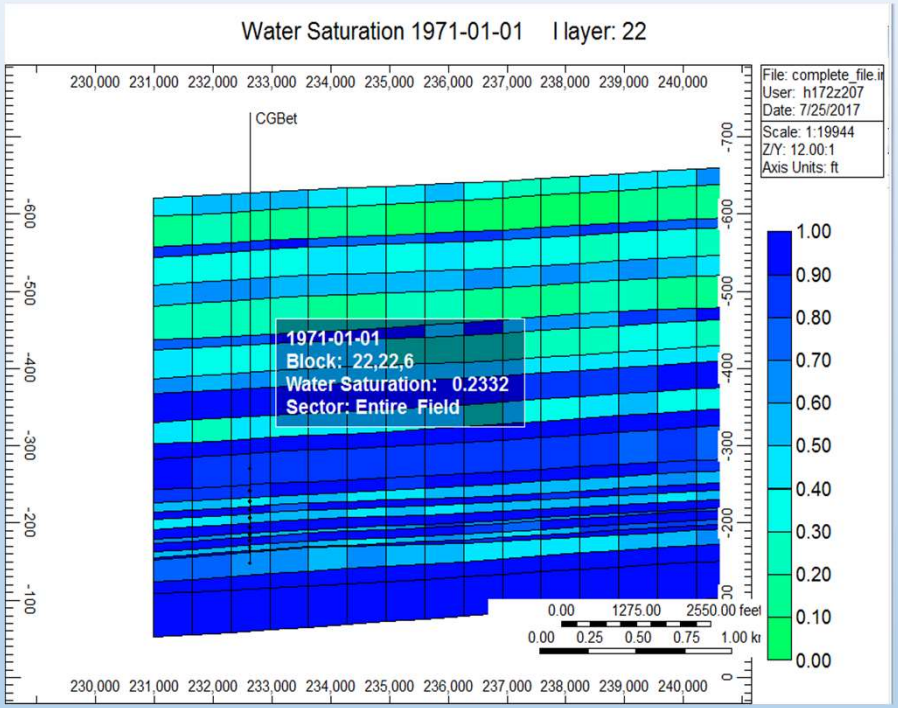

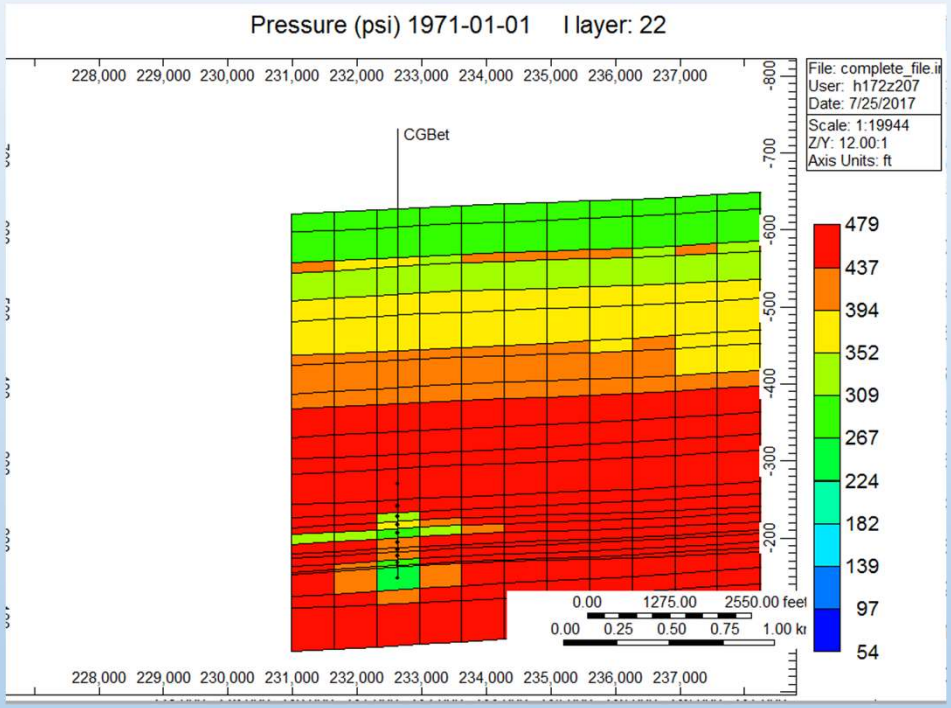

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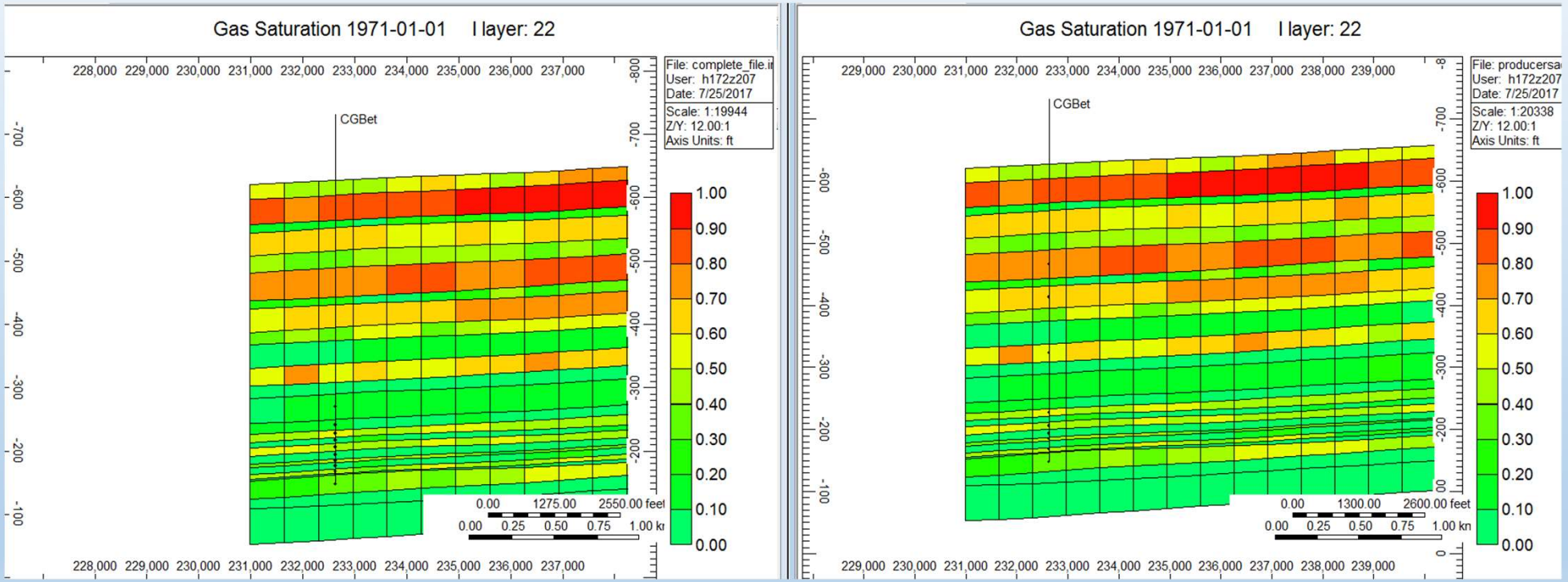

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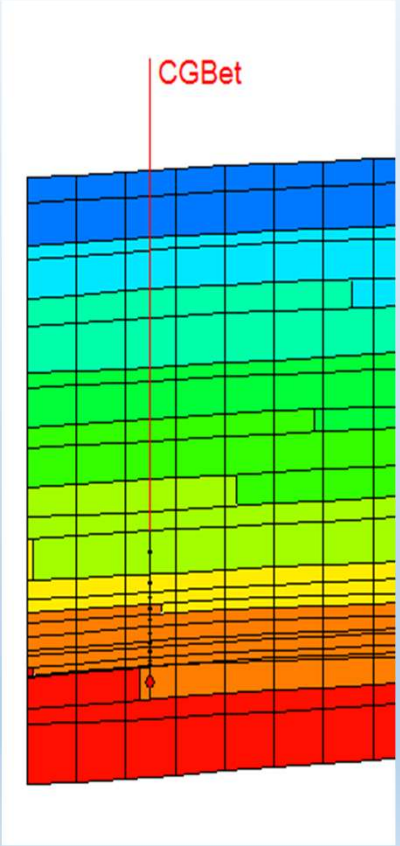
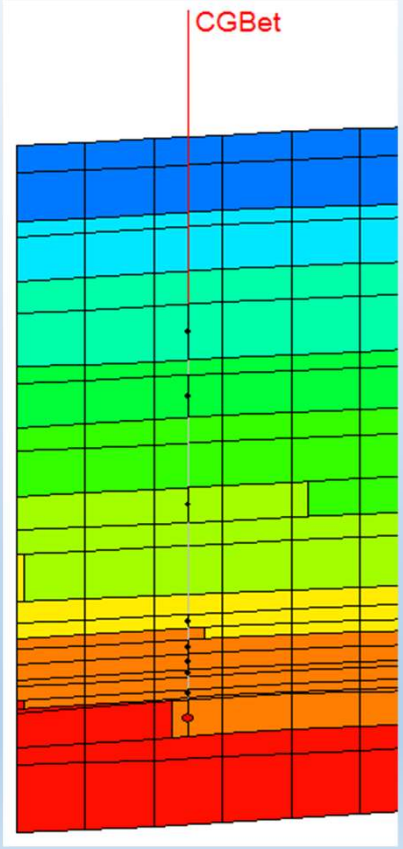


Before



After

#	User Block Address	Connect to	Form factor FF	Status	Ref.Layer	WI (md*ft)	L
1	22 22 13	Surface	6	Open	◉	1.936	4
2	22 22 14	1	6	Open	○	1.585	1
3	22 22 15	2	6	Open	○	9.025	1
4	22 22 16	3	6	Open	○	0.328	9
5	22 22 17	4	6	Open	○	885.198	1
6	22 22 18	5	6	Open	○	2.423	1
7	22 22 19	6	6	Open	○	2.616	5
8	22 22 20	7	6	Open	○	0.367	1
9	22 22 21	8	6	Open	○	32.557	7
10	22 22 22	9	6	Open	○	0.077	1
* 11	22 22 23	10	6	Open	○	387.731	3

After

Well & Date: ● CGBet 1970-06-01 PRODUCER

General | Perforations | Rel.Perm.Options

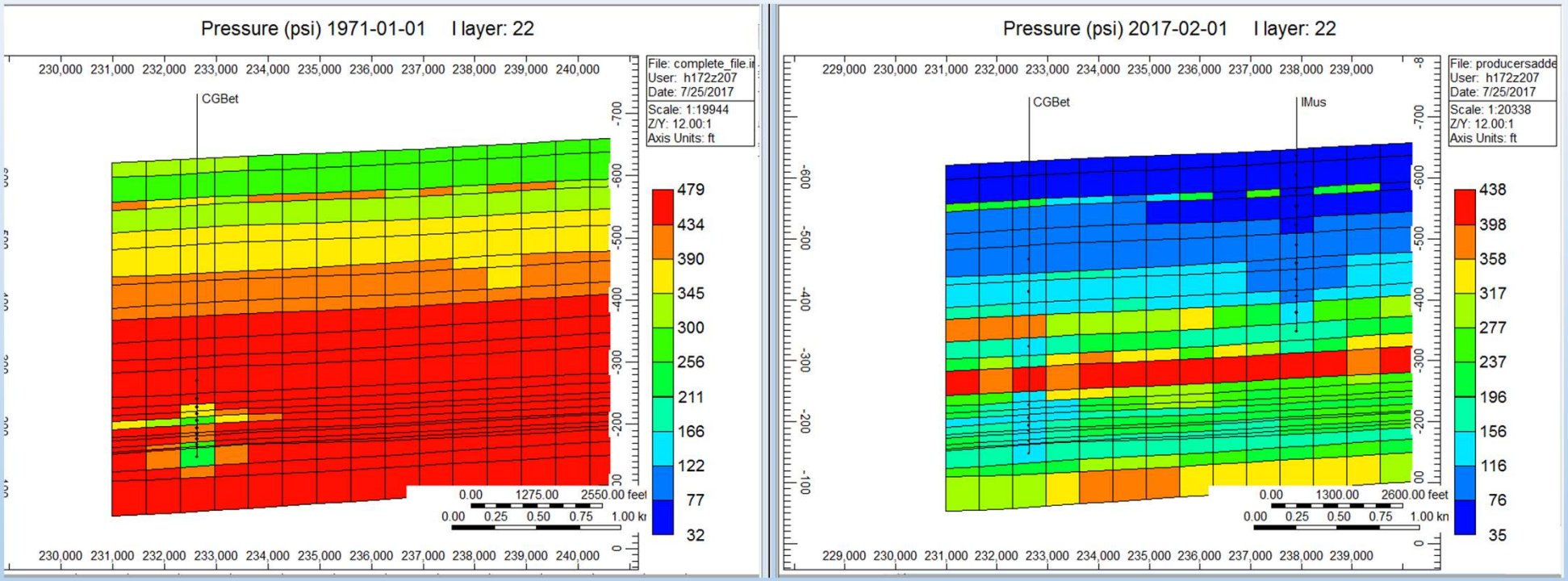
Perforated grid blocks: Use trajectory perf intervals... | Add perfs with the mouse: Begin

#	User Block Address	Connect to	Form factor FF	Status	Ref.Layer	WI (md*ft)
1	22 22 6	Surface	6	Open	◉	1556.198
2	22 22 8	1	6	Open	○	149.214
3	22 22 11	2	6	Open	○	193.575
4	22 22 15	3	6	Open	○	9.025
5	22 22 17	4	6	Open	○	885.198
6	22 22 18	5	6	Open	○	2.423
7	22 22 19	6	6	Open	○	2.616
8	22 22 21	7	6	Open	○	32.557
* 9	22 22 23	8	6	Open	○	387.731

Reset Well | OK | Cancel | Apply | Help

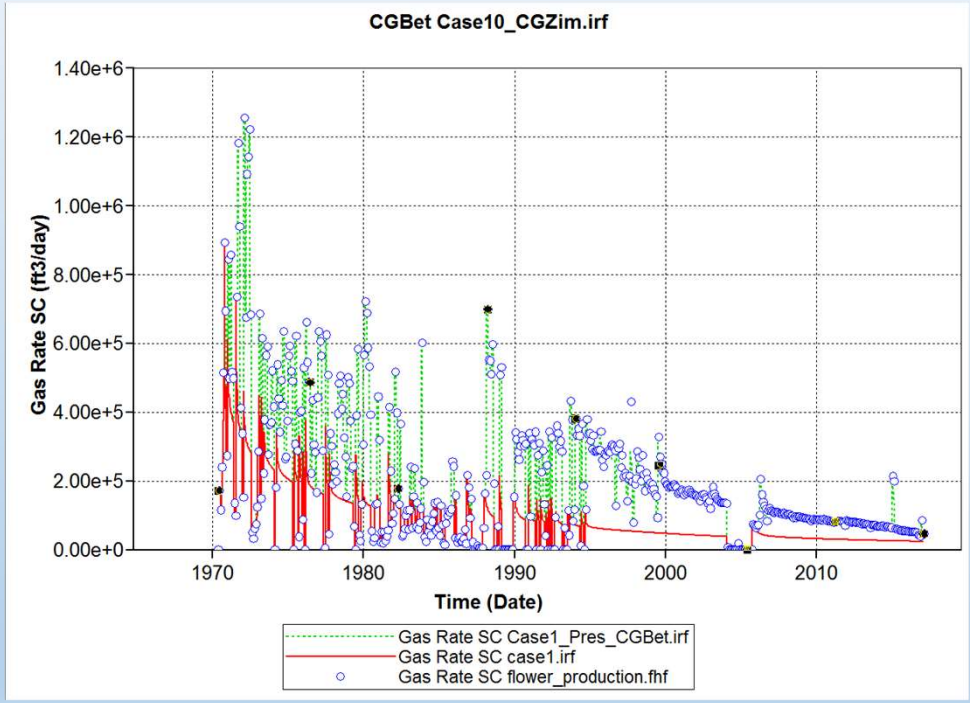
Before

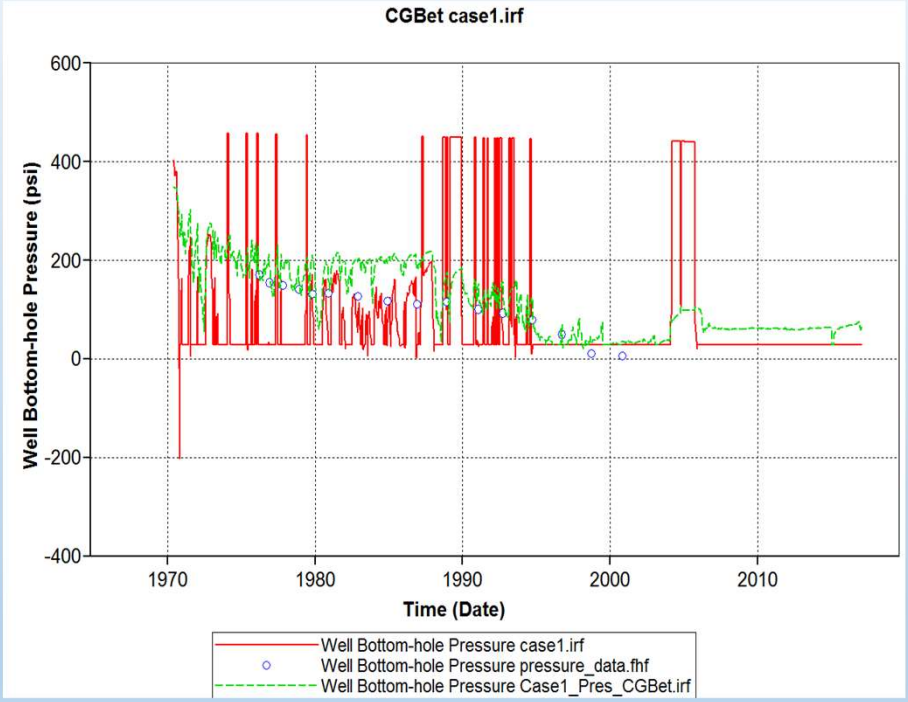
History Matching



Decrease in Pressure

History Matching





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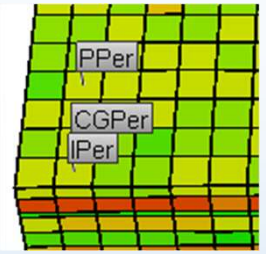
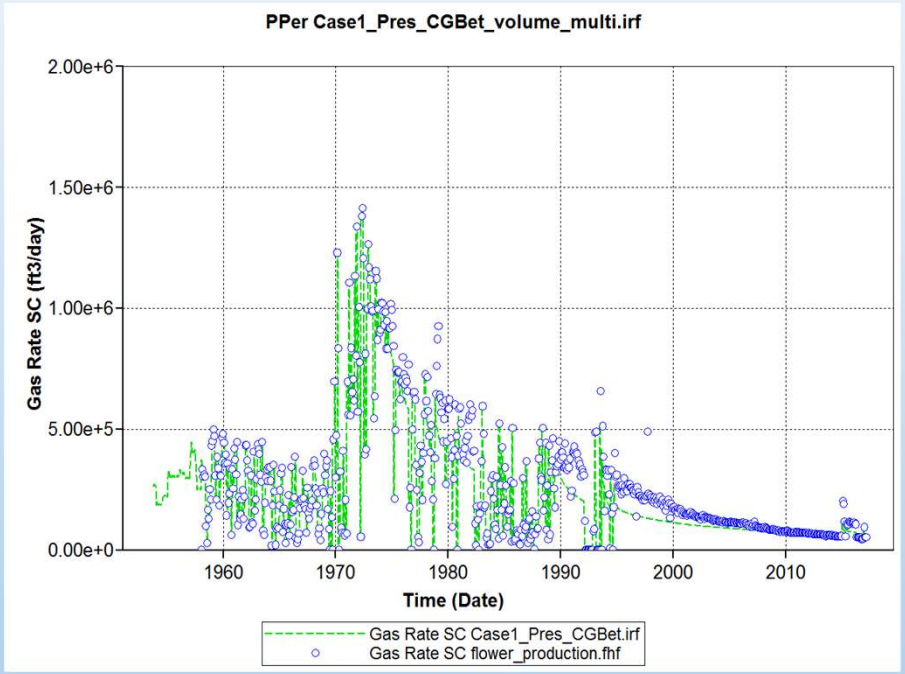
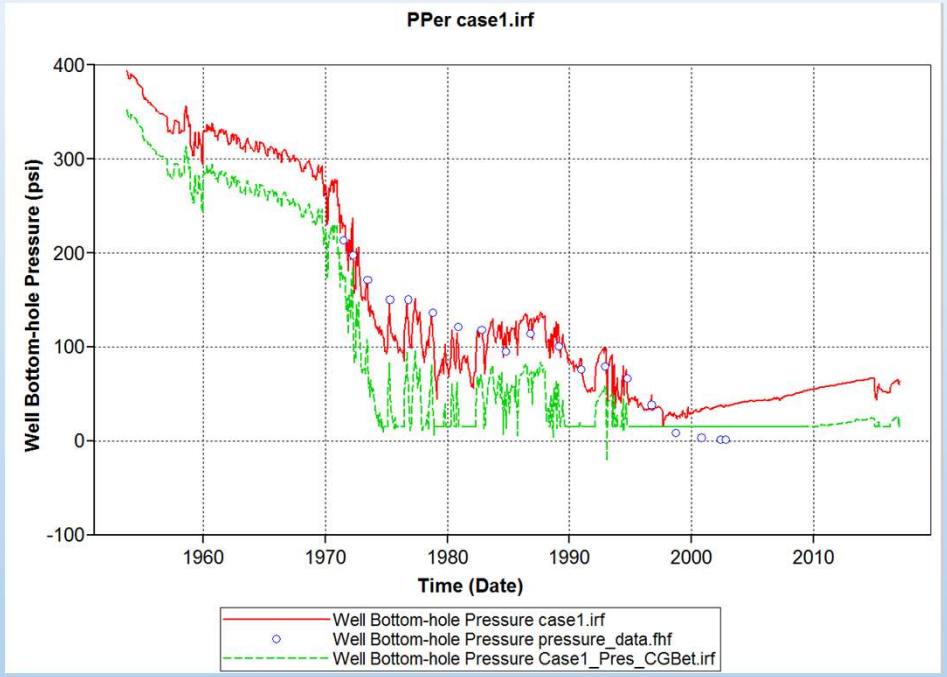
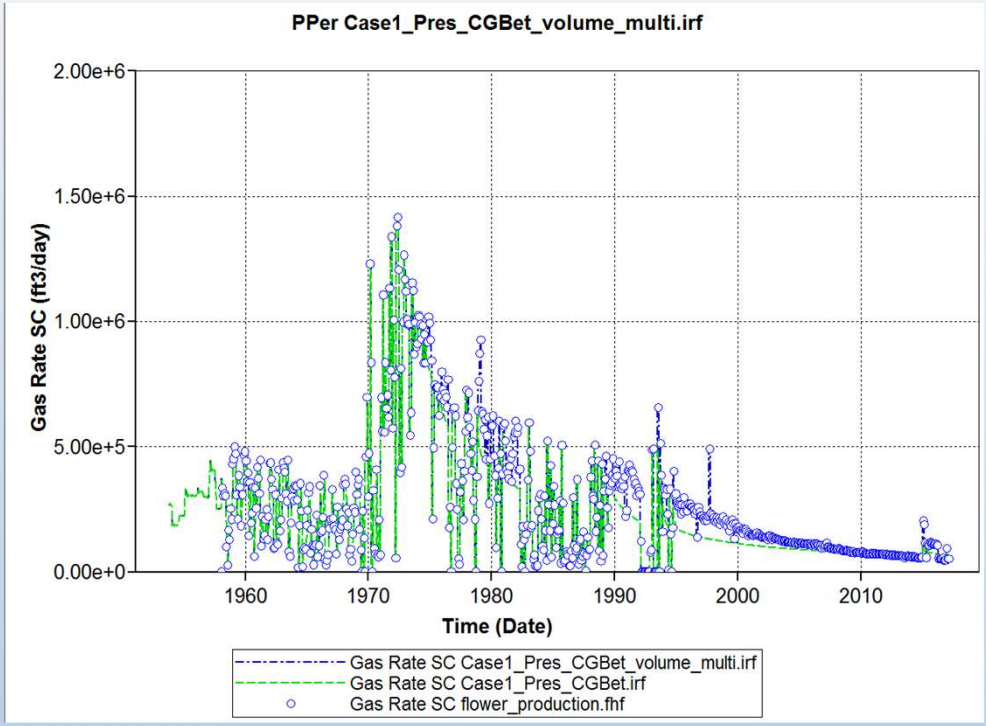


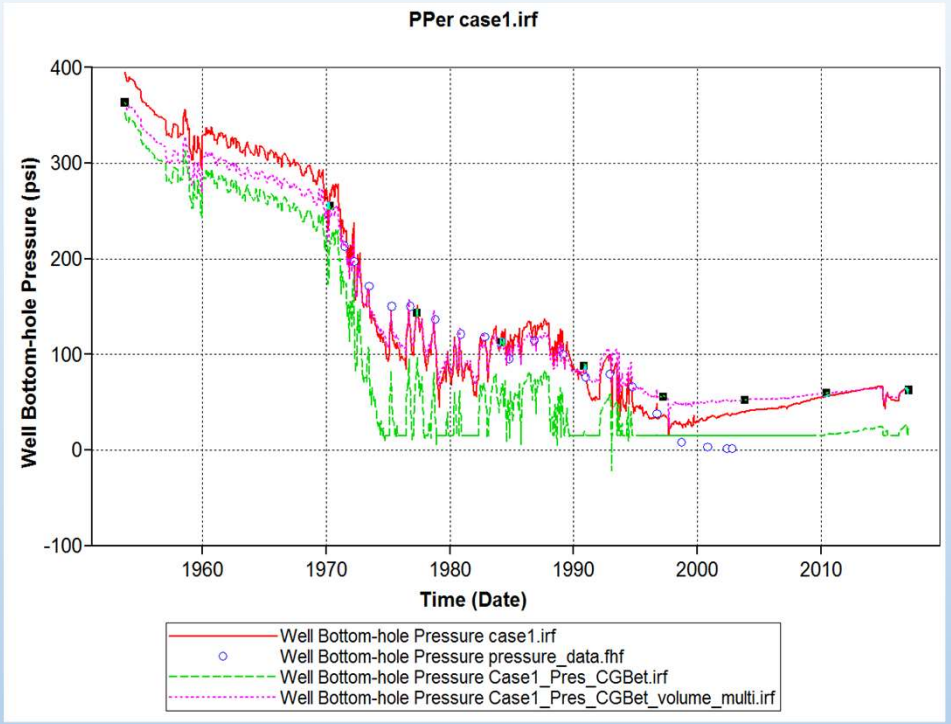




Boundary Well PPer

History Matching





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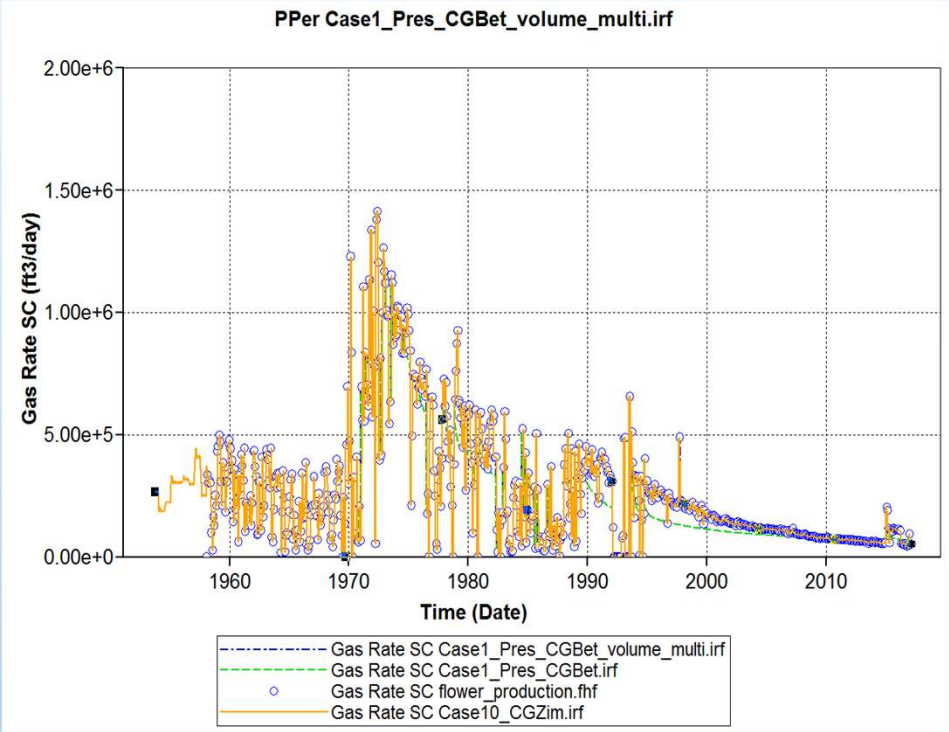

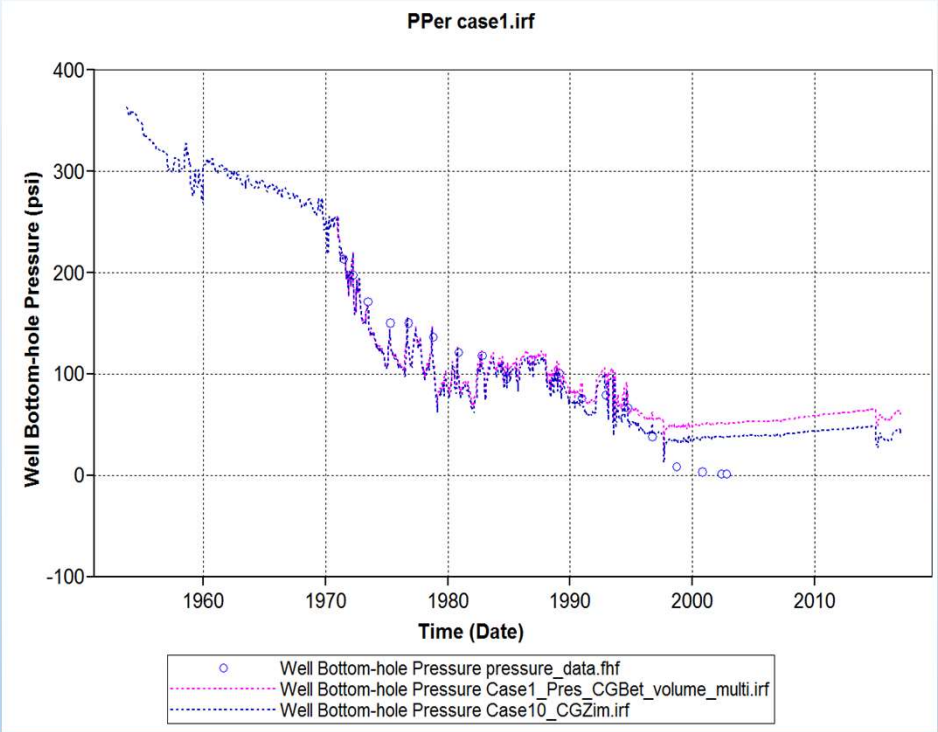

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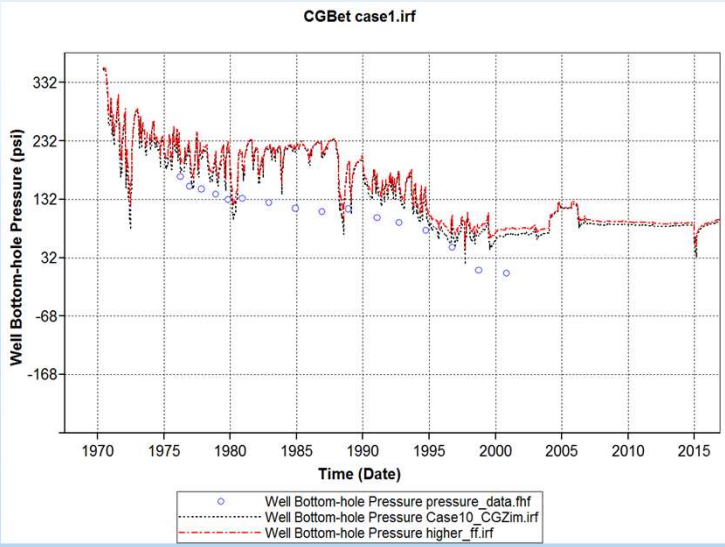
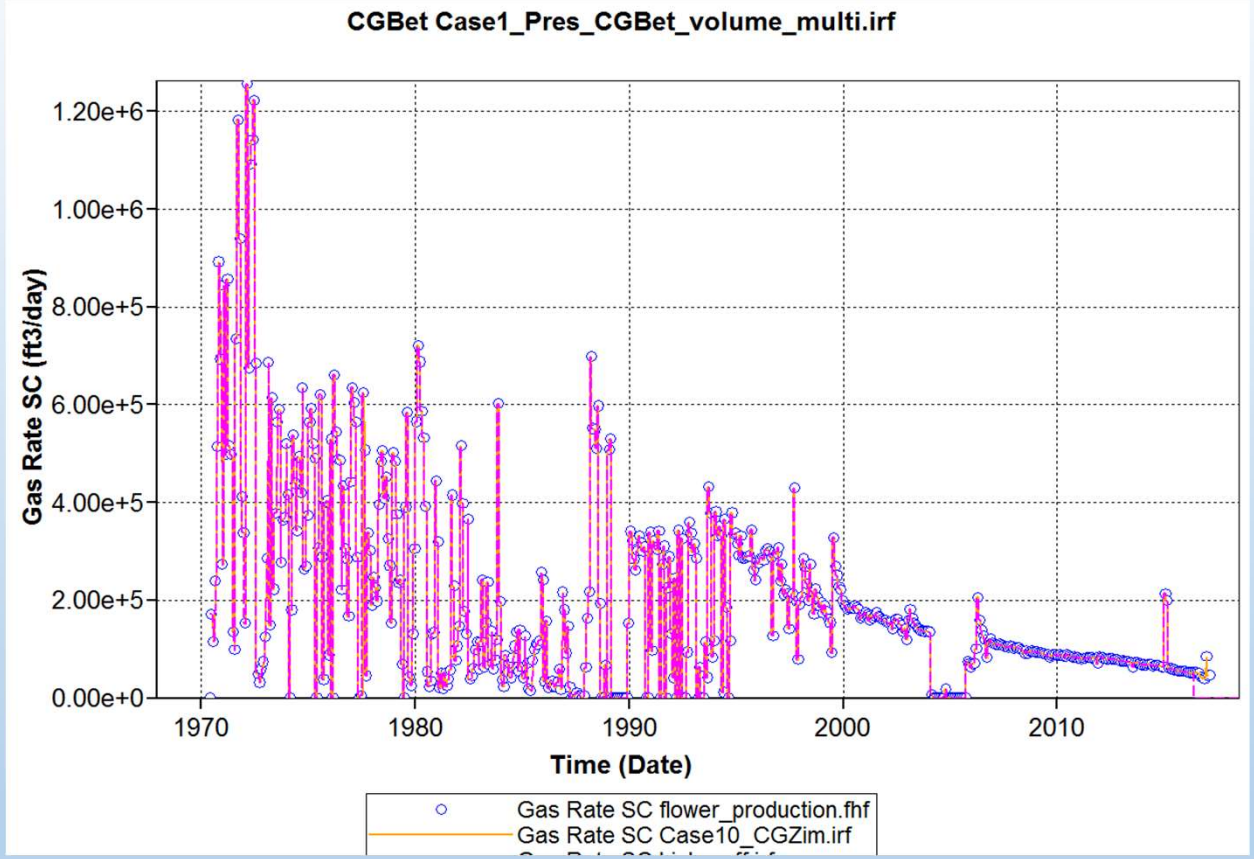
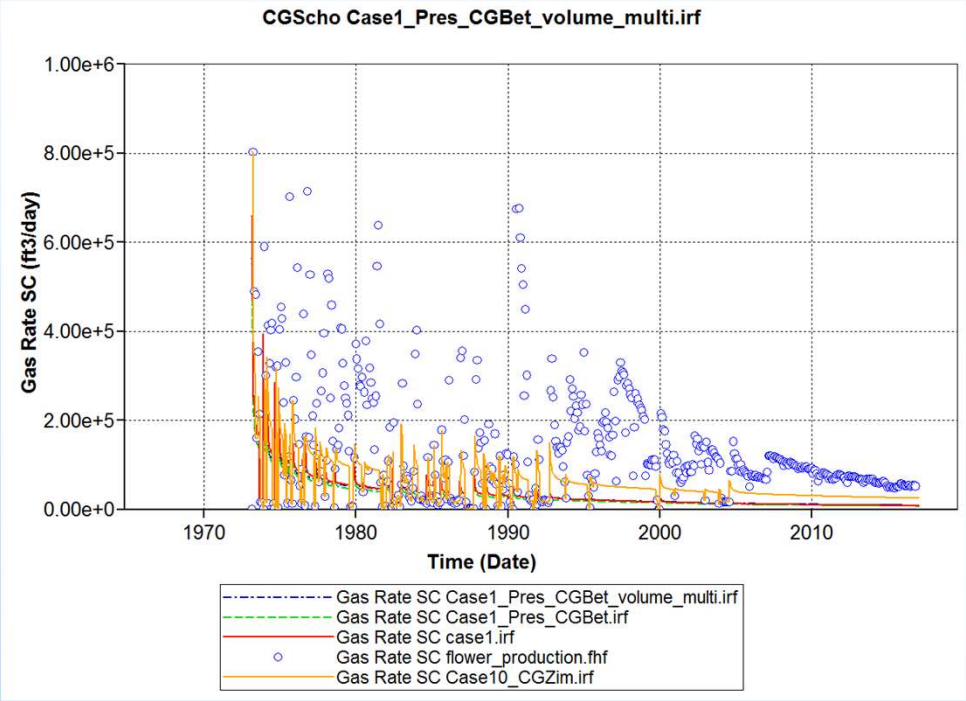
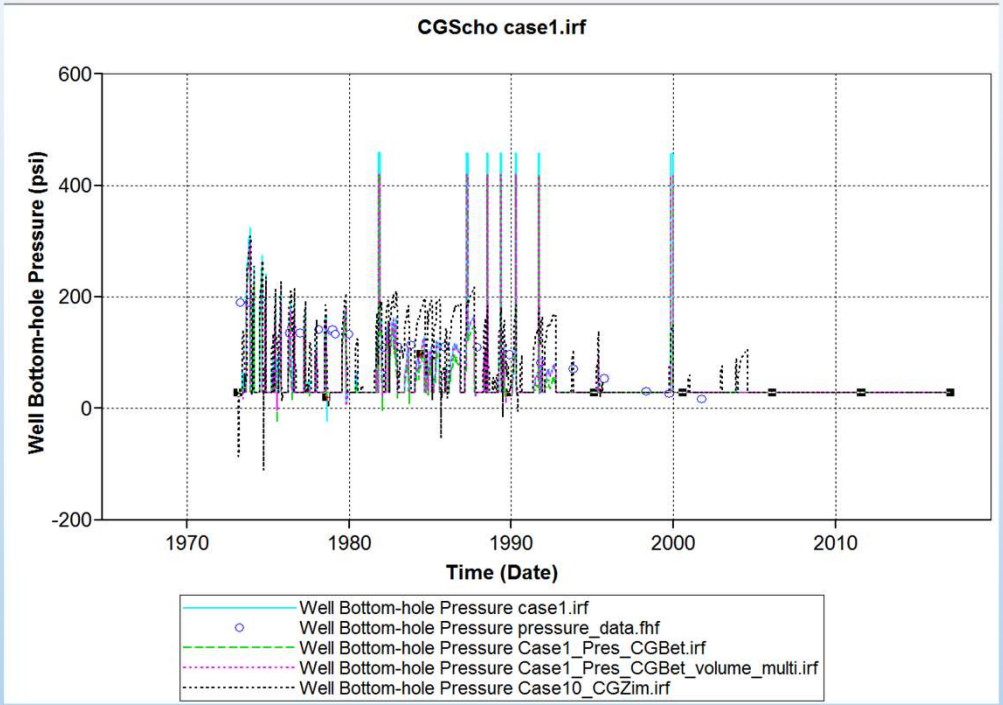




Higher ff, better results?

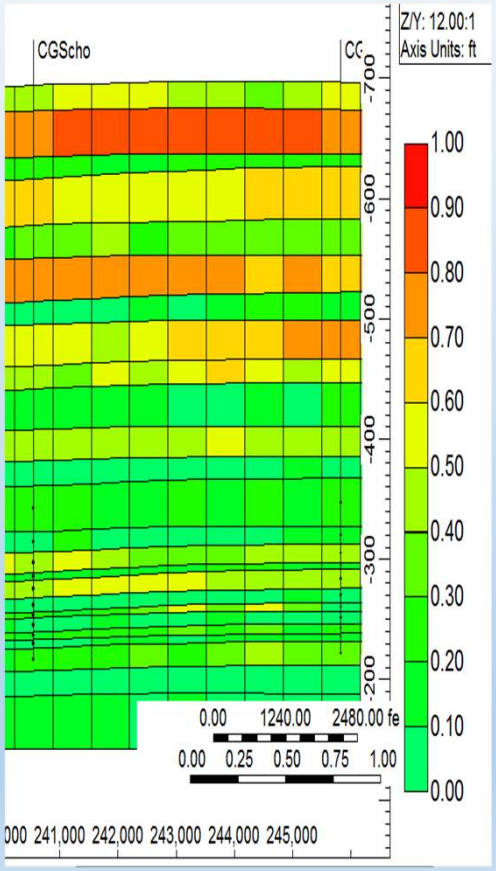
History Matching



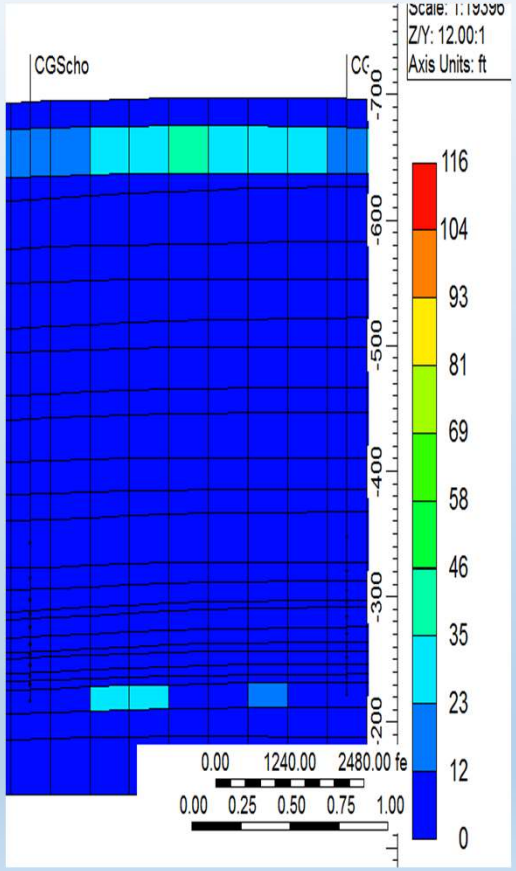


Error

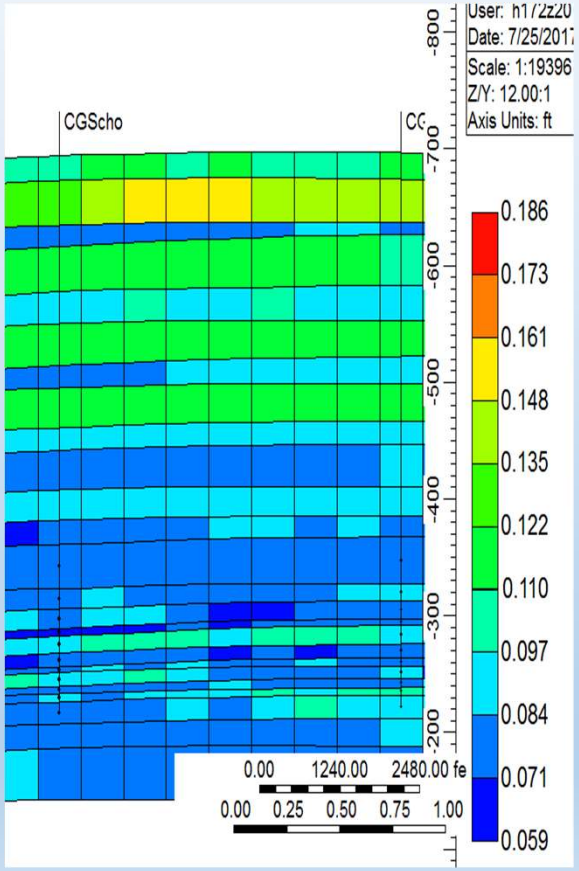
History Matching



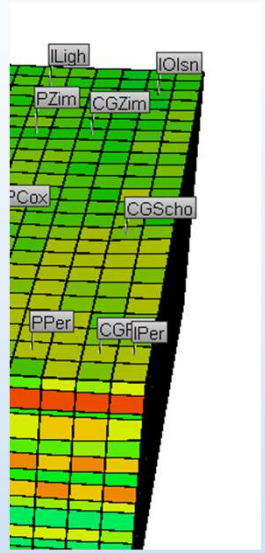
Gas Saturation



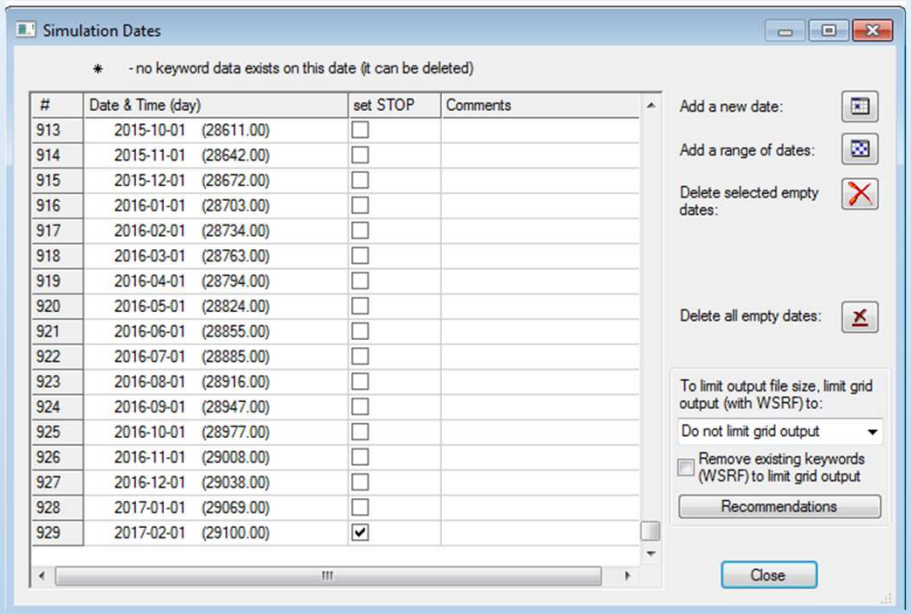
Permeability

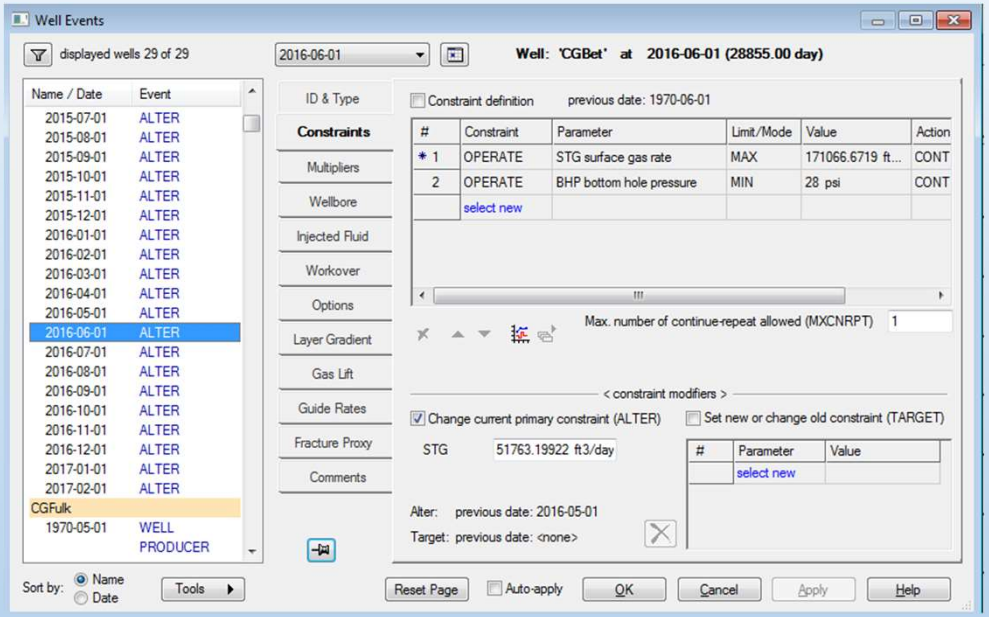


Porosity



Future Prediction





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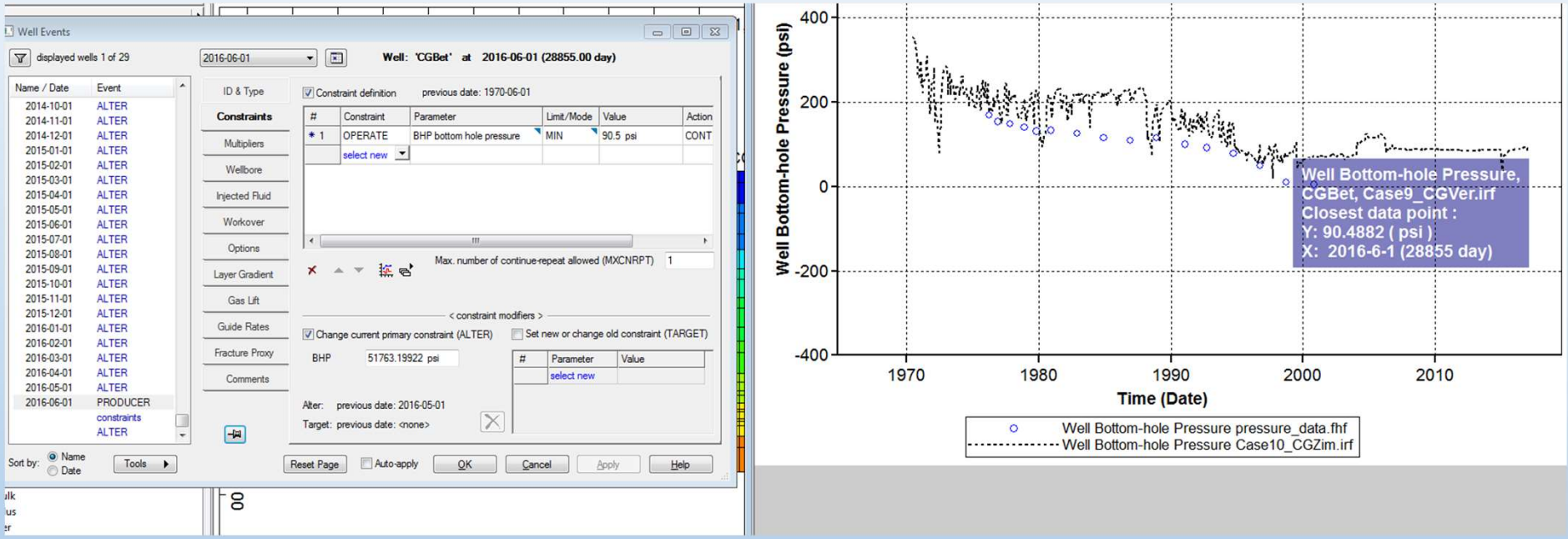

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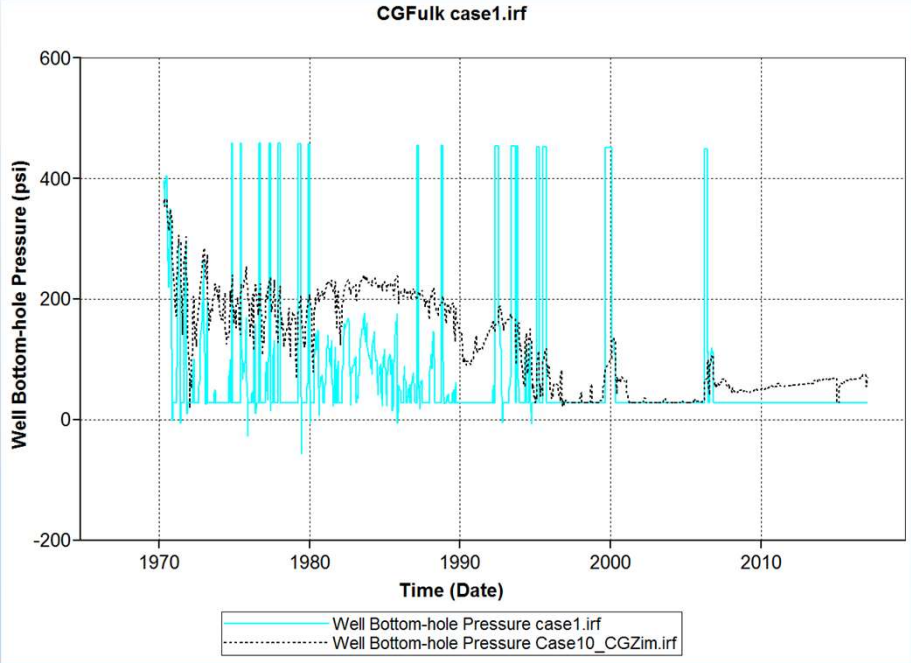

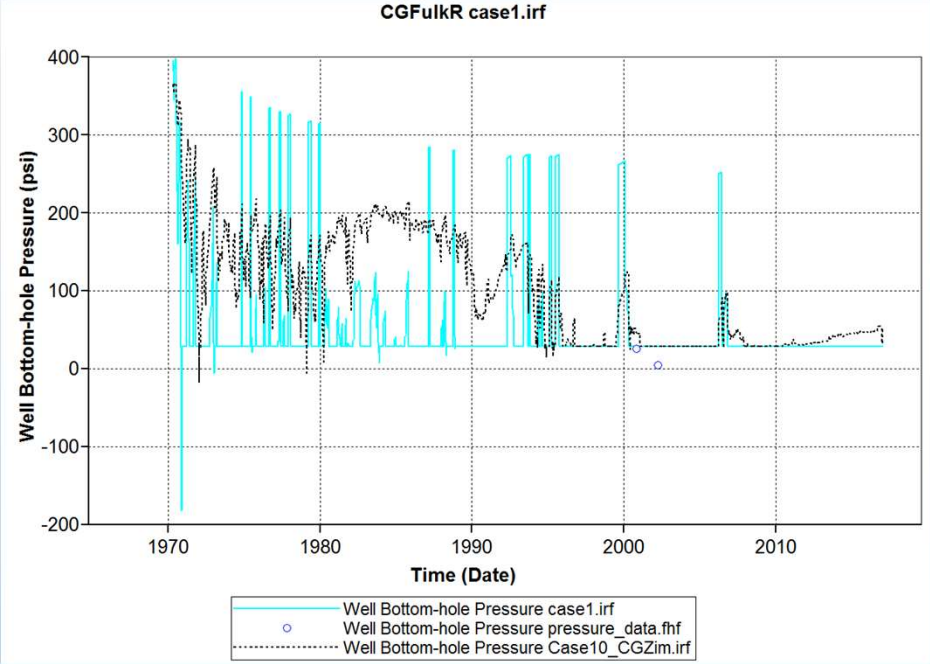

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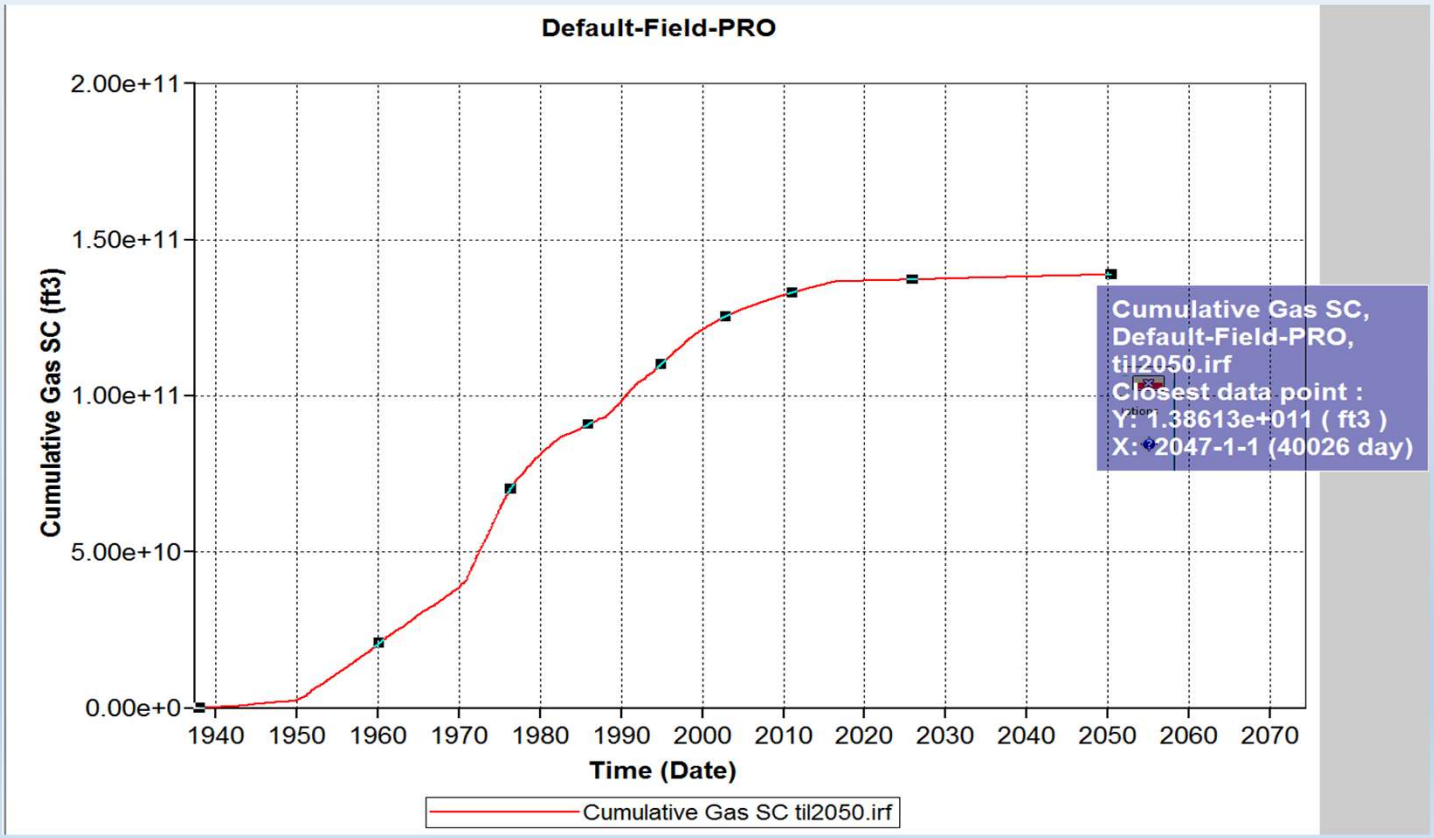

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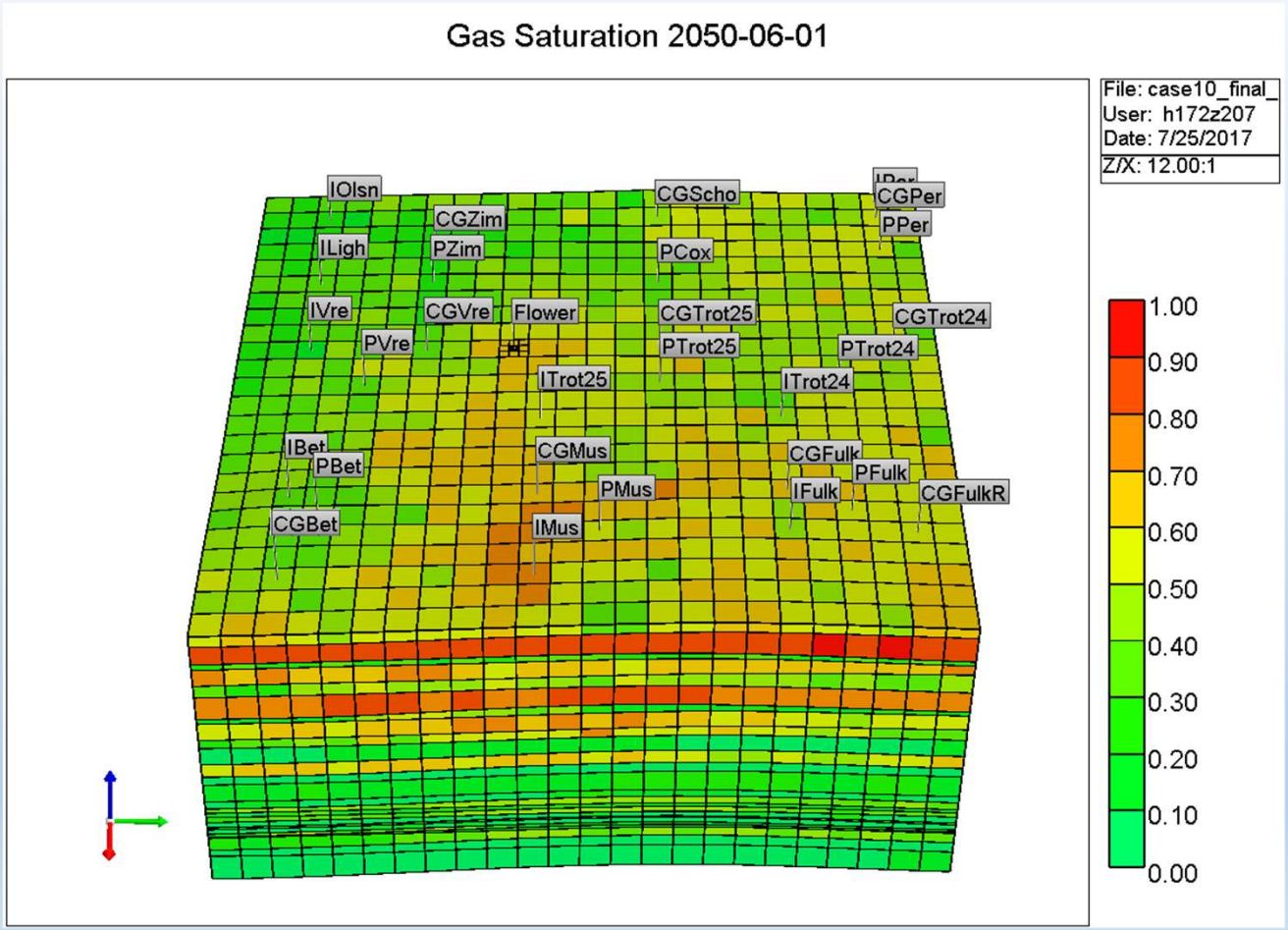
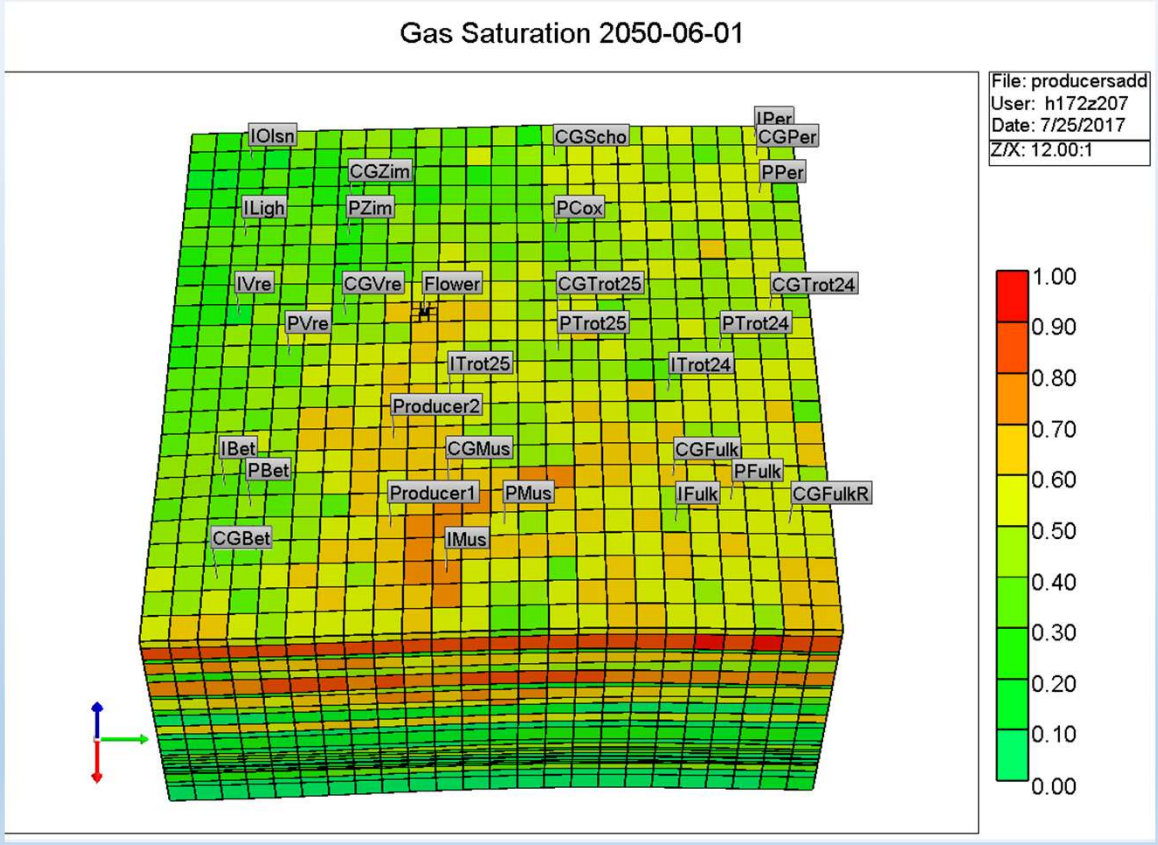


Results 3D
2014.10

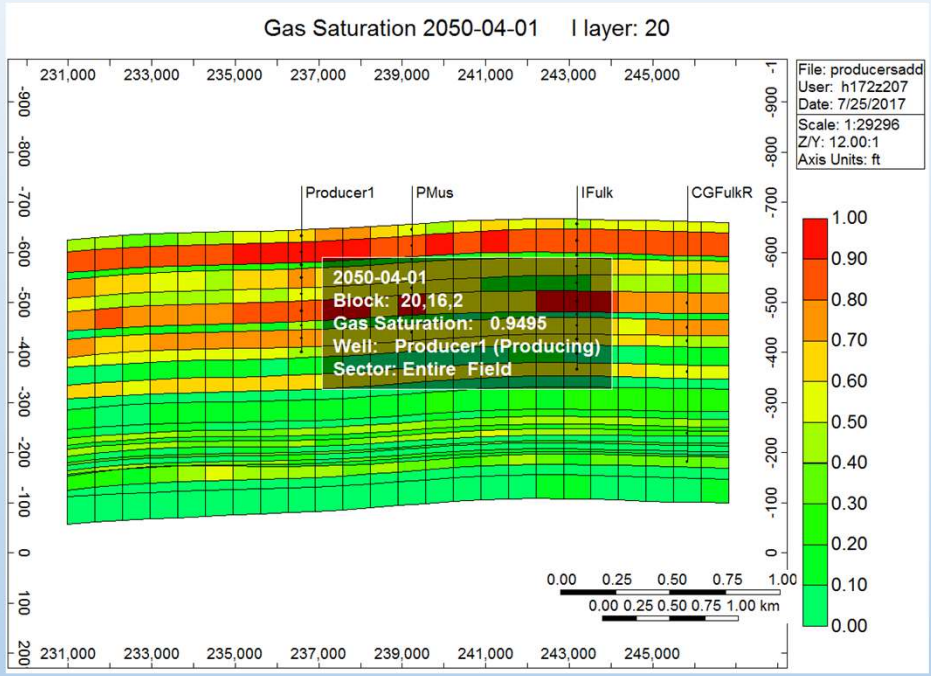
From CMG result 3D

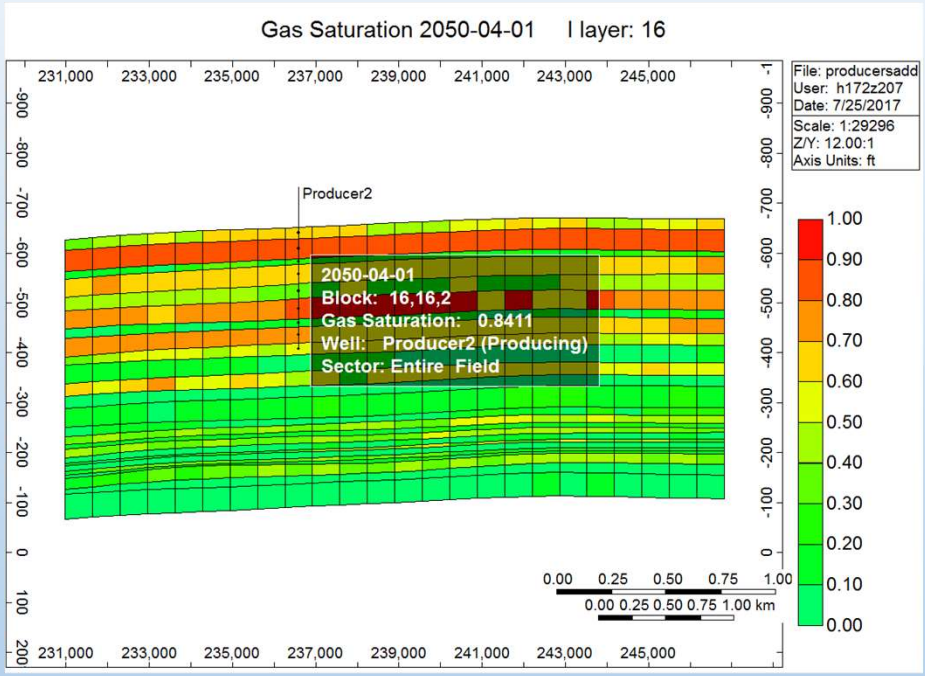
New Wells Optimum Locations



Perforated to layer 9

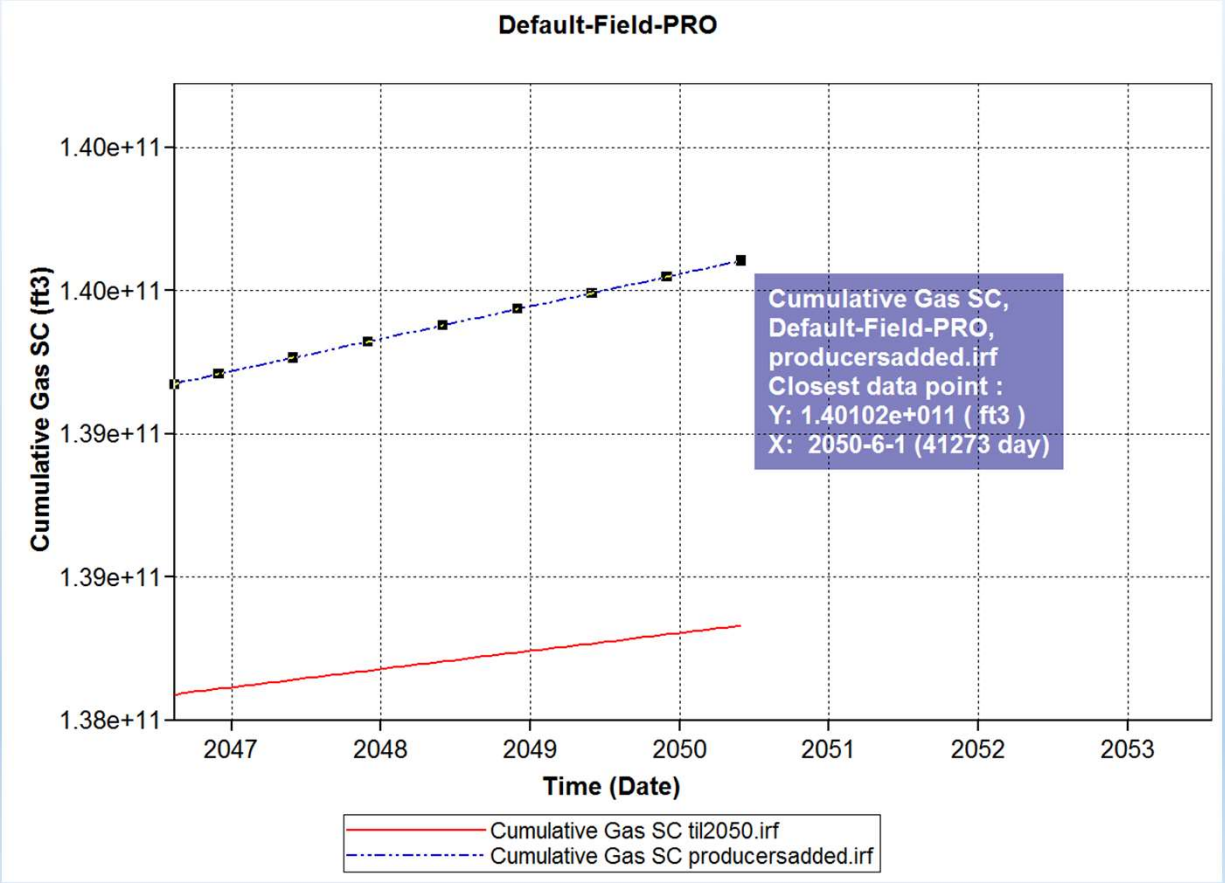
New Wells Optimum Locations

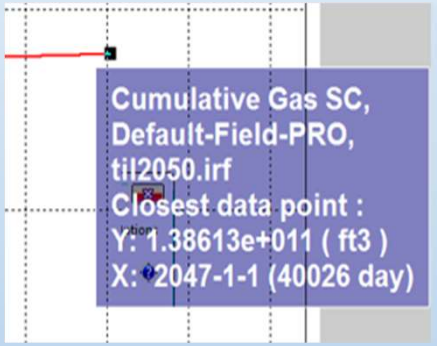




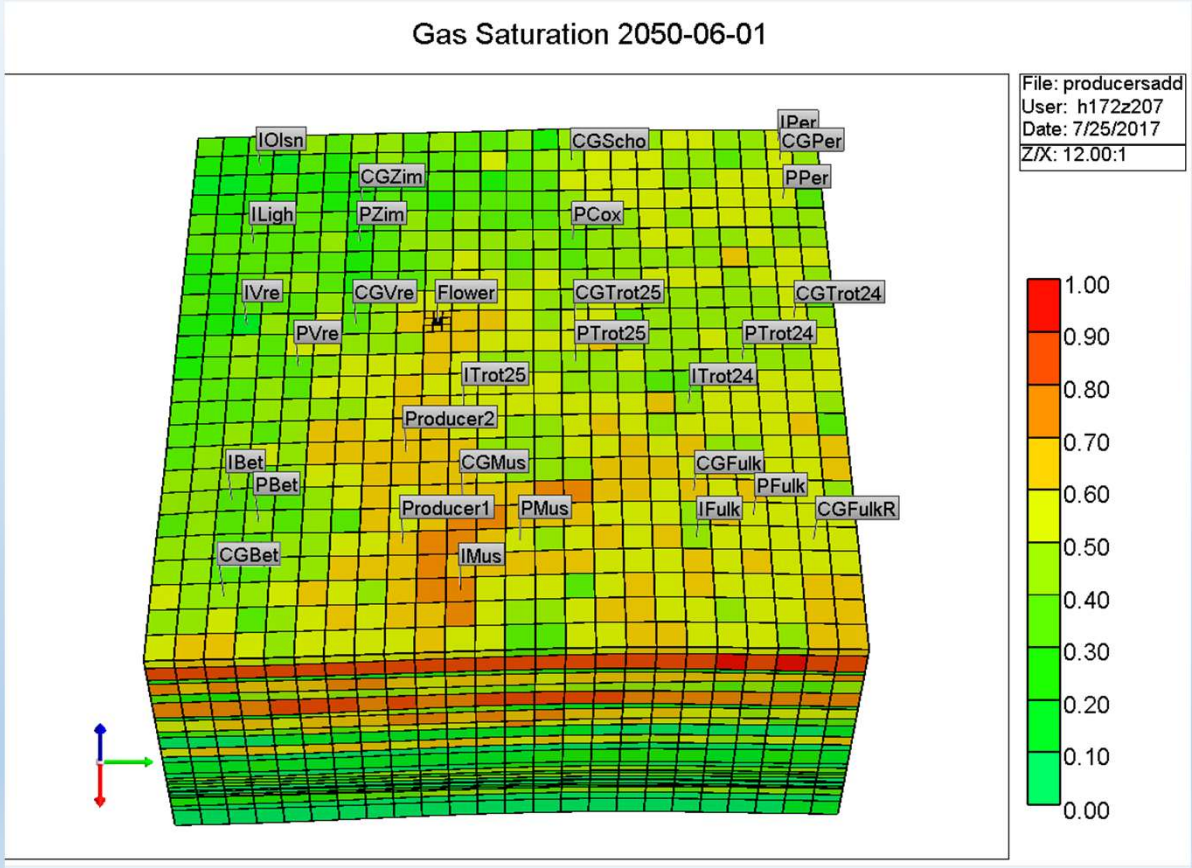
Perforated to layer 9

New Wells Optimum Locations



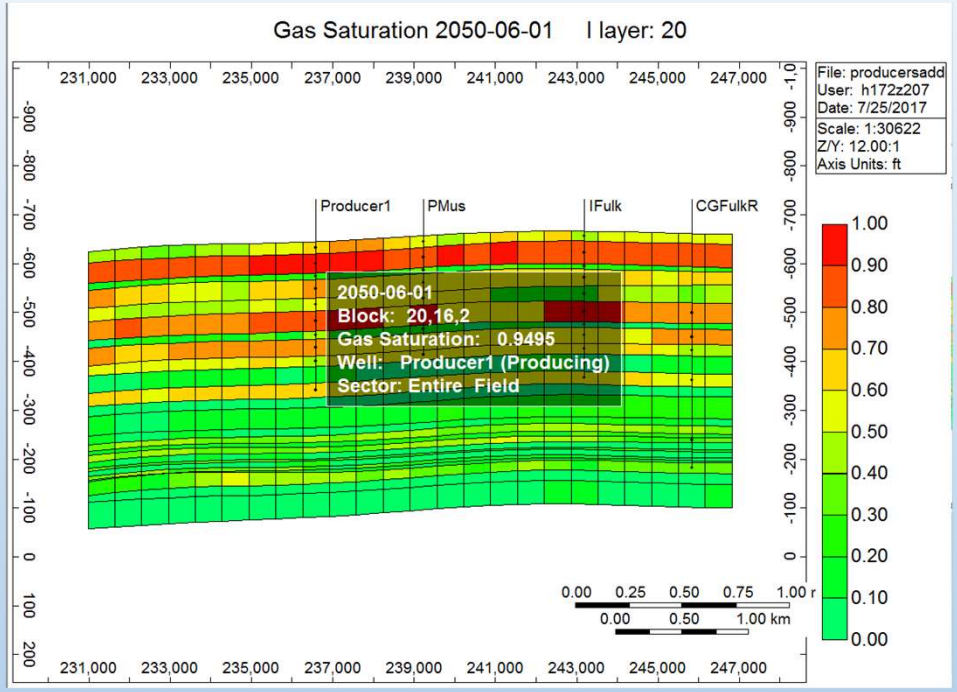


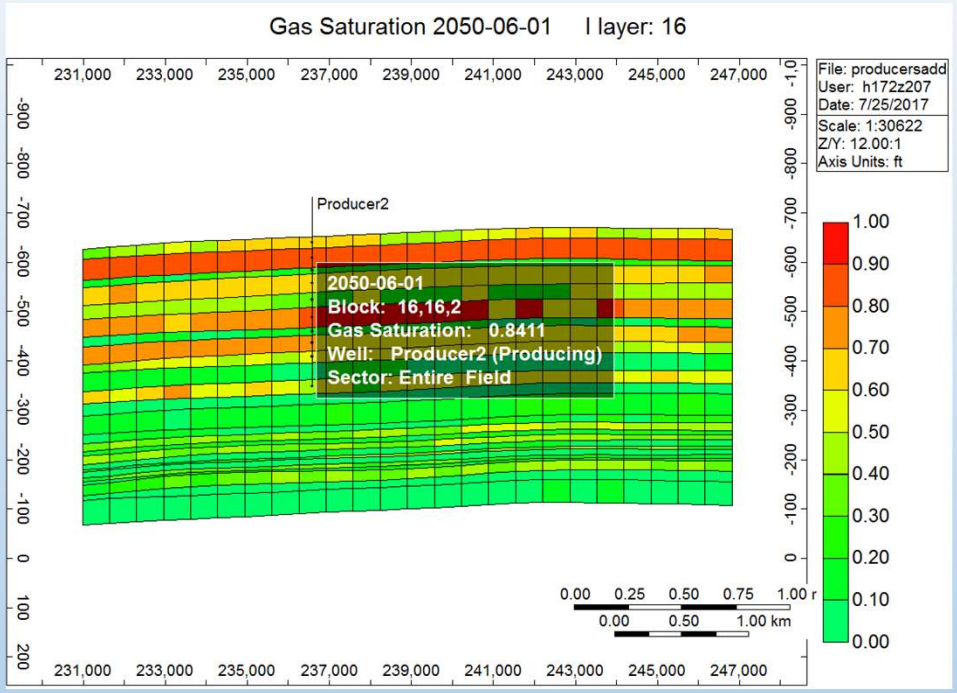
New Wells Optimum Locations



Perforated to layer 11

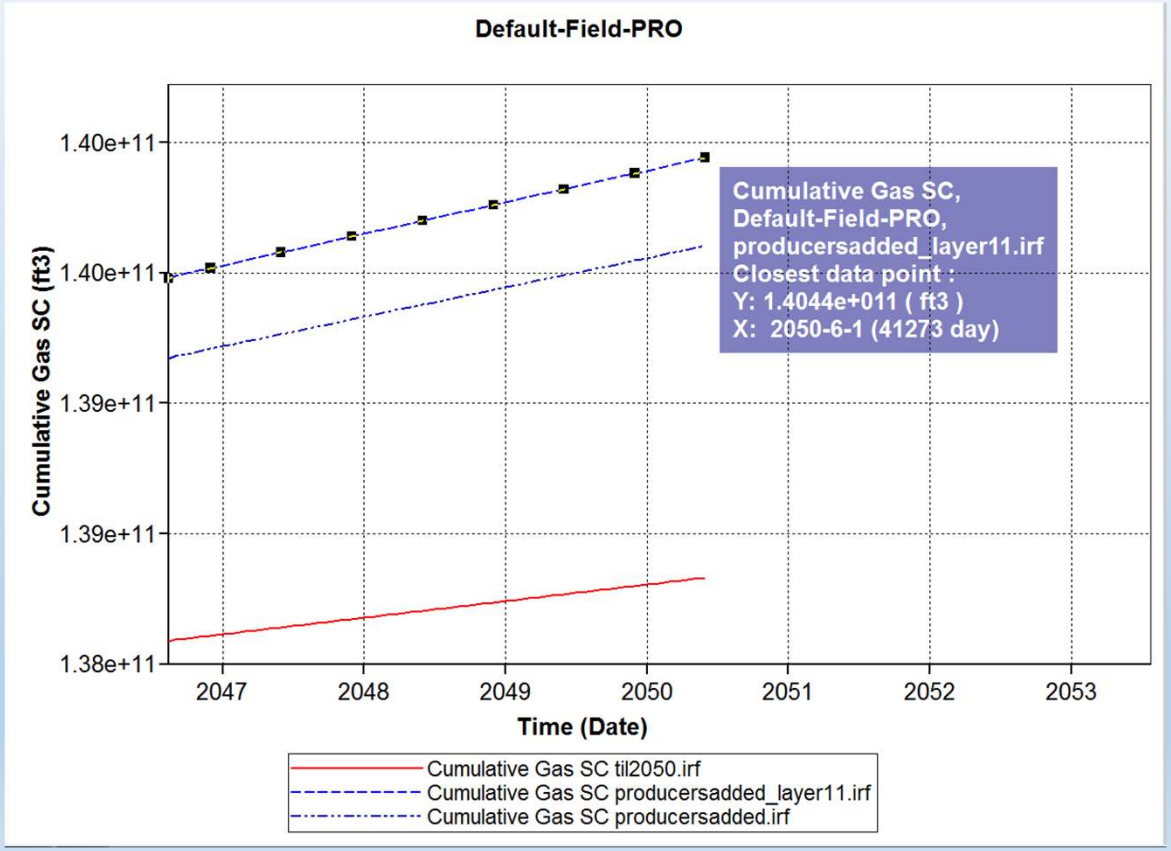
New Wells Optimum Locations

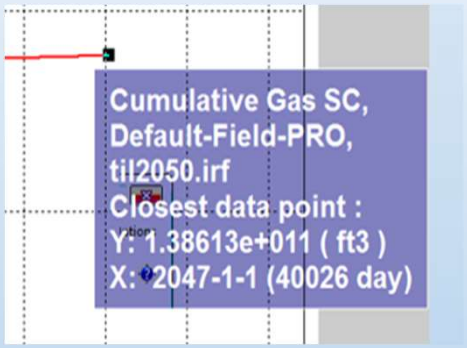




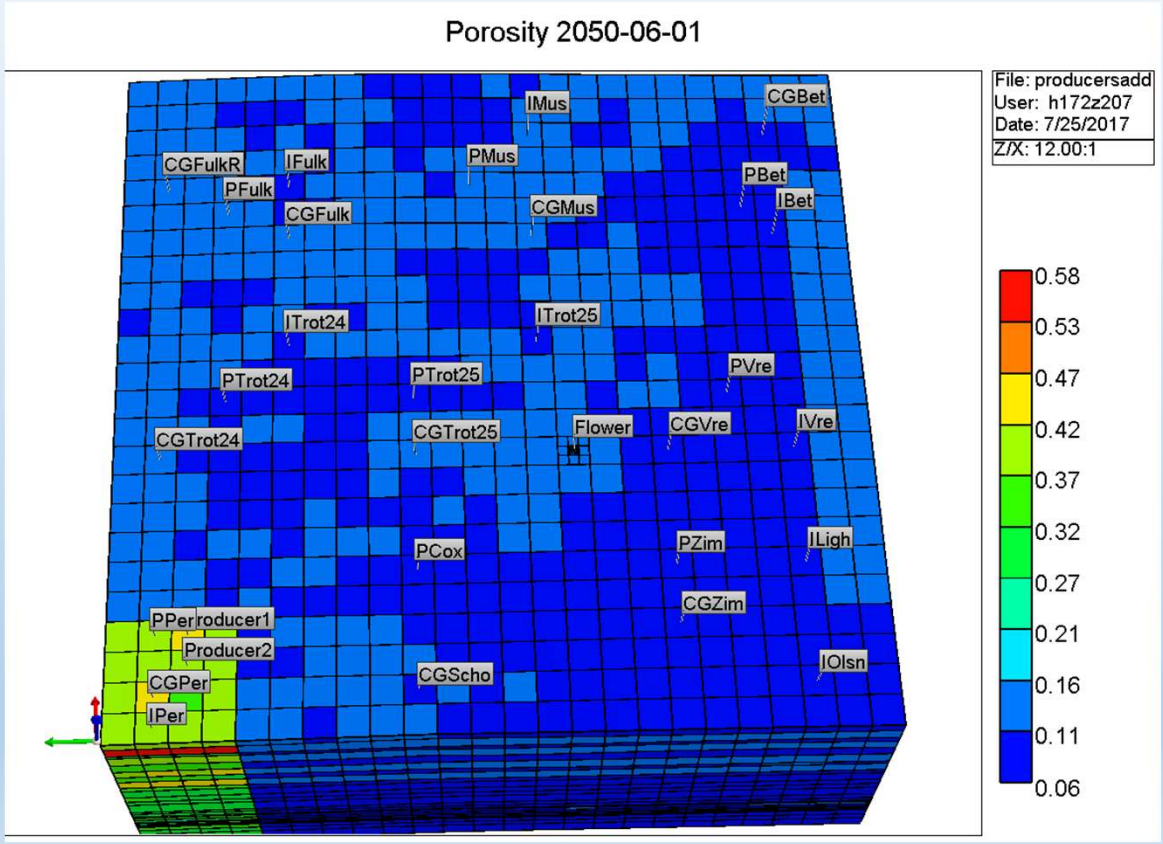
Perforated to layer 11

New Wells Optimum Locations

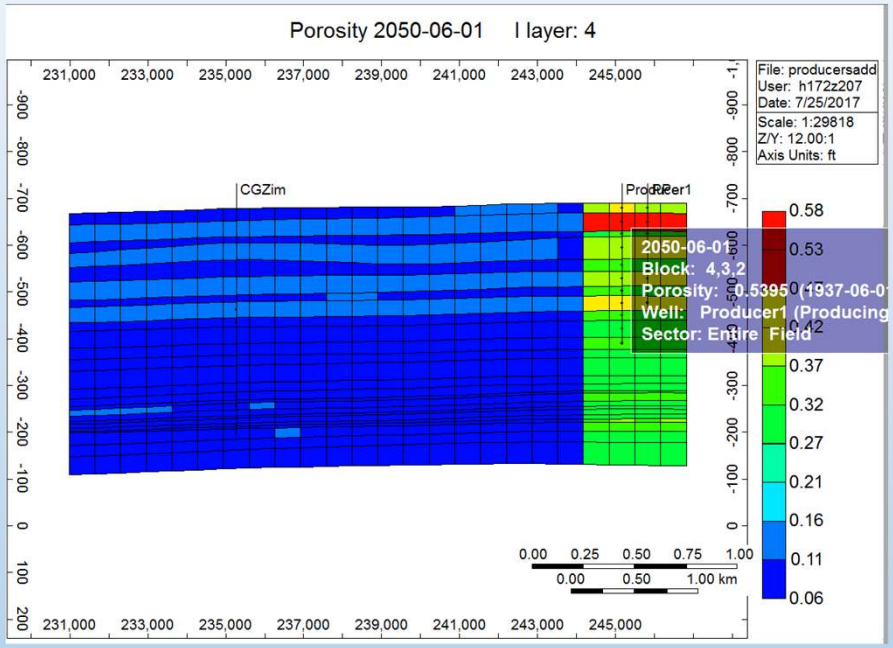


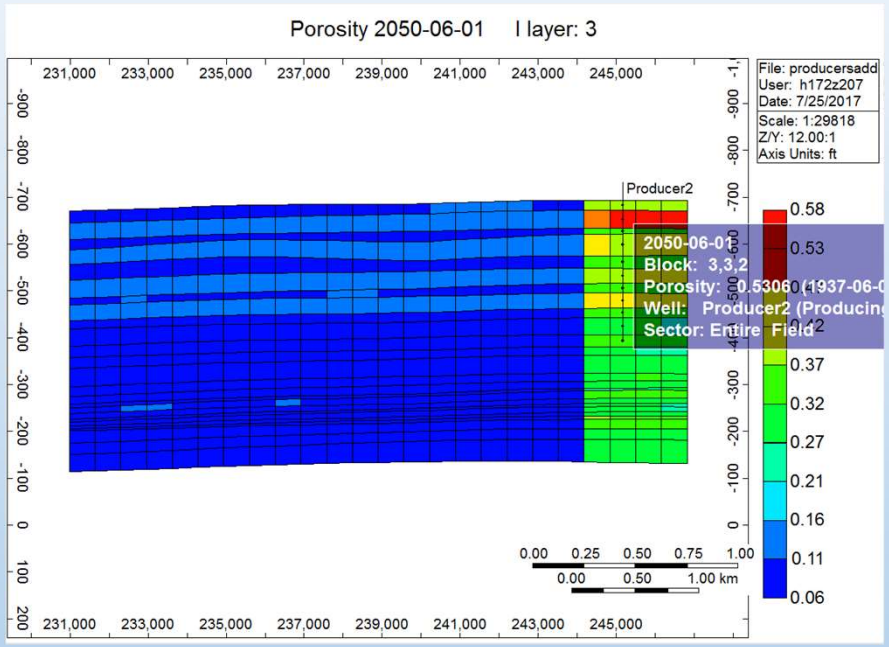


New Wells Optimum Locations

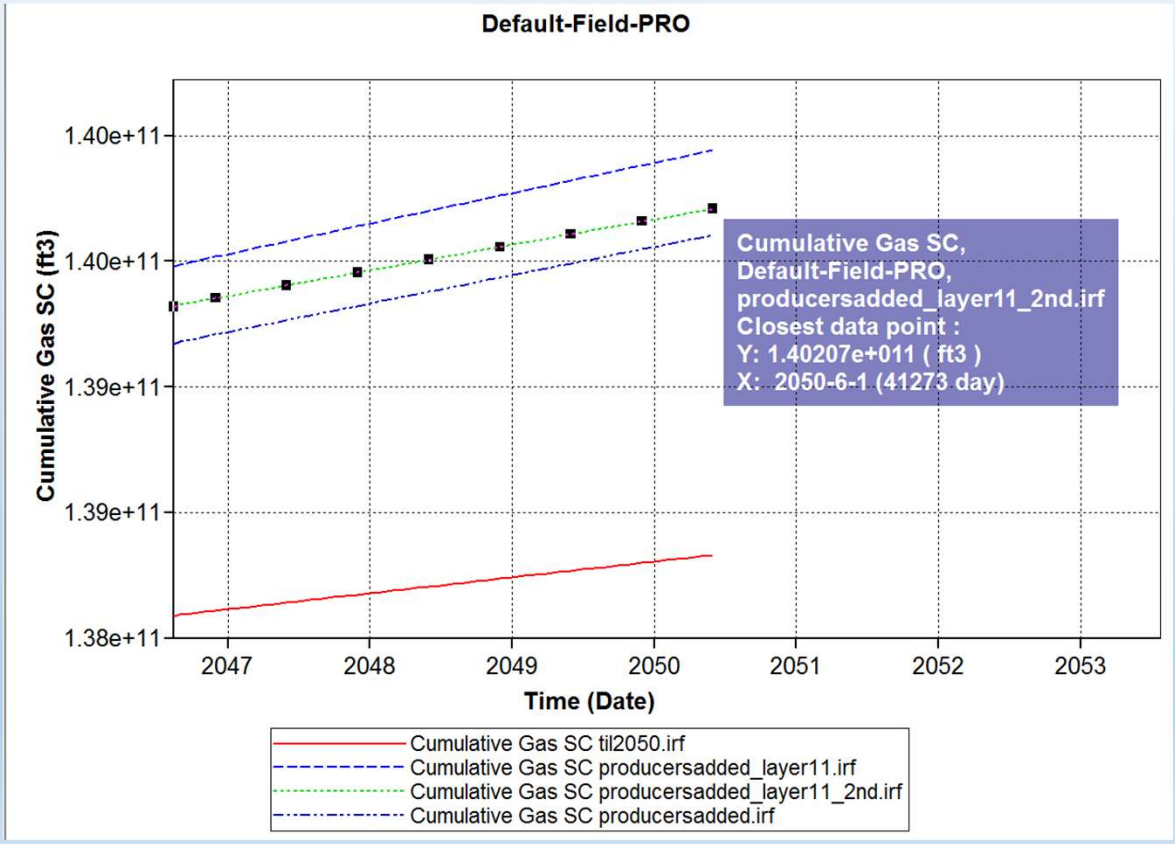


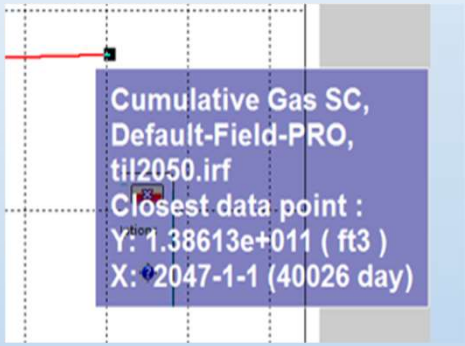
New Wells Optimum Locations





New Wells Optimum Locations





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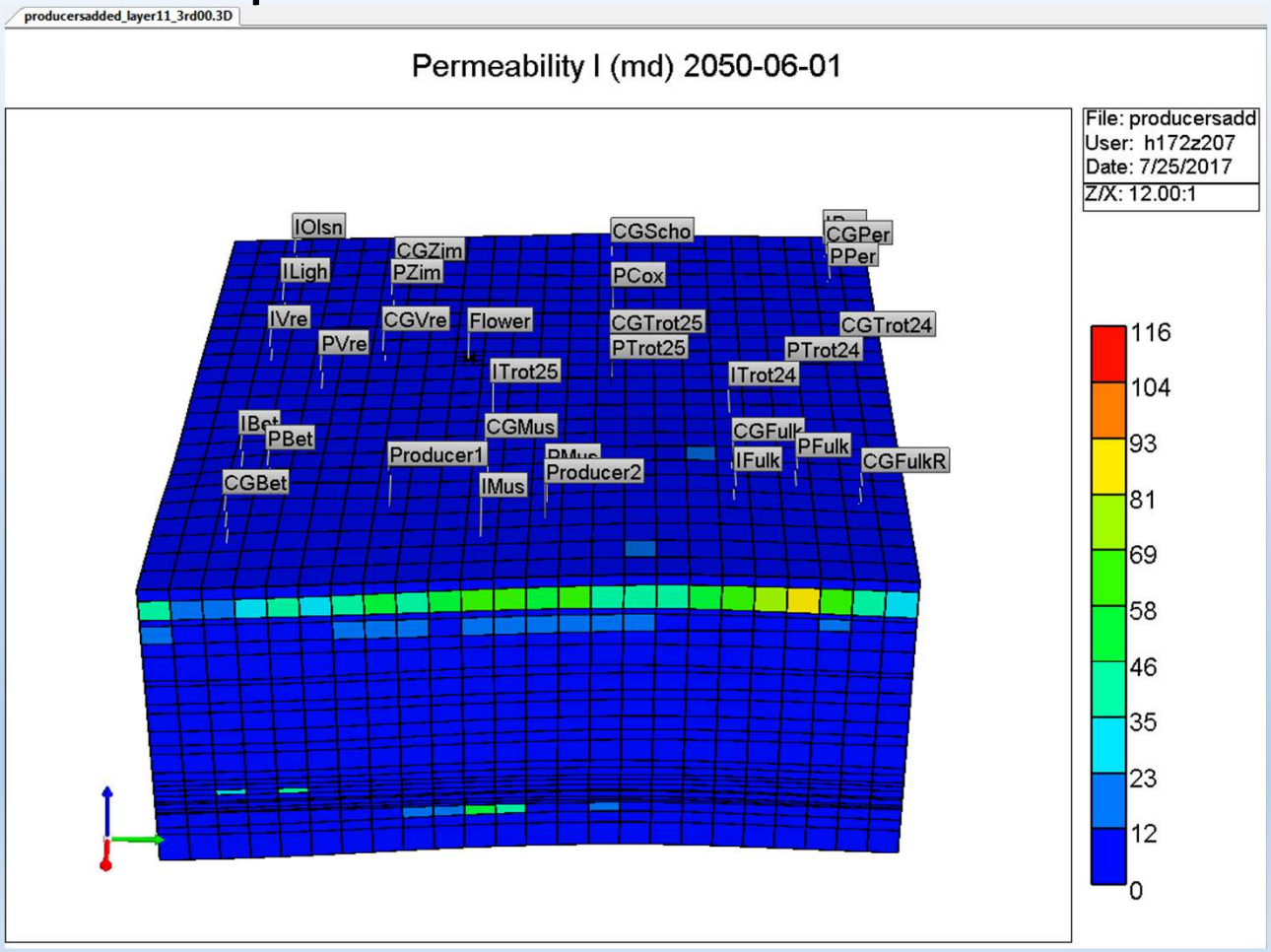
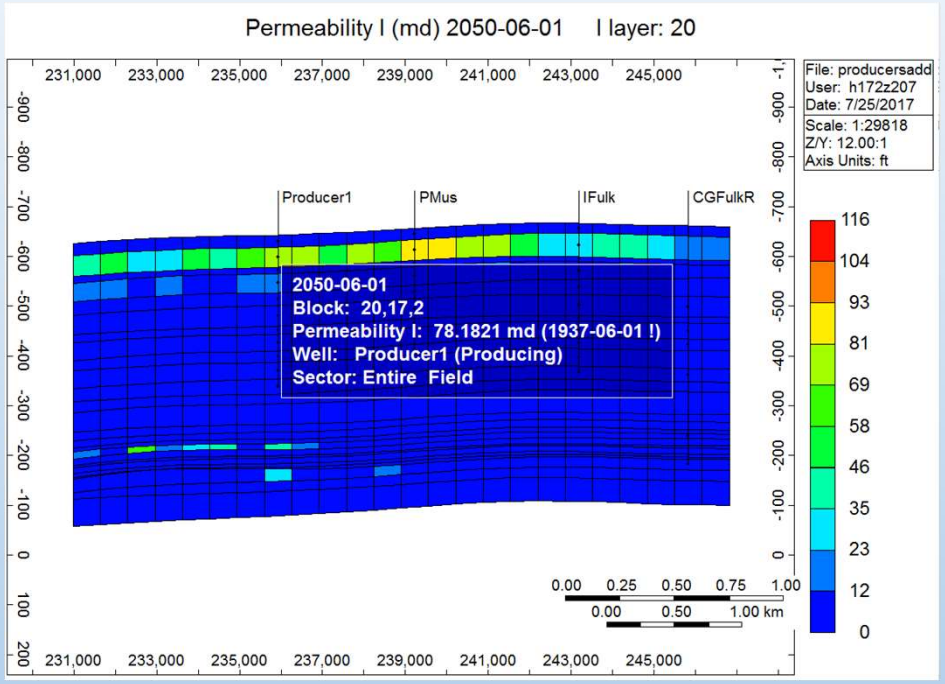
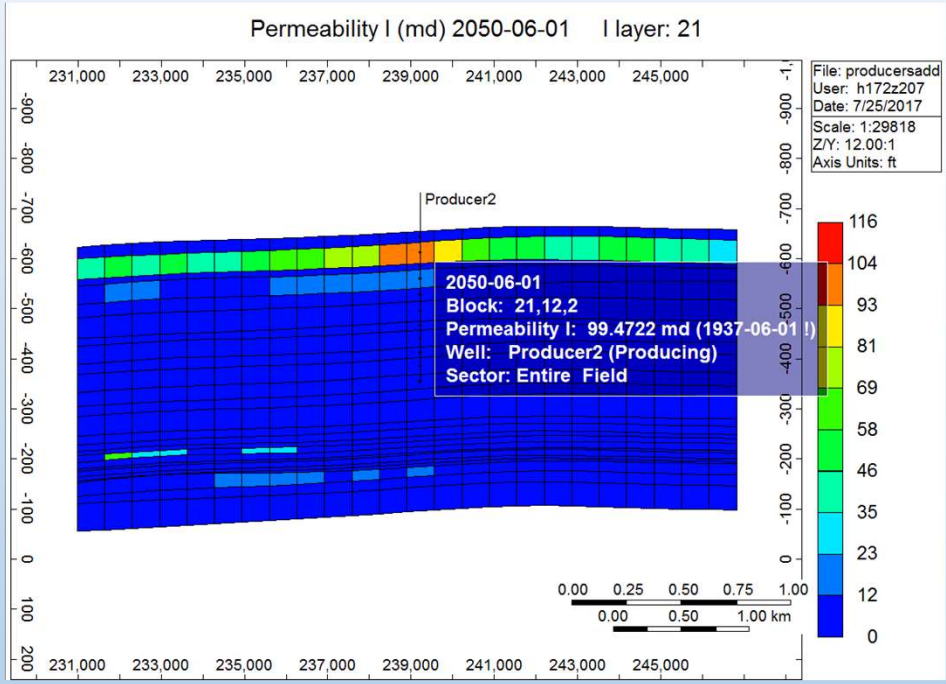
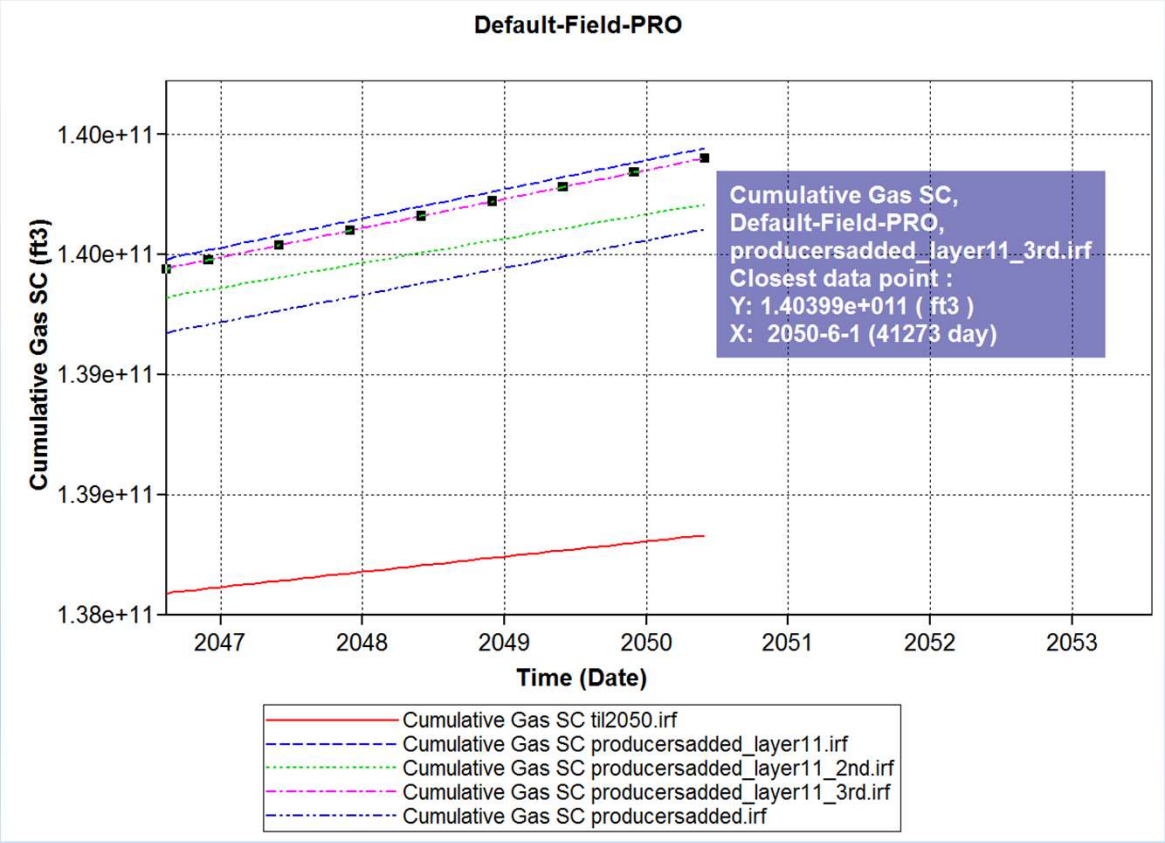


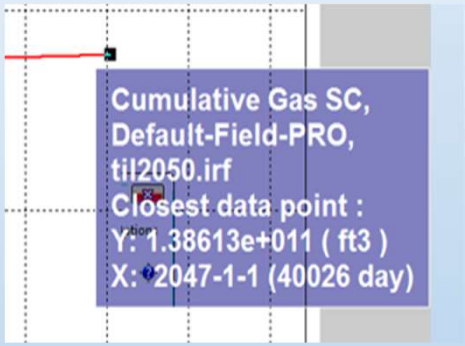
New Wells Optimum Locations



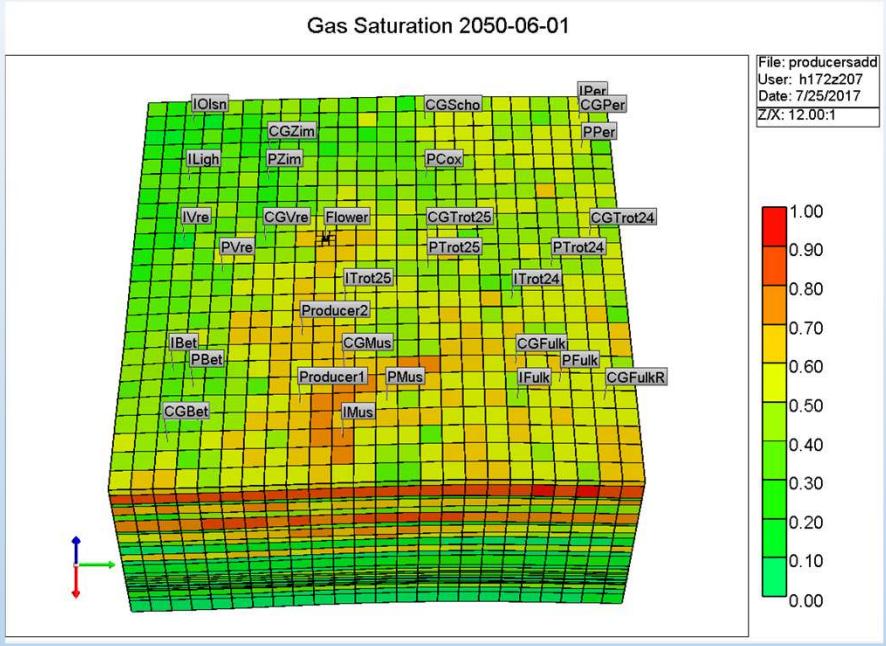


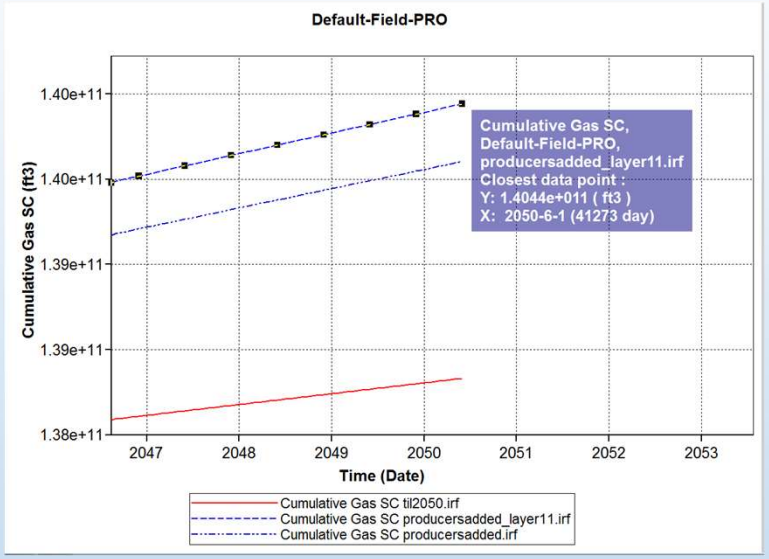
New Wells Optimum Locations

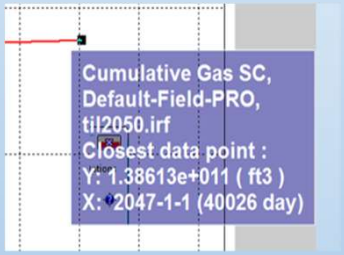




Conclusion







Perforated to layer 11

Total Production Increased: 0.01827 e+11 ft^3

Total percent of Production Increased: 1.3009%

Thank You for Watching

Especially thanks for Dr. Esmail Ansari for instructing the course during the summer.

Wish you all have a good rest of your Summer.