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Project Director

AECOM

DESIGN, OPERATIONAL AND PROCEDURES FOR THE APPLICATION OF IN SITU CHEMICAL OXIDATION TREATMENTS IN FRACTURED BEDROCK AQUIFER IMPACTED BY AN OLD DNAPL

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ROADMAP



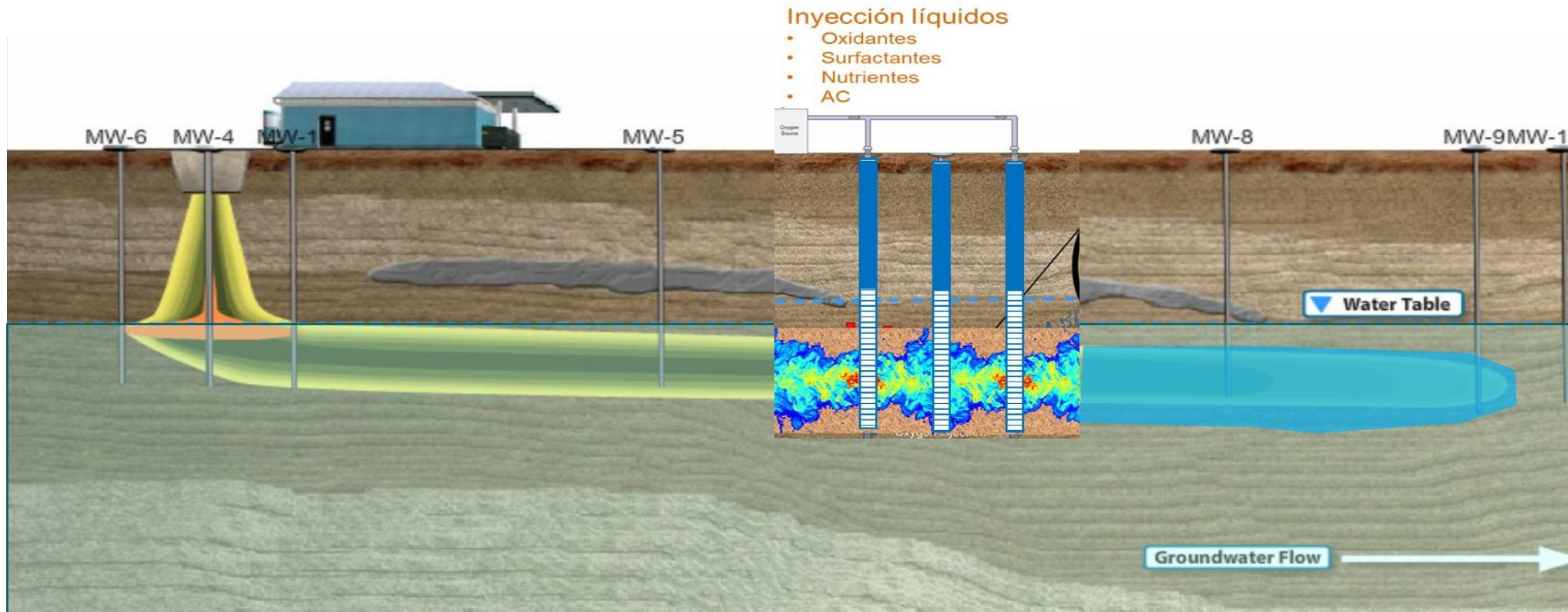
IN SITU CHEMICAL OXIDATION (ISCO) : THE KEY TO SUCCESS

“ISCO is a CONTACT sport ”



Establish contact between a sufficient mass of oxidant and contaminants
for the time necessary for their destruction.

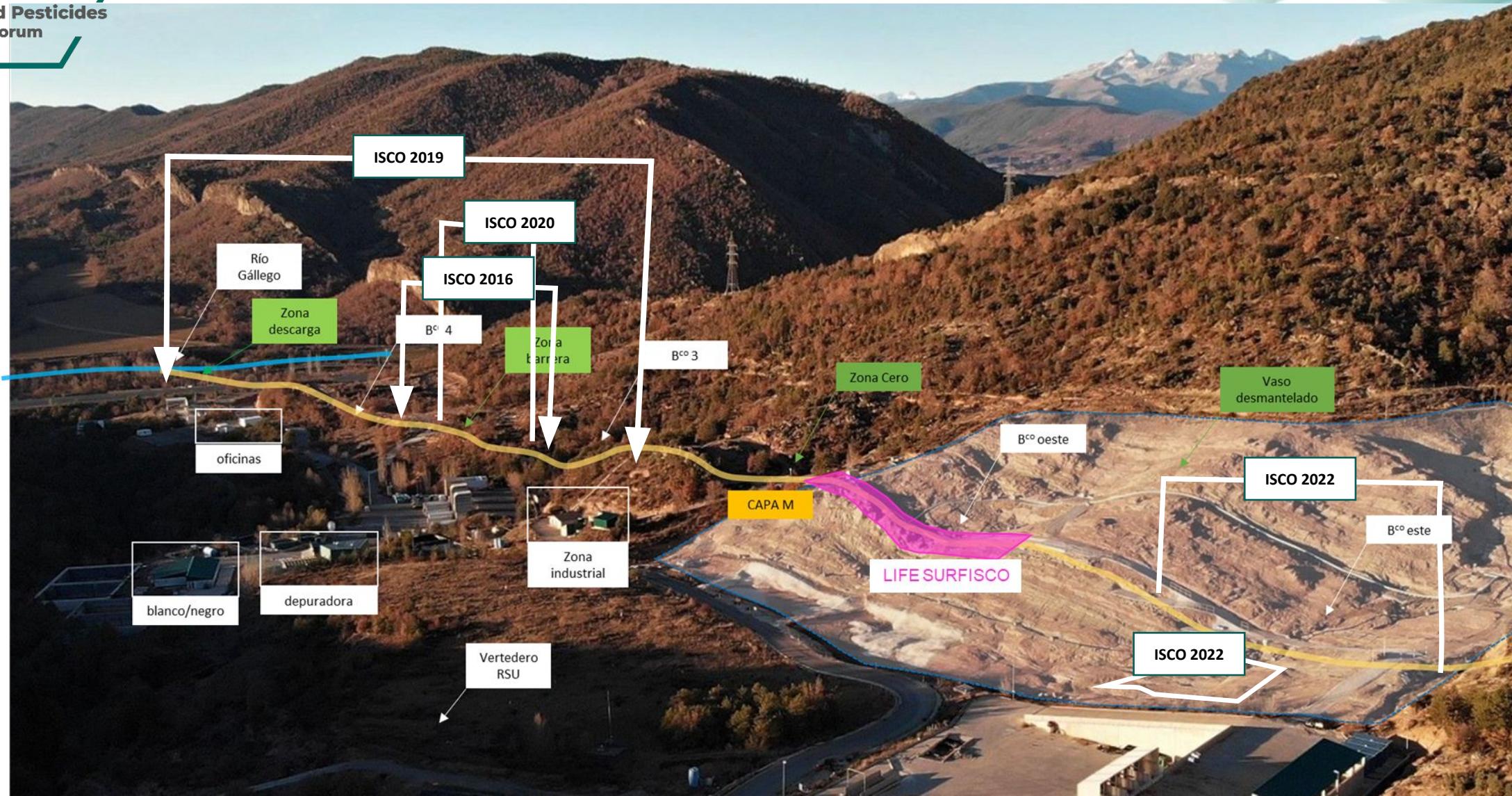
APPLICATION IN GROUNDWATER. THEORETICAL CONTEXT



Fuente: GSI LORAX

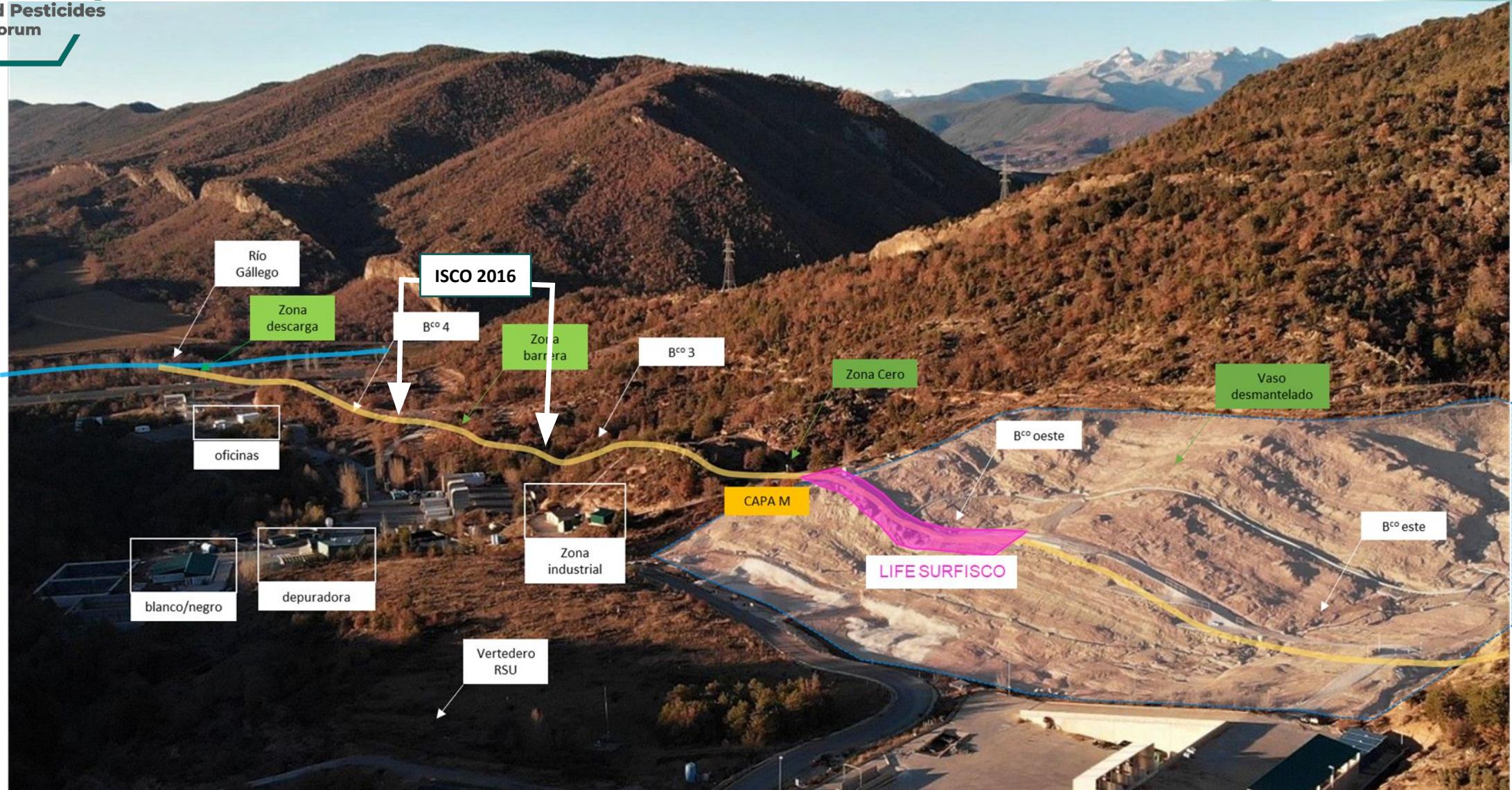
Establish contact between a sufficient mass of oxidant and contaminants for the time necessary for their destruction → Not as easy in “real fractured aquifer”

ISCO TESTS PERFORMED

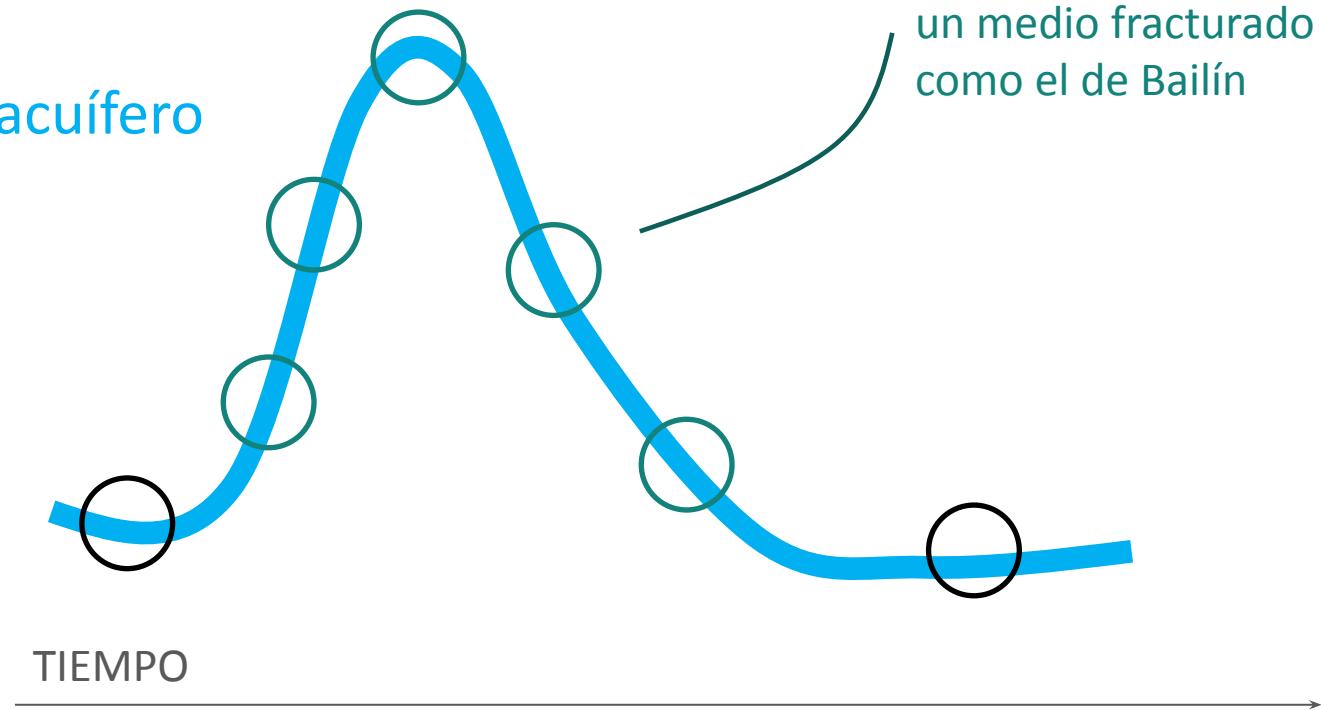


ISCO TESTS PERFORMED

M layer (sandstone)					mudstone
2010	2016	2019	2021	2022	
<ul style="list-style-type: none">• Laboratory Tratability studies• Persulfate (oxidant)• NaOH activator	<ul style="list-style-type: none">• Pilot test• 200 m• Persulfate + NaOH	<ul style="list-style-type: none">• Full-scale• 700 m• PersulfOx (self-activated)	<ul style="list-style-type: none">• Pilot test• 150 m• PersulfOx (self-activated)	<ul style="list-style-type: none">• Pilot test• Source zone• ↓ Kinetic• Provectus (microbial friendly)	
					Middle GW plume
					GW Source zone



Lo que pasa en el acuífero



Imprescindible en
un medio fracturado
como el de Bailín

Lo que ves...
e interpretas

ISCO 2016



ISCO 2016



Instalación de packer



Bombas de aire comprimido



Tanque de mezcla



GRG de mezcla



Tanque de agua de red



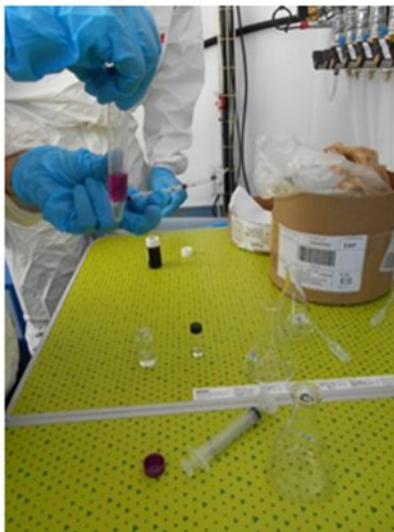
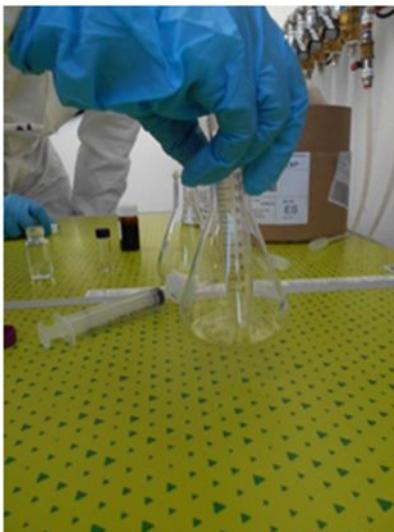
Cuadro de bombas



Detalle de las bombas de inyección

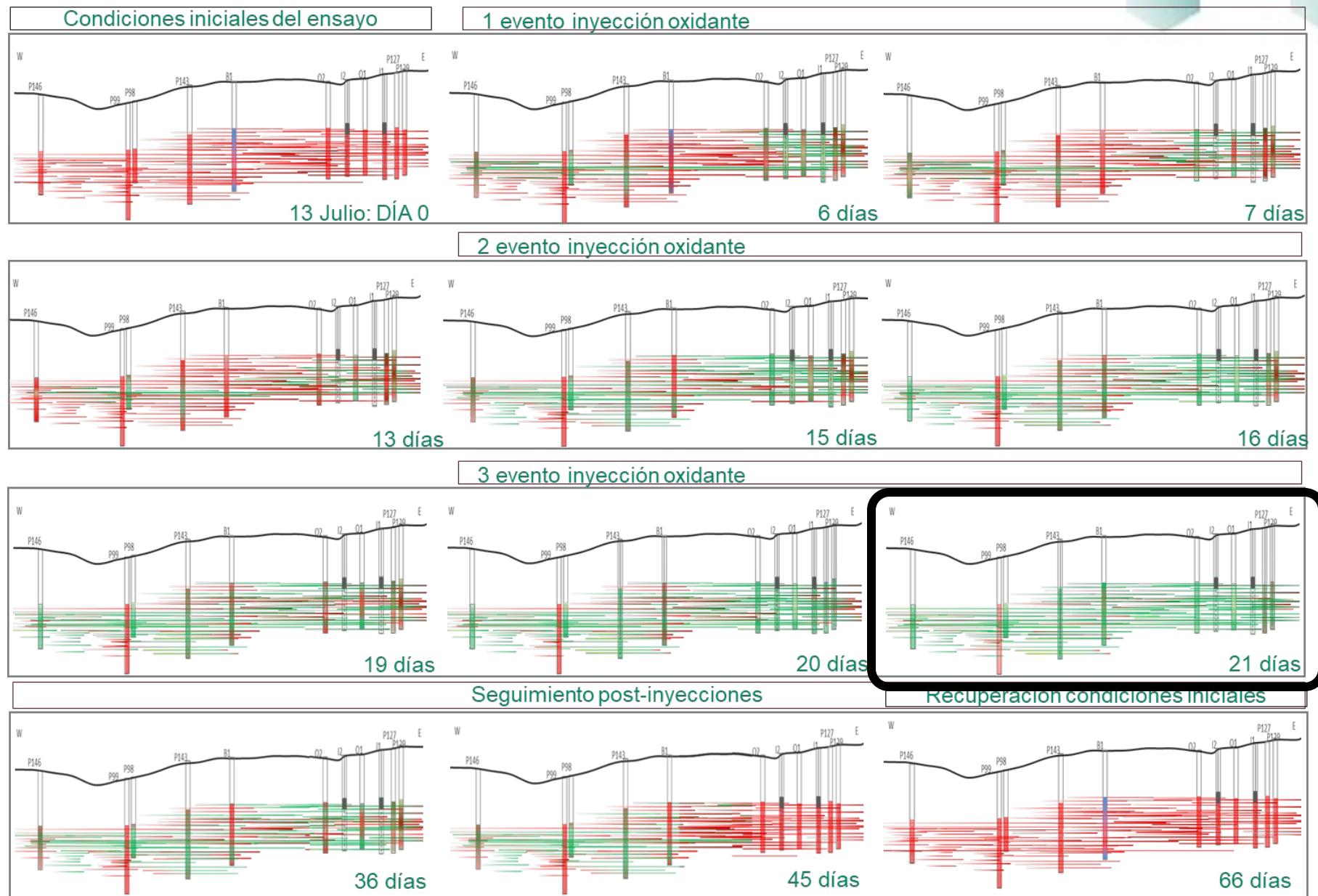


Determinación de la concentración de persulfato en una muestra de agua mediante kit in situ



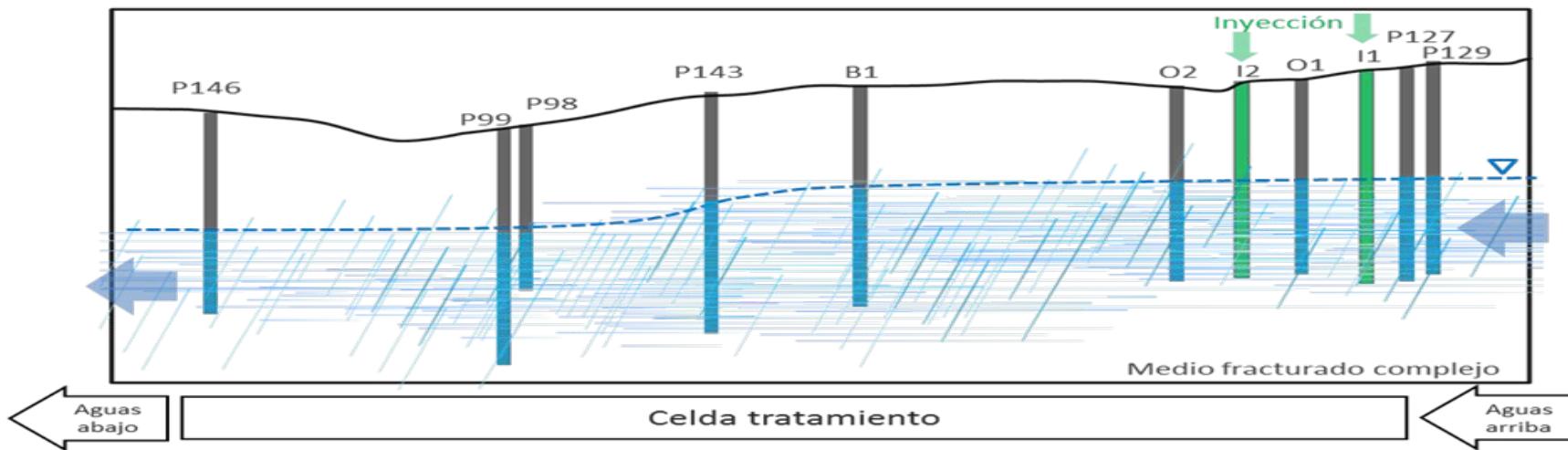
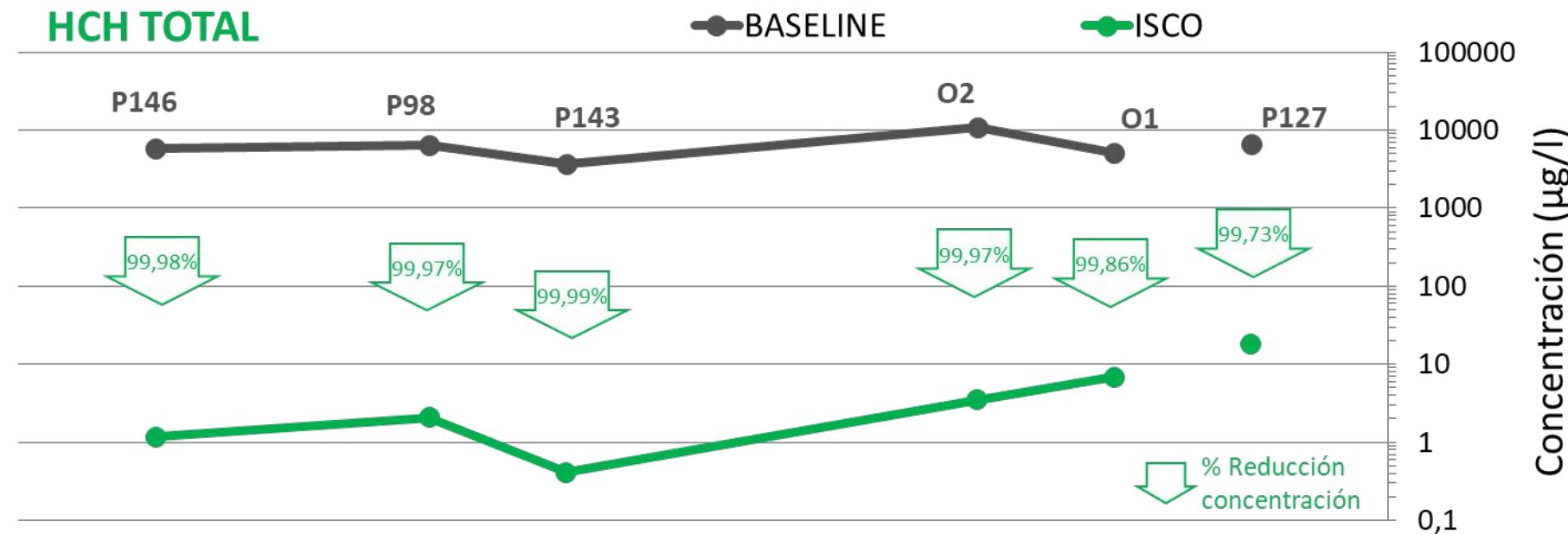
Determinación de la concentración de persulfato en una muestra de agua mediante kit in situ

ISCO 2016: THE SEED



ISCO 2016: THE SEED

HCH TOTAL

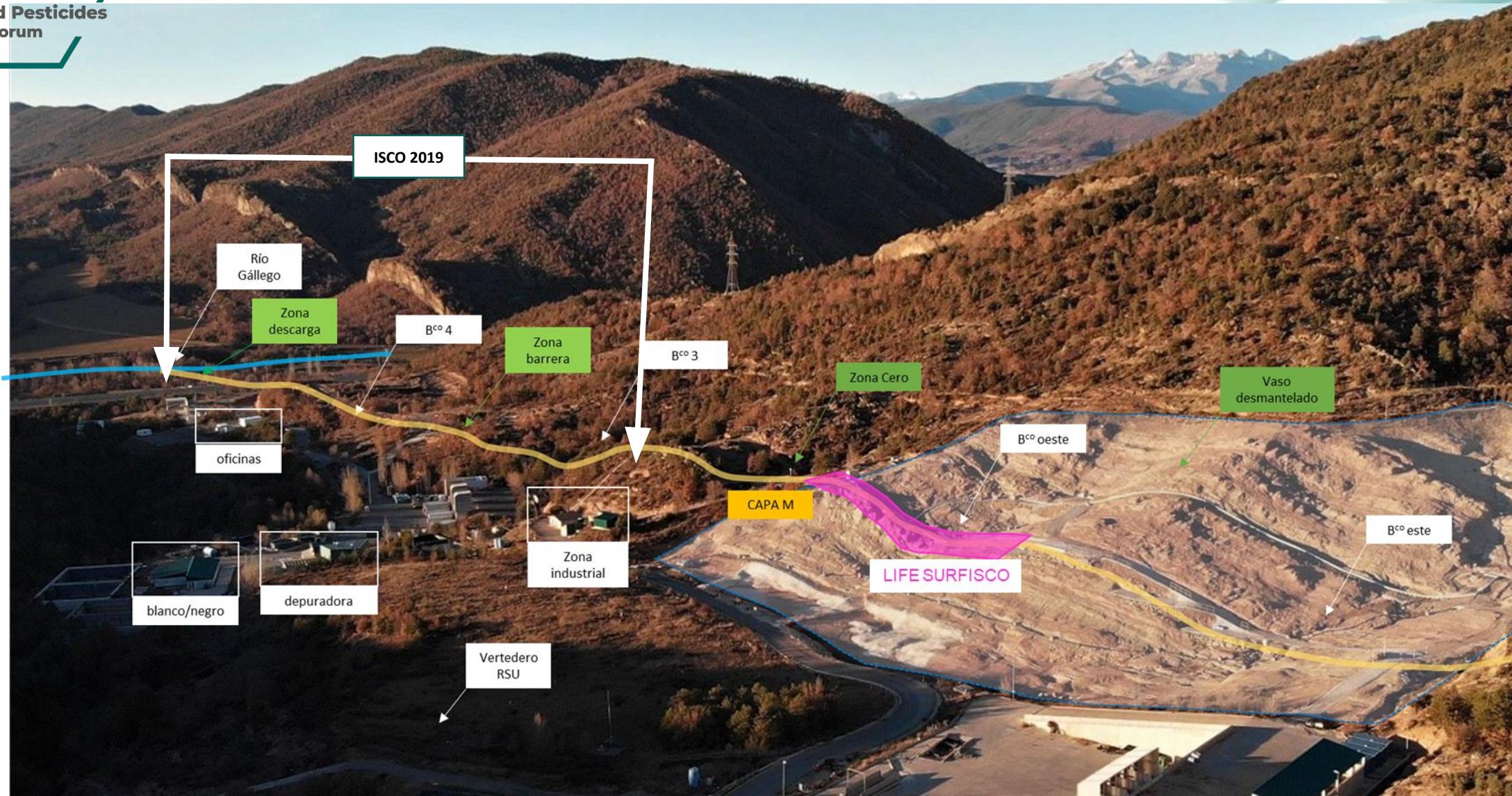




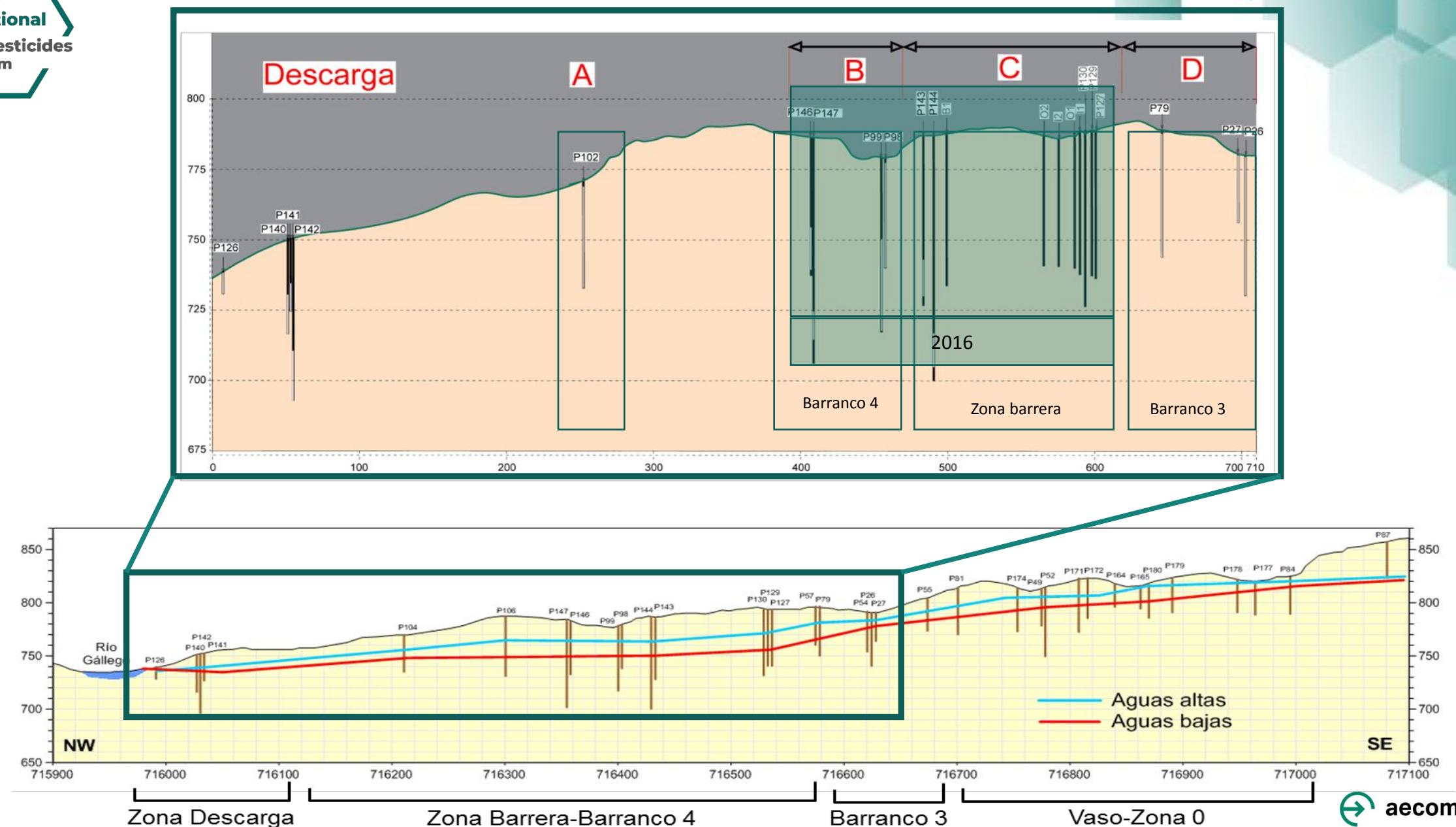
2016 PILOT TEST: RESULTS

- Concentration Yields reductions of 99% for HCH, 80% MCB, 95% BC
- Mass removed 5 - 6 kg
- Lessons learn for the full-scale

ISCO 2019- FULL-SCALE



ISCO 2019- FULL-SCALE



ISCO 2019- FULL-SCALE

2019 Injection equipment designed by
AECOM

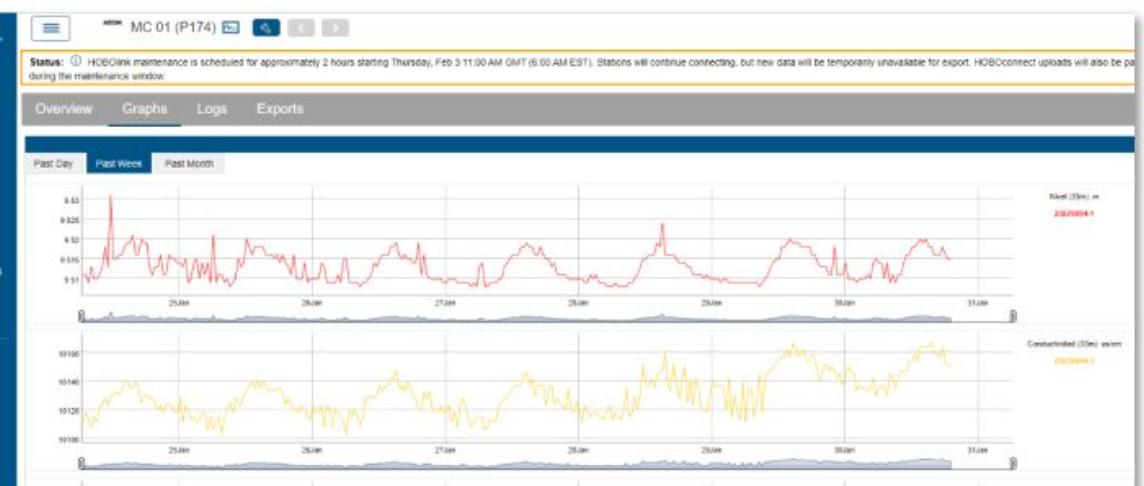


2016. Injection equipment. Fix, oversize, not versatile, and difficult to operate & control.



ISCO 2019- FULL-SCALE

Monitoring and visual data in real time → facilitates timely decision making and adjustments in the field



- GW levels
- Conductivity
- pH
- T °C
- Redox

ISCO 2019- FULL-SCALE

Monitoring of persulfate consumption concentration - dosage adjustments

Field kit test A para la determinación *in situ* de persulfato
Concentraciones < a 7 mg/l

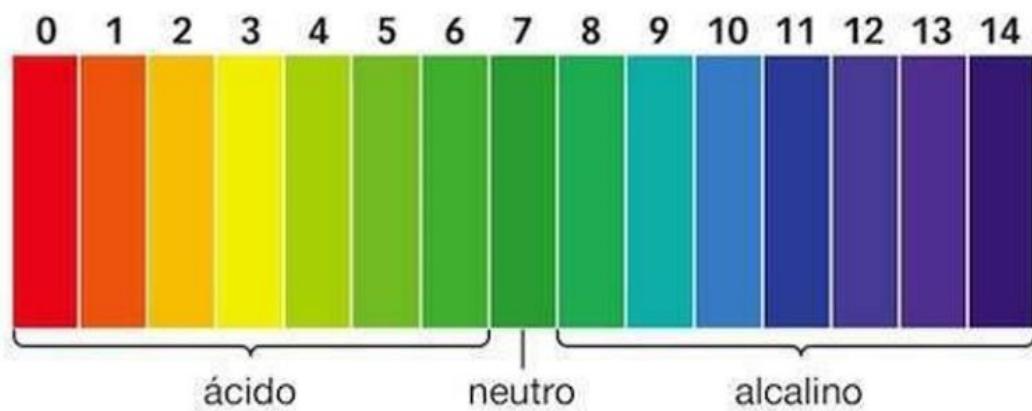


Field kit test B para la determinación *in situ* de persulfato
Concentraciones > a 7 mg/l

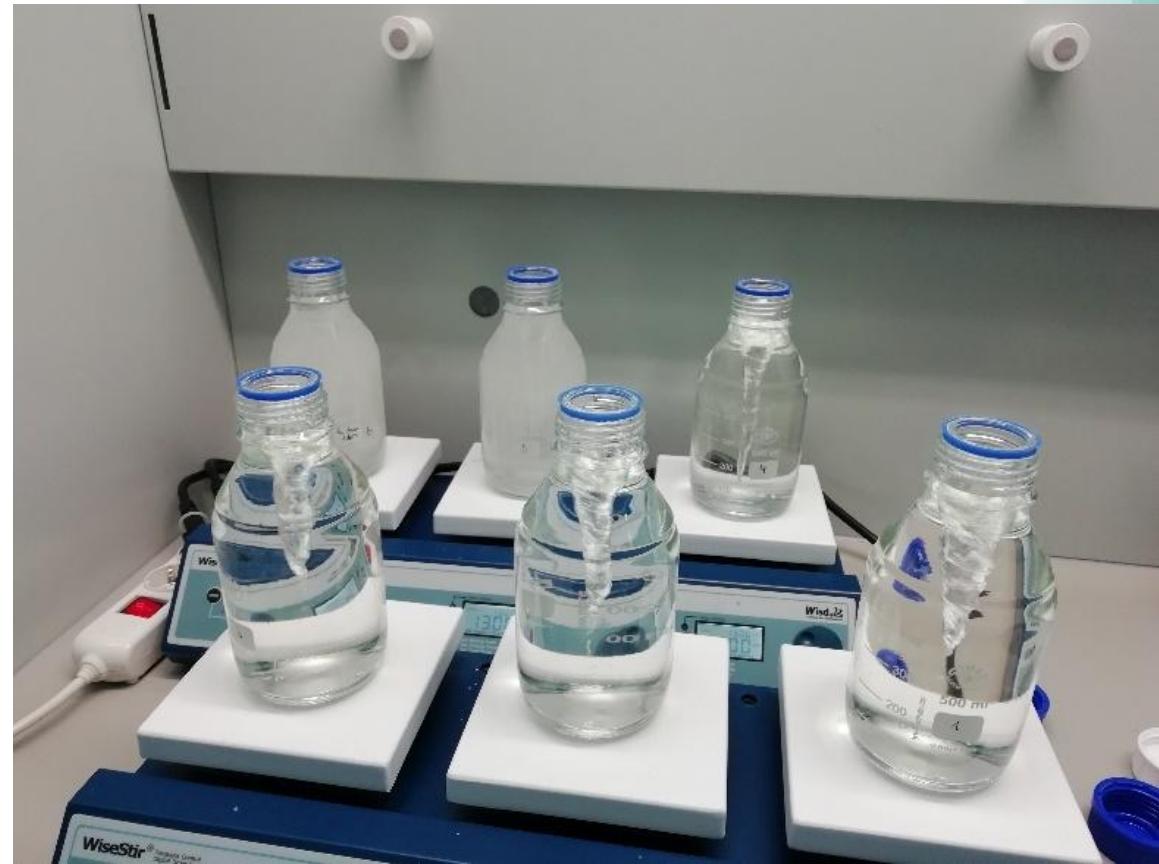


ISCO 2019- FULL-SCALE

pH controls during test



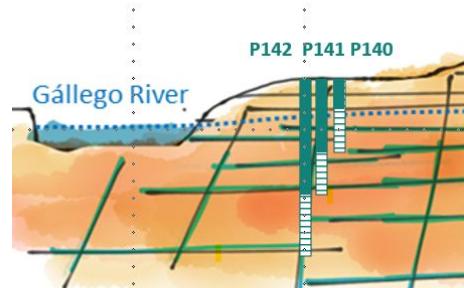
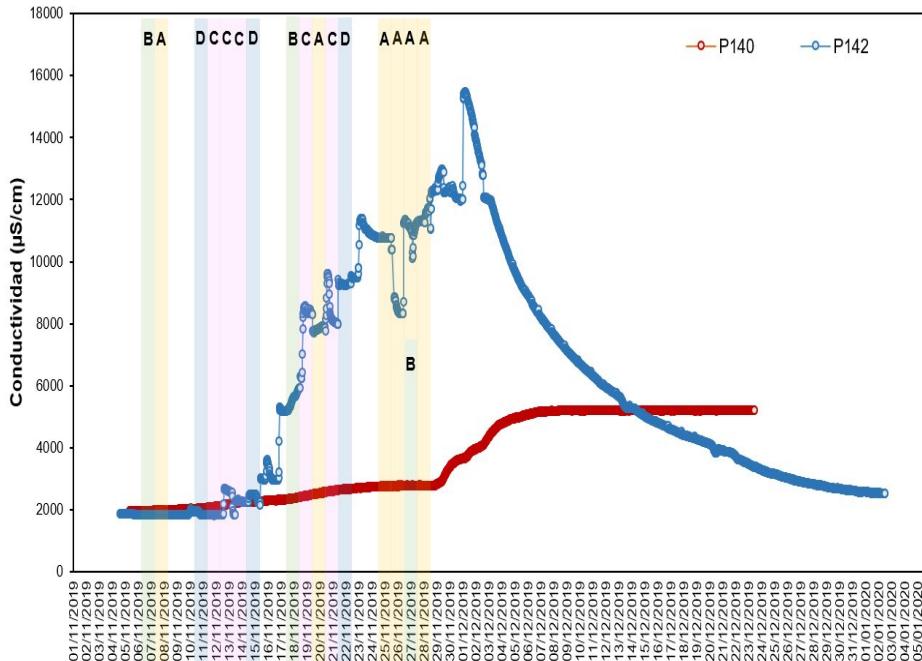
stabilization and cut-off reaction in sampling



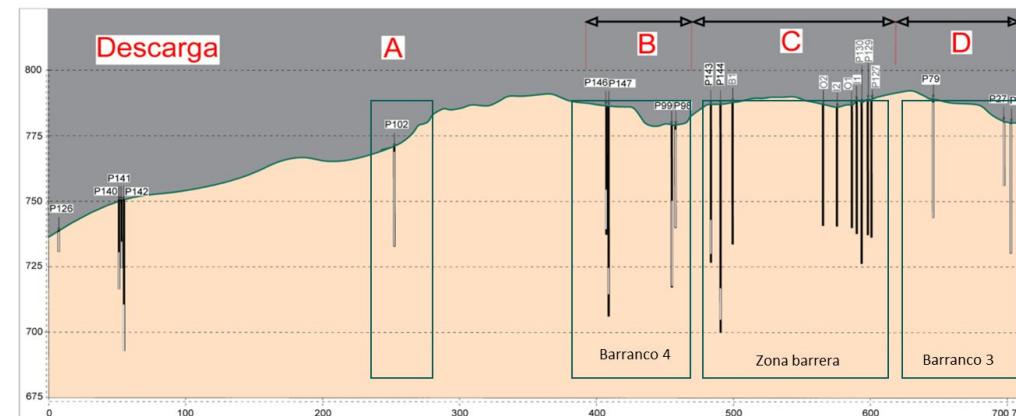
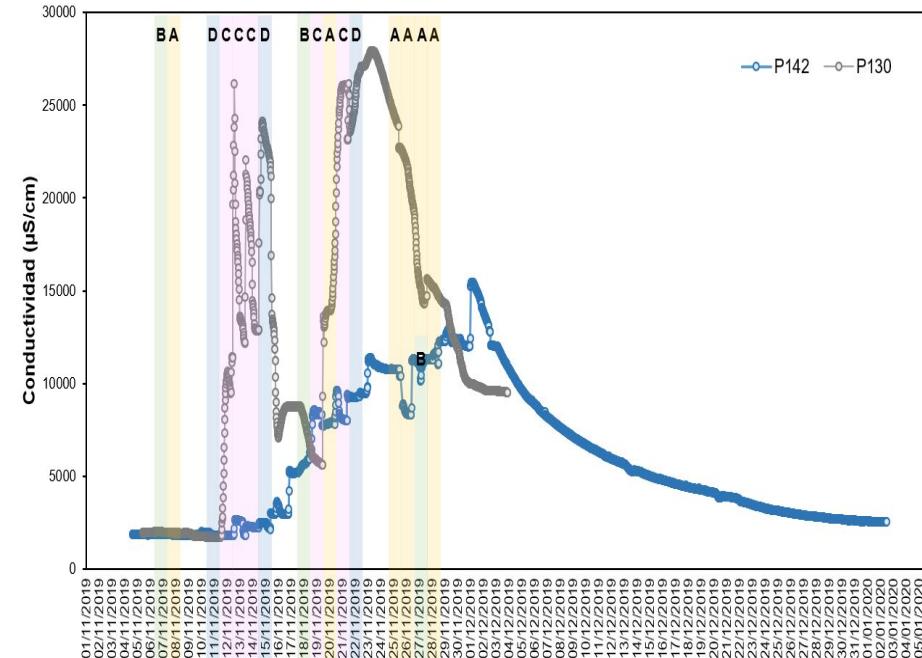
ISCO 2019- FULL-SCALE

Respuesta a las inyecciones – estimaciones tiempo y velocidades flujo inducidas

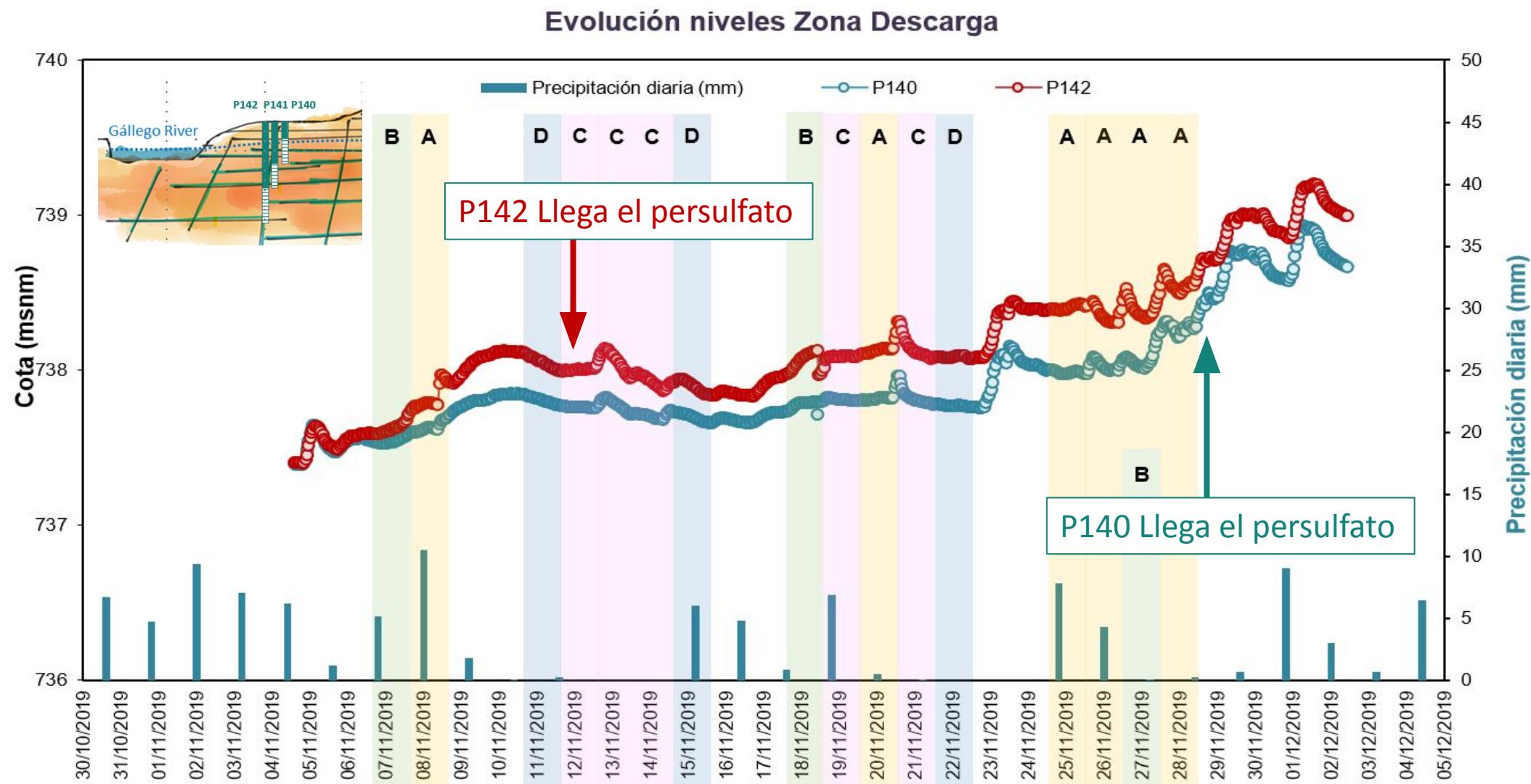
Evolución de la conductividad en la Zona de Descarga P140 (somero) P142 Profundo



Comparativa de la evolución de la conductividad en los sondeos P130 y P142

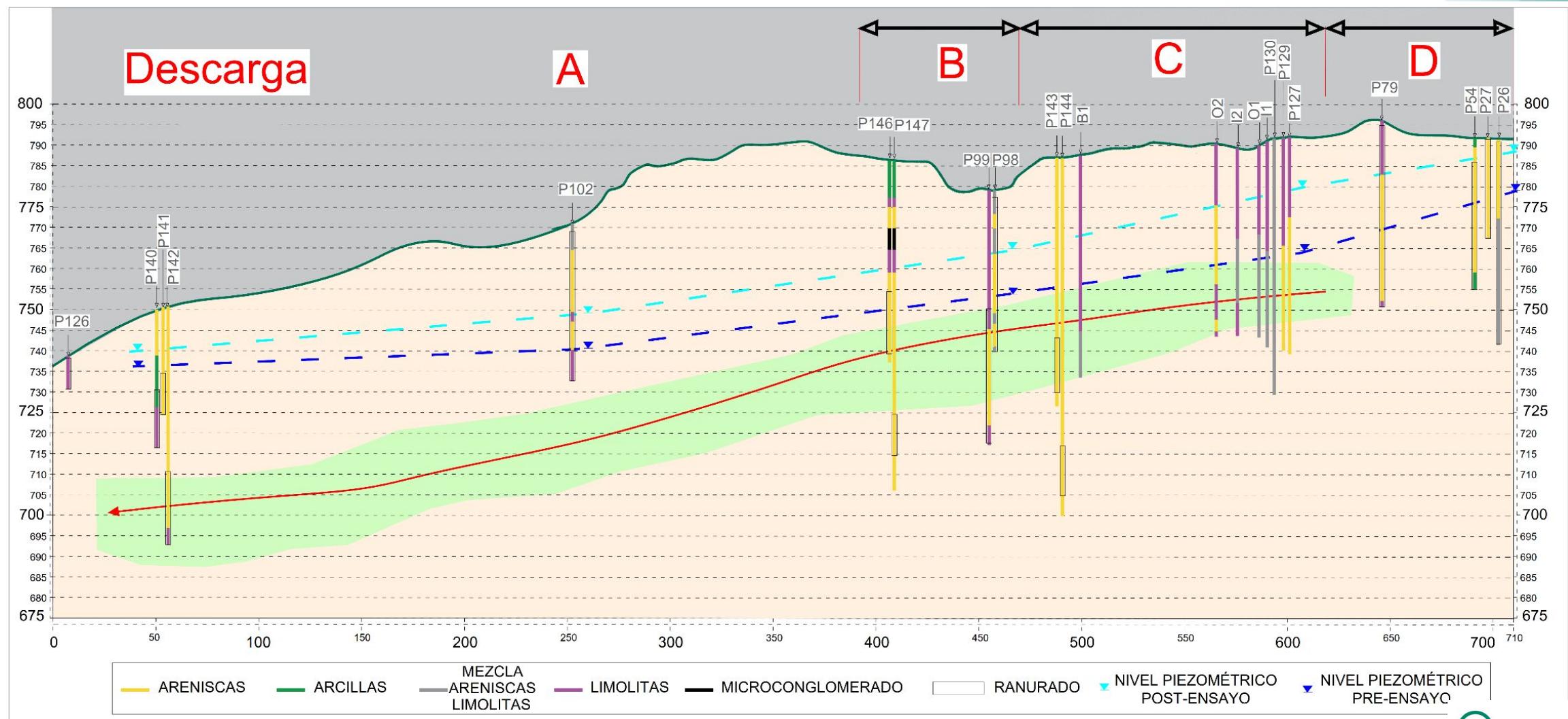


ISCO 2019- FULL-SCALE

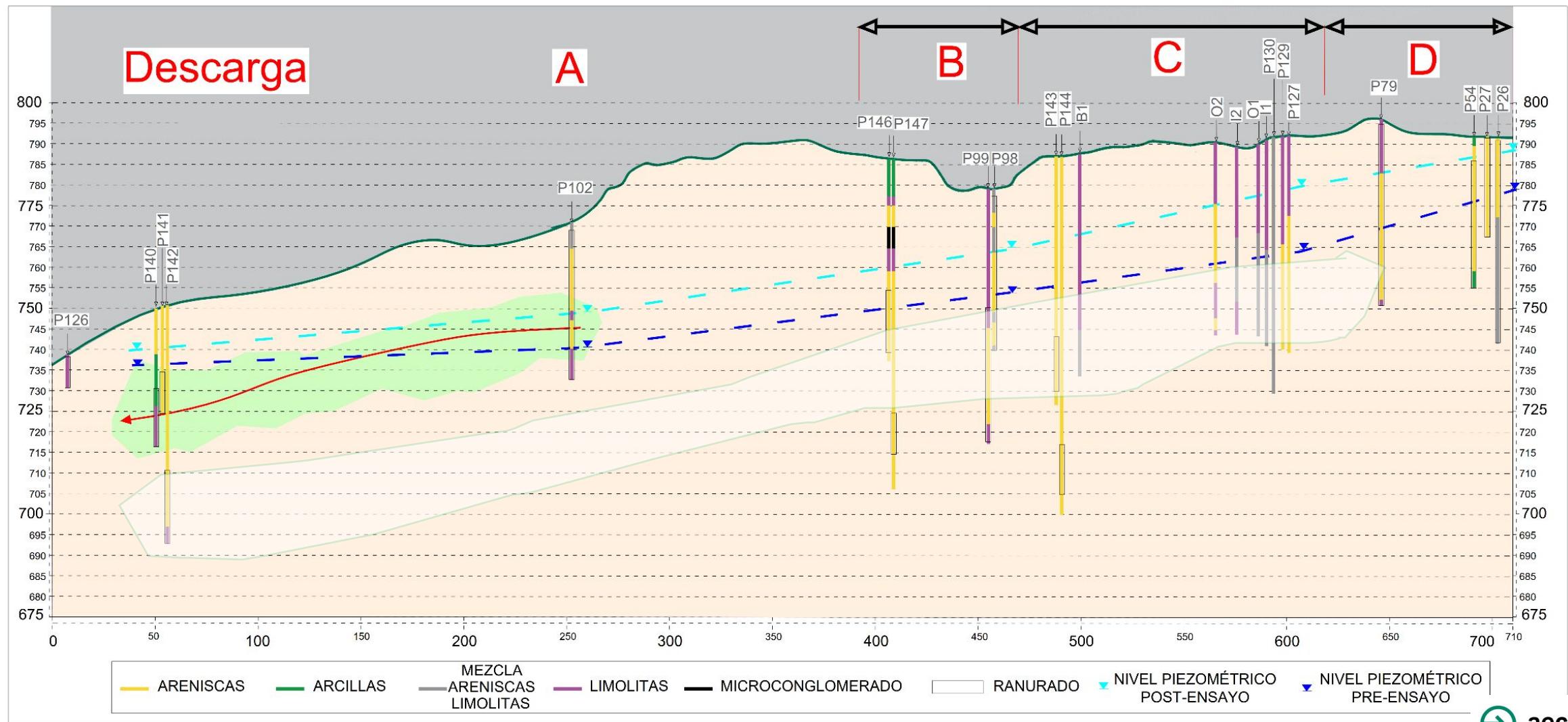


ISCO 2019- FULL-SCALE

Comportamiento de la distribución de oxidante desde la zona C hacia los sondeos de la Zona de Descarga



Comportamiento de la distribución de oxidante desde la zona A hacia los sondeos de la Zona de Descarga





ISCO 2019- FULL-SCALE: RESULTS

- Concentration Yields reductions of 60-80% for HCH, 93% MCB, 94% BC
- Mass removed 36 – 52 kg
- The full-scale test Improve the conceptual site model for future injection works
- Need to drill new boreholes (≈ 40 m) to ensure Oxidant reach upper fractures in the discharge zones



THANK YOU FOR YOUR ATTENTION

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