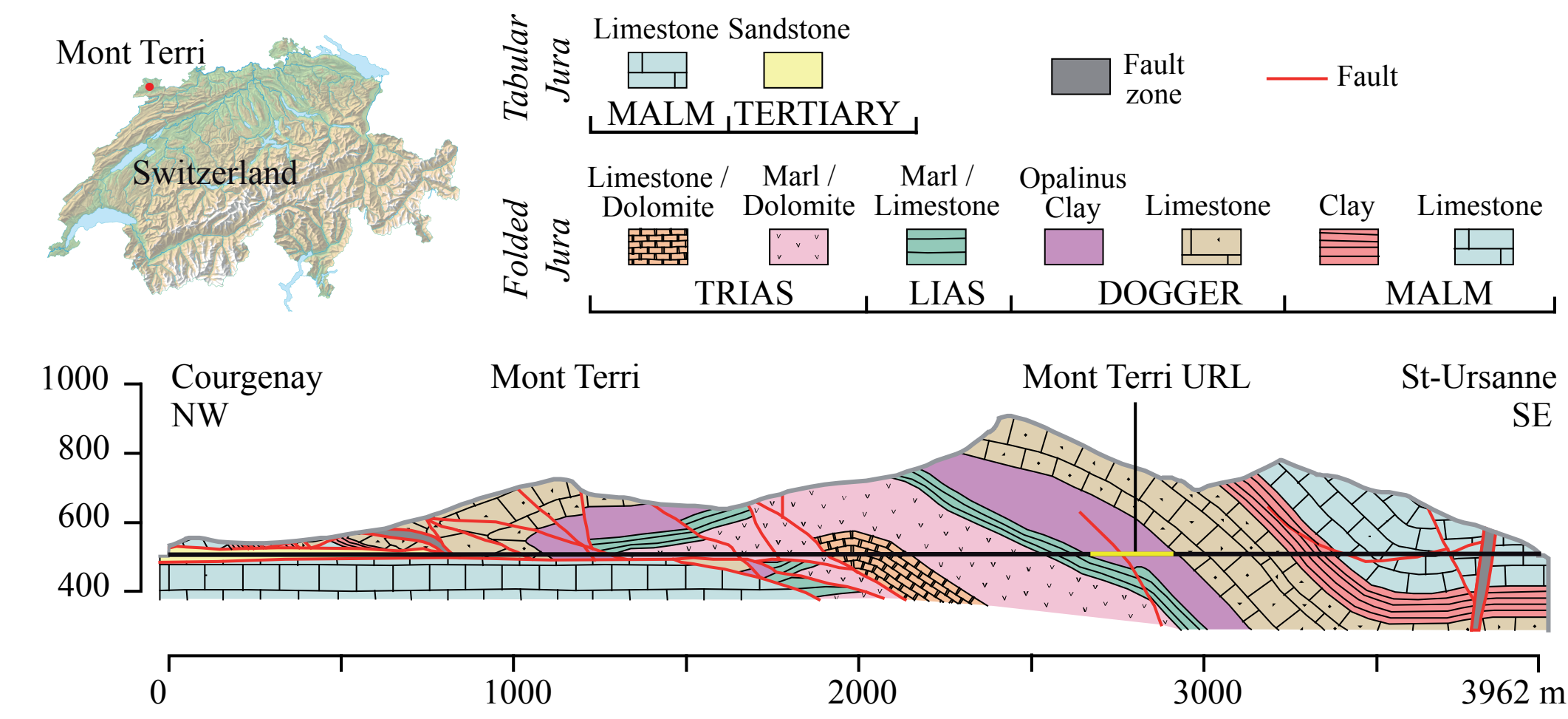


# Geophysical monitoring of the EDZ during a gallery excavation in the Opalinus Clay of the Mont Terri URL: anomalies of noble gases and self-potential associated with fractures and fluid dynamics in a horizontal borehole

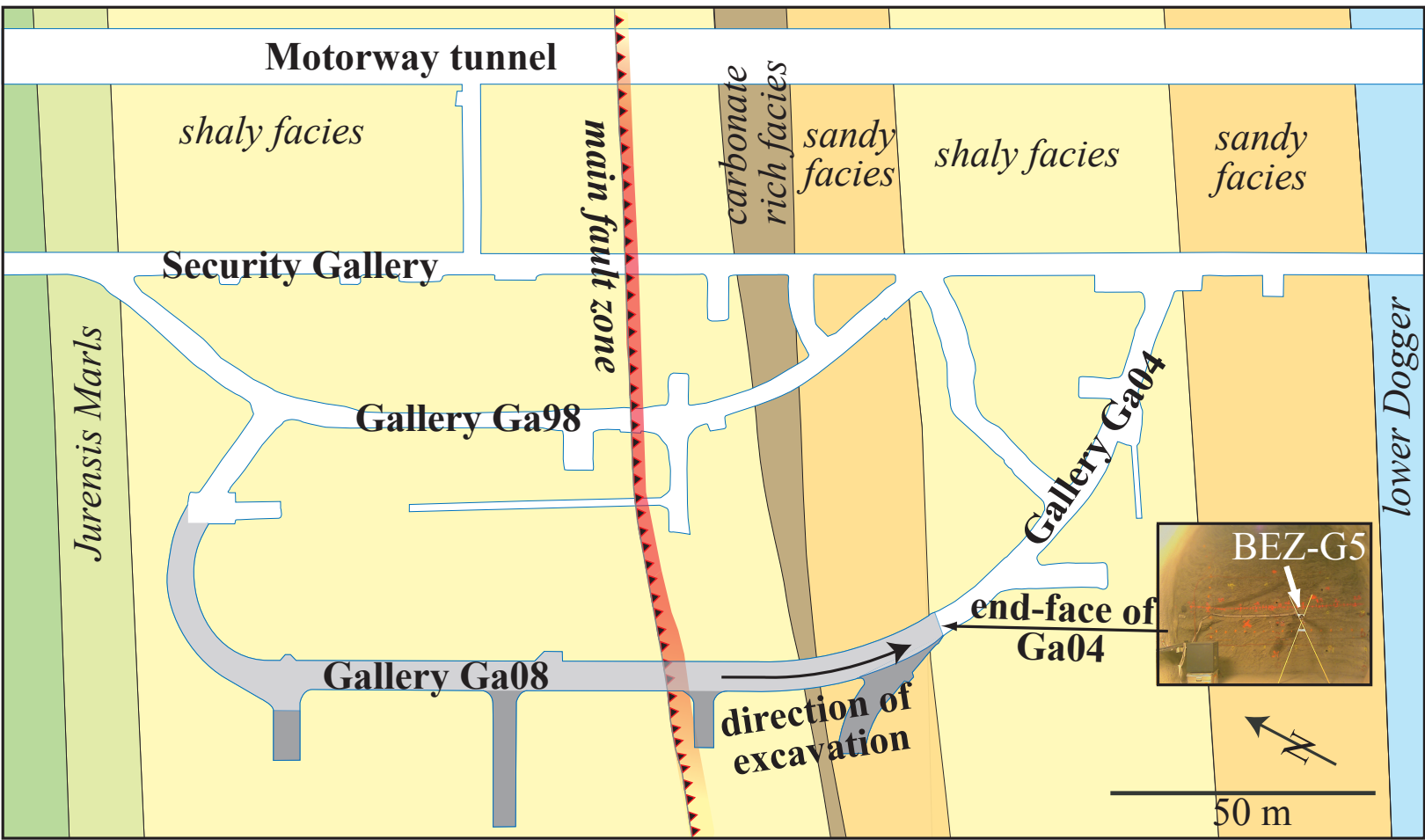
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## The Mont-Terri EZ-G08 experiment

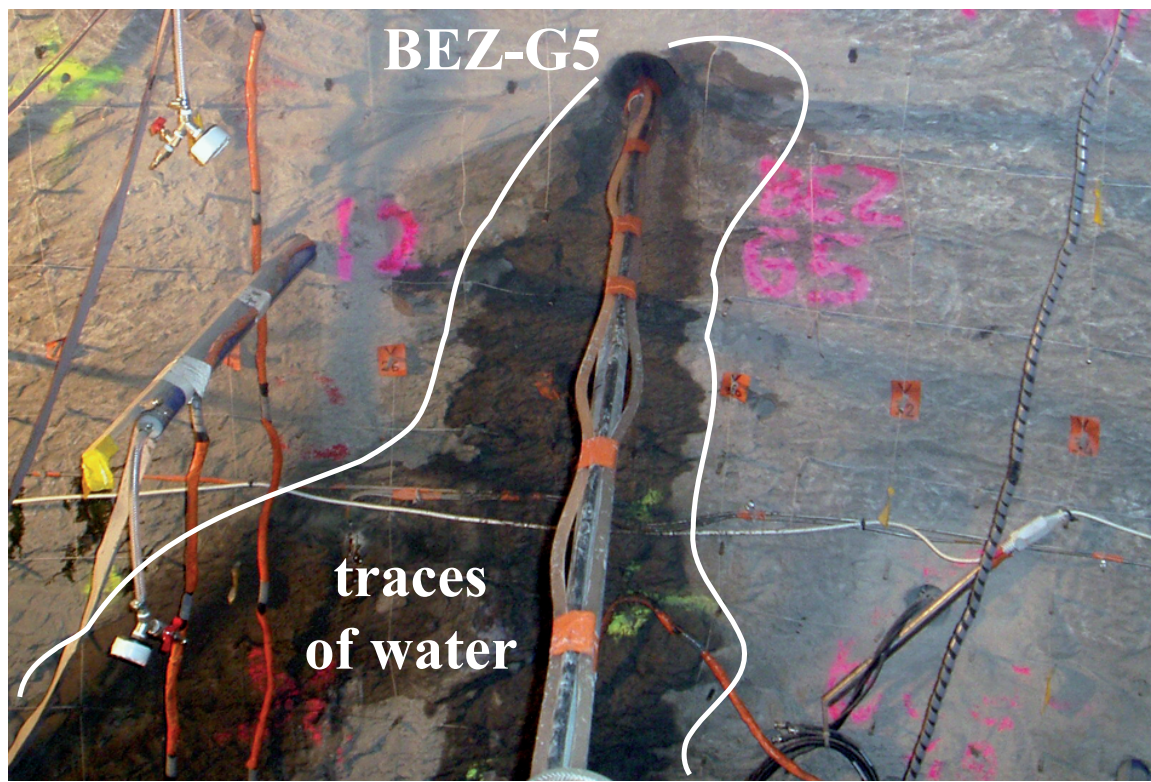


The research underground rock laboratory (URL) of Mont-Terri is aimed at studying the hydromechanical, thermal, geochemical and **geophysical** behaviour of argillaceous formations in the context of radioactive waste disposals.



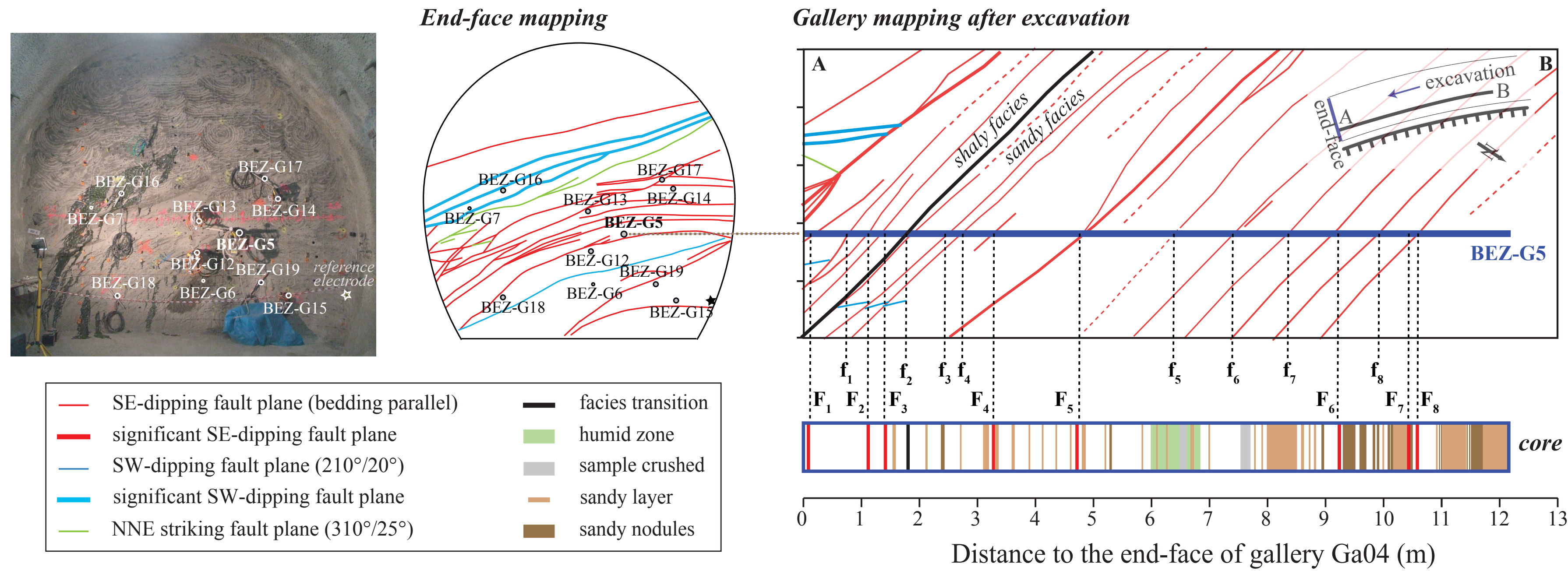
The EZ-G08 experiment was designed to **monitor the EDZ evolution** by means of geophysics during the tunnelling of gallery Ga08, between November 2007 and August 2008. The end-face of gallery Ga04 was therefore instrumented with several sub-horizontal boreholes (in particular BEZ-G5).

Before the excavation starts, the petrology, structural properties and **noble gas content** of the core of BEZ-G5 (12-m long) were characterized to get an idea of the initial state.



An **inflow of pore water** occurred in BEZ-G5 few weeks after its drilling. The borehole was thus instrumented to monitor the evolution of the **self-potential** (SP) from Feb. 21<sup>st</sup> 2008. (*see poster by Le Gonidec et al.*).

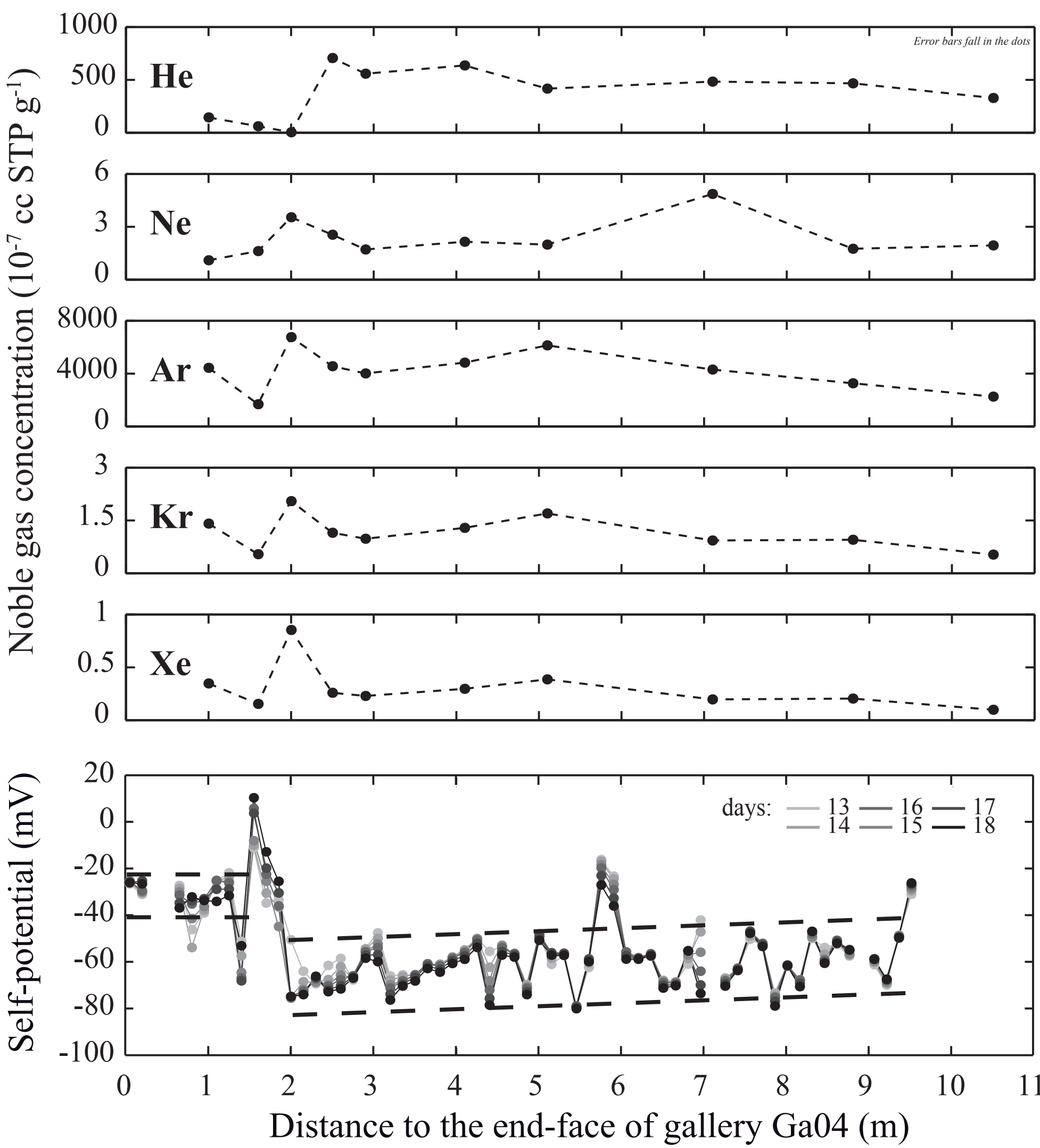
## Structural and geological properties of the rock mass



A main SW-dipping fault divides the end-face of gallery Ga04 into two compartments. The lower one contains a lot of SE-dipping fractures parallel to the bedding, and a NNE-striking fault. This system formed a **well-interconnected fracture network**. As a consequence, only few vertical EDZ fractures developed parallel to the face: **the EDZ network consists mainly of reactivated, pre-existing tectonic fractures**.

Behind the end-face, the rock-mass is mainly crossed by SE-dipping faults, with a major one crossing BEZ-G5 at 5 m from its mouth. **Fractures f<sub>1</sub> to f<sub>8</sub>** were not observed in the core as they were sealed by calcite and clays. **They are unlikely resulting from excavation of gallery Ga08, but pre-existing and reactivated.**

## Initial noble gas and SP anomalies



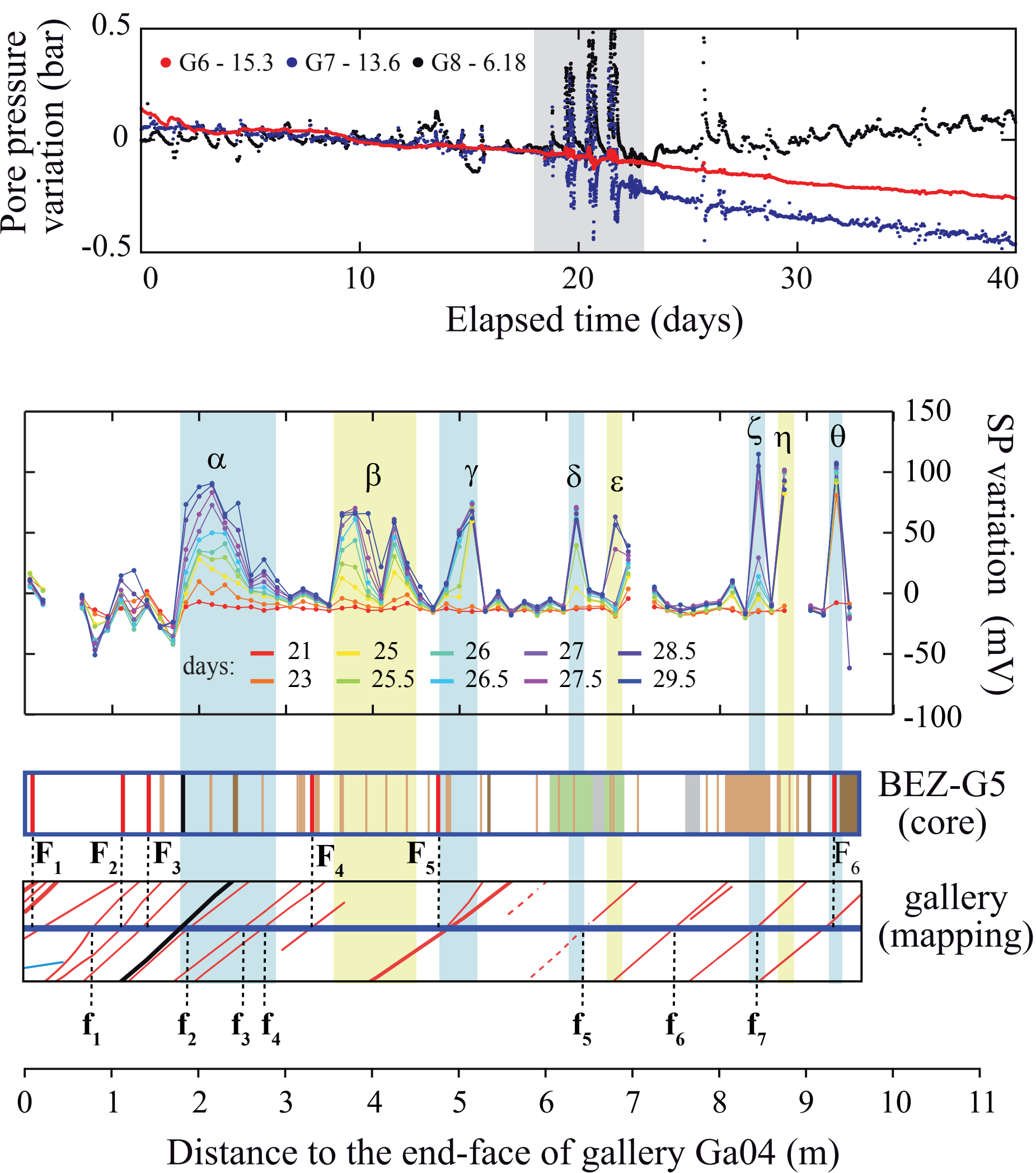
In both noble gas and SP profiles along BEZ-G5, **an anomaly occurs in the 2 first meters**.

It can be explained by the **EDZ**:

- He depletion and enrichment in other gases at 2 m may be due to the presence of reactivated, tectonic fractures that enable gas transfer.

- SP anomaly may result from the desaturation of the rock in the 2 first meters.

## Dynamic SP anomalies



Between days 18 and 23, **drilling operations** were carried out in the end-face (boreholes BEZ-G12 to BEZ-G19). They disturbed the pore pressure field in the rock mass, as recorded in BEZ-G6/7/8.

The localised variations of SP (with respect to the initial anomaly) occurring after day 22 should result from **pore water inflows** in BEZ-G5 due to the modification of the pore pressure field.

These anomalies can be related to pre-existing reactivated faults, or to sandy lenses (circulation at microscale fractures).

## Conclusions

The noble gas concentrations and initial SP anomaly evidence that the 2 first meters of the rock-mass behind the end-face of Ga04 have a particular behaviour. It attests the development of an EDZ after the excavation of gallery Ga04, yielding to desaturation and exchange processes through reactivated pre-existing tectonic fractures that accommodated the stress change in the near field.

The dynamic SP anomalies are related to the change in the near stress field resulting from drilling operations in the end-face, which led to free water releasing from the claystone, to subsequent variation of the pore pressure and thus to fluid circulation. The comparison of their location with the position of the fractures mapped after the excavation of gallery Ga08 suggest that the drilling operations (and also the earlier excavation of gallery Ga04) reactivated pre-existing but sealed macroscale fractures, that acted as flow-paths.