



Interference analysis and its impact on field development in carbonate objects of Kharyaga field

Гидропрослушивания скважин и их влияние на разработку месторождений в карбонатных коллекторах Харьягинского месторождения

AGENDA

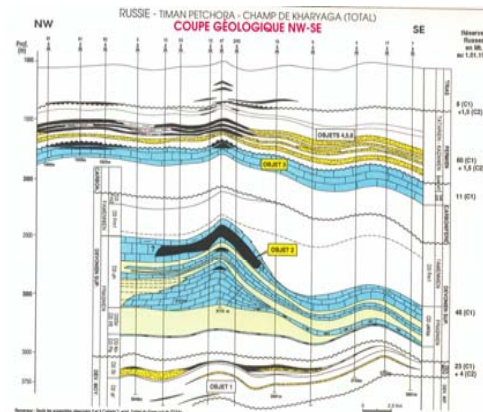
- Kharyaga project
- Data acquisition planning and tools
- Pressure interference test examples and interpretation
- Tracers injection
- Integration of pressure/tracers results
- Application in reservoir management

Kharyaga project

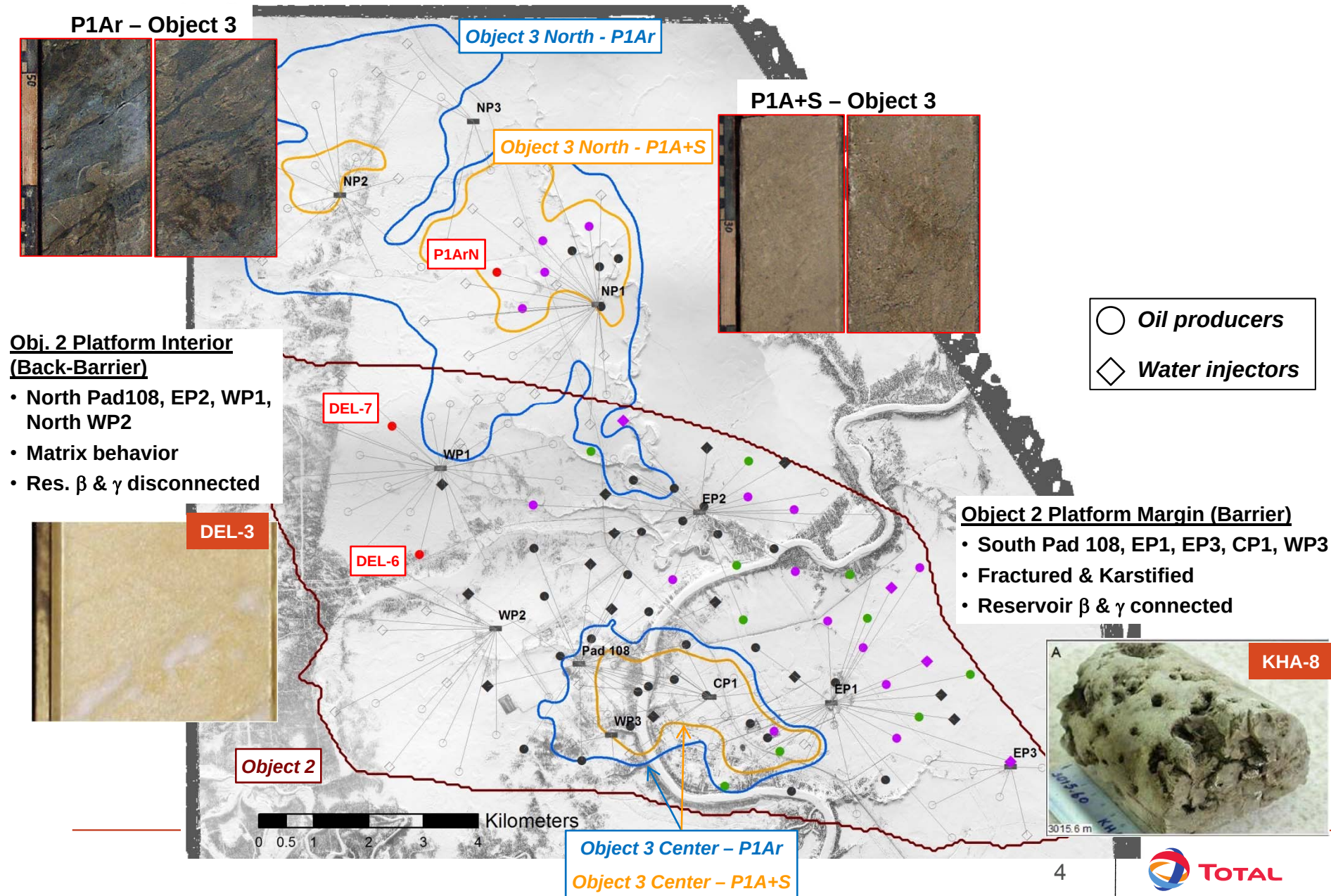
- Located in Timan- Pechora
- Producing since 02/10/1999
- Total - operator
- 100% export at Primorsk (2500 km via pipe to Primorsk)
- Sour paraffinic undersaturated oil (H_2S)
- Carbonate reservoirs: Object 2 & 3



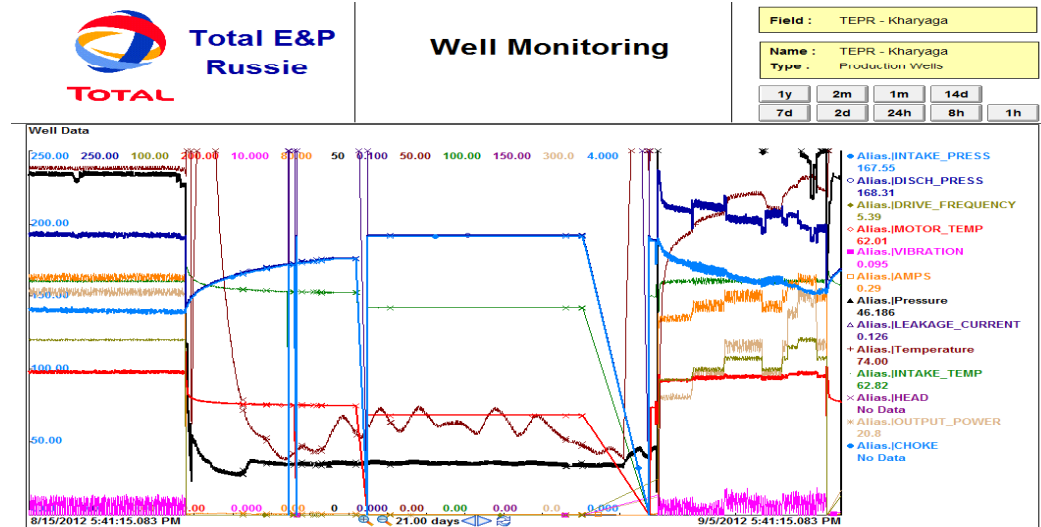
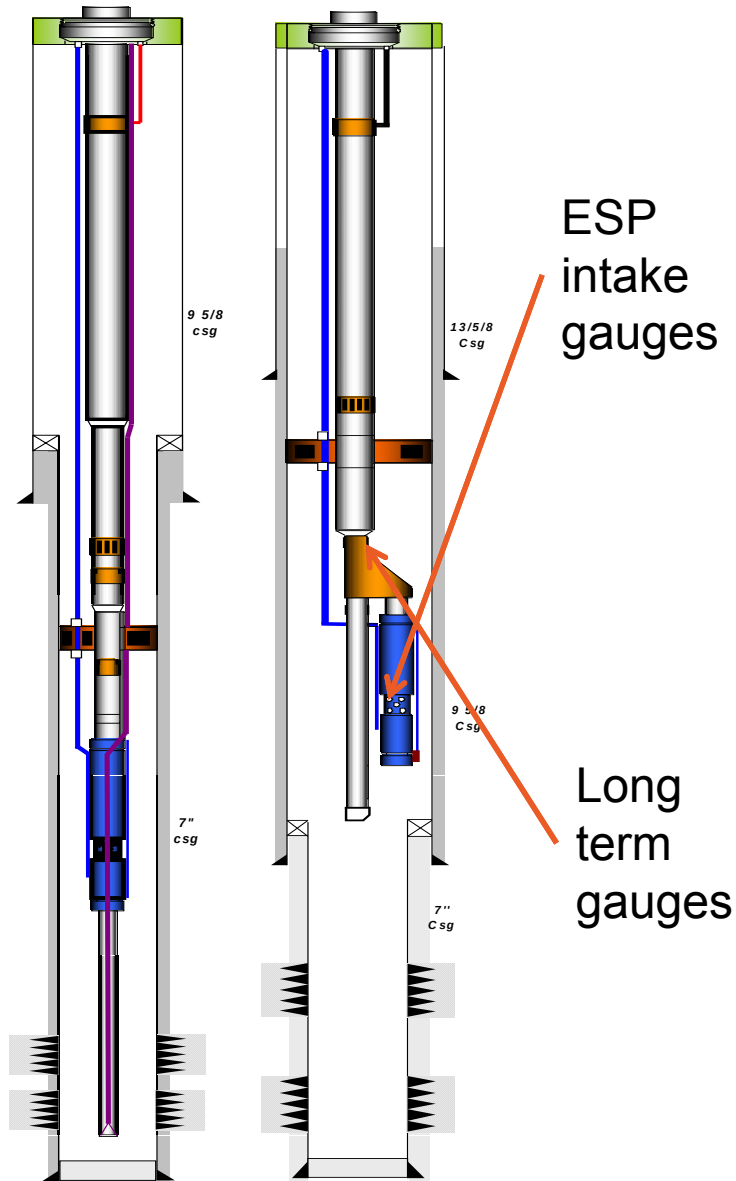
Kharyaga Field Production



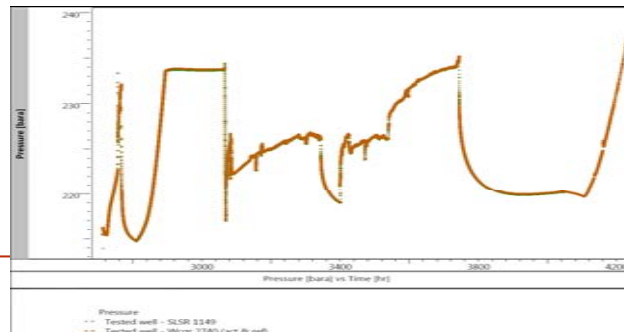
KHARYAGA EXISTING WELL LOCATIONS AND FUTURE DEVELOPMENT



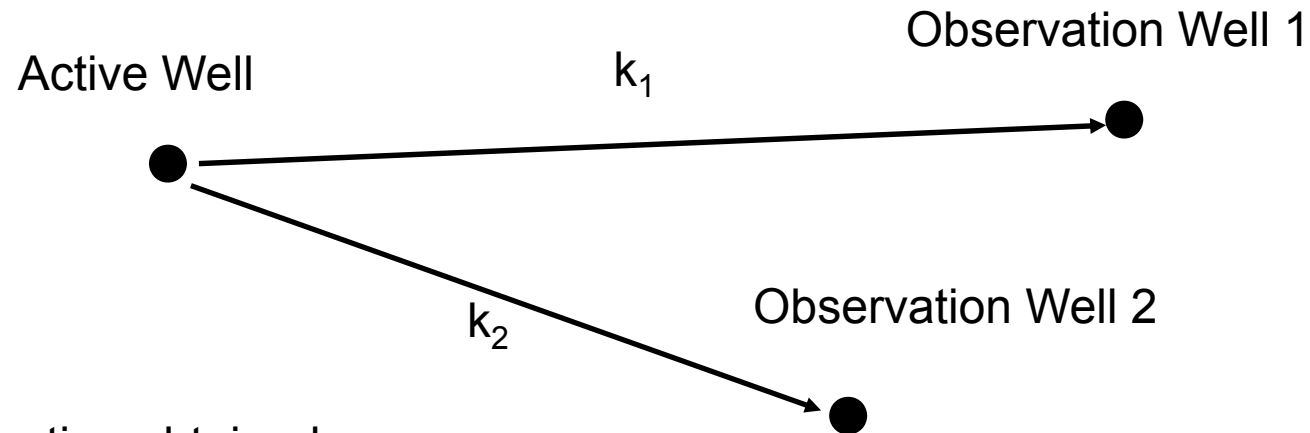
DATA ACQUISITIONS AND QUALITY CONTROL



Gauge Type	WCQR	SLSR
Sensor type	Saphire	Quartz
Pressure range	10000 psi	15000 psi
Accuracy	+/-5psi	+/-1psi to 2.5 psi
Resolution	0,05psi @ 1 sec	0,01psi @ 1 sec
Temperature range	0 to 130 degC	0 to 177 degC
Temp. accuracy	+/-0.5degC	+/-0.5degC
Temp. resolution	+/-0.01degC	+/-0.01degC



INTERFERENCE TEST



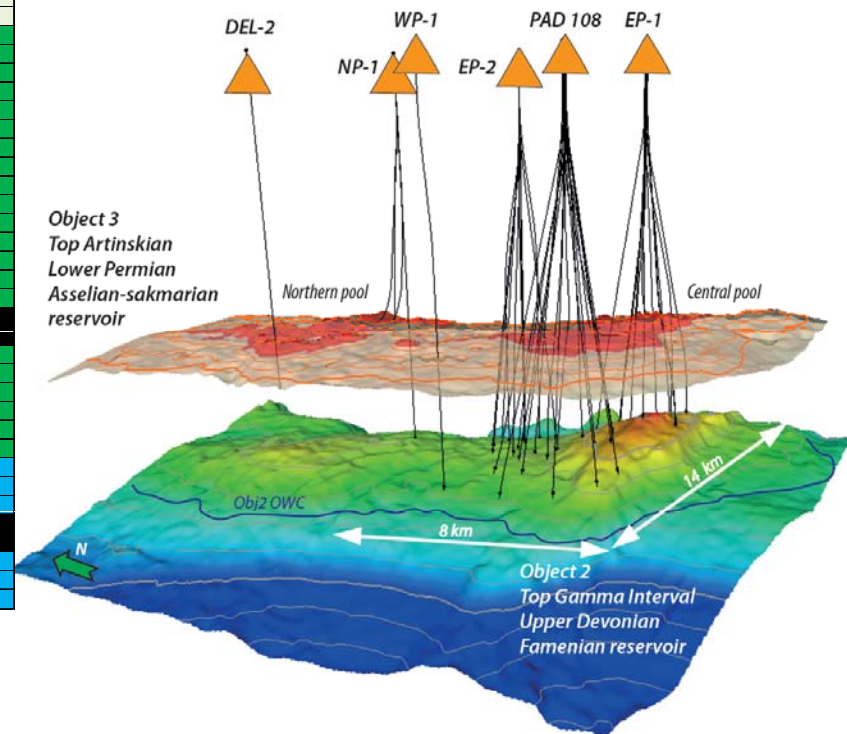
Information obtained:

- Hydraulic connectivity
- Formation properties
- Directional changes in properties
- Interference velocity

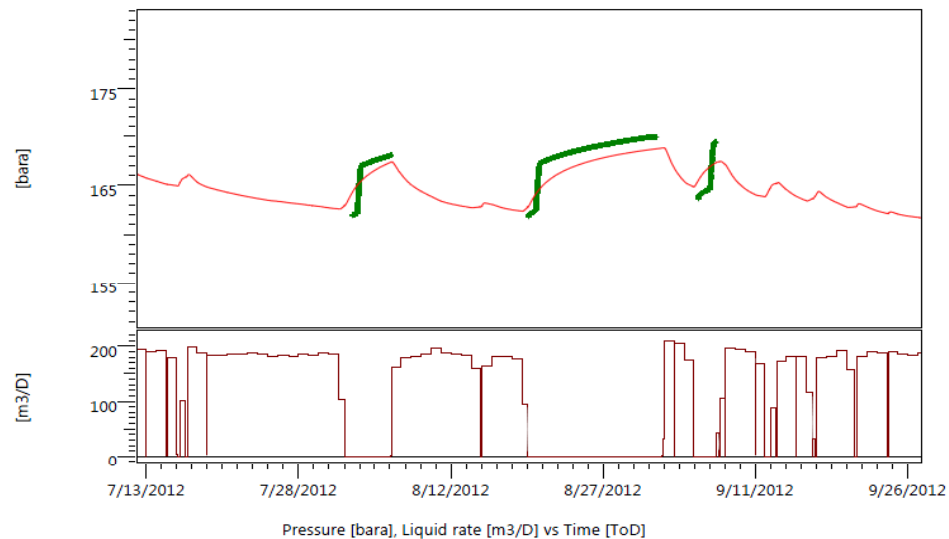
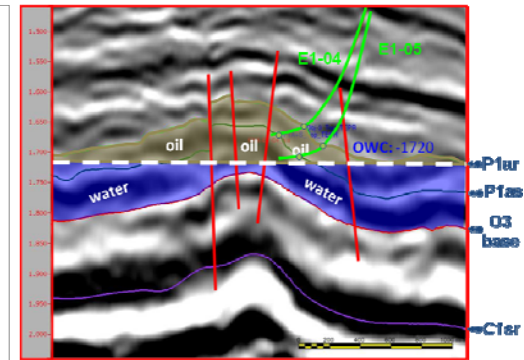
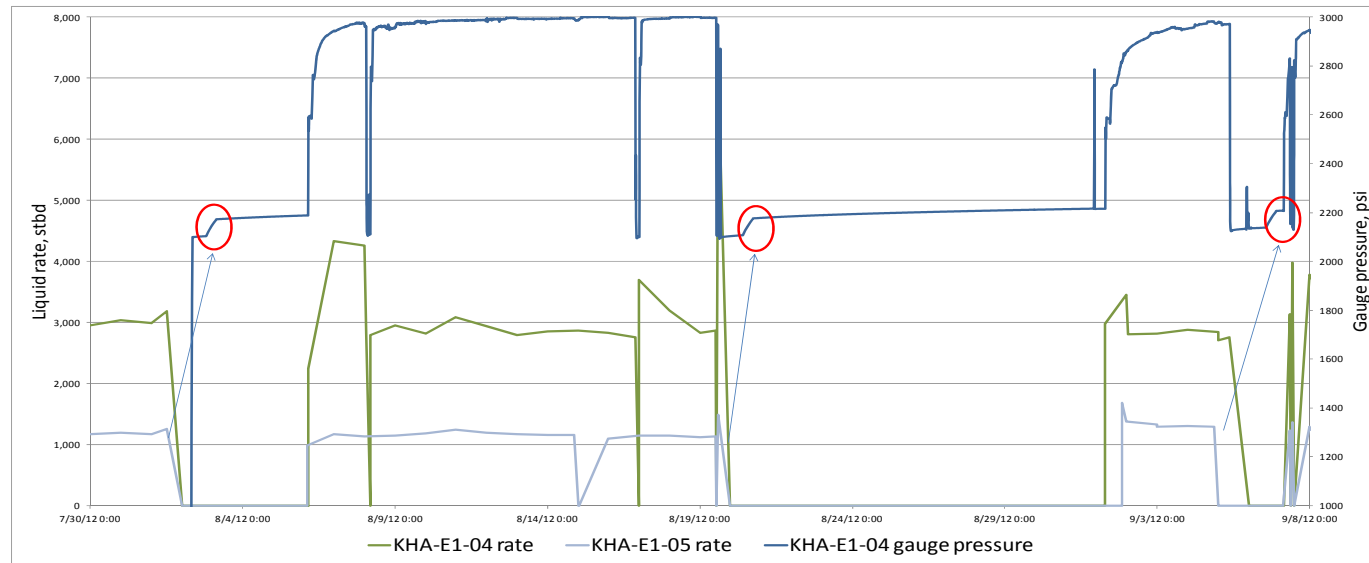
PLANNING OF ACQUISITIONS

- Monitoring program during summer maintenance period
- Using of stopped or not-connected wells as observations

well/operation	Aug-12																															Sep-12									
	SD																																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	
KHA-E2-01 POOH gauges			X																																						
KHA-E2-02 POOH gauges				X																																					
KHA-E1-09 POOH gauges					X																																				
KHA-E1-04 RIH gauges						X																																			
KHA-E1-05 RIH gauges							X																																		
KHA-E1-06 RIH gauges	X																																								
KHA-E1-08 RIH gauges	X																																								
KHA-E1-03 POOH and RIH gauges								X																																	
KHA-7 mPSP																																X	X	X	X						
KH-2045																																									
KH-2046																																									
KHA-1																																									
KHA-5																																									
KHA-6																																									
KHA-7																																									
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KHA-E1-06																																									
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KHA-2																																									
KHA-11																																									
KHA-12																																									
KHA-E1-04																																									
KHA-E1-05																																									
DEL-1																																									
KHA-N1-01																																									
KHA-N1-02																																									
KHA-N1-03																																									
KHA-3																																									
KHA-4																																									
KHA-9																																									
KHA-15																																									
KHA-17																																									
KHA-18																																									
KHA-E1-03																																									
KHA-E1-07																																									

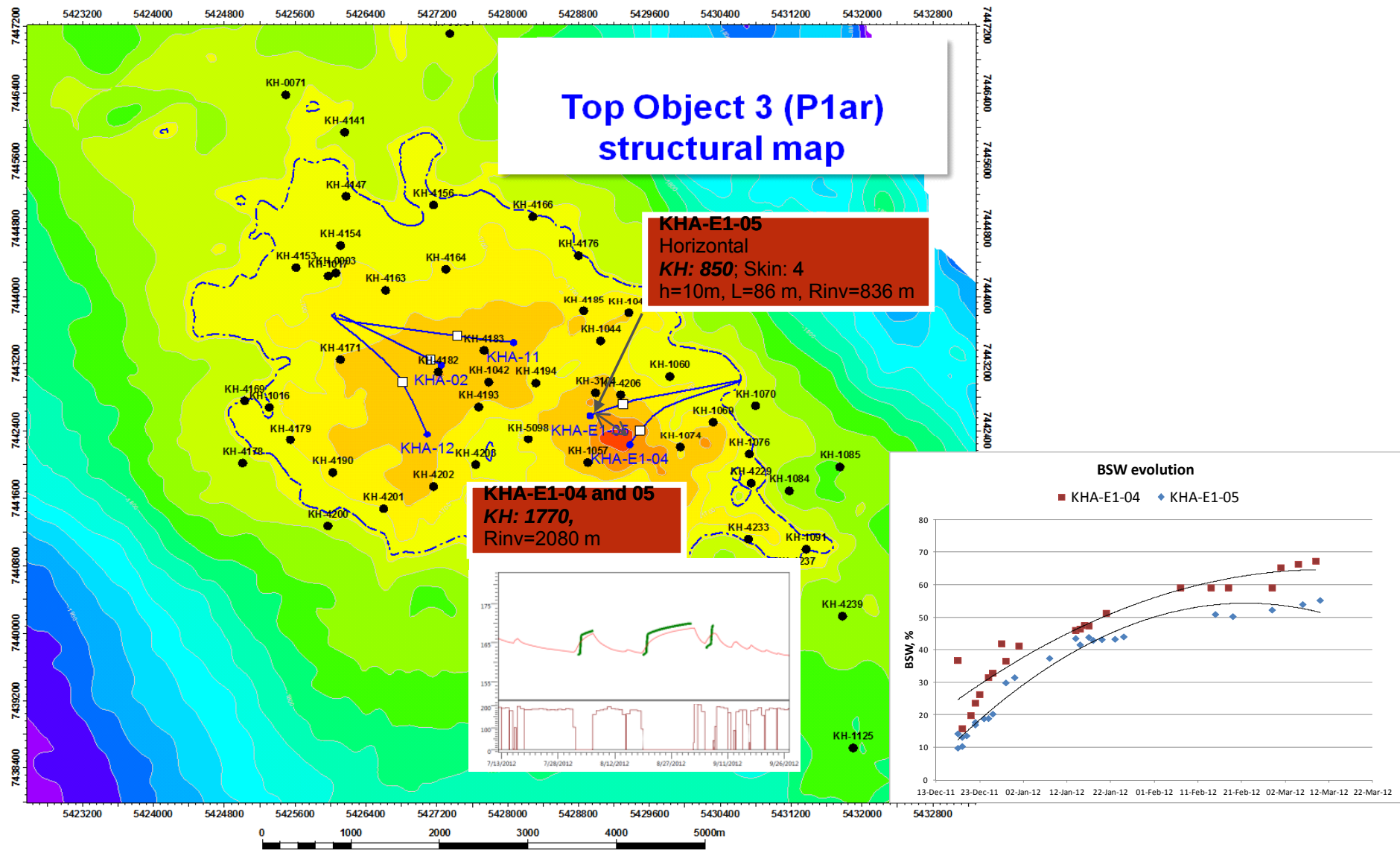


KHA-E1-04 (P1AR) AND KHA-E1-05 (P1A+S) INTERFERENCE ANALYSIS

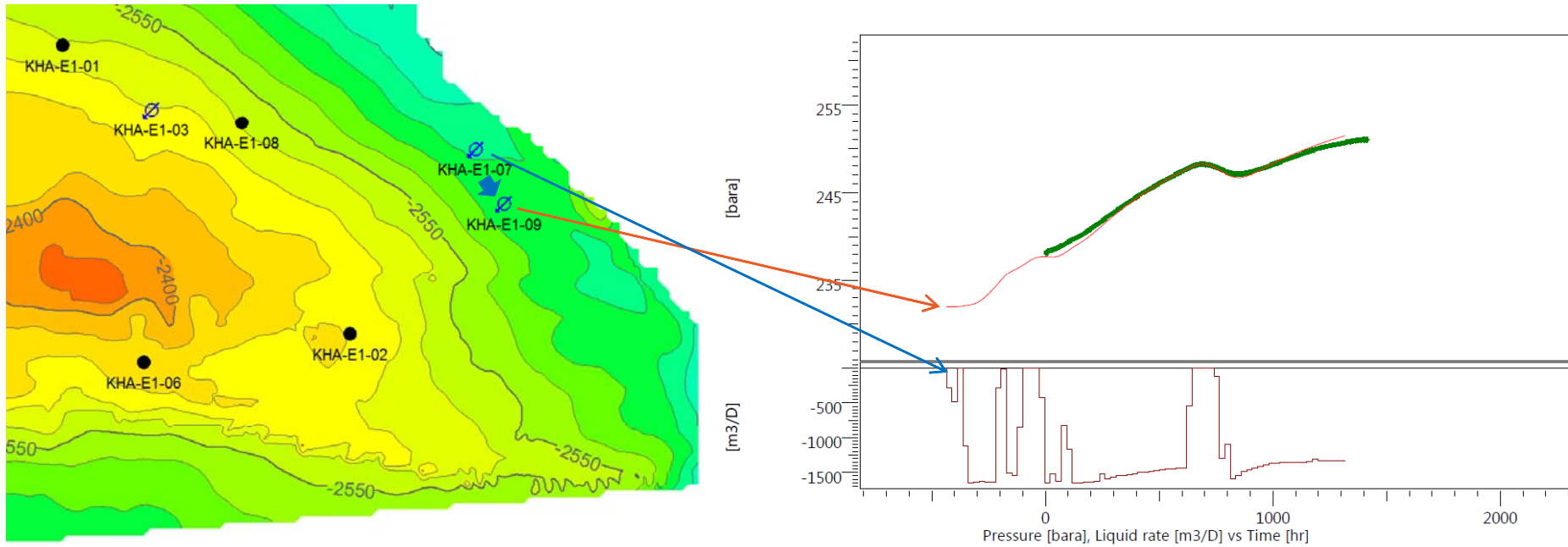


kh, mD*m	1770
k, mD	177
Well model	Line source
Reservoir	Homogeneous
Boundary	Infinite
Radius of investigation, m	415

OBJECT 3C P1A+S AND P1AR

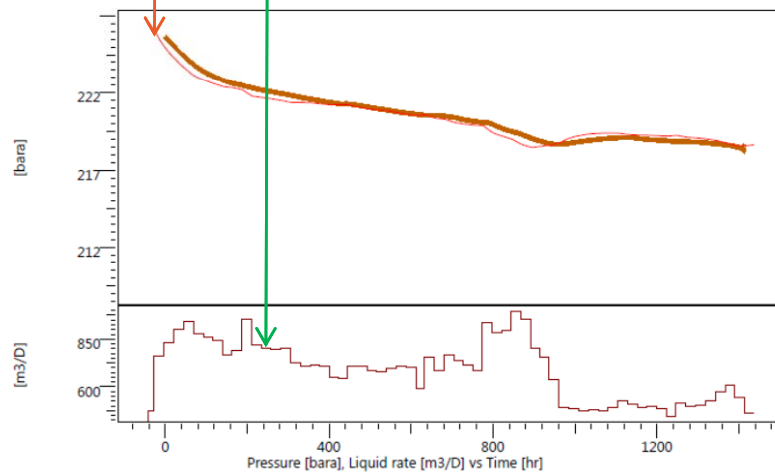
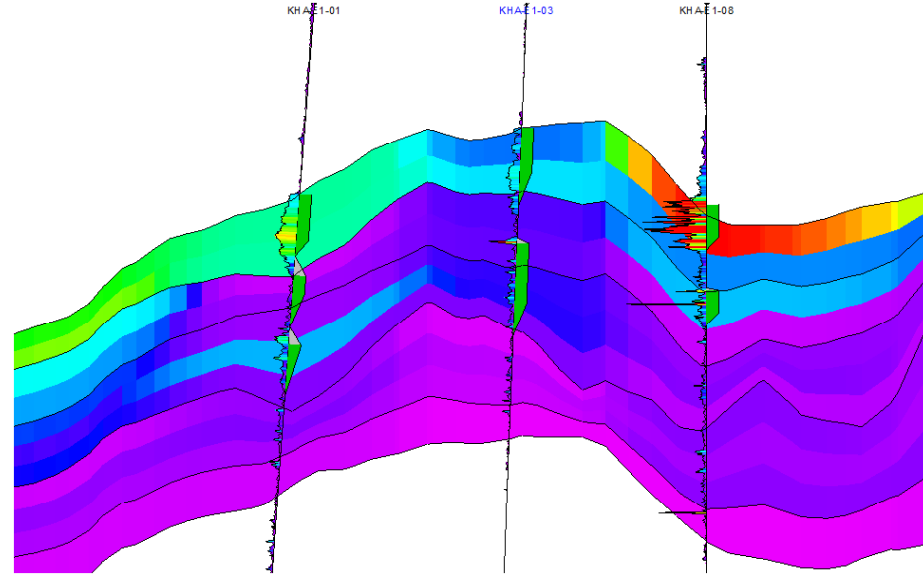
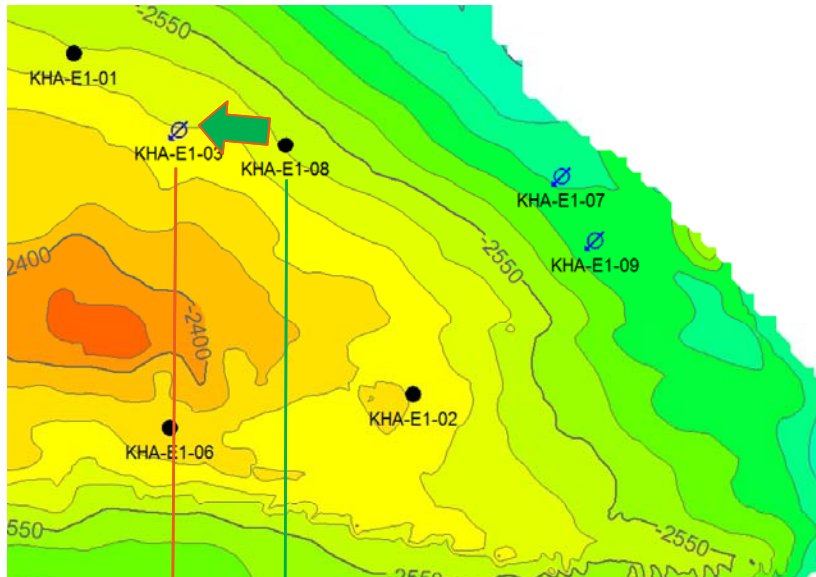


KHA-E1-07 (ACTIVE) AND KHA-E1-09 (OBSERVATION) INTERFERENCE ANALYSIS



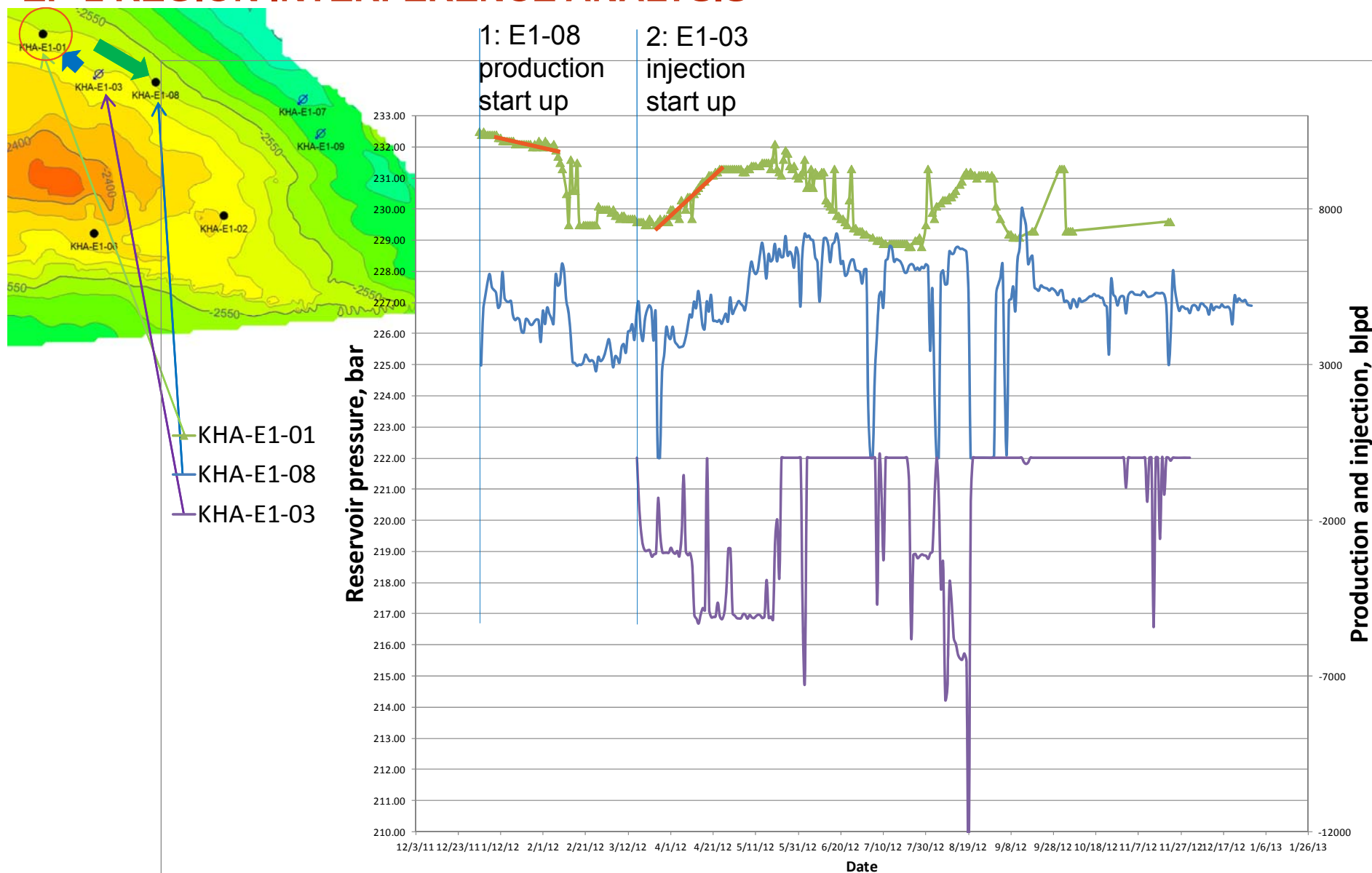
kh, mD*m	1060
k, mD	35
S	0,7
Well model	Vertical
Reservoir	Homogeneous
Boundary	Infinite
Well distance, m	503

KHA-E1-08 (ACTIVE) AND KHA-E1-03 (OBSERVATION) INTERFERENCE ANALYSIS

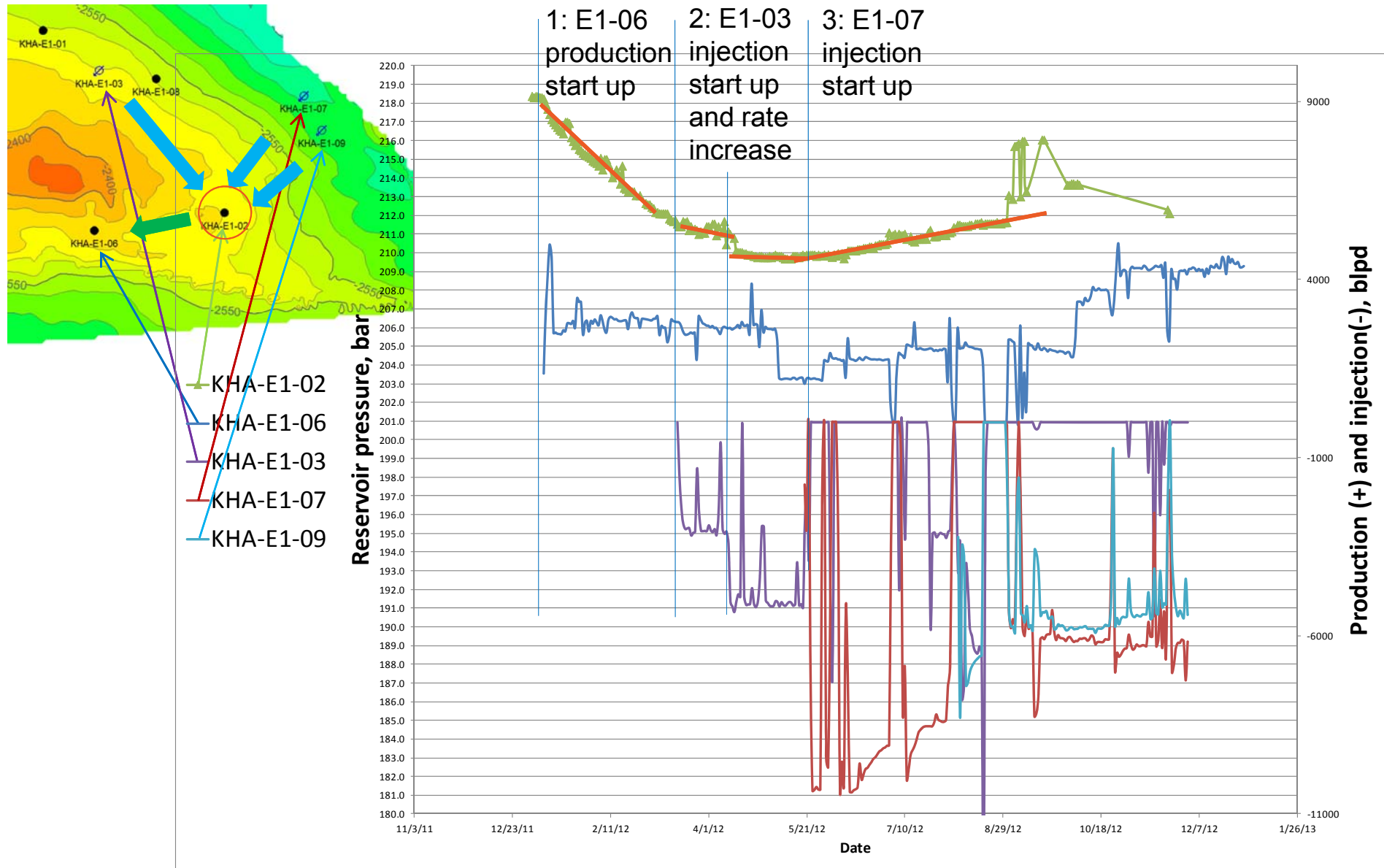


Thickness, m	9
Permeability, mD	660
Porosity	0,12
Reservoir pressure, bar	226,5
kh, mD*m	5940
Box-shaped reservoir boundaries, m	5×5×5×2,5 km

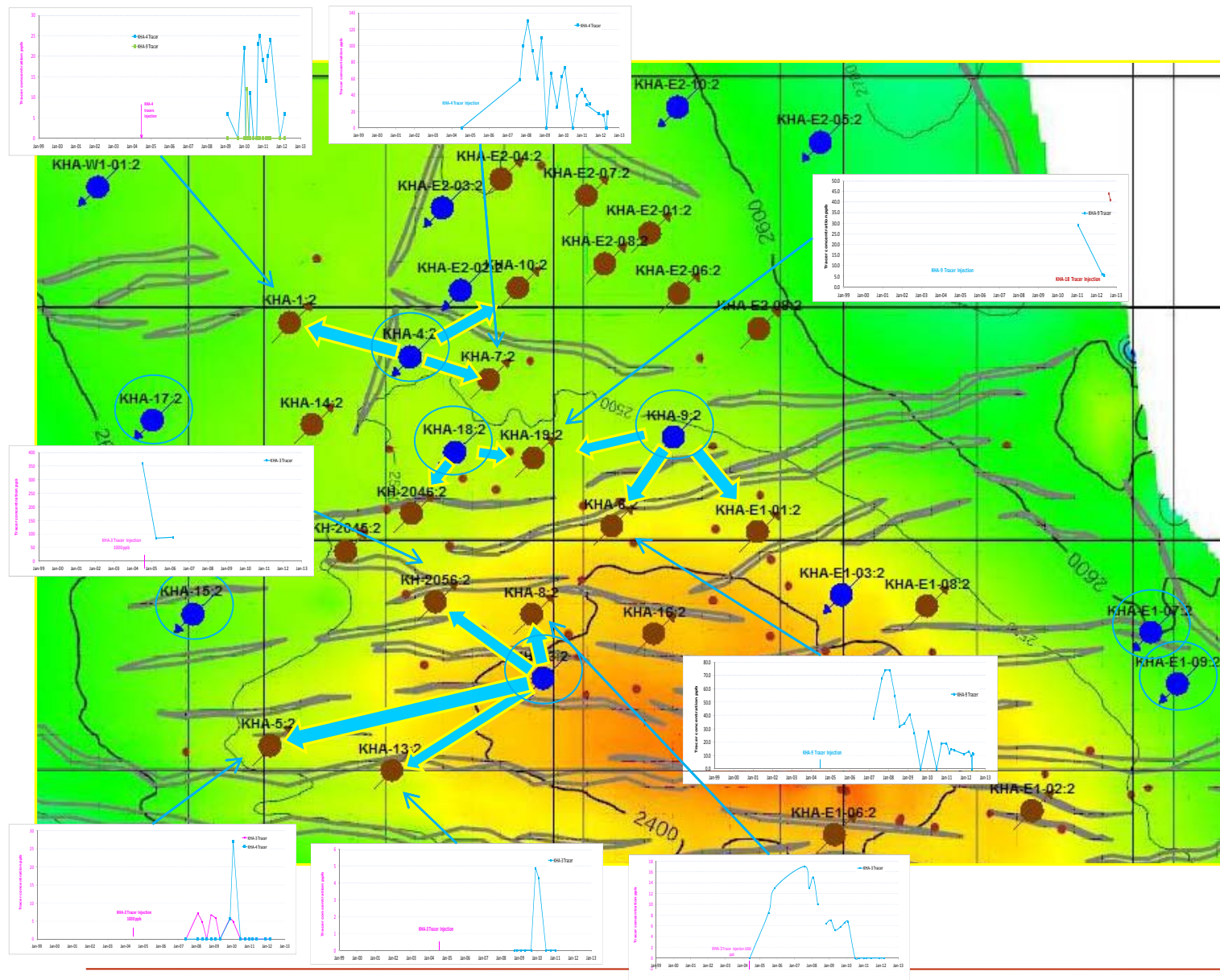
EP-1 REGION INTERFERENCE ANALYSIS



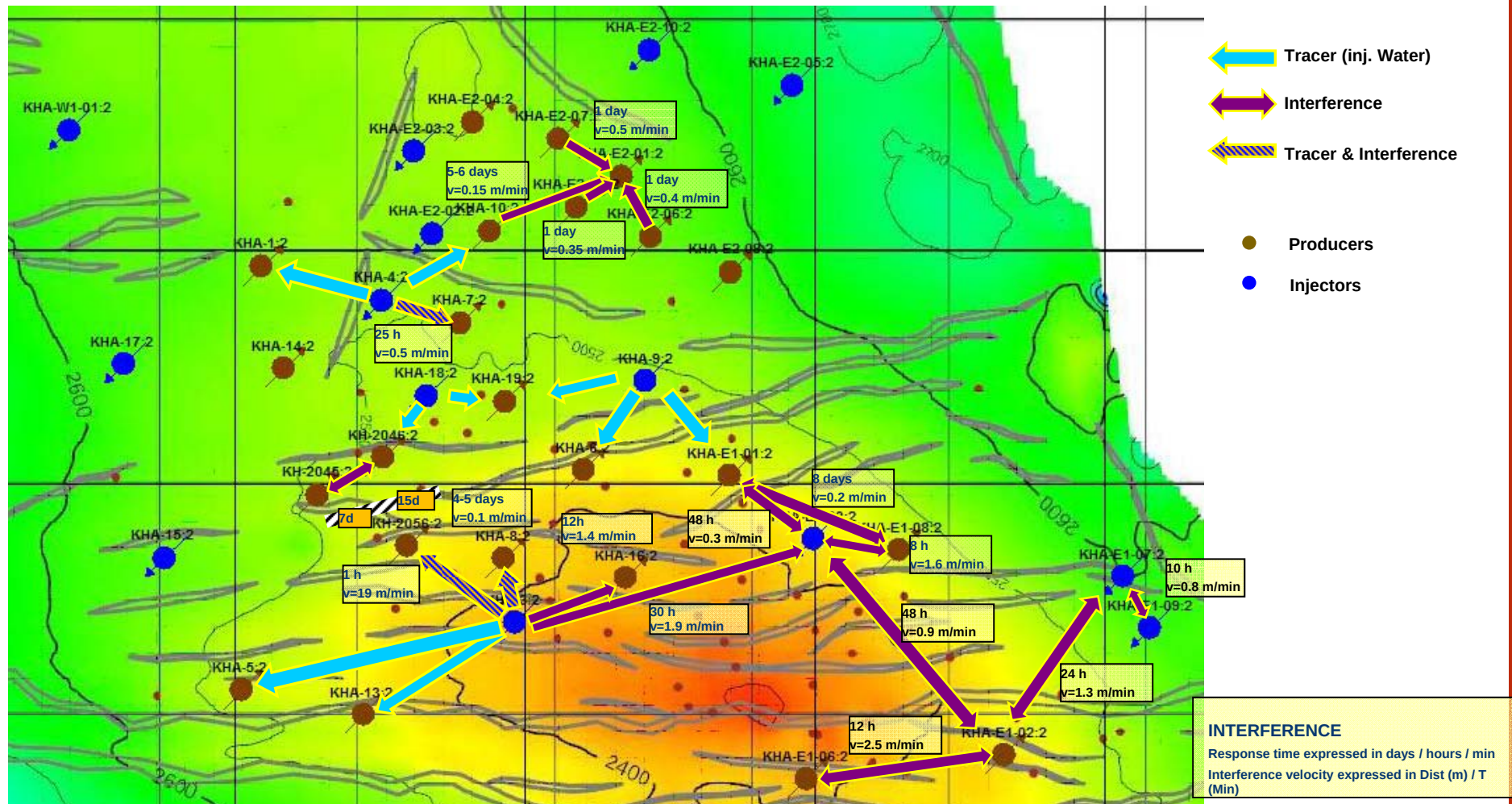
EP-1 REGION INTERFERENCE ANALYSIS



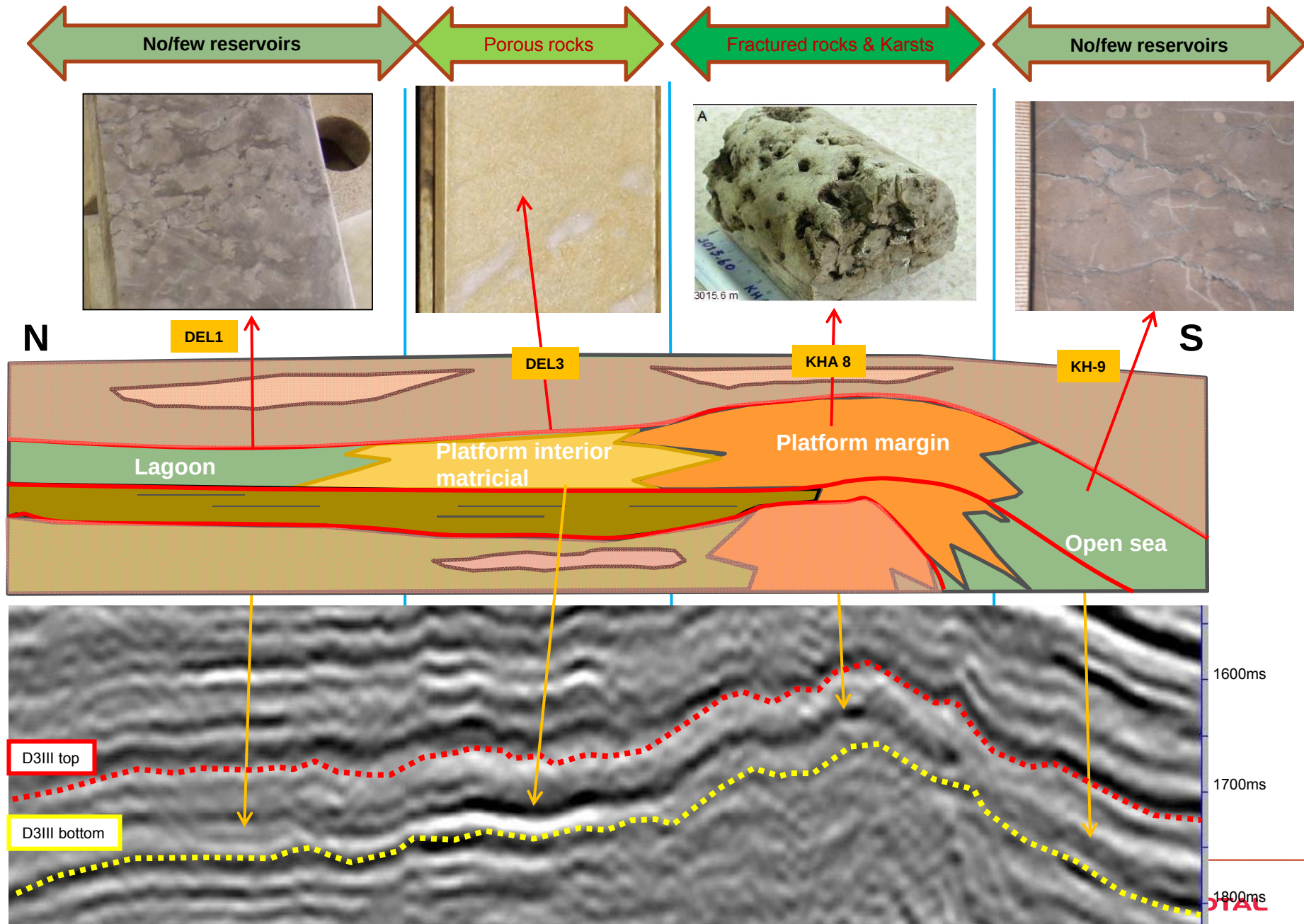
TRACERS INJECTION CAMPAIGN RESULTS



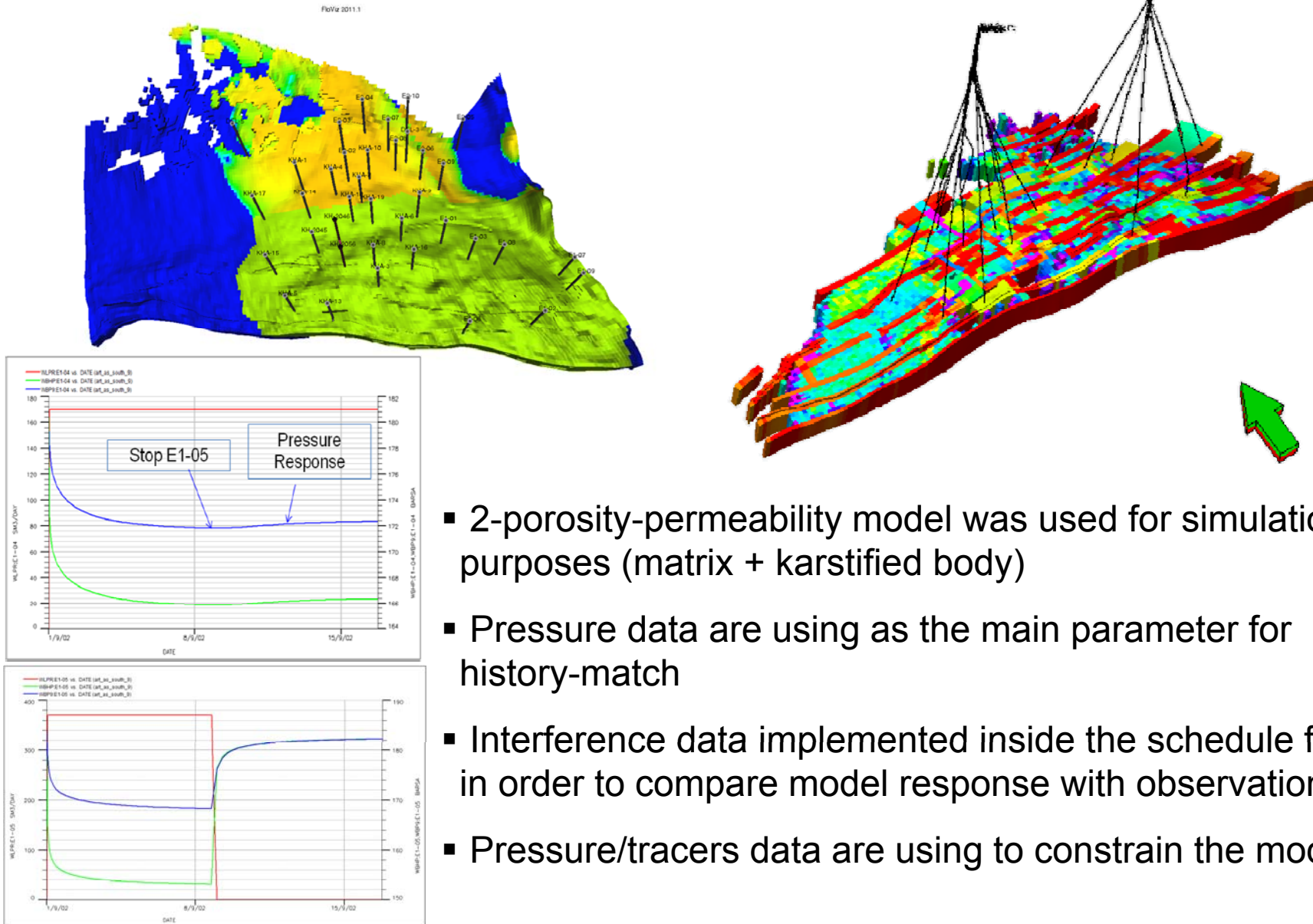
Kharyaga - Object 2 well interference & tracer results



Conceptual geological model with core

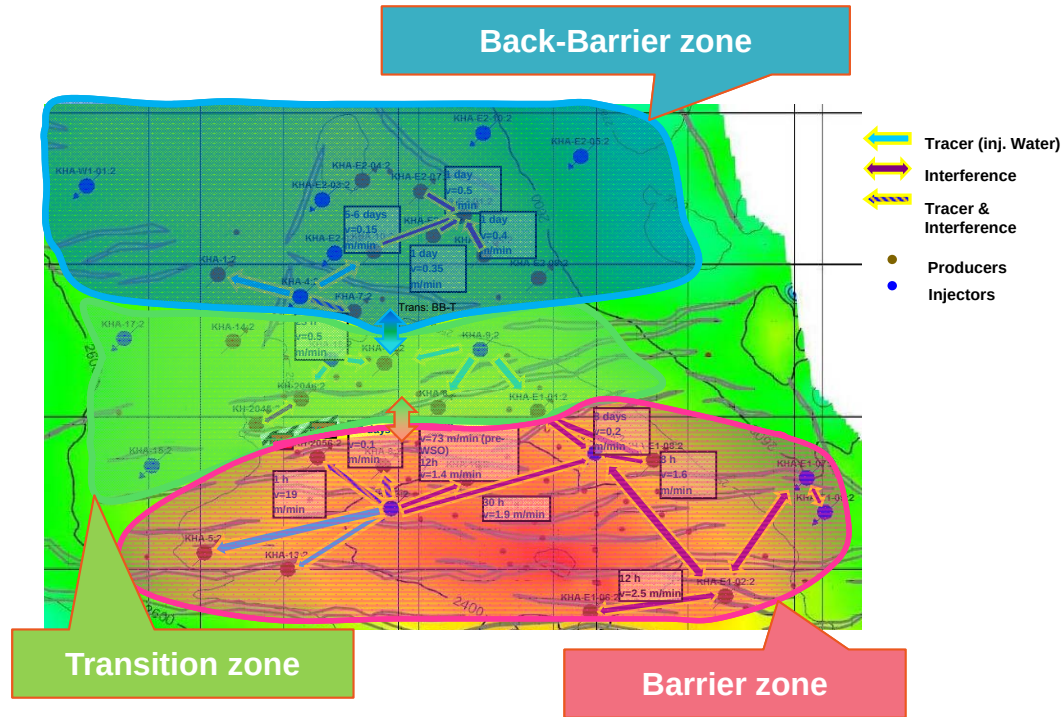


RESULTS INTEGRATION INTO SIMULATION MODEL



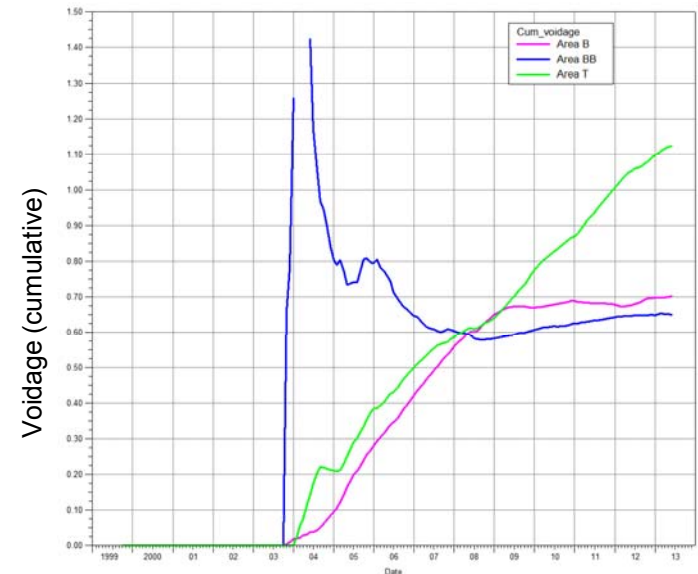
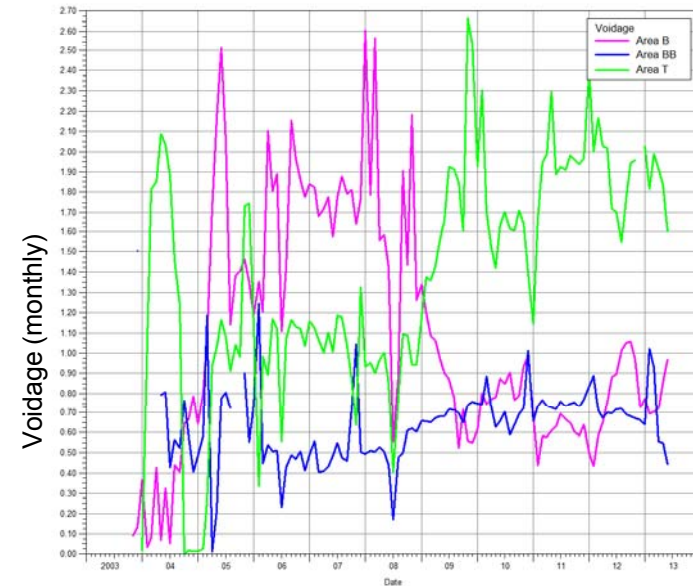
- 2-porosity-permeability model was used for simulation purposes (matrix + karstified body)
- Pressure data are using as the main parameter for history-match
- Interference data implemented inside the schedule file in order to compare model response with observation
- Pressure/tracers data are using to constrain the model

INJECTION STRATEGY: MANAGEMENT BY ZONES



Strategy:

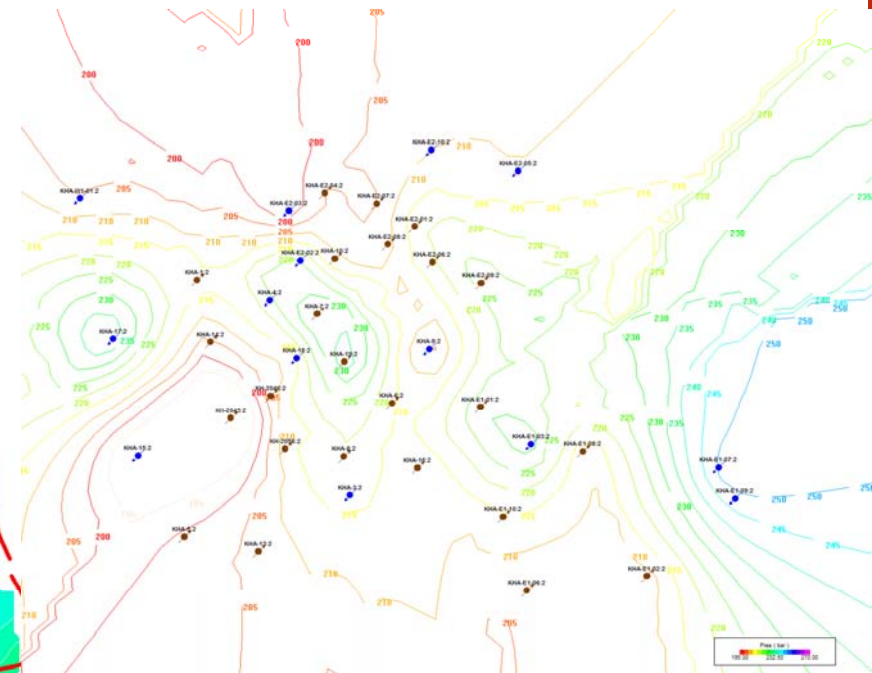
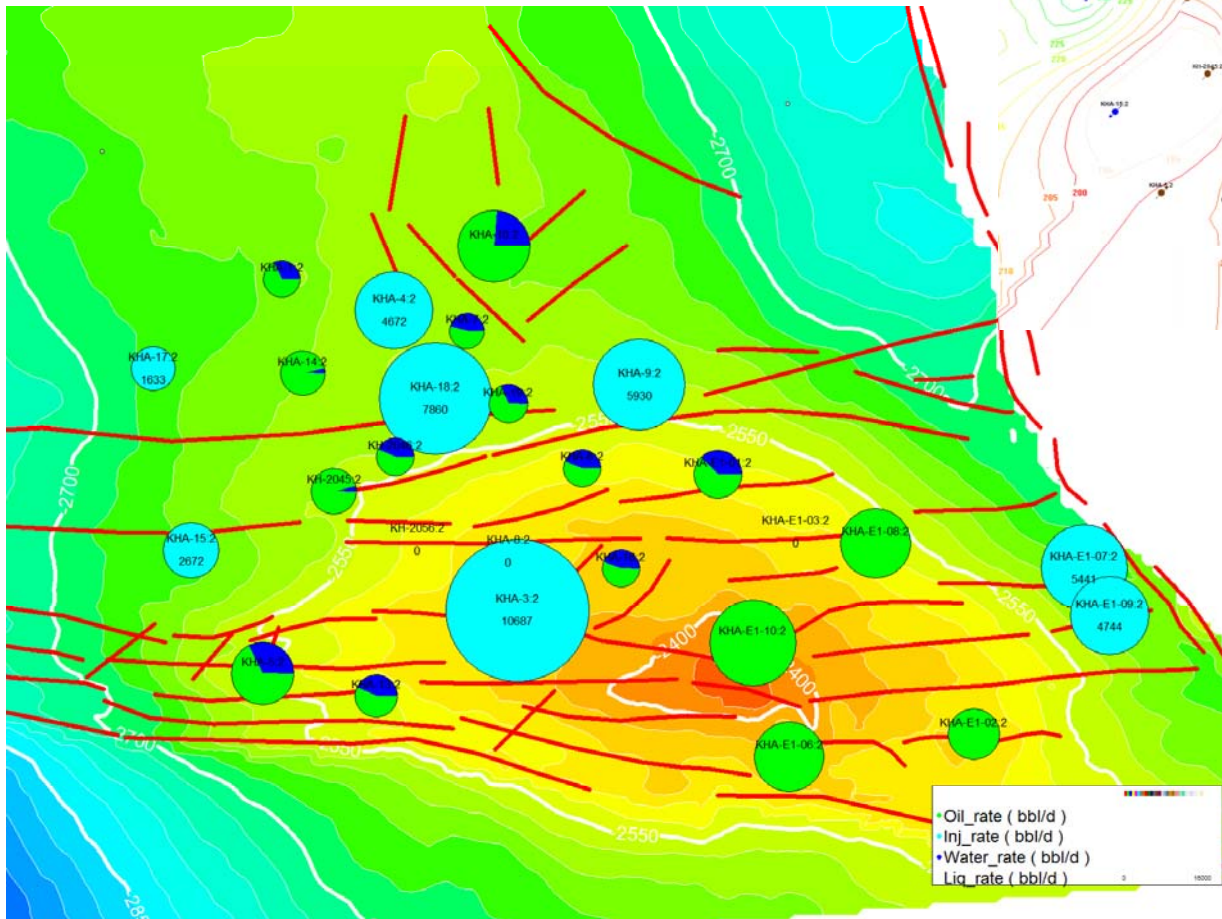
- Overall field voidage targeting = **105%**
- Homogeneous injection distribution by zones
- Injection from flanks in the barrier part



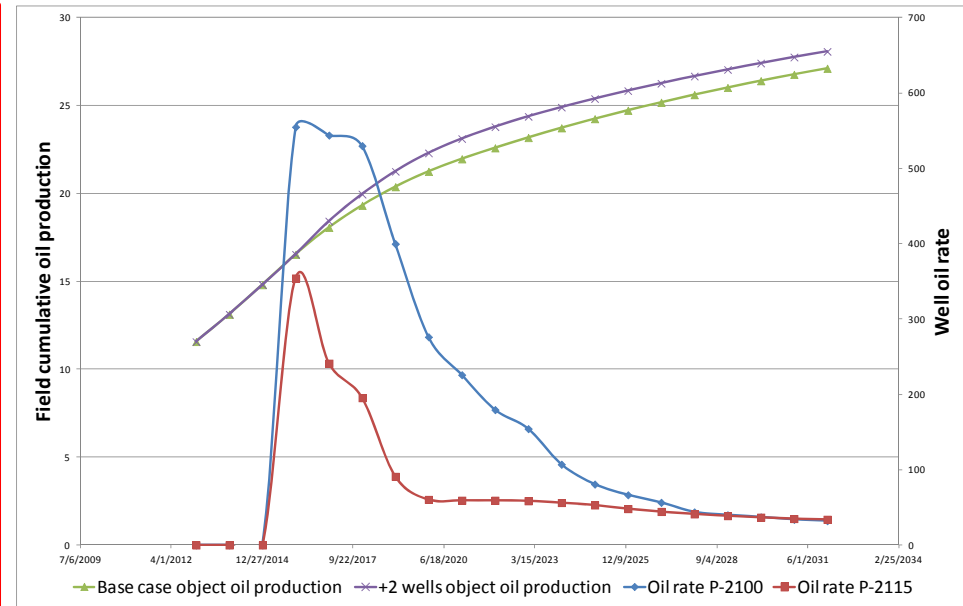
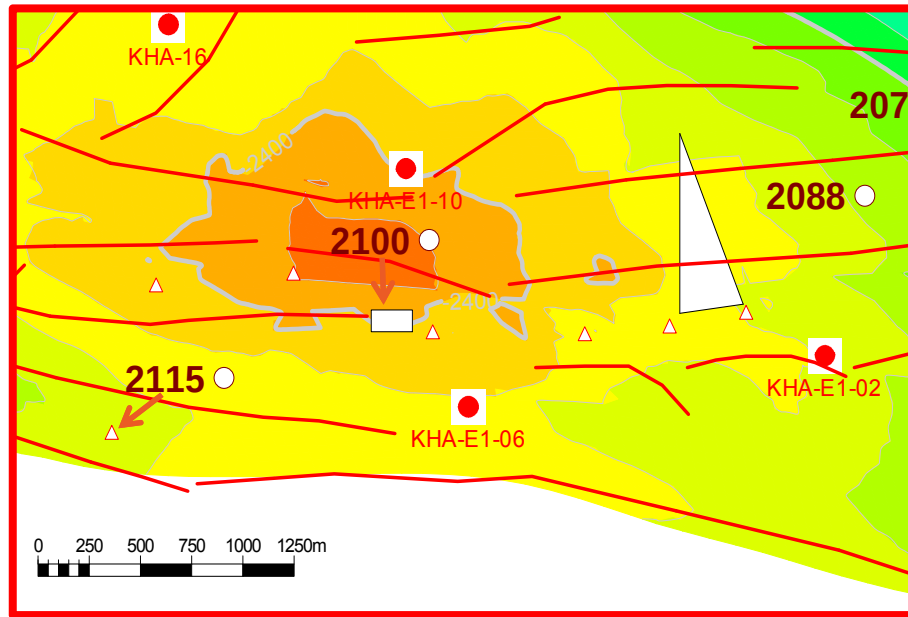
KHARYAGA INJECTION DISTRIBUTION

Object 2 compartmentalization:

- Back-Barrier:
Producers: KHA-5/13/16/KH-2056/KHA-E1-06/KHA-E1-02/KHA-E1-08/KHA-E1-01(30%)
Injectors: KHA-3/KHA-E1-03/KHA-E1-07/KHA-E1-09, KHA-9(25%)
- Transition:
Producers: KHA-14/6/KH-2045/KH-2046/KHA-E1-01(70%)
Injectors: KHA-15/17/KHA-9 (75%)
- Back barrier area:
Producers: KHA-17/10
Injectors: KHA-4



IMPACT ON INFILL DRILLING STRATEGY



P2100 and P2115 reserves evaluation:

- Cumulative oil production (P2100+P2115) = 10,7 Mboe
- $Q_{cum}(+P2100+P2115) - Q_{cum}(\text{Base case}) = 6,1 \text{ Mboe}$
- Due to the huge connected volume in the barrier zone, abovementioned difference in reserves could be extracted by other wells!

CONCLUSIONS

- Objects 2,3 of Kharyaga field represent a complex carbonate reservoir with karstification and dynamic information is a key information for the reservoir behaviour understanding
- Detailed monitoring programs on well basis combined with different acquisition tools (ESP intake gauges, LTG) allows to receive high quality data for further interpretation
- Interference test results allows to identify reservoir properties and connectivity in the reservoir, better characterize reservoir
- Synthesis of the all available dynamic information with geological concept cause to the proper simulation model and reservoir management decisions
- Interference effects should be taken into account during reserves evaluation

ACKNOWLEDGEMENTS

- Total E&P Russie for the permission to present
- GSR department for the constantly improving knowledge and fruitful discussions
- Operation/Well service/Completion teams for the full support of our monitoring programs