

Novel Well Architectures and Completions Improve Well Injective Performance in Poorly Consolidated Sediments. Application to Paris Basin Upper Cretaceous Clastics

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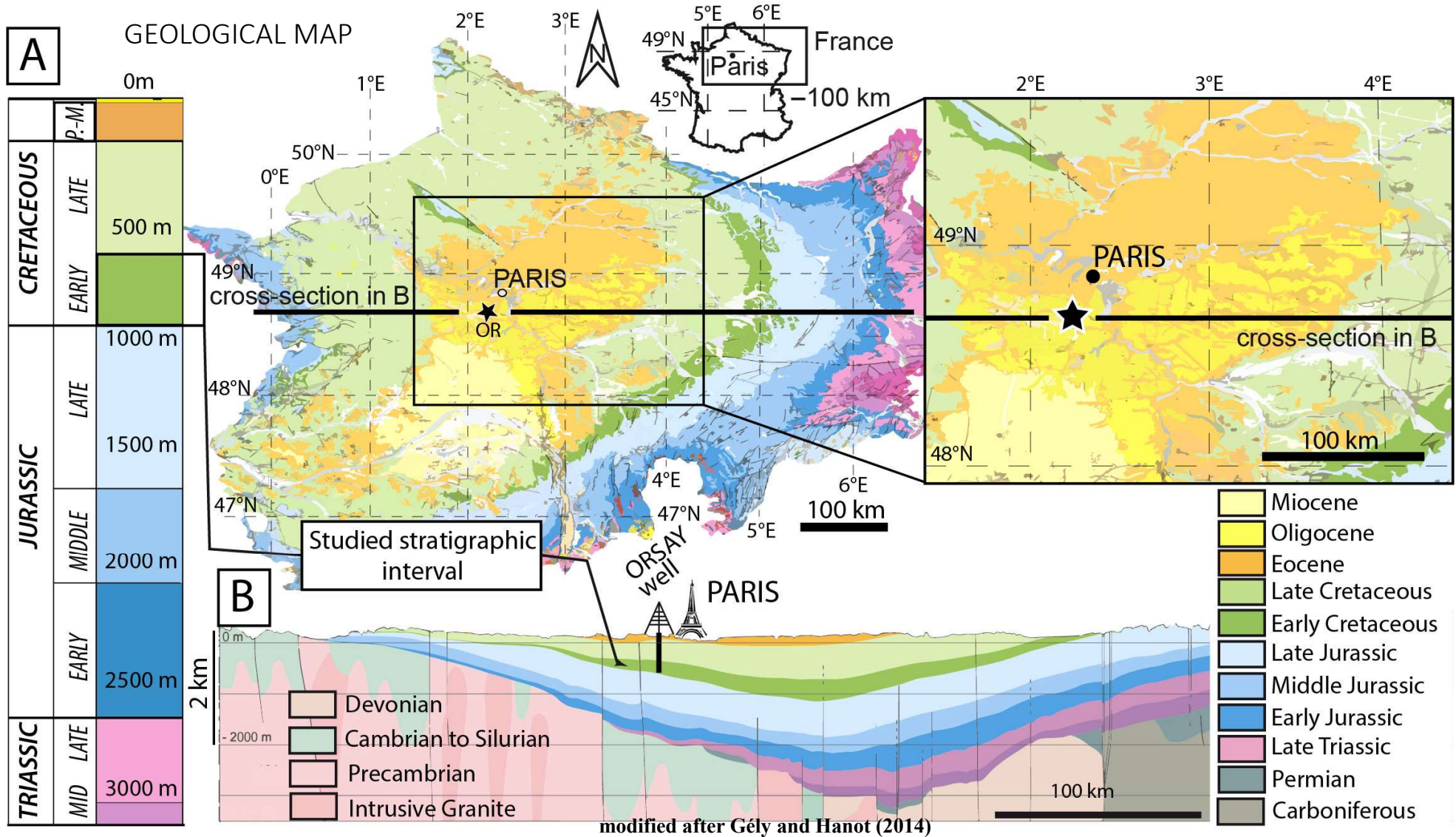


OUTLINE

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- INDUCED WATER INJECTION DAMAGE
 - LABORATORY EXPERIMENTS
- NOVEL WELL DESIGN
- OPTIMUM GEOTHERMAL LOOP DESIGN
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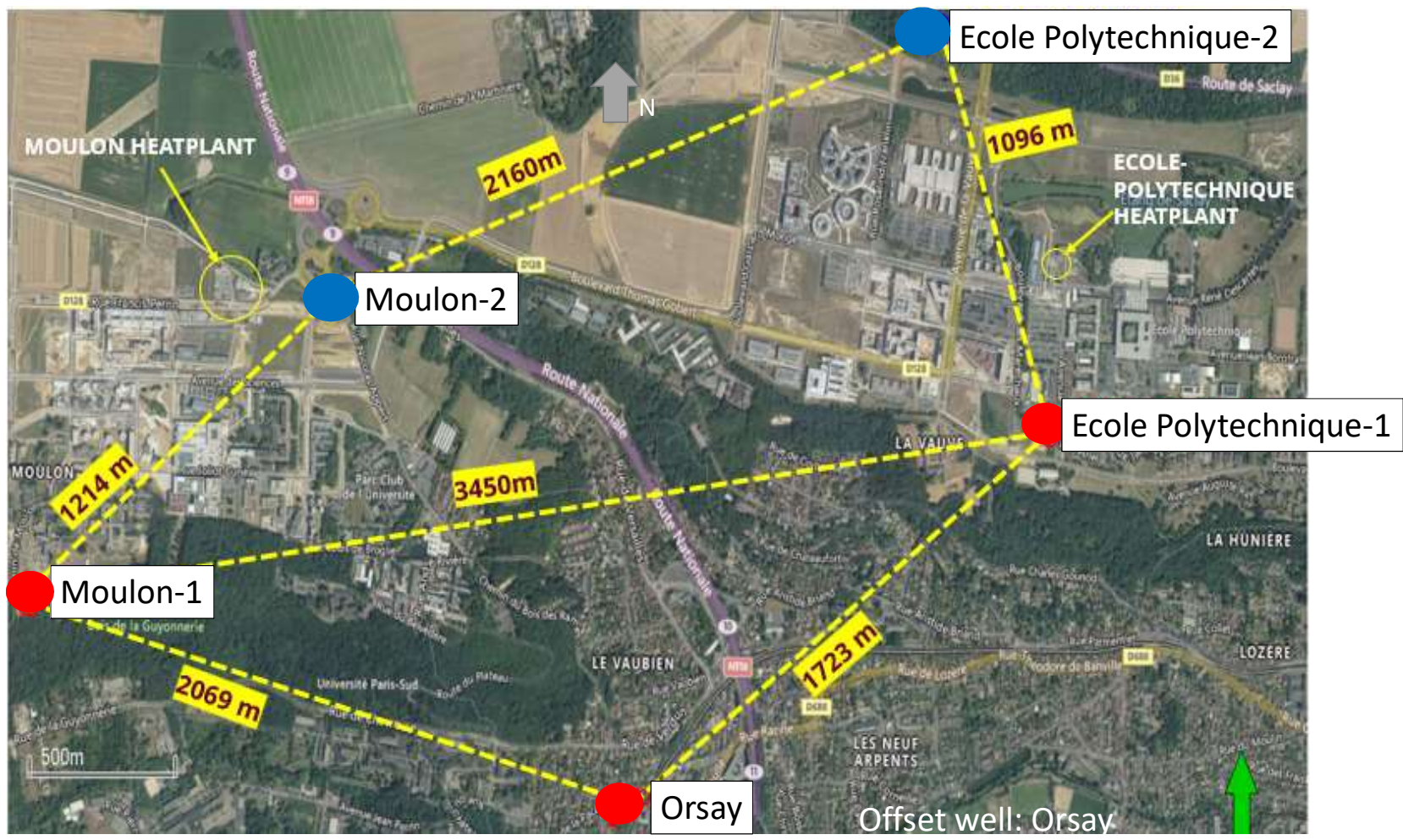


GEOLOGICAL CONTEXT

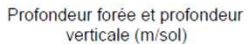


PARIS SACLAY GEOTHERMAL WELL LOCATIONS:

Saclay heatplant and wells location



WELFF DESIGN



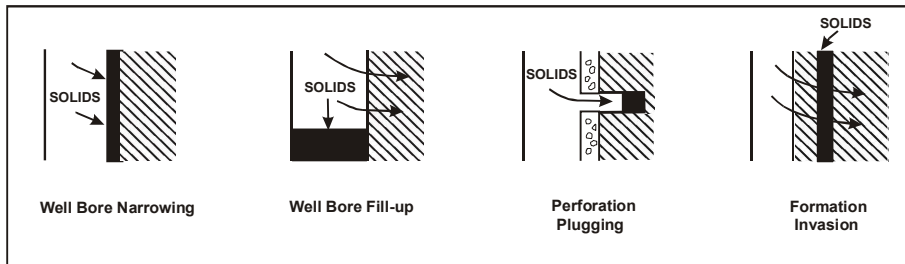
Coupe litho-stratigraphique					
	m/sol	mNGF	Age	Formation	
TERTIAIRE	0	+151	Quaternaire	Limons	
	5	+146	Stampien	Sables de Fontainebleau Argiles à Meulière	
	82	+69	Bartonien	Alternances de Marnes et Calcaires	
	129,5	+21,5	Lutétien	Calcaire	
	164	-13	Yprésien	Argile plastique	
	178	-27	Sénonien	Craie blanche à silex Bio-clastique	
CRETACE SUPERIEUR	449	-298	Turonien	Craie argileuse blanche	
	562	-411	Cénomannien	Calcaire silteux marneux	
	615,5	-464,5	Albien Supérieur	Argile calcaire	
CRETACE INFERIEUR	656,5	-505,5	Albien Inférieur	Sable fin - Moyen à grossier	
	721,5	-570,5	Aptien	Argile silteuse grise	

Légende :
 TG= Tube Guide
 T = Tubage
 F = Forage
 EL = Elargissage
 LH = Liner Hanger
 GP = Gravel pack
 CREP. = Crépines
 ID = Diamètre intérieur
 OD = Diamètre extérieur



INDUCED WATER INJECTION DAMAGE

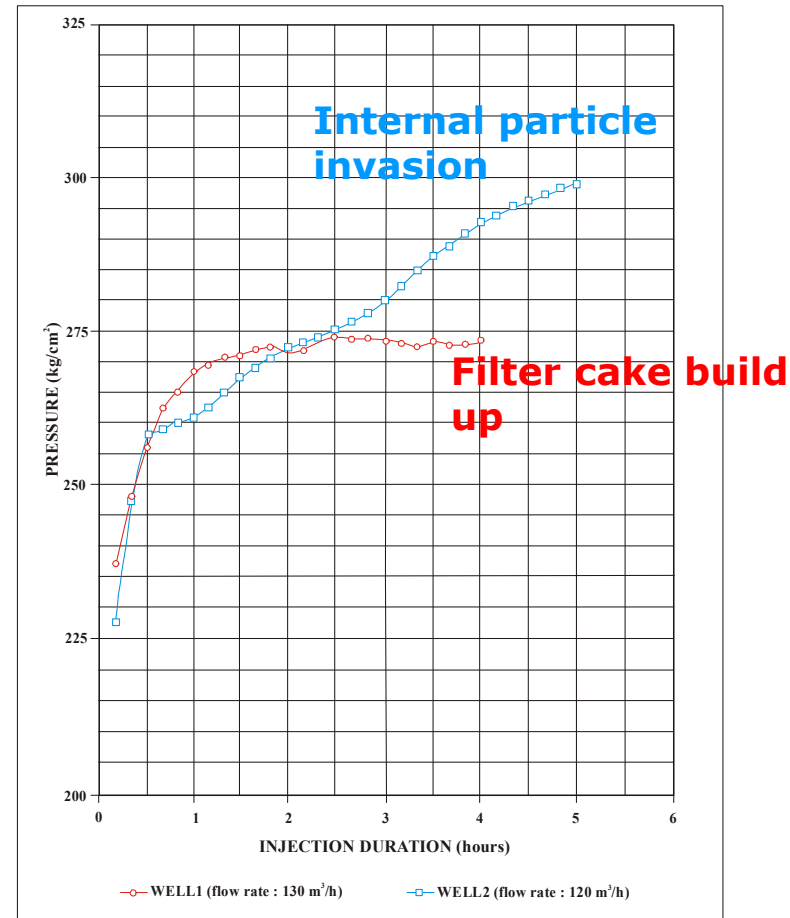
PARTICLE INDUCED DAMAGE MECHANISMS



Source : Barkman Davidson in Ungemach 2003

A PRECURSORY TEST TRIAS ACHÈRES 1983 EVIDENCE OF (EXT./INT.) CLOGGING CAKES

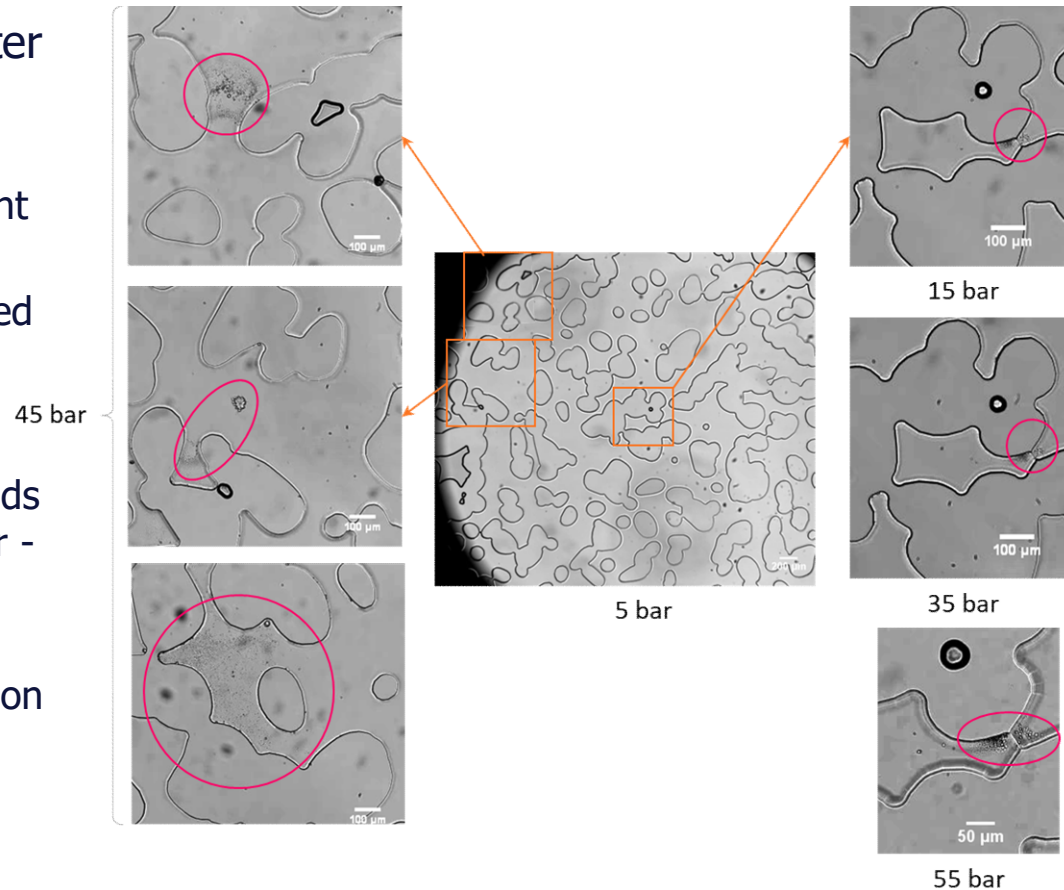
PARTICLE INDUCED DAMAGE EVIDENCE



FILTRATION AND MICROFLUIDIC CHIPS

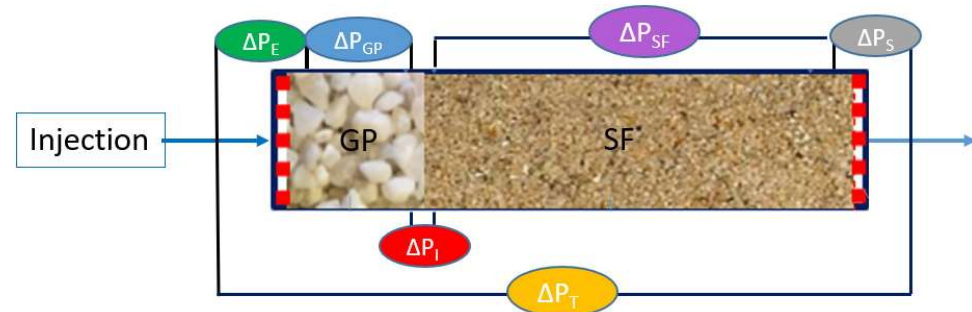
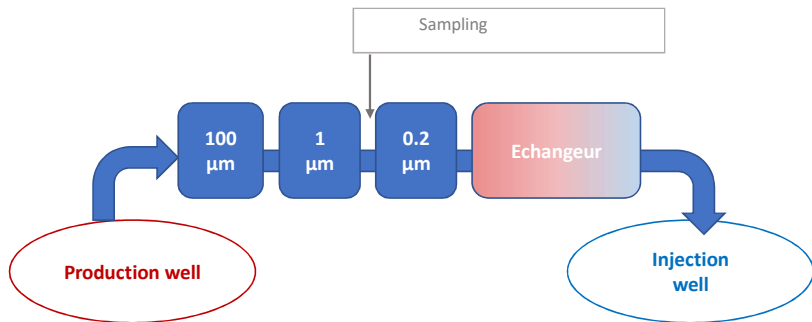
LABORATORY EXPERIMENTS

- Fluid before the heat exchanger after 0.2 μm filtration:
 - Observation of aggregate formation corresponding to pressure-dependent flocculation of nanoclay particles
 - No impact of temperature is observed on colloidal stability.
- Fluid after heat exchanger:
 - Filtration at 1 μm of the sampled fluids shows significant fouling of the filter - impact of shear on flocculation.
 - Observation of aggregates on fluids sampled after exchangers in operation possible impact of shear and temperature on flocculation.

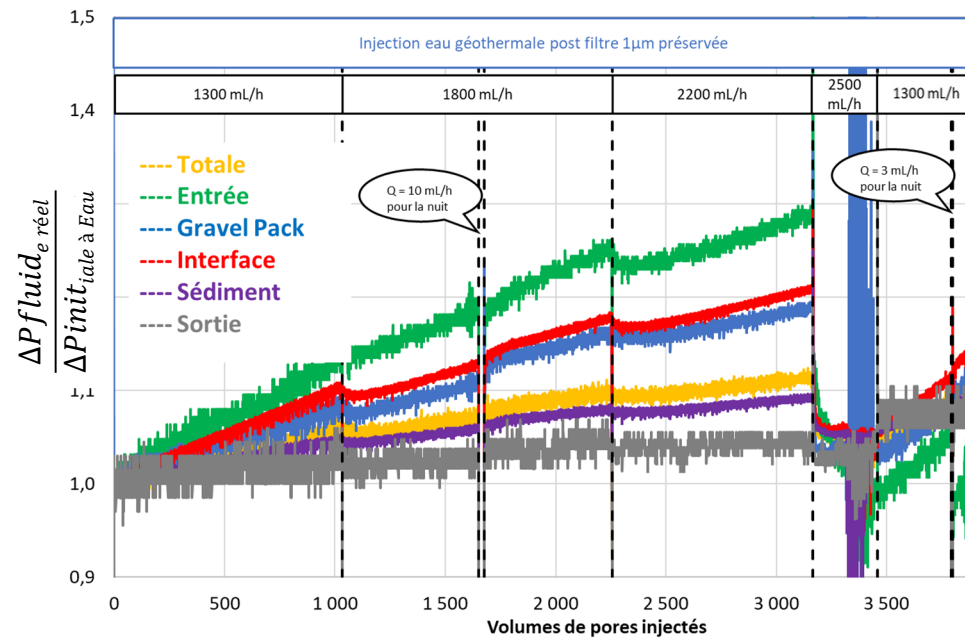


Evolution of GMOU geothermal water at 120 m³/h after 1 μm filtration during pressure rise ($T \approx 7^\circ\text{C}$).

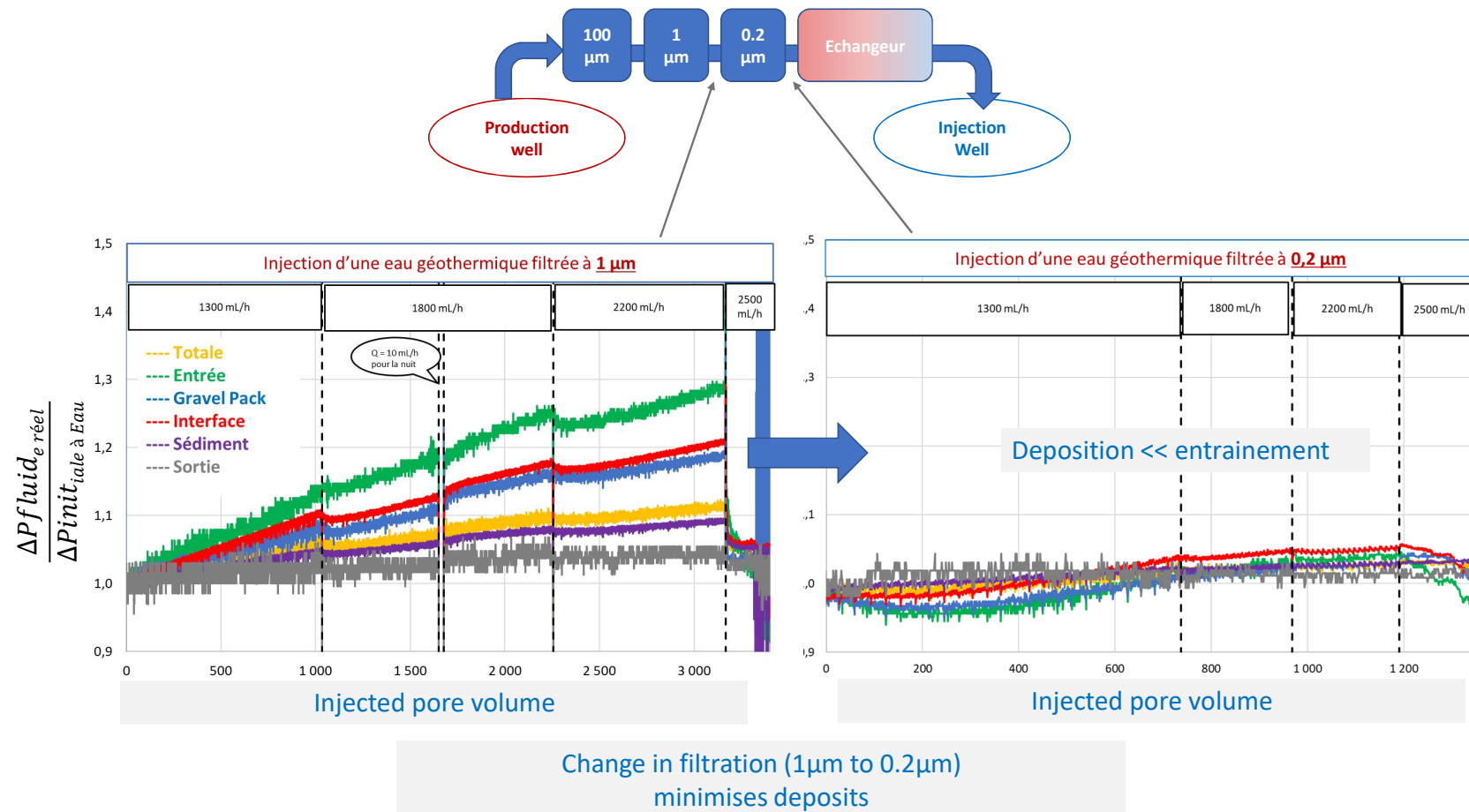
IMPACT OF INJECTION OF THE FILTERED @ 1MICRON RESERVOIR FLUID



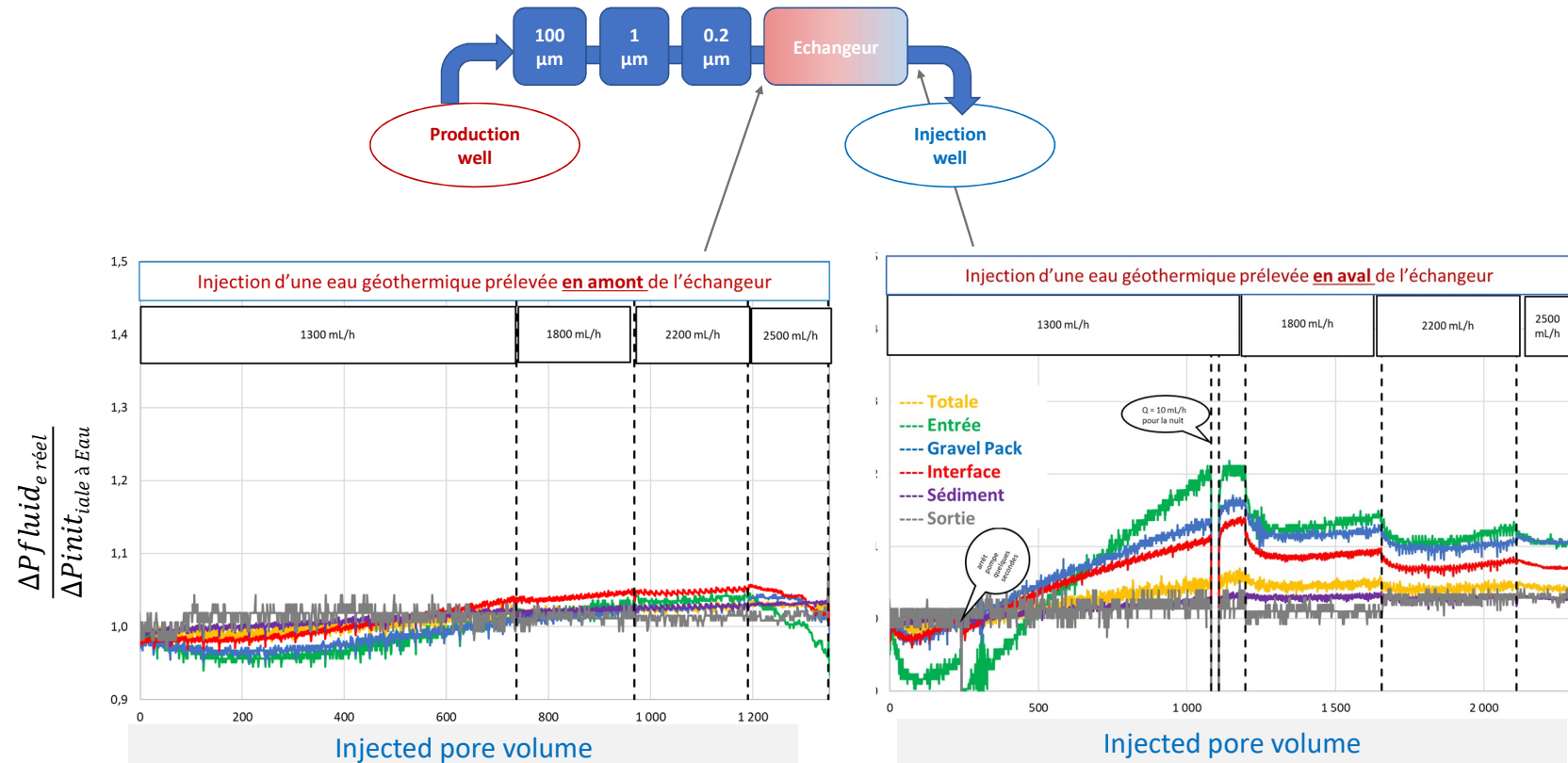
- Rapid appearance of deposits in all sections, especially at the inlet
- Deposition rate decreases with increasing flow rate
- At maximum flow rate ($Q_{max} = 2500$ ml/h):
 - High mobilisation of deposits
 - Entrainment of deposits towards the sediment and the outlet



FAST DEPOSITION IN ALL SECTIONS, ESPECIALLY AT THE INLET COMPARISON OF TWO FILTRATION LEVELS



IMPACT OF THE HEAT EXCHANGER COMPARISON UPSTREAM/DOWNSTREAM HEAT EXCHANGER (NOT OPERATING)

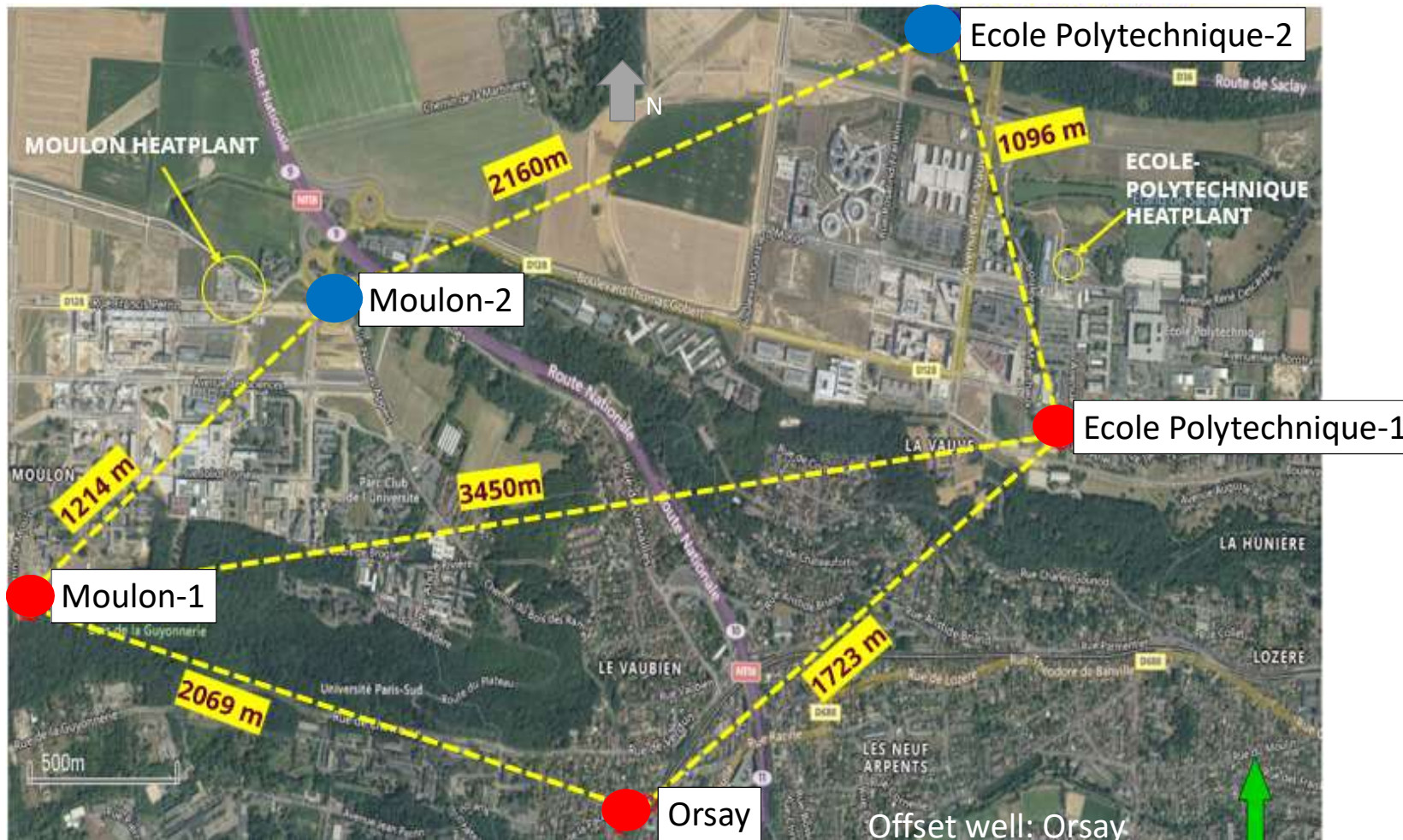


The passage through the exchanger seems to favour flocculation, even when it is not operating
This deposition could also be increased with the operation of the exchanger

STRUCTURAL AND FACIES GEOMODELLING :

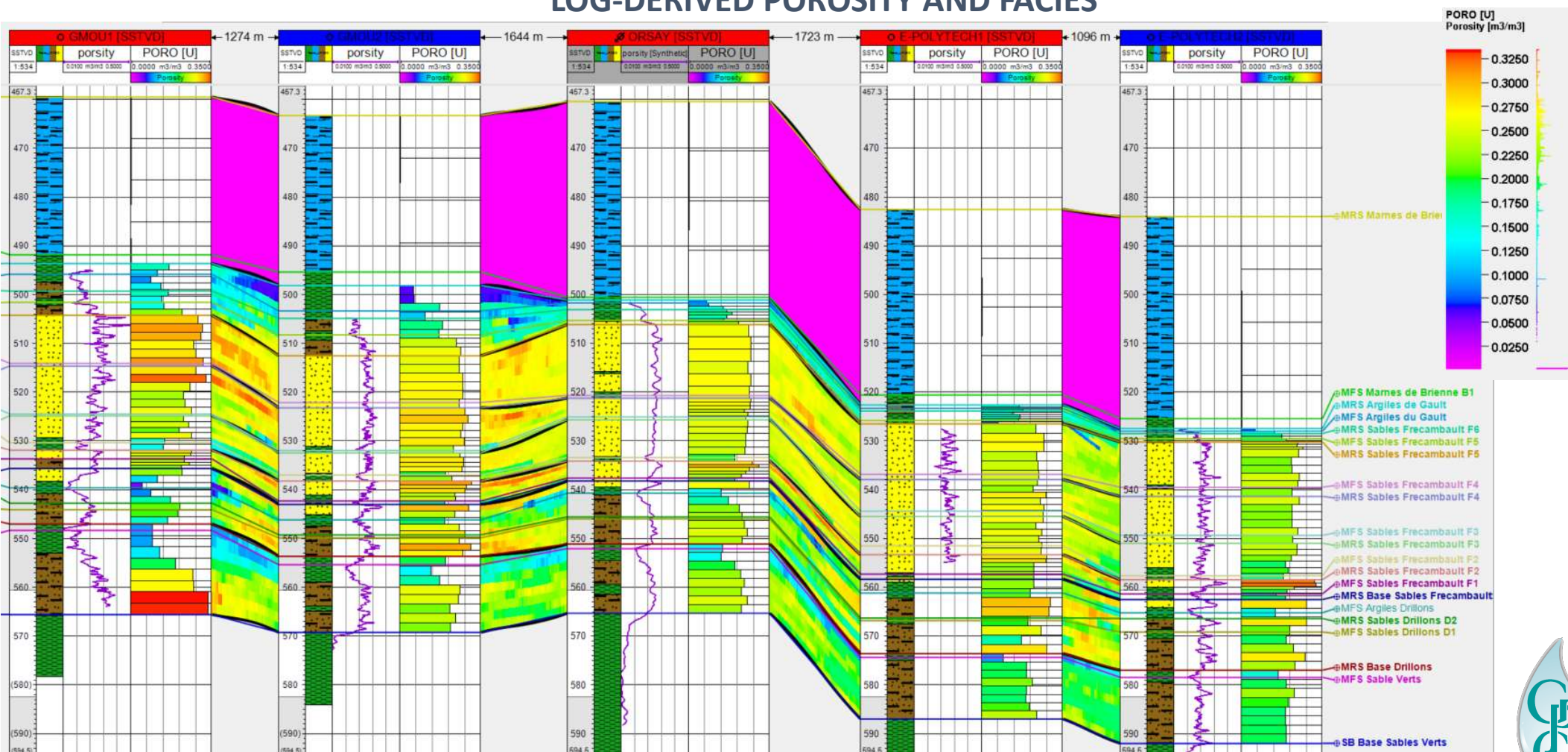
Saclay heatplant and wells location

- Injection wells
- Production wells



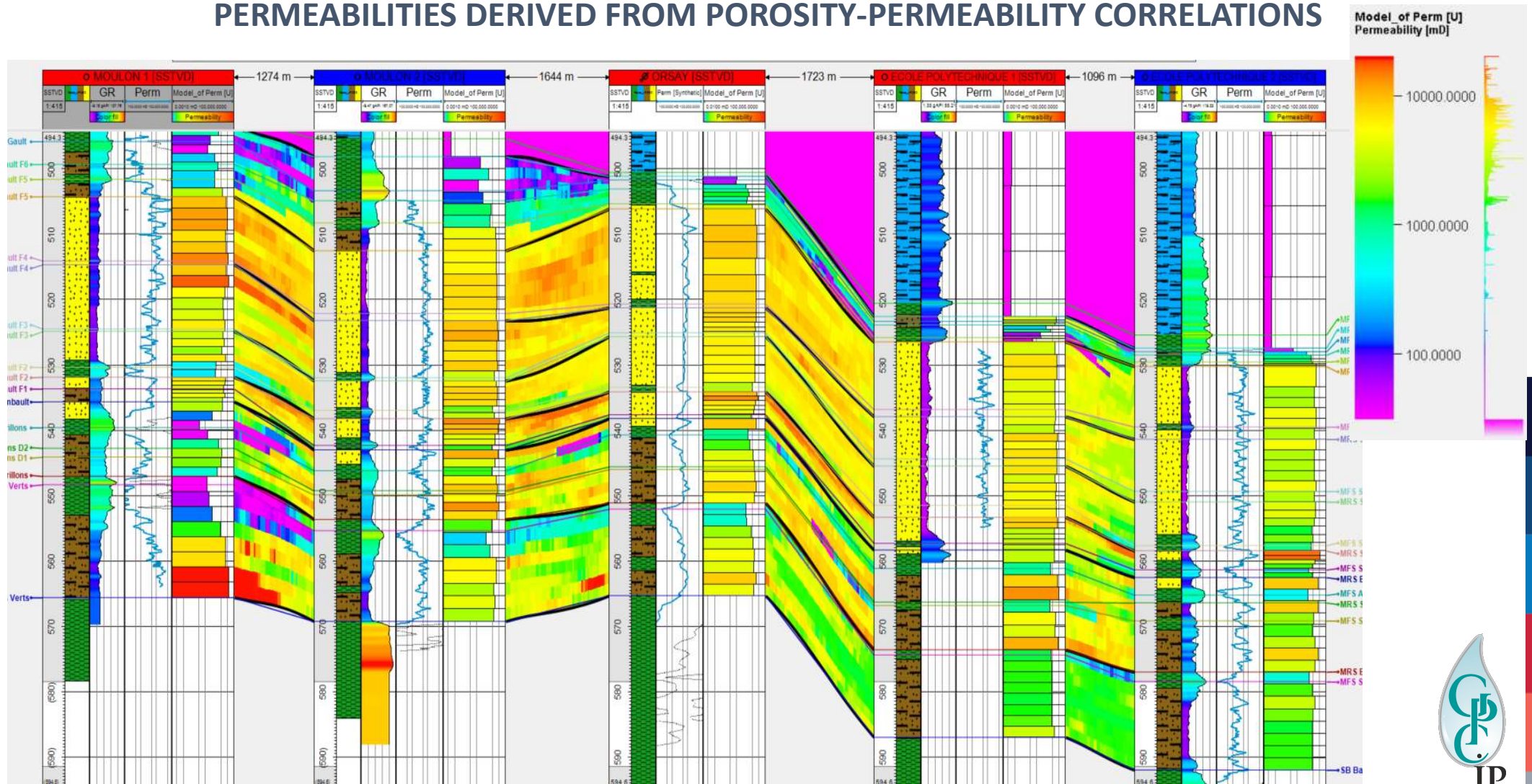
STRUCTURAL AND FACIES GEOMODELLING

LOG-DERIVED POROSITY AND FACIES



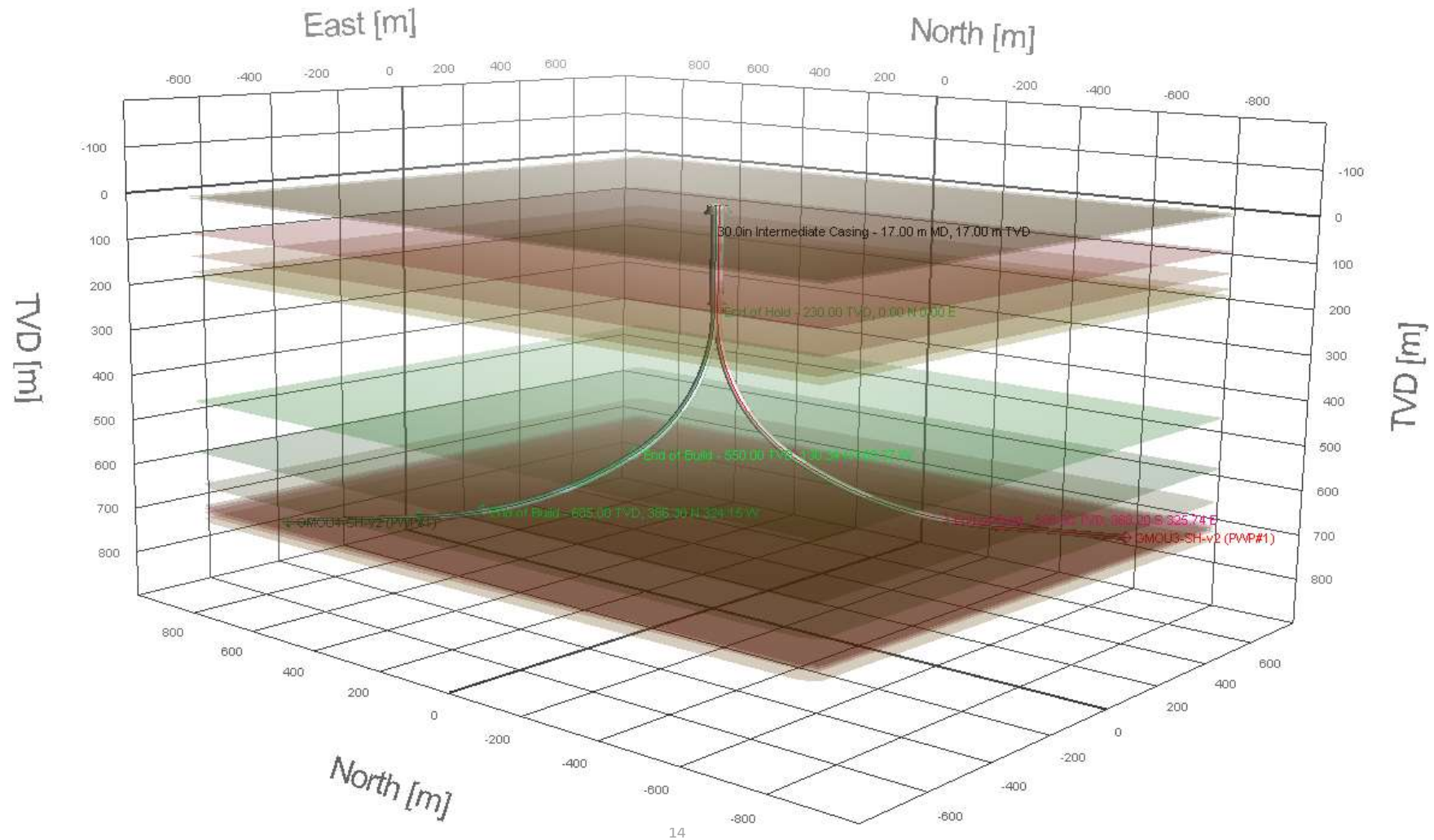
STRUCTURAL AND FACIES GEOMODELLING

PERMEABILITIES DERIVED FROM POROSITY-PERMEABILITY CORRELATIONS



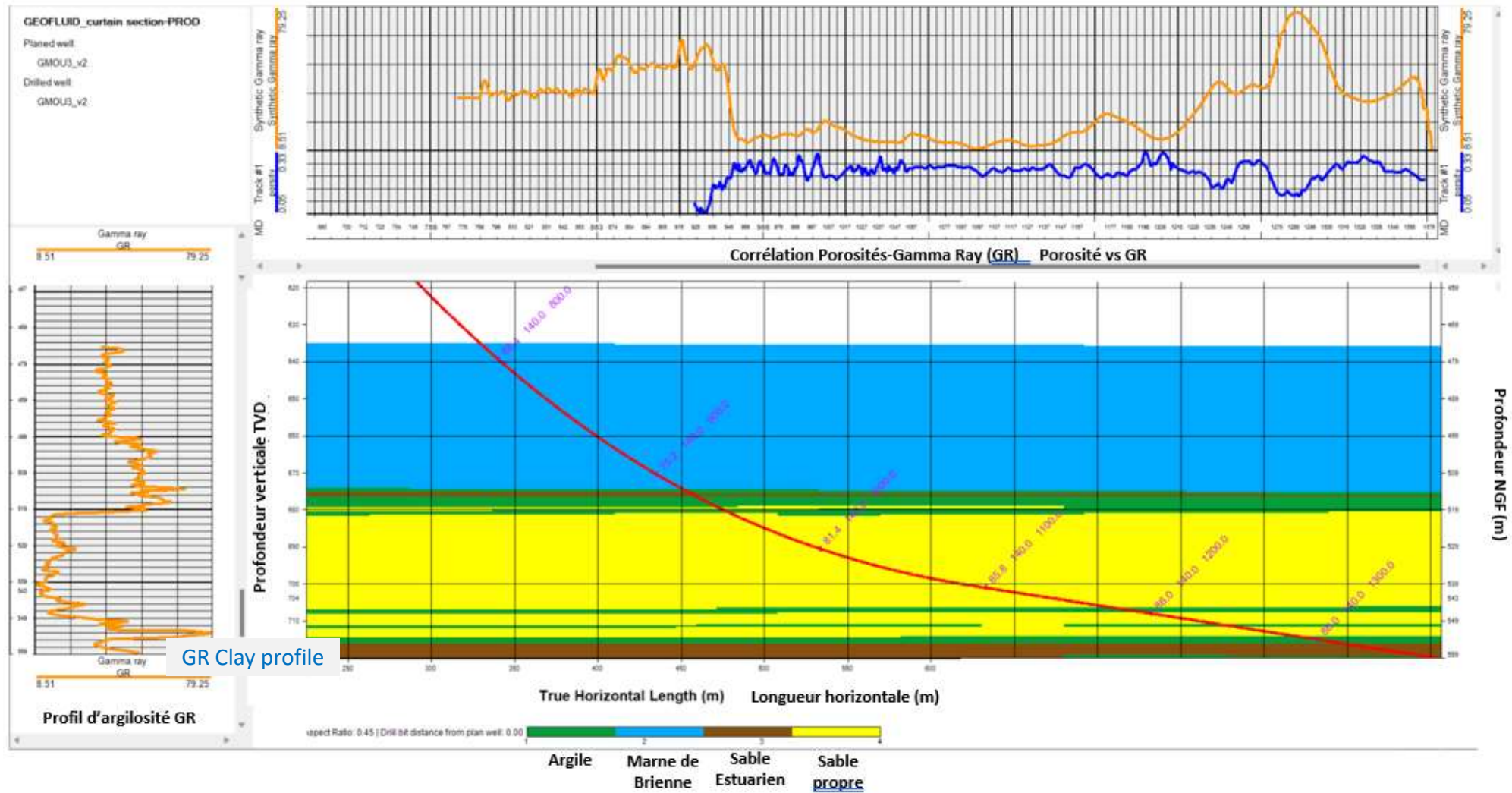
SUBHORIZONTAL (SH) WELL ARCHITECTURE

3D REPRESENTATION OF THE SUBHORIZONTAL DOUBLET



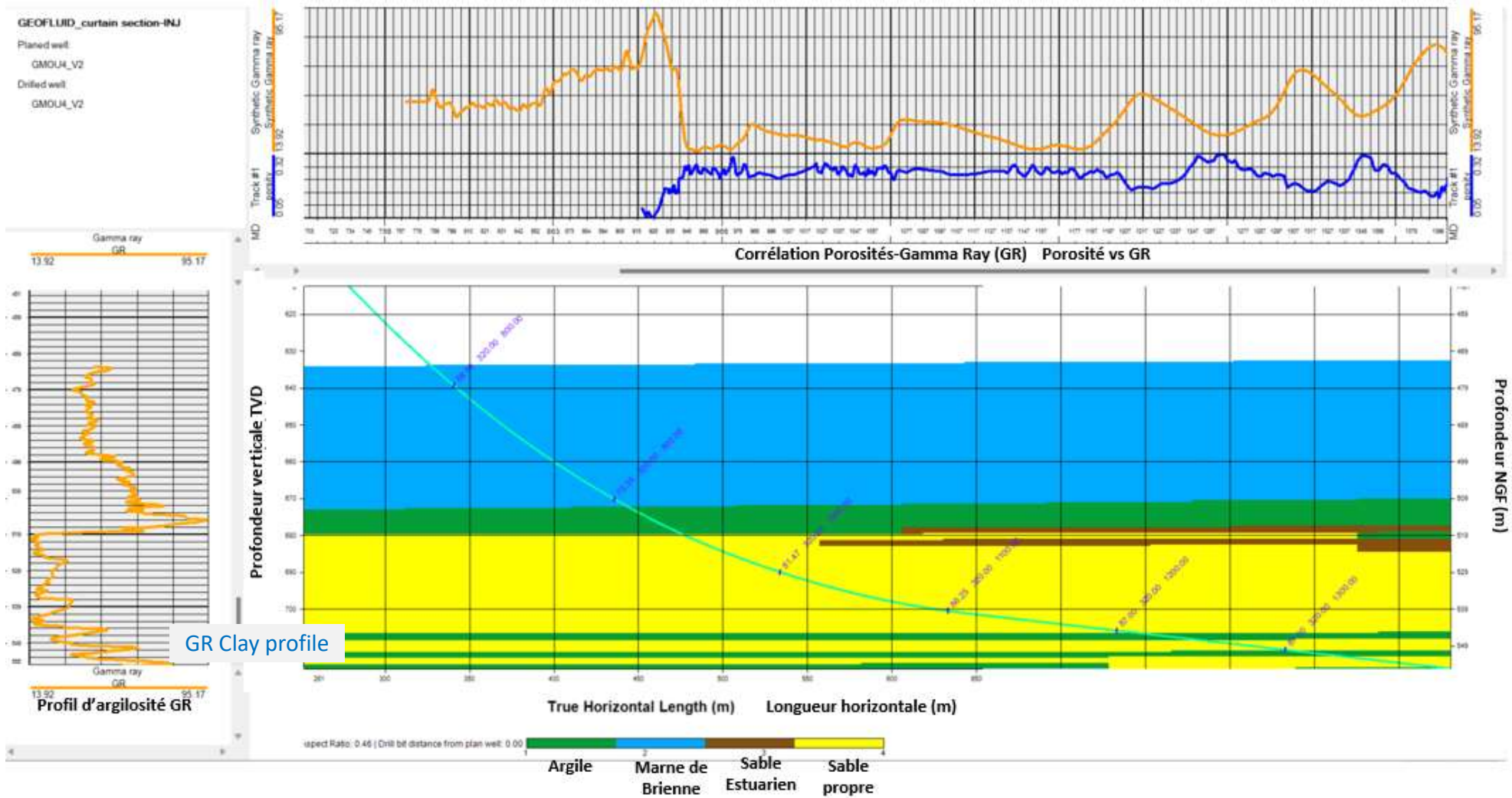
PRODUCTION WELL ARCHITECTURE

SH DRAIN PATH PRODUCER GMOU3-SH



INJECTION WELL ARCHITECTURE

SH DRAIN PATH GMOU4-SH INJECTOR



COMPLETION DESIGN

PREPACKS-INTERFACE COMPLETION TESTING

FILLING MATERIALS AND PERCOLATION TESTS

Albien sands (SA)

IMHOF CONES



Cônes IMHOF

GP Gravel Pack



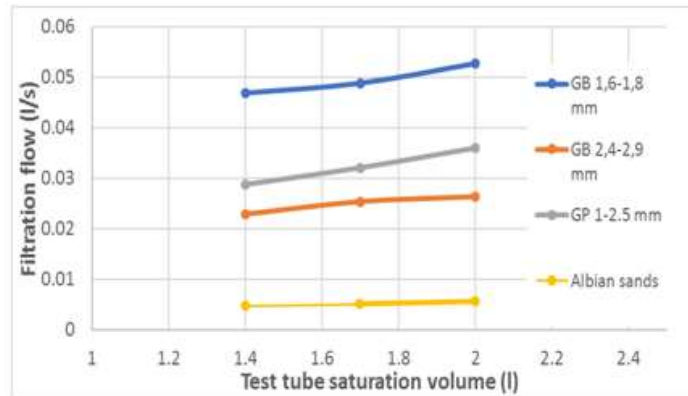
GP Gravel Pack

GB Glass beads



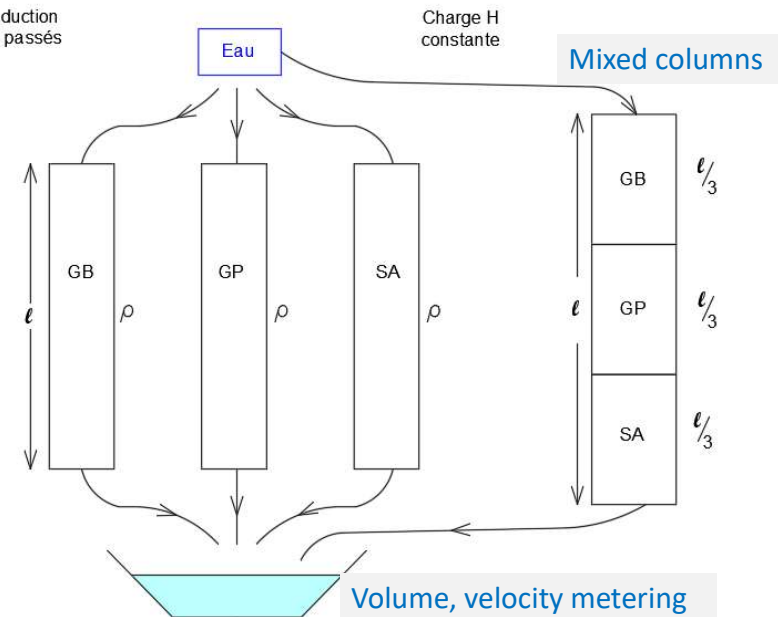
GB Billes de verre

VS.



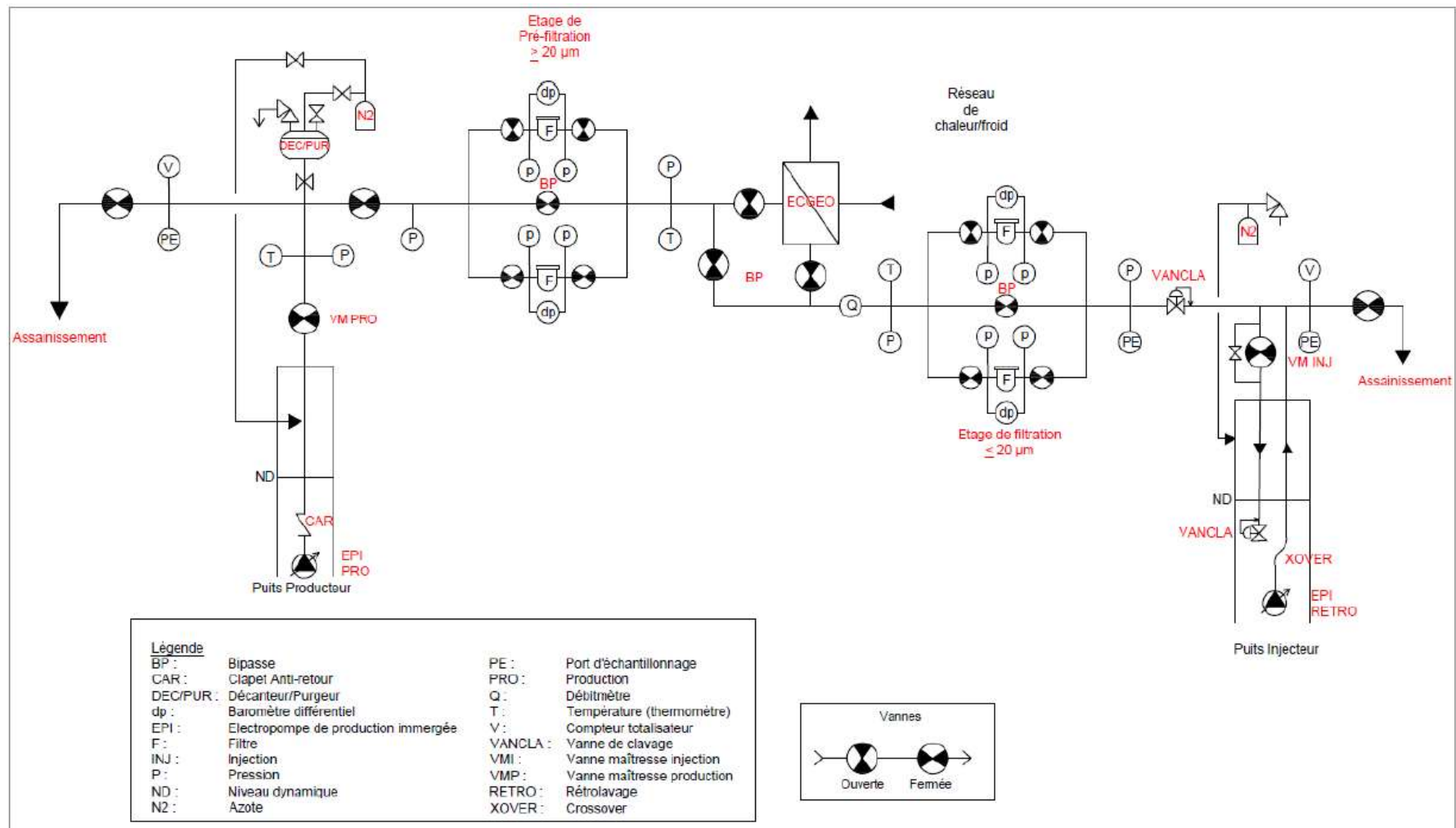
Percolation tests

Reproduction
essais passés



Percolation tests

OPTIMUM GEOTHERMAL LOOP DESIGN



Nitrogen intertisation, filtering, upstream/downstream heat exchanger, downhole pressure control valve, ESP backwash

CONCLUSIONS

- Fine filtration (at 0.2 μ m colloidal rating) is effective as a result of the removal of a large proportion of suspended particles.
- Flocculation of colloidal clays occurring mainly in the heat exchanger (impact of shear forces and temperature) downstream filtration is recommended.
- Nitrogen inerting keeps the system oxygen free.
- Hydrodynamic forces at high flow rates drive the deposits out of the completion into the reservoir trend more effective than backwashing.
- Similarly sub-horizontal well design stabilises the velocity regime at a dramatically low level, spread over a long drain length, thus preventing fines flocculation.
- Completion associating glass beads and gravel pack, dimensioned via prior percolation tests, limits deposits at the gravel-pack completion interface at manageable head losses.



An aerial photograph of an industrial facility, possibly a power plant or refinery, featuring a prominent tall smokestack emitting a plume of smoke. The facility is surrounded by various industrial buildings and storage tanks. In the background, a dense residential neighborhood with multi-story apartment buildings is visible. The entire image is overlaid with a semi-transparent red filter.

**Thank you for your
attention!**