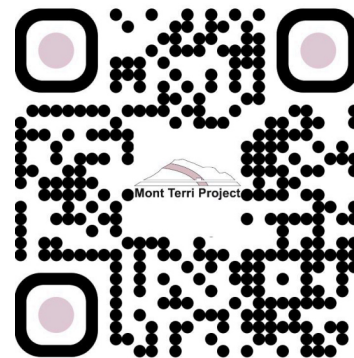


Mont Terri Project

Underground Rock Laboratory



Report period: June 15–21, 2026

Assembled and edited by swisstopo, St-Ursanne

Scientific Publications swisstopo

Please choose a category and a publication (original language).

CATEGORY

Mont Terri - 43rd Technical Meeting 29-30 April 2026 [52]

PUBLICATION

MTTM43-201 : Fifteen years of BN experiment: fate of nitrate and selenium from bituminized radioactive waste in a clayey ho...

MTTM43-201 : Fifteen years of BN experiment: fate of nitrate and selenium from bituminized radioactive waste in a clayey host rock

The Bitumen-Nitrate-Clay interaction (BN) experiment at the Mont Terri Rock Laboratory in Switzerland was launched in 2010. The initial BN tests focused on the fate of nitrate in a deep clay formation (i.e., Opalinus Clay) in the absence or presence of other substances released from bituminized waste (bitumen degradation products — or BDP in short — such as acetate or H_2), and in the presence of a versatile microbial community. Furthermore, the effect of nitrate on the speciation and migration of redox-sensitive radionuclides has been studied with stable selenium in Se(VI) form as a proxy for ^{79}Se . This paper summarizes the key findings and observations from 15 years of in-situ tests.

[Download MTTM43-201 PDF](#)

DOI

<https://doi.org/10.60695/swisstopo.mttm43.201.2026>

43rd Mont Terri Technical Meeting, Porrentruy, 29–30 April 2026 201

Fifteen years of BN experiment: fate of nitrate and selenium from bituminized radioactive waste in a clayey host rock

Néle Bleyen^{1*}, Katrin Hendrix¹, Kristel Mijndonckx¹, Jef Mathijs¹, Steven Smets¹, Veerle Van Gompel¹, Pierre De Cannière², Michael Jendras³, Torben Weyand³, Yannick Linard⁴, Marjina Surkova⁵, Charles Wittebroodt⁶ and Elie Valcke¹

¹ Belgian Nuclear Research Centre (SCK CEN), Mol, Belgium
² Independent consultant, formerly with the Federal Agency for Nuclear Control (FANC), Brussels, Belgium
³ Federal Office for the Safety of Nuclear Waste Management (BfS), Berlin, Germany
⁴ Agence Nationale pour la Gestion des Déchets Radioactifs (Andra), Châtenay-Malabry Cedex, France
⁵ Federal Agency for Nuclear Control (FANC), Brussels, Belgium
⁶ Autorité de sûreté nucléaire et de radioprotection (ASN), Fontenay-aux-Roses, France
* nbleyen@sckcen.be

1 Introduction

In many countries, such as Belgium, France, Switzerland, and Germany, deep clay formations are being investigated as potential host rocks for the disposal of radioactive waste. Suitable clay formations exhibit several favorable hydromechanical and geochemical characteristics relevant to long-term safety, including low permeability, high sorption capacity, and reducing conditions, which contribute to the containment and retardation of radionuclides (e.g., Andra 2005; Van Geet et al. 2023).

Nitrate-bearing intermediate-level long-lived bituminized waste is currently foreseen for disposal in clay formations in countries like Belgium and France. After repository closure, resaturation will lead to a slow water uptake by bituminized waste, causing gradual dissolution and leaching of $NaNO_3$ along with radionuclides immobilized in the bitumen matrix (Valcke et al. 2022). A key question is therefore whether such a nitrate plume would perturb the redox conditions in the clay and could oxidize (part of) the clay. Such perturbations may affect the clay's reducing capacity towards redox-sensitive radionuclides, including ^{79}Se , an important contributor to the long-term dose to man (De Cannière et al. 2010). Although ^{79}Se is expected to leach from bituminized waste as selenate (i.e., SeO_4^{2-} or Se(VI)), its speciation in the near field of a geological repository remains elusive, as its redox state depends strongly on the prevailing redox conditions in the clay. Low redox potentials favor the formation of poorly soluble Se(0) and selenides, while intermediate reducing conditions allow Se(VI) (selenate or SeO_4^{2-}) to persist, with its mobility constrained by precipitation and sorption. In contrast, an oxidizing environment stabilizes the more mobile Se(VI) (Finck & Dardenne 2016).

Besides abiotic reactions, nitrate and selenium oxyanions may undergo microbial reduction in areas where microbes thrive. On the one hand, microbial nitrate reduction may enhance the potential nitrate-induced perturbation of the clay host rock. On the other hand, microbial reduction of selenium oxyanions would further affect their mobility. Understanding these coupled processes is therefore essential.

The Bitumen-Nitrate-Clay interaction (BN) experiment at the Mont Terri Rock Laboratory in Switzerland was launched in 2010 precisely to investigate these issues. The initial BN tests focused on the fate of nitrate in a deep clay formation (i.e., Opalinus Clay) in the absence or presence of other substances released from bituminized waste (bitumen degradation products — or BDP in short — such as acetate or H_2), and in the presence of a versatile microbial community. Furthermore, the effect of nitrate on the speciation and migration of redox-sensitive radionuclides has been studied with stable selenium in Se(VI) form as a proxy for ^{79}Se . This paper summarizes the key findings and observations from 15 years of in-situ tests.

<https://doi.org/10.60695/swisstopo.mttm43.201.2026>



Spotlight of the week: We are glad to announce that all 51 conference papers and the proceedings of the 43rd Mont Terri Technical Meeting - 30th anniversary have now been published on <https://docs.swisstopo.admin.ch> and the DOI registration has been completed. The metadata will be harvested and indexed by external services such as OpenAlex, OpenAIRE and ORCID. As an example you can see the article #201 by Bleyen et al. on swisstopo's landing page. All contributions can be downloaded as pdf. We thank all authors for their contributions!

Important note

- On Friday, June 19, Starting on July 6, the lab will be closed for its annual summer break. This year, we close for six weeks and will be back in operation on August 17. An emergency standby service is organized. In case you have an urgent matter with your experiment, don't hesitate to contact the site management.

CD-A (Influence of Humidity on Cyclic and Long-Term Deformations) experiment

- On Friday, June 19, S. Schefer (swisstopo) restarted the computer for the psychrometric system.

CL (CO₂LPIE-CO₂ Long-Term Periodic Injection) experiment

- On Monday, June 15, D. Jaeggi (swisstopo) switched all pH and Eh sondes to monitoring mode.
- On Thursday, June 18, D. Jaeggi (swisstopo) switched all pH and Eh probes back to bypass mode.

CS-E (Mini-Fracturing and Sealing) experiment

- On Wednesday, June 17, A. Rinaldi (ETHZ) did some maintenance in the borehole BCS-D2 flushing intervals 2, 3, 4, 5, cleaned up the CS-E circulation lines and moved them to monitor interval 2 and 4 of borehole BCS-D1. The injection system was also checked and a filter removed to enable easier refilling of the pump.

DB-B (Deep Borehole to resolve the Mont Terri Anticline Hydrogeology) experiment

- From Monday to Tuesday, June 15–16, the Solexperts team performed hydro tests in the open hole section and took 2 water samples from downhole. (**Figure 1**)
- From Wednesday to Friday, June 17–19, the Solexperts team performed mini-fracks on 7 locations, followed by 5 sleeve reopening tests on the previously stimulated areas. (**Figure 2**)
- On Friday, June 19, M. Frädrieh (Terratec) performed the post-frac ABI inside BDB-B1.

DR-C (Diffusion in a Thermal Gradient) experiment

- On Thursday, June 18, Y. Lettry (Solexperts) performed pressure and flow adjustments in the main pressure vessel from BDR-C6.
- On Thursday, June 18, Y. Lettry (Solexperts) replaced the flowmeter of BDR-C1, resaturated the heating pressure vessel and adjusted pressure and flow in the main pressure vessel.
- On Friday, June 19, S. Schefer (swisstopo) inserted two new vials into samplers #2 and #3 for boreholes BDR-C1 and BDR-C6.

DR-D (Heterogeneity of Sandy Facies by Geophysical Characterization and Diffusion Studies) experiment

- On Thursday, June 18, Y. Lettry (Solexperts) performed pressure and flow adjustments in circulation cabinet of BDR-D3.
- On Friday, June 19, S. Schefer (swisstopo) inserted two new sampling vials into samplers #2 and #3.

FE-M (Long-Term Monitoring of the Full-Scale Emplacement Experiment) experiment

- On Monday, June 15, J. Windisch (swisstopo) restarted the UPS of heater 1.
- On Monday, June 15, J. Windisch (swisstopo) refilled the calibration bath with 25 L of water.

FS-B (Imaging the Long-Term Loss of Faulted Host Rock Integrity) experiment

- From Monday to Wednesday, June 15–17, P. Cook (LBNL) prepared the injection double packer system for BFS-B15 and with the help of N. Rentsch, C. Etter, J. Windisch and S. Schefer (swisstopo) lowered it to the target depth of 44.25 m. He attached the new injection packers to the existing system installed at BFS-B2. (**Figure 3**)

MA-A (Modular Platform for Microbial Studies) experiment

- On Tuesday, June 16, A. Brown (NAGRA) and C. Rolland (EPFL) collected 20 L of water from borehole BMA-A2.

SW-A (Large-Scale Sandwich Seal in Opalinus Clay) experiment

- On Friday, June 19, S. Schefer (swisstopo) refilled the HPT from shaft 1.

Varia

- On Monday, June 15, T. Rebetez and J. Compagnon (BKW) installed a special radio antenna cable to connect the electricity meter to the mobile phone network.

Visits

Day	Date	Group Name	Group Size	Visitors Guide
Mon	15.6.2026	CEFF, Moutier	15	R. Nicol (swisstopo)
Tue	16.6.2026	Swiss Nanoscience Institute, University Of Basel	11	R. Nicol (swisstopo)
Tue	16.6.2026	Neue Mitarbeiter Der Nagra	7	M. Kollmann (Nagra)
Wed	17.6.2026	CEJEF, Division Technique	13	R. Nicol (swisstopo)
Thu	18.6.2026	TEIT Technical Group Hungary	14	H. Sager (Nagra)
Thu	18.6.2026	Schule Bern Brunnmatt	48	H. Hauser (freelance) R. Nicol (swisstopo)
Fri	19.6.2026	Familienausflug 60+ T. Leimer	13	R. Nicol (swisstopo)
Sat	20.6.2026	Famille Dominique Marquis	20	J.P. Meusy (freelance)

Figures



Figure 1: DB-B: Starting the hydro tests (S. Schefer, swisstopo)



Figure 2: DB-B: The flow board for the sleeve reopening test (S. Schefer, swisstopo)



Figure 3: FS-B: Lowering the system into BFS-B15 is about to start (S. Schefer, swisstopo)