Challenges and Development of Hosszúpályi-South Gasfield

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Object:

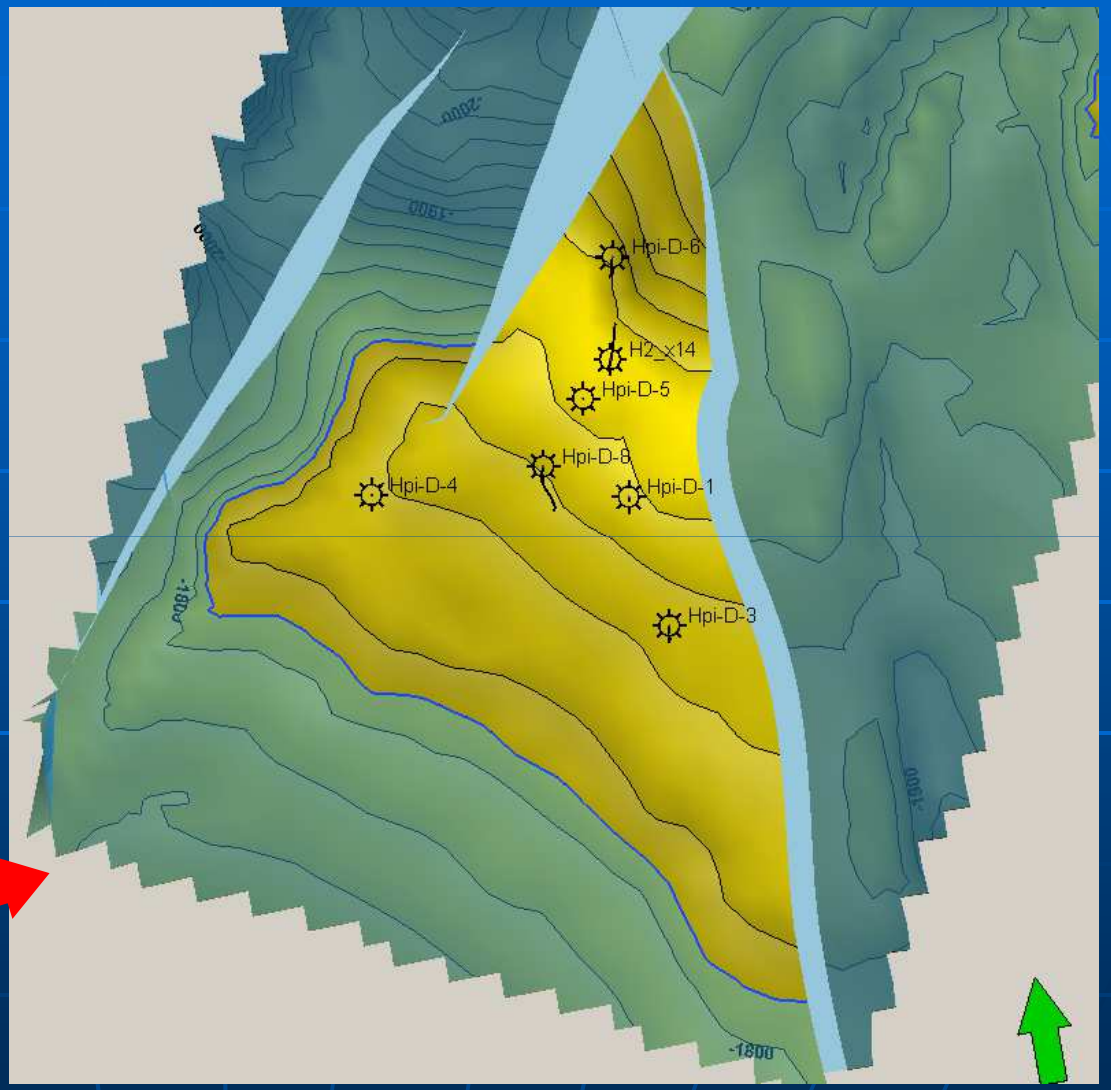
The Hosszúpályi gas field was discovered in 2001 and 13 reservoirs were founded in upper-pannonian sandstone reservoir. This field was the biggest discovery in tha past 20 years. Its volumetric OGIP was estimated more than $5*10^9$ m^3 (176 Bcf)

Already in the first year of production it became obvious that the OGIP was overestimated and in the next years we have faced further problems, such as more intensive water influx, steeper pressure trend, insufficient gas inflow.

In 2009 a full field simulation model (included reservoir – well – surface model) was built for Hosszúpályi-South gas field to study uncertainties and investigate the optimum development strategy for the reservoirs.

Reservoir description

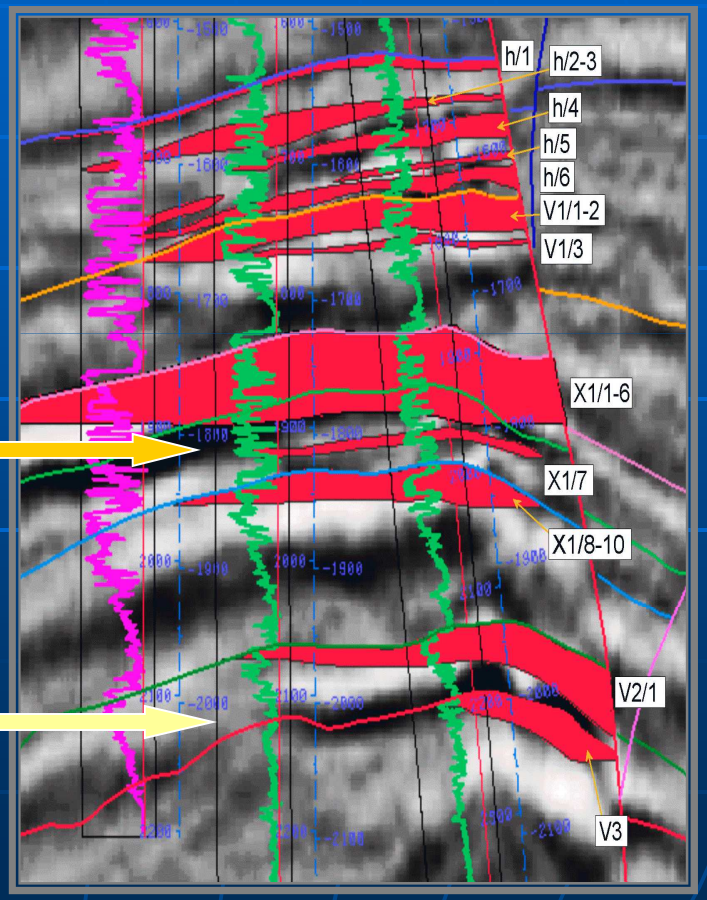
- First well H-1: 2001
- 15 gas res. found after drilling 3 wells
- in 2005 the 3 largest reservoirs were put on production with 7 wells
- currently 8 production wells



Reservoir description

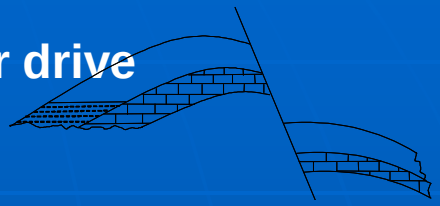
First volumetric estimation of O.G.I.P., 2003

Resrevoirs	O.G.I.P. $10^6 m^3$	Reservoir type
h/1	85	Upper-pannonian sandstone
h/2-3	74	
h/4	79	
h/5	27	
h/6	150	
V1/1-2	304	
V1/3	86	
X1/1-6	2883	
X1/7	127	
X1/8-10	386	
V2/1	796	Lower-pann. sandstone
V3	58	
TOTAL	5055	



Reservoir description

Reservoir type: Faulted anticline with edge water drive



Facies type: River environment with braided and meandering channel

Rock type:	Lower and Upper-Pannonian sandstone
Initial pressure:	167-211 bar (hydrostatic pressure)
Permeability:	UP: 200-2000 mD, LP.:1-50 md
Porosity:	UP: 0.23, LP: 0.17
Inital water sat.:	UP: 0.27, LP: 0.41
Gas composition:	C_1:90%, C_2:4%, C_3:1.5%, CO_2:2.5%, HV: 40 MJ/m^3

Development plan, 2004

Predicted gas production:

	OGIP, Mm^3	closed	$r_k/r_b = 4$	$r_k/r_b = 10$	well numb.
X1-6	2658	2248	2198	1945	4
$\eta\%$		***85***	***83***	***73***	
V2/1	765	638	613	593	2
$\eta\%$		***83***	***80***	***78***	
V1-2	328	271	246	174	1
$\eta\%$		***83***	***75***	***53***	

Factors which can influences the RF%:

- Information only from 3 drilled wells $\rightarrow$ parameter (k,Φ,h,h_{eff},S_{wi}) distribution, reservoir boundary can change
- Unknown aquifer size
- Sealing or non-sealing faults

Field Production

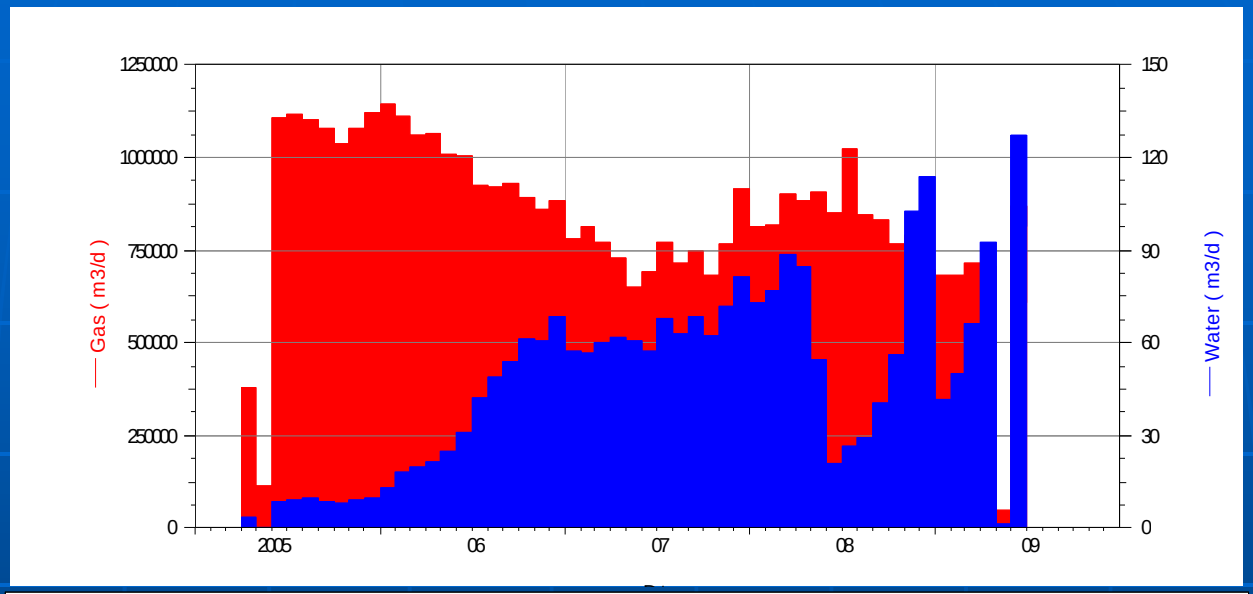
Start of prod: 2005

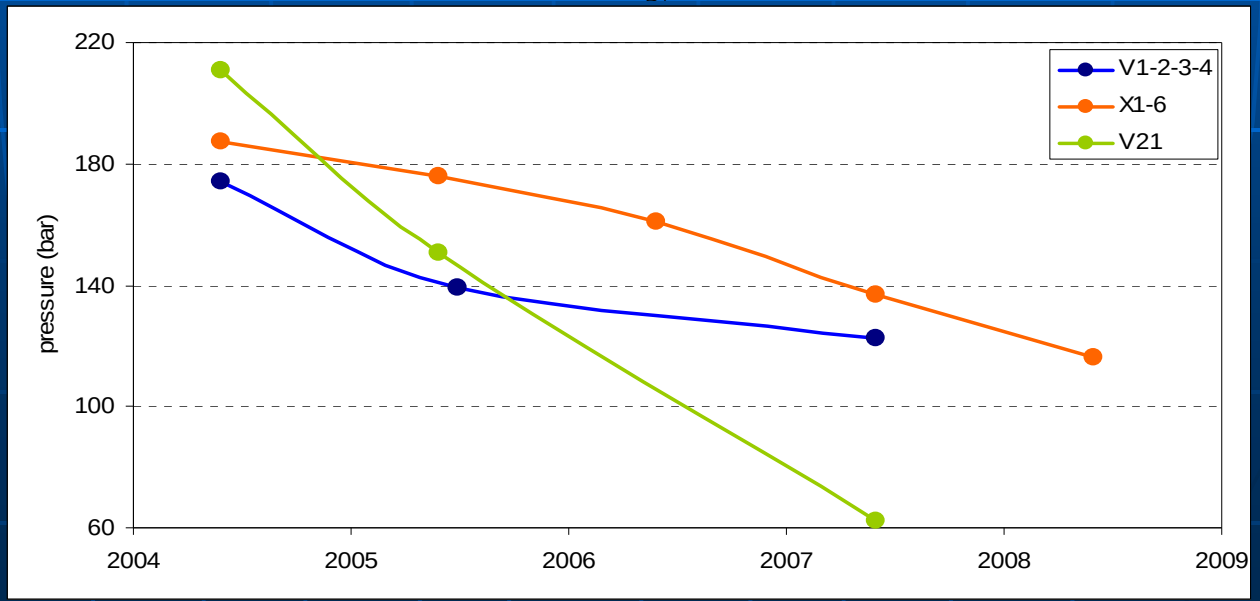
X1-6: 4 wells

V2/1: 2 wells

V1-2: 1 well

Cum.gas: 1.2 Bm^3





Production history of V1-2 & 3-4 reservoirs

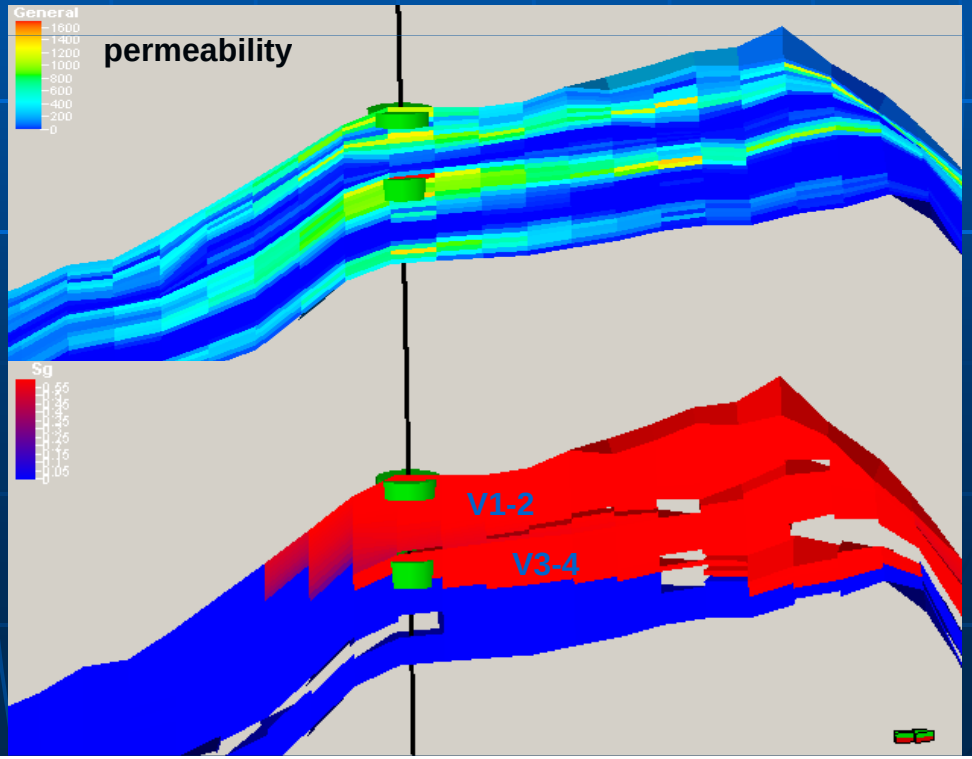
2006: - H-1: increasing water production in V1-2

2008: - end of production 05/2008

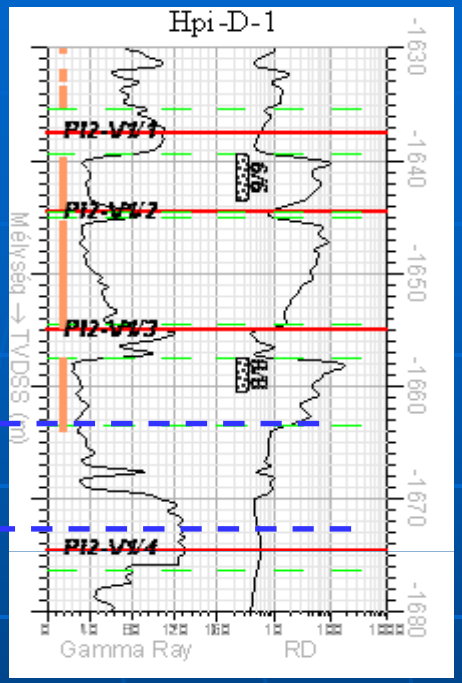
- Re-perforation for reservoir V3-4 in 08/2008

- 10/2008 increasing water production

- V3-4: end of production 12/2008



History matching of V1-2-3-4 reservoirs, 2009



V1-2: GWC= 1670 mss, P_i = 175, P_{2008}= 123 bar

V3-4: GWC= 1664 mss, P_i = 175, P_{2008}= 165 bar without prod.

V1-2 and V3-4: one reservoir, common GWC

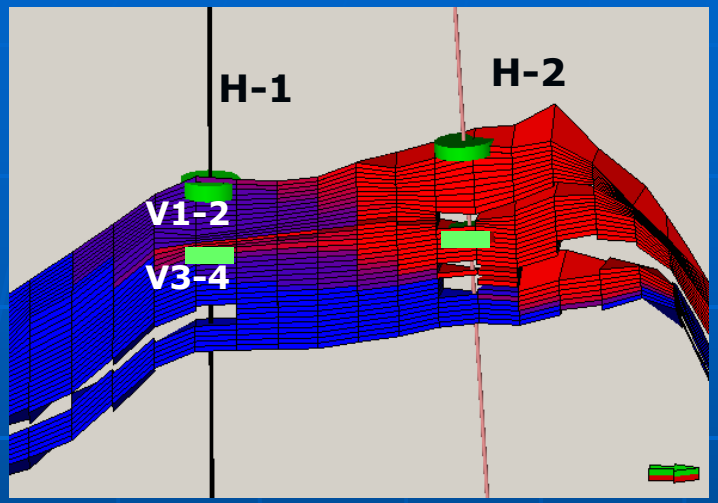
Simulation result: with modified reservoir modell and GWC

OGIP Mm3 = V1-2: $328_{2004} \rightarrow 203_{2006} \rightarrow 187_{2009}$

V3-4: $111_{2004} \rightarrow 111_{2009}$

RF% = V1-2-3-4: 190/298 = 63.7

Future activities



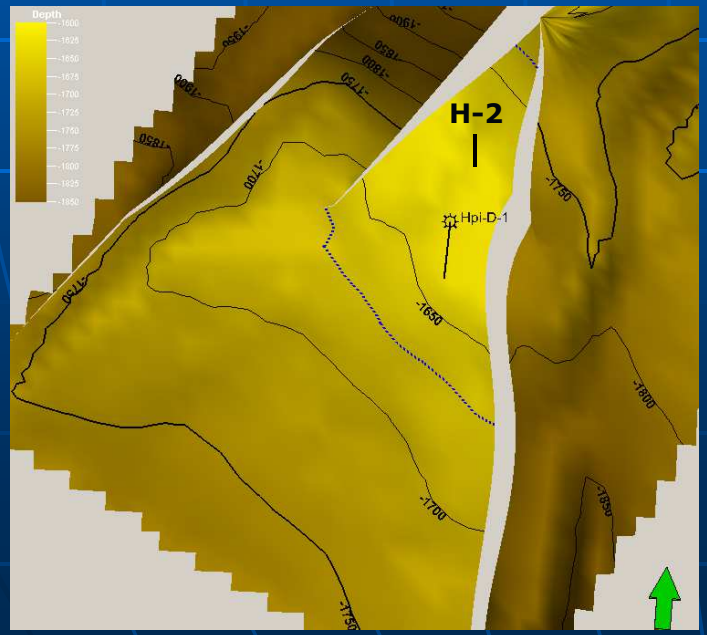
- H-1: close to GWC → killed by water
- Perforations in top zone in both layers

→ No option to re-perforate in higher pos.

OGIP = 297 Mm^3

Gp = 103 Mm^3

→ Sg ~ 100 Mm^3



Best candidate: H-2

Perforation 1: V/3-4 top zone

Perforation 2: V/1-2 top zone

RF expected ~ 70%

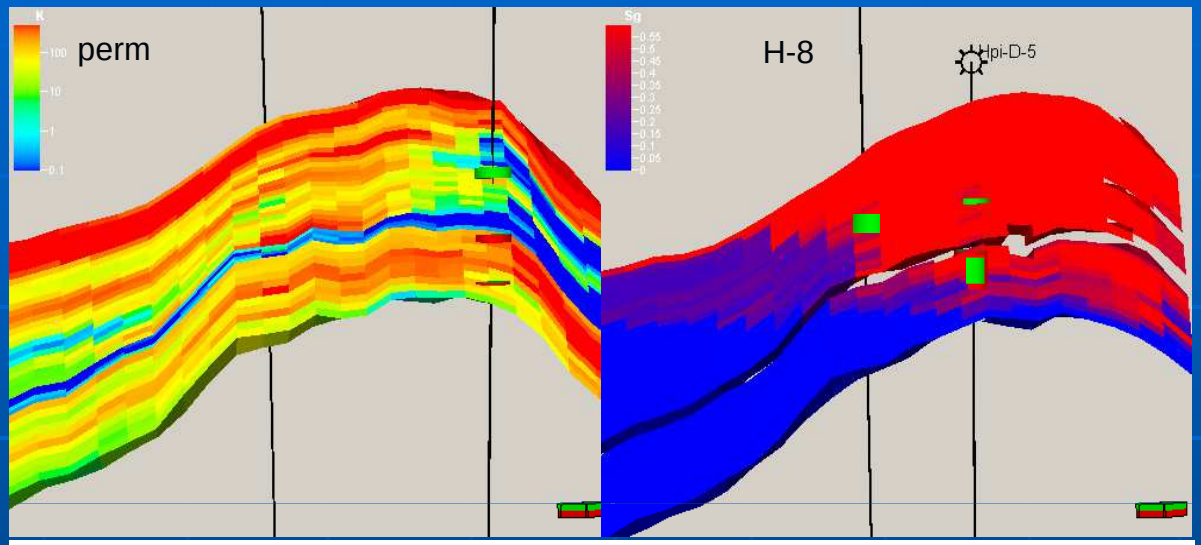
Production history of X1-6

2006:

- H-5: increasing water production from layer X5

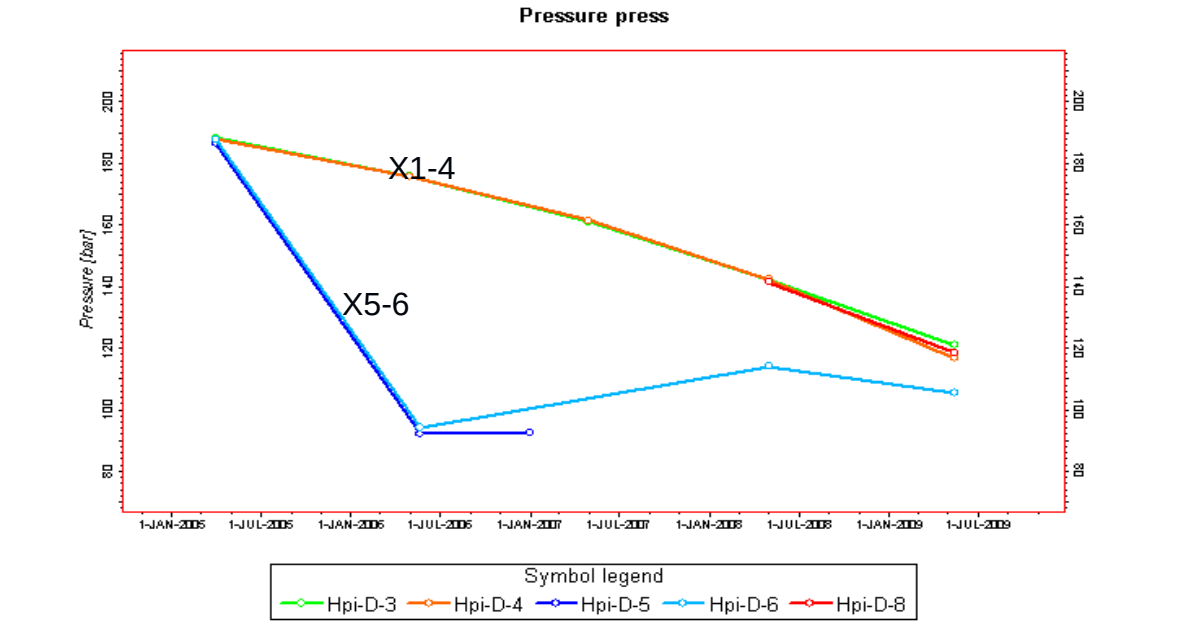
2007:

- H-5: sqeezed layer X/5 re-perforated for X/4
- H-8 drilled, completed for X/3



- based on the P_{res}:

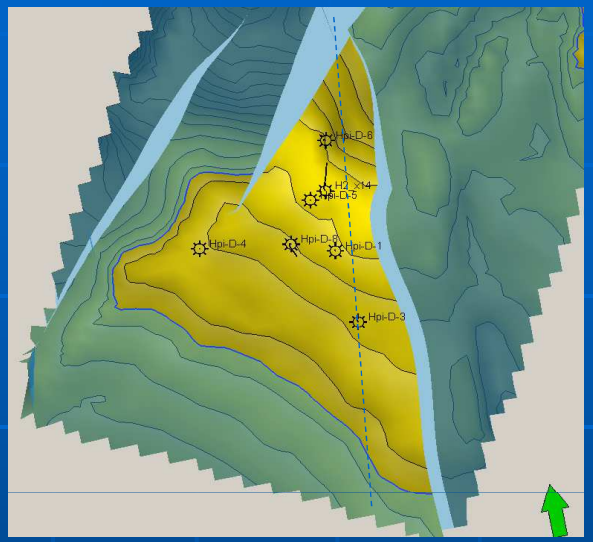
X/1-4 and X5-6 are separate layers, with limited hydrodynamic connection

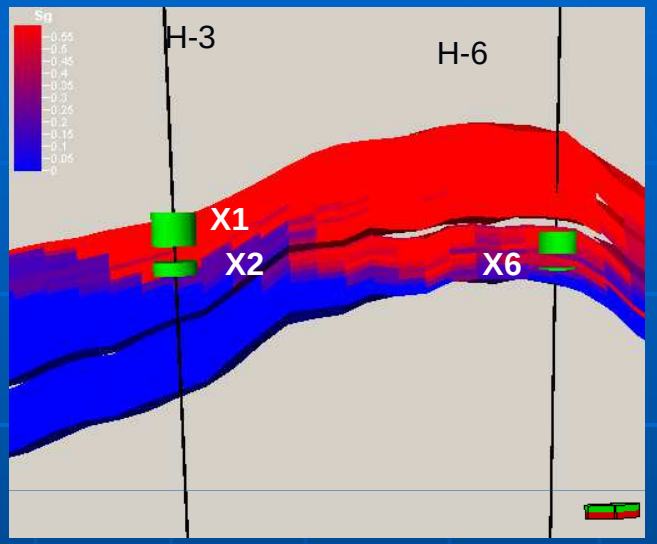


Production history of X1-6

2008:

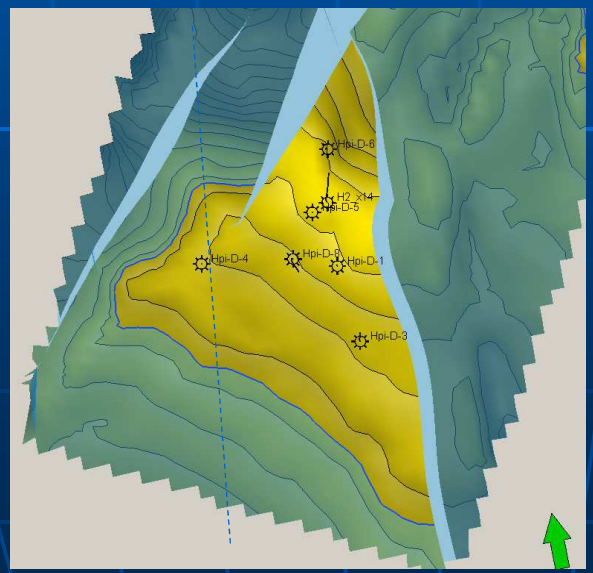
- H-3: increasing water production from X2
- H-6: increasing water production from X6

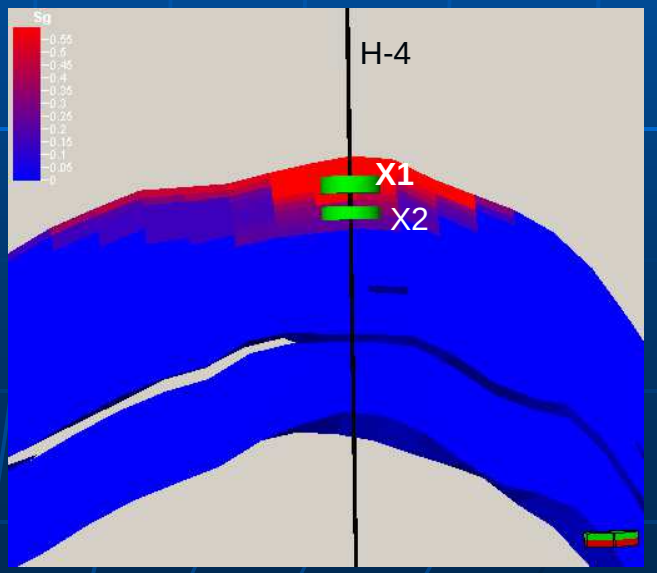




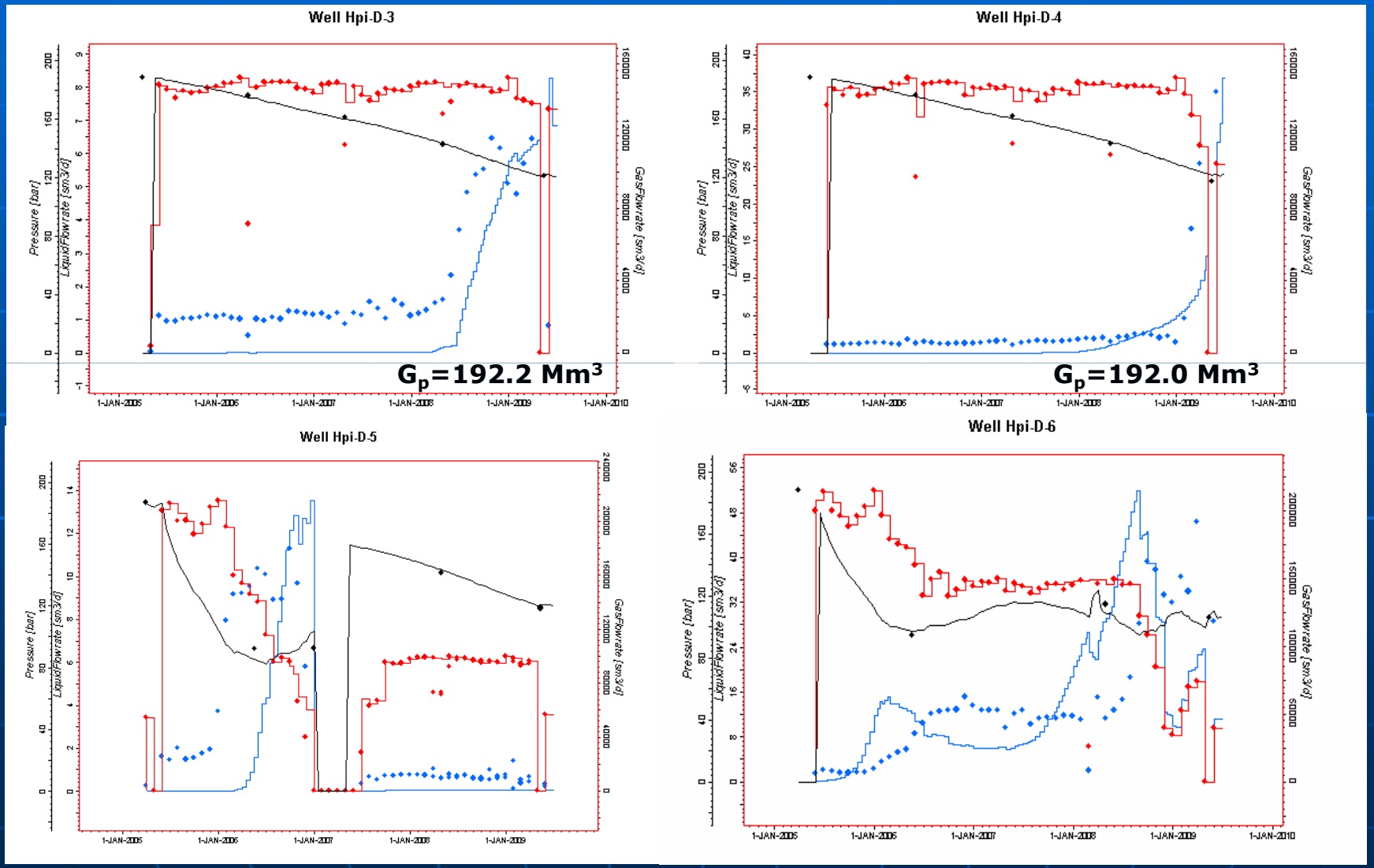
2009:

- H-4: increasing water production from X2





History matching of X1-6



History matching of X1-6

	Model:	O.G.I.P. (Mm^3)	Gp (Mm^3)
2004:	unknown aquifer size	2659	0
2006:	some water influx	2622	262
2009:	considerable water influx	1709	857

X1-6 uniform reservoir $\rightarrow$ X1-4 & X5-6 semi-separated

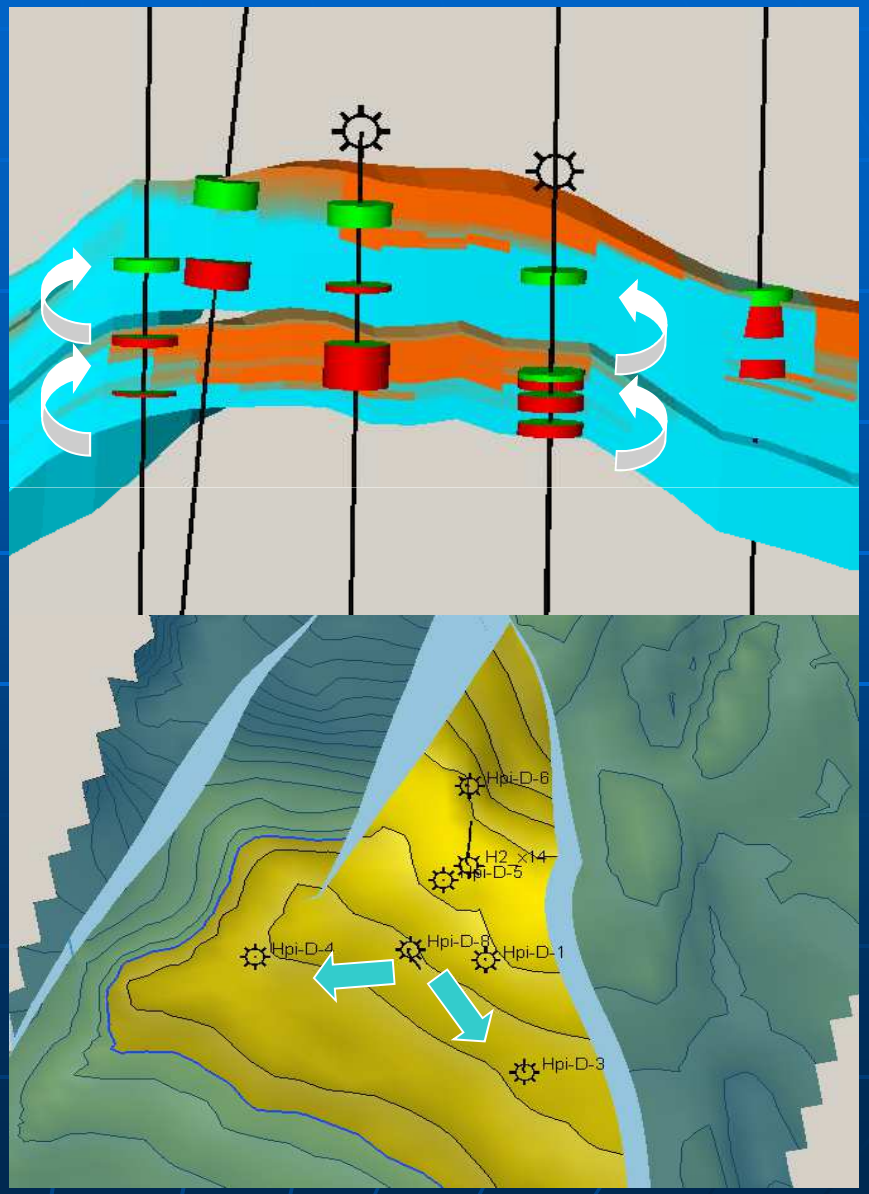
Future activities

X1-6 is the main reservoir, with largest OGIP

- Compelition order: layer by layer
- Radioactive log before perforation in all cases to make sure about S_g
- Reduced production rate in order to delay water influx

Optional activities:

- New well
- Water disposal by edge wells
- Another compressor to decrease further the gathering pressure



Production history of V2/1 reservoirs

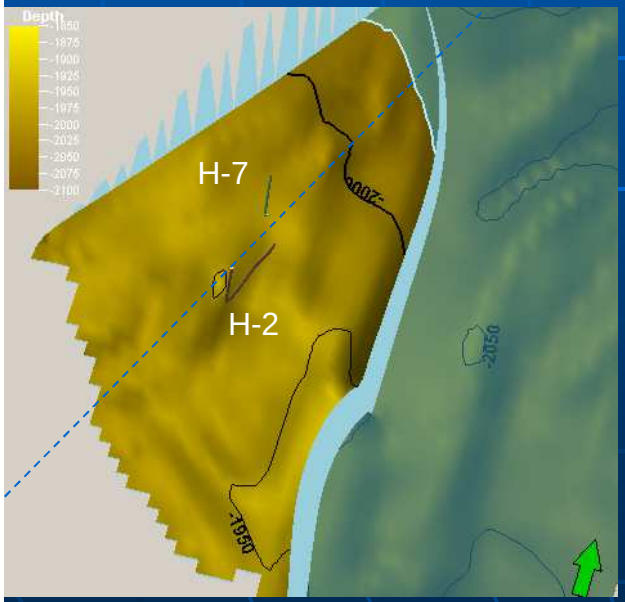
2006: • H-7: increasing water production in V2/1

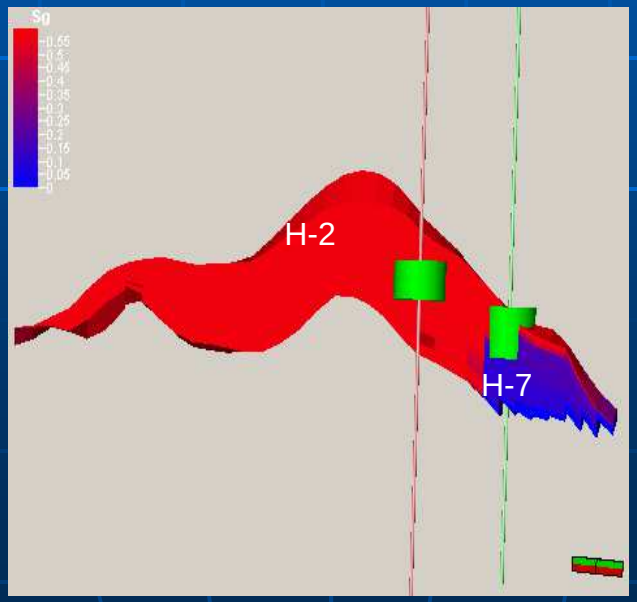
2007: • H-7 end of production

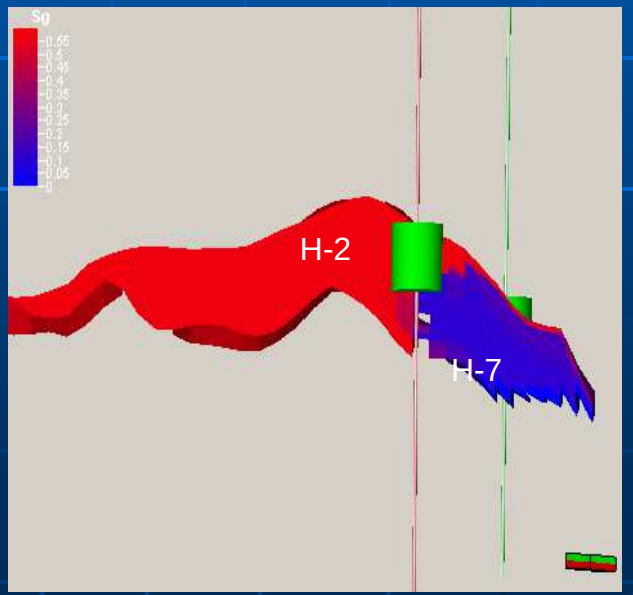
2008: • H-2: increasing water production

• Sqeezing water interval, re-perf top zone.

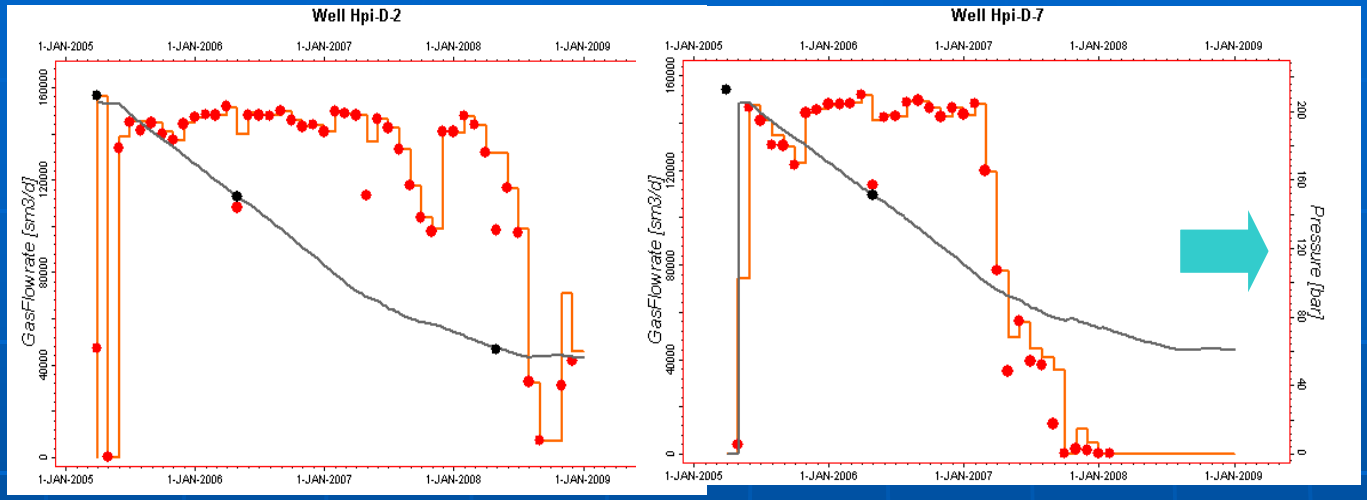
2009: • H-2: increasing water production from top zone







History matching of V2/1

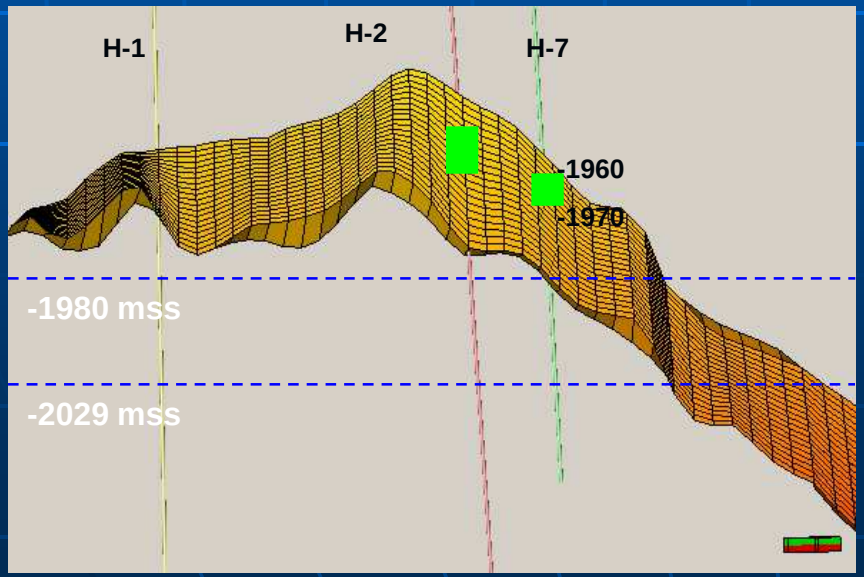


OGIP = 346 Mm^3

(2004: 728)

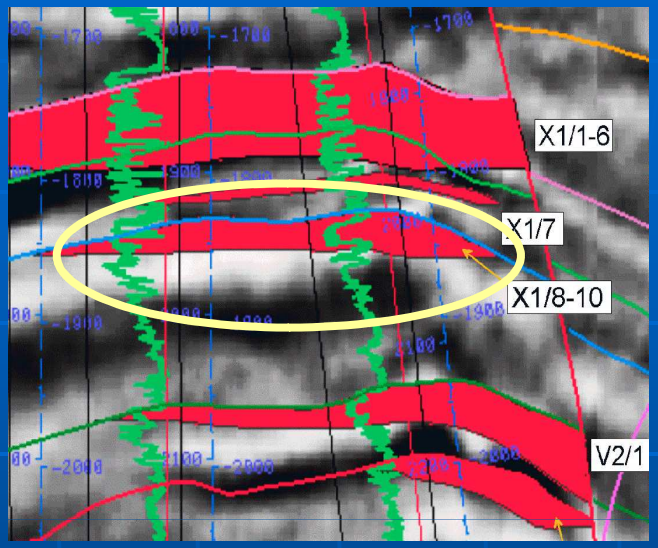
GWC = -1980mss

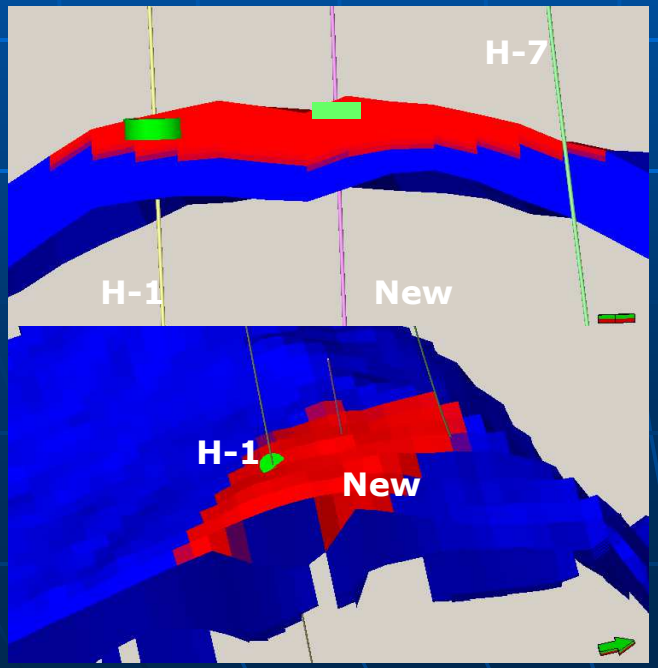
(2004: -2029)



- GWC_{2004}: calc.from H-1, not proven
- if GWC = 2029 → how H-7 water in 2007
- GWC must be ~ -1970-2029
- from simulation → the best matching at 1980 mss

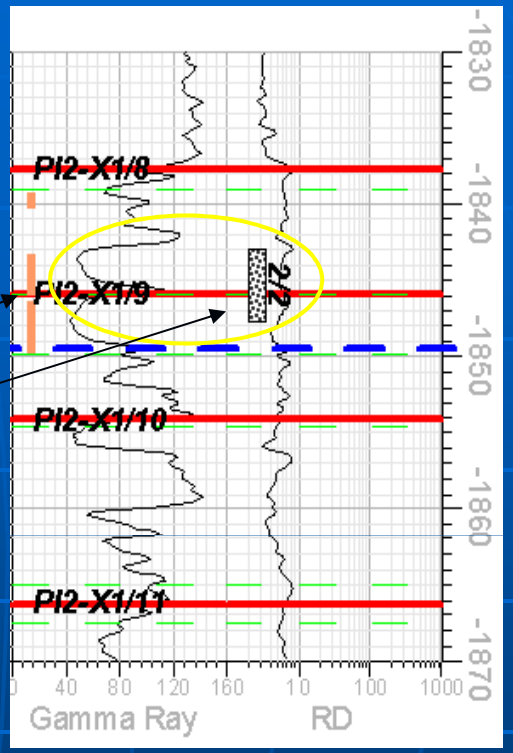
X/8-10 reservoir



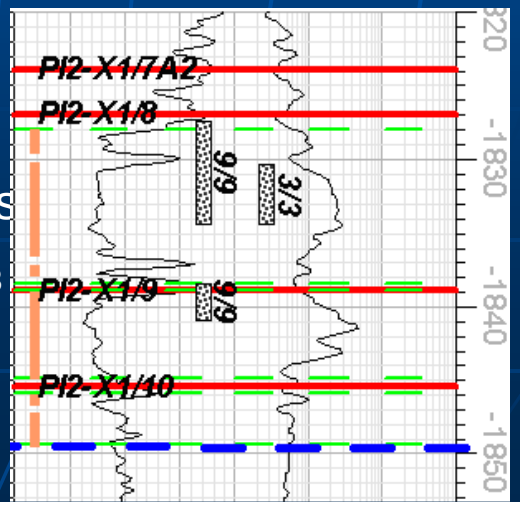


- $OGIP_{2004}$: **325** Mm^3
- GWC_{2004}: 1849 mss
- Plan was: prod with H-7
- Radioactive log: +mark
- well test 1843 – 47 mss:

  $w=22m^3$, $g=15\ km^3$
- modified GWC: 1844 mss
- new OGIP: **312** Mm^3

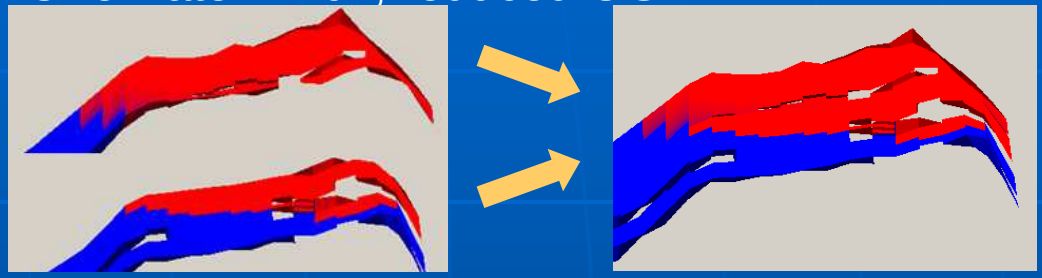


- Rad.log: +mark
- Completion H-1: 1830-39 mss
- Result: g=104 000m^3 w=2m^3
- Proposal for new well

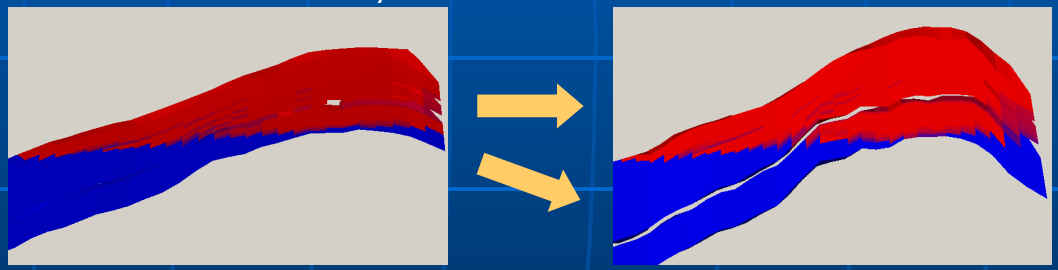


Conclusions

V1-2 : Not separate reservoir, but semi-separate layers
V3-4 : intensive water influx, reduced OGIP



X/1-6: X/1-4 & X/5-6 semi-separate layers
intensive water influx, reduced OGIP



X/8-10: modified GWC, reduced OGIP

V2/1 : modified GWC, reduced OGIP

Conclusions

• In spite of the detailed seismic attribute analysis, well-log measurements and interpretation there is a great uncertainty in the geological model. The main cause of this uncertainty is the extent and connectivity of the braided and meandering fluvial sandbodies.

• The driving mechanism and the hidrodymanic connection between the sandbodies is much more complex than it was originally assumed. This river envirovnment has a great inpact on fluid flow. Therefore, in case of similar reservoir we have to build as detailed geology model as possible including accurate reservoir boundary.

• The wells drilled so far penetrated the sandbodies of the central part but we have no wells at the flanks. Because of these facts there is still uncertainty in the delimitation and gas initial in place of the reservoirs until now.

• Furthermore there is no logical answer why certain gas saturated intervalls confirmed by radioactive logs produce water after workover jobs.

THANK YOU FOR YOUR ATTENTION