DROPSTONE

BUREAU D'ÉTUDES
GÉOLOGIE ET HYDROGÉOLOGIE

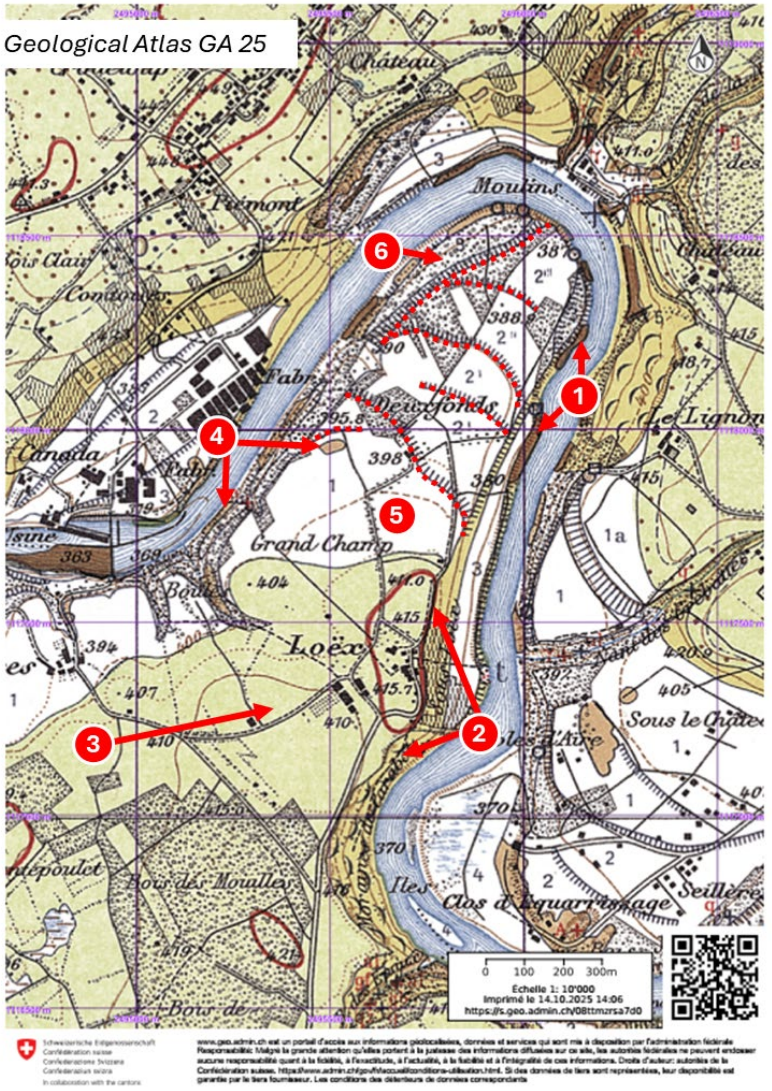
ERT-IP 3D APPLIED TO QUATERNARY DEPOSITS

LOËX - GENEVA

Results of a 3D geoelectrical survey of alluvial gravel

October-December 2025

1. Molasse bedrock
2. Würmian Moraine Solifluxion
3. Recent glaciolacustrine (Würmian retreat)
4. Alluvial deposits from plateaus (Gravels)
5. Alluvial valley floor (Terrasses 1-4)
6. Rockfall

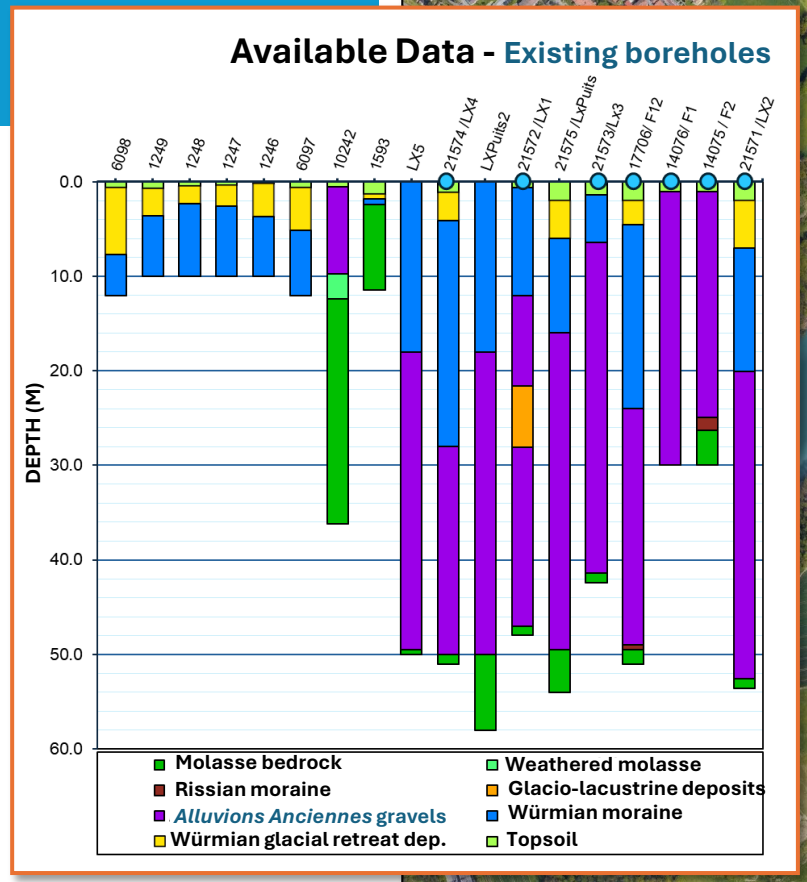


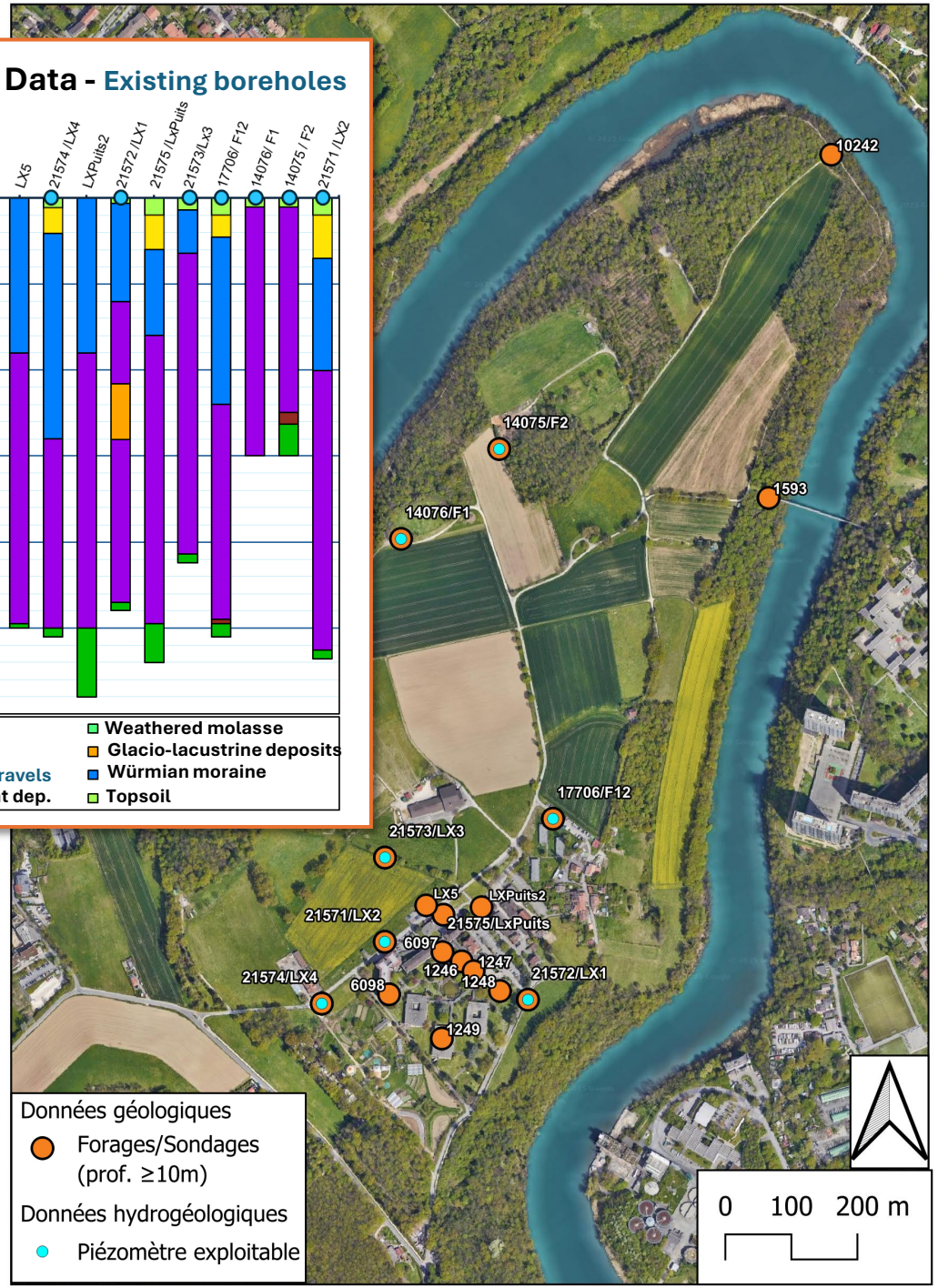
KEY IDEA

IN QUATERNARY DEPOSITS: AQUIFER = GRAVEL

- ❑ The initial objective was aquifer mapping
- ❑ In alluvial deposits, aquifers correspond to gravel bodies
- ❑ Imaging the aquifer = imaging **the gravel resources**

→ This method directly images the exploitable material





METHODOLOGY

Non-destructive surface method

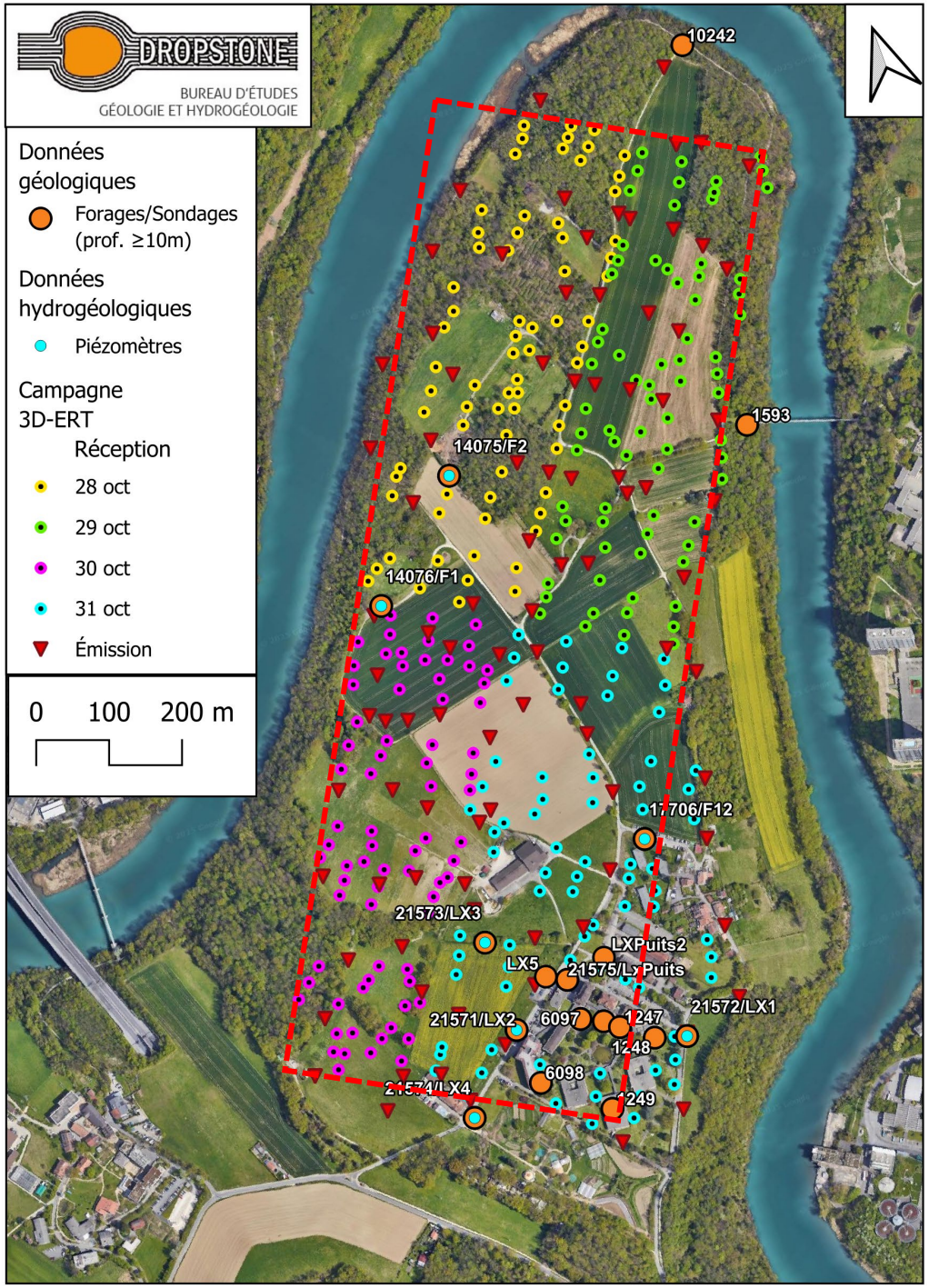
Two methods in one:

- Resistivity (ERT) → coarse vs fine / dry vs saturated
- Induced Polarization (IP) → clays/ gravels

→ **ERT–IP 3D = reliable gravel discrimination**

DEVICE FOR ACQUISITION

- ❑ Lightweight equipment
- ❑ Fast and flexible deployment
- ❑ Surface-based acquisition
- ❑ No drilling, no excavation
- ❑ Minimal disturbance of operations



DATA ACQUSITION

- 25 V-fullwaver receiving boxes per day
- 300 nodes of reception
- 95 nodes of transmission

RESULTS

- ❑ **Rapid data acquisition: only 4 days**
- ❑ **Cost-effective compared to drilling and seismic**
- ❑ **Large volumes imaged in short time: 0.64 km^2**
- ❑ **Required depth of investigation here : 100m**

→ **3D Investigated volume : 64 × 10^6 m^3**

GEOLOGICAL UNIT

ERT–IP RESPONSE

Geological unit	Resistivity (Ω·m)		IP chargeability (mV/V)*		Interpretation for gravel extraction
Würmian deposits	~40 – 150		> 3		Fine-grained deposits (silts & clays) – **non-exploitable**
Alluvions anciennes **gravels**	**~160 – 365**		**< 3**		**Clean gravel – main exploitable resource**
Molasse bedrock	~80 – 160		> 3		Bedrock – base of the deposit
		colour references		*colour references*	

Clean alluvial gravels are clearly identified by high resistivity and low chargeability, allowing us to map the exploitable gravel volume in 3D.

3D RESULTS
ERT–IP MODELS

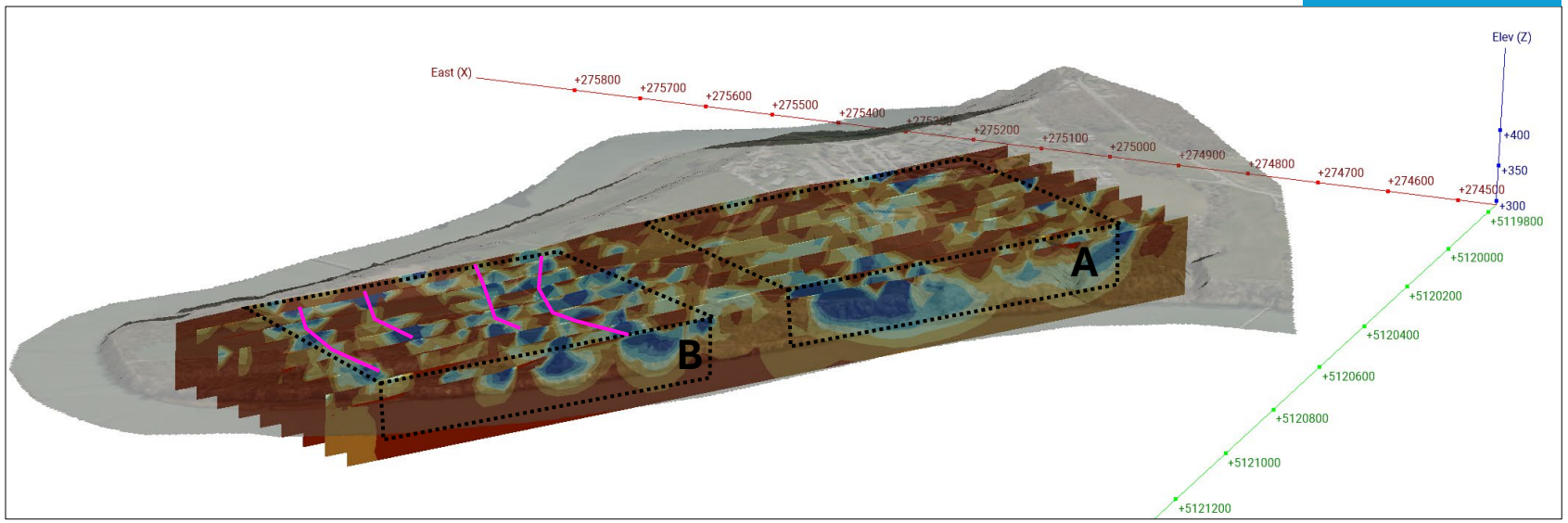
A. Thick and continuous body detected at the south-west

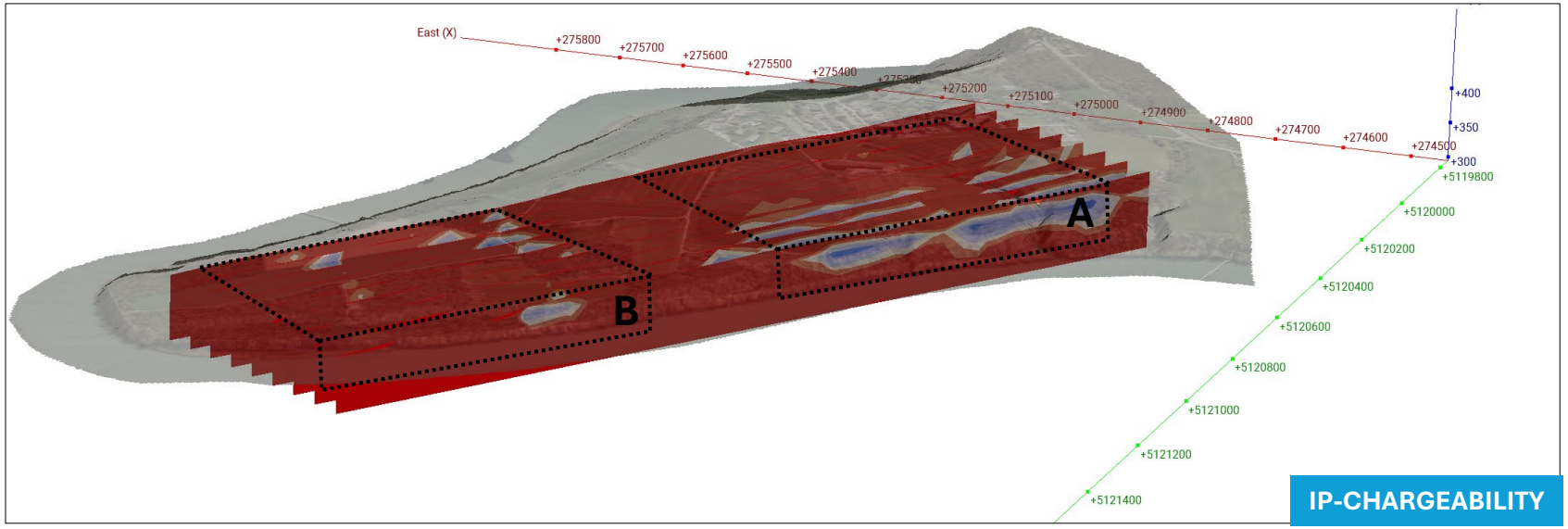
- High resistivity > 180 ohm.m
- Very low IP < 3 mv/V
- → **Clean gravel**

B. Discontinuous small bodies connected along W-E detected

- Mostly high resistivity > 180 ohm.m
- Diffusive chargeability trend

ERT-RESISTIVITY





IP-CHARGEABILITY

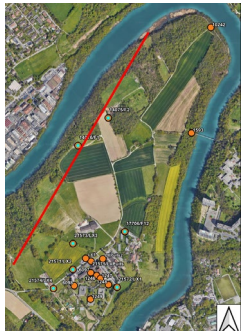
RESULTS: ERT–IP MODELS

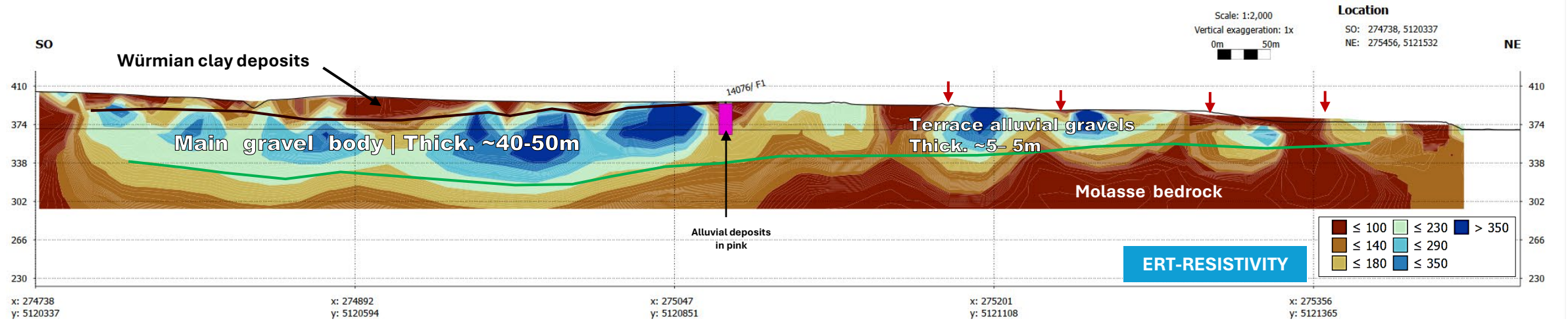
This cross-sections clearly show where the clean gravel is, how thick it is, and how it changes laterally — information that drilling alone cannot provide.

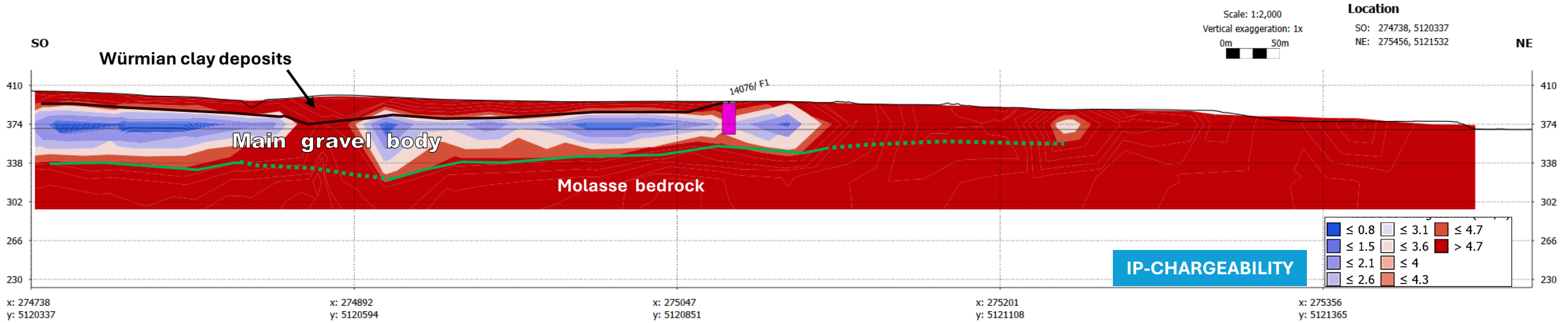
Terrace alluvial edge

"Würmian deposit – *Alluvions anciennes* gravels" contact

"*Alluvions anciennes* gravels – Molasse bedrock" contact





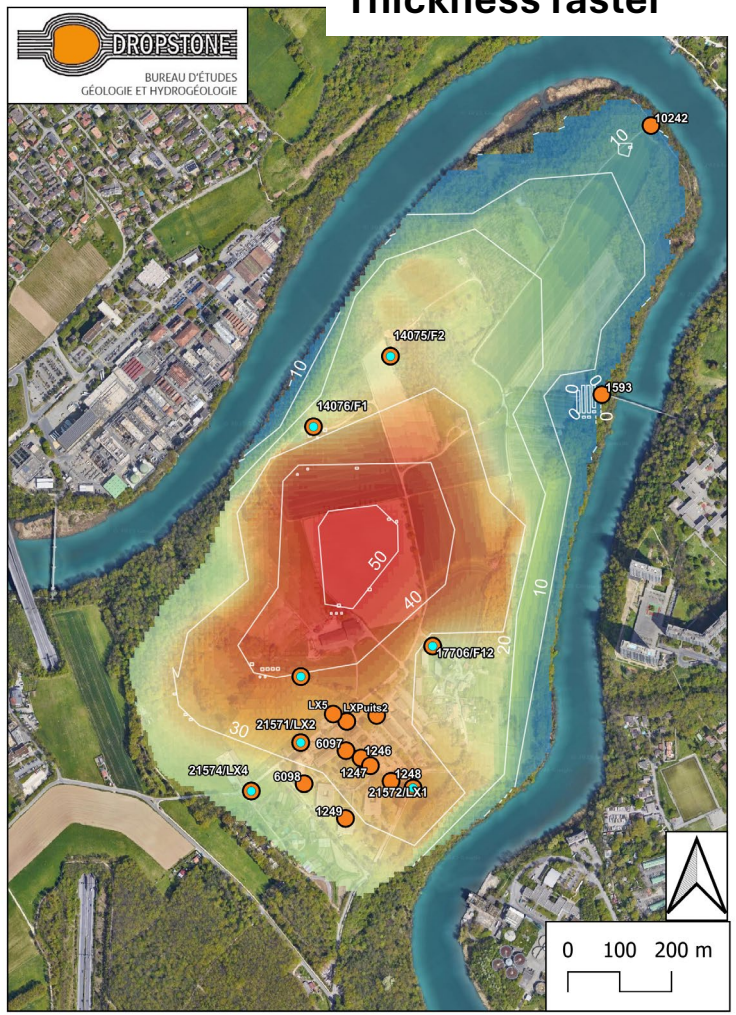


EXTENT OF ALLUVIAL DEPOSITS

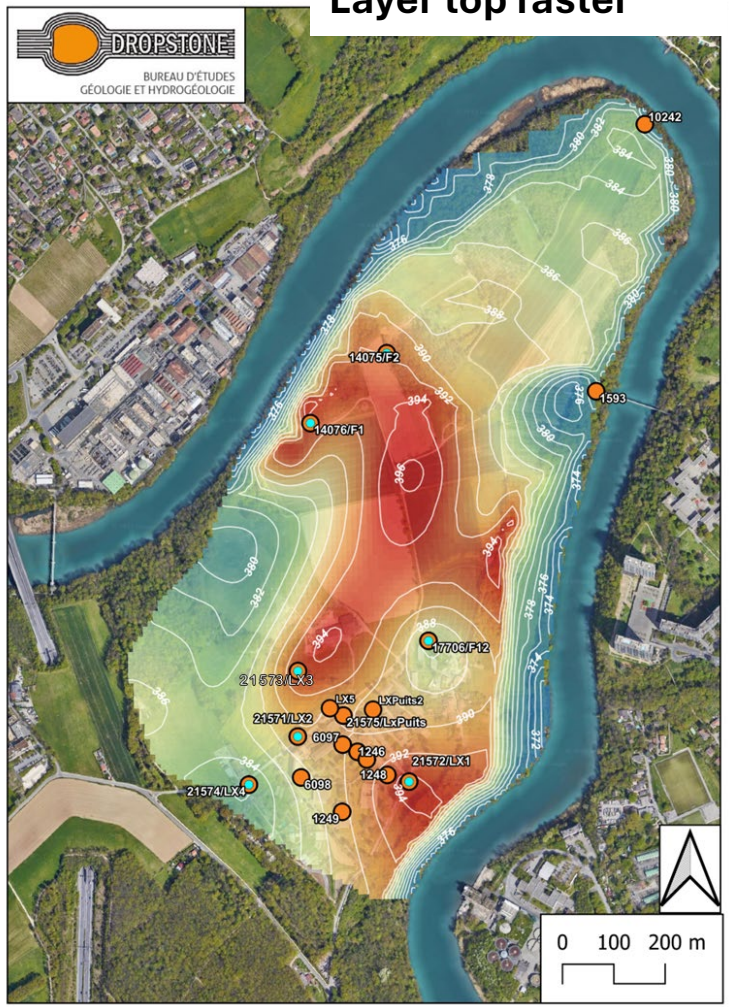
SYNTHESIS

- Widespread presence of alluvial deposits: main **aquifer = GRAVEL**
- Central part generally elevated
- Maximum thickness: > 40m at the level

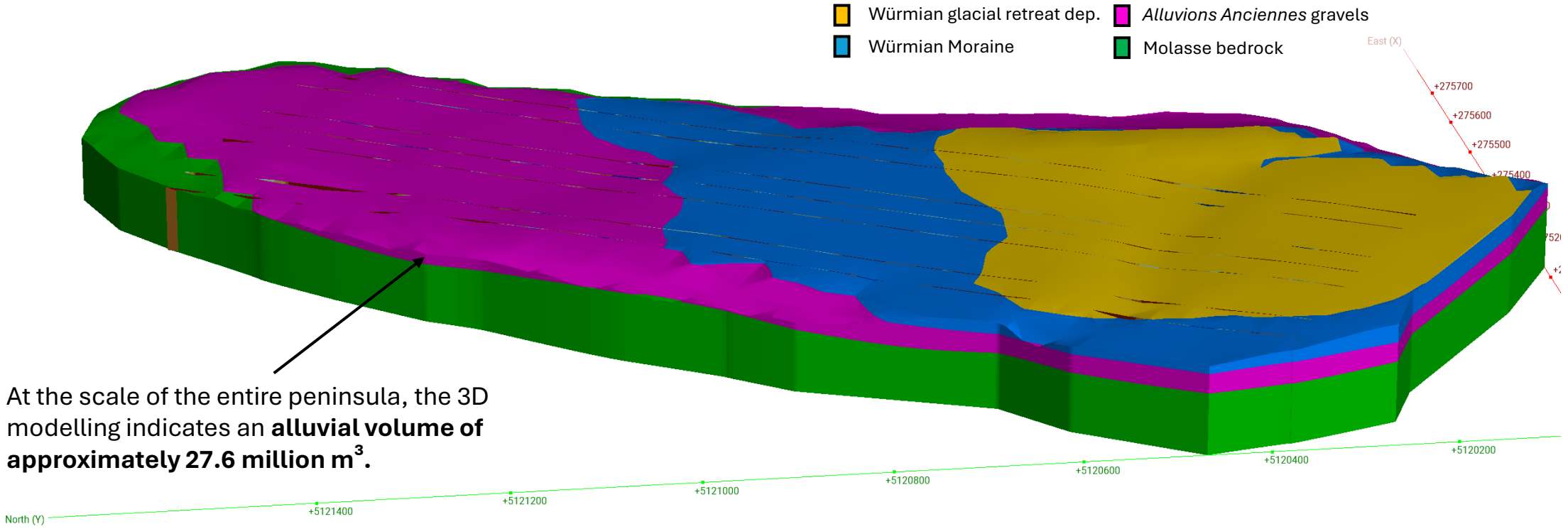
Thickness raster



Layer top raster

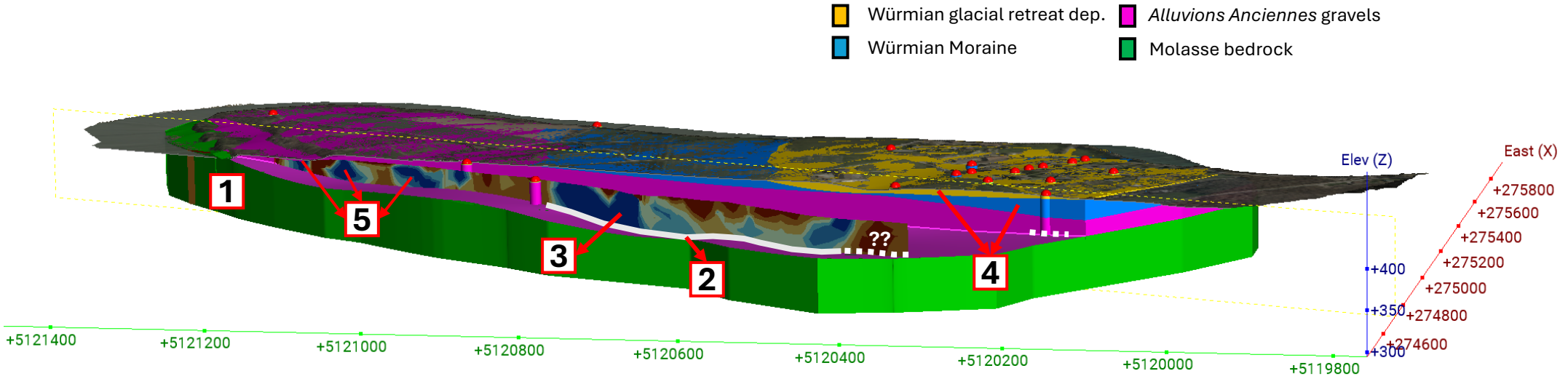


3D GEOLOGICAL MODEL



At the scale of the entire peninsula, the 3D modelling indicates an **alluvial volume of approximately 27.6 million m^3.**

CONCEPTUAL MODEL



1 Tertiary: Formation of the impermeable molasse substrate of the basin

2 Rissian glaciation: Shaping and over-deepening of the molasse roof

3 Interglacial phase: Deposition of *alluvions anciennes* deposits / Filling of the overdeepening

4 Würm glaciation: Covering of *alluvions anciennes* deposits

5 Post-glacial phase: Recent alluvial deposits forming terraces

WHY USE ERT–IP 3D FOR GRAVEL EXTRACTION?

Direct operational value

- ❑ Reduce exploratory drilling time
- ❑ Better estimation of gravel volumes
- ❑ Optimise extraction phases
- ❑ Anticipate water-related constraints

When it matters

- ❑ Before opening a new site
- ❑ Before extending an existing quarry
- ❑ To de-risk an investment
- ❑ For long-term planning

Key message : ERT–IP 3D provides a reliable 3D image of the gravel body

Less uncertainty | Better decisions | Lower risk