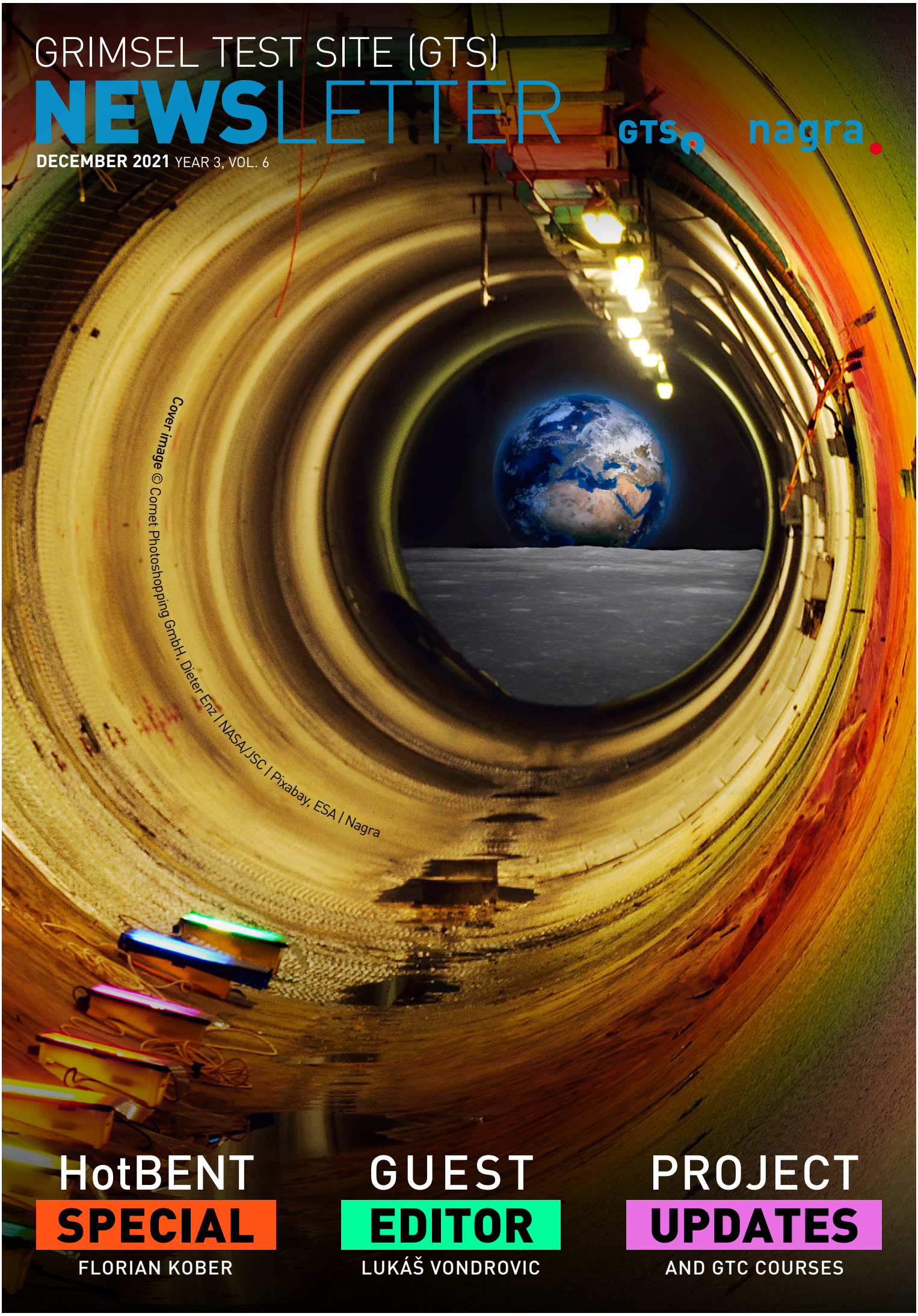
GRIMSEL TEST SITE (GTS)

NEWSLETTER

DECEMBER 2021 YEAR 3, VOL. 6



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HotBENT SPECIAL

FLORIAN KOBER

GUEST EDITOR

LUKÁŠ VONDROVIC

PROJECT UPDATES

AND GTC COURSES

▷ I. BLECHSCHMIDT

Dear colleagues and partners,

The year 2021 is drawing to a close and it is time again to review the last 6 months. Unfortunately, these months were again overshadowed by the ongoing COVID-19 pandemic and many of the originally planned activities could not be carried out as hoped. After almost 2 years of COVID-19-related restrictions, we have become cautious about making predictions and are trying to deal with the situation as best we can and make the best of it.

This year's International Steering Committee Meeting of the GTS partners (ISCO 2021) was held in September (as decided at the beginning of the year), unfortunately only online again. Optimistic as we are, we have planned the next ISCO meeting as a physical meeting in Switzerland for June 2022. Online meetings as information meetings do have their advantages, so it was possible to welcome almost 60 participants from all participating organisations during the technical-scientific sessions and to inform and discuss about the progress in the different projects and future joint activities. The technical part was complemented by the subsequent Executive Meeting of the Grimsel Partner Organisations. Yet, there is certainly a great benefit of physical meetings to discuss new projects or advances in more detail.

In this issue we focus in particular on (i) the successful completion of the installation of the HotBENT experiment - represented by a "pictorial" journey through the last more than 12 months of intensive installation activities, (ii) the start of the circulation of the radioactive tracer cocktail of the CIM project and (iii) the activities in the framework of the Grimsel Training Centre (GTC) with an outlook on the programme in 2022.

We are pleased to inform you that the newly re-designed GTS website (www.grimsel.com) was also launched in September and will continue to provide you with more information about the activities in the laboratory between the GTS newsletters.

We would also like to take this opportunity to thank Lukáš Vondrovic (of SÚRAO, Czech Republic) for his guest editorial contribution in this issue. As SÚRAO's representative in the GTS Executive Group for many years, he and his colleagues have contributed significantly to the success of the research programme in the GTS over the past decade, for which we would like to express our special thanks today.

At the end of this issue, we answer two burning questions: why six potential future astronauts were locked up in the lab for 8 days; and who is actually behind the GTS newsletter.

We hope that you will find the content of the current newsletter interesting and enjoy reading it. And as always, we are looking forward to your feedback.

Yours sincerely,

INGO BLECHSCHMIDT
Head of Grimsel Test Site (GTS)

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SÚRAO, ACTIVE PARTNER OF THE GRIMSEL TEST SITE

▷ L. VONDROVIC

Data obtained from in-situ experiments conducted in underground laboratories play a crucial role in the development of deep geological repositories. In the necessarily highly conservative nuclear industry, underground research laboratories are unique in terms of their high level of innovative and research potential, which can also be applied beyond the nuclear field. The research involves the participation of multidisciplinary and international research teams, whose members consist of a wide range of experts in various fields.

The diversity of views and approaches accompanied by intensive expert discussions and the exchange of knowledge form the foundation for the success of both the underground laboratory research approach and deep geological repository development programmes in general. The know-how that is provided via in-situ experiments in terms of the overall design, initial model assumptions, construction techniques, the commissioning approach, and the monitoring and evaluation of potential changes in the disposal system require unique professional and managerial experience.

The Grimsel underground laboratory fulfils all the aforementioned requirements. SÚRAO, as an active partner of the Grimsel Test Site, has benefited from several decades of continuous research cooperation and, thanks partly to the experience obtained from this underground laboratory, the Czech Republic currently has one of the most advanced deep geological repository programmes in Europe. SÚRAO's ongoing research priorities are fully in line with experiments that are currently underway at Grimsel. Participation in the MaCoTe, LTD and CIM projects is providing invaluable experience and data for the further development of the Czech disposal concept.

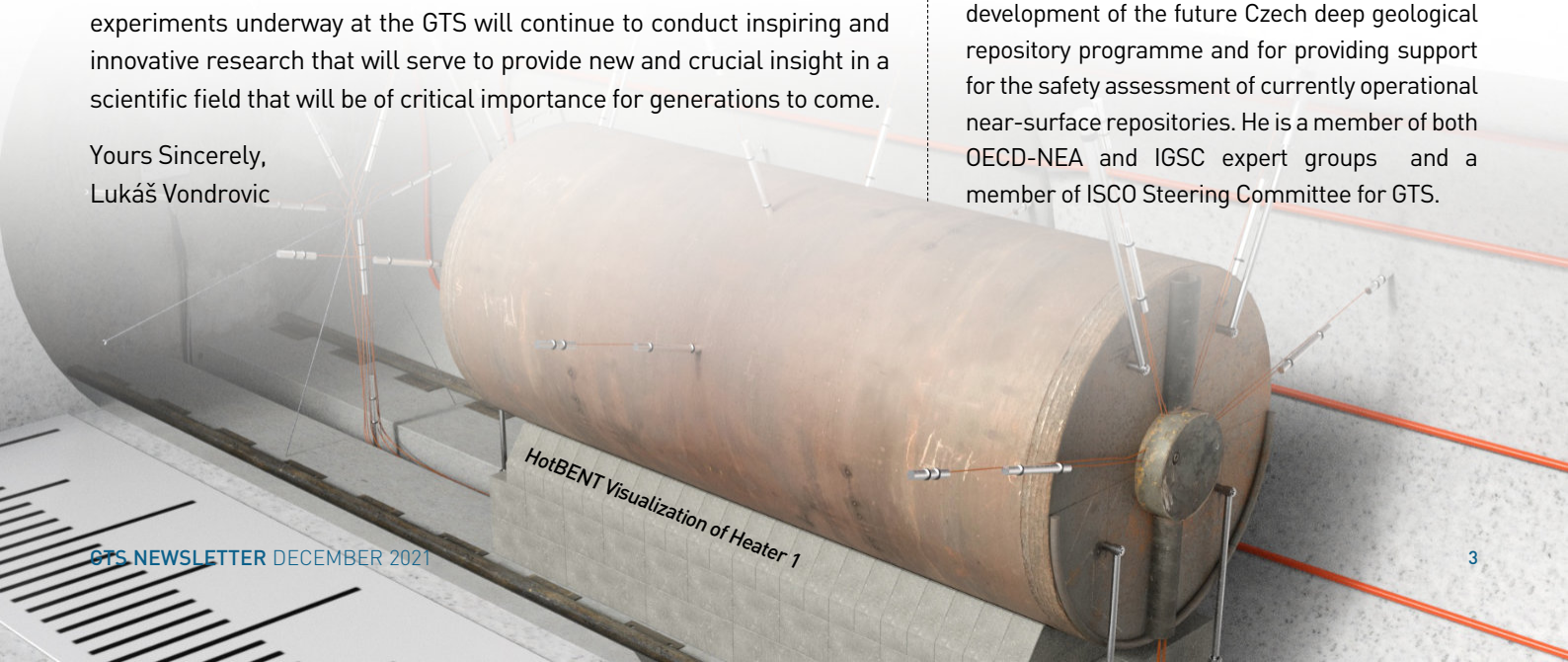
The HotBENT experiment will allow for the verification of both the repository boundary conditions and the degree of conservatism of the parameters that have been applied to repositories constructed in crystalline rock environments for several decades.

I am confident that all the research teams involved in the various experiments underway at the GTS will continue to conduct inspiring and innovative research that will serve to provide new and crucial insight in a scientific field that will be of critical importance for generations to come.

Yours Sincerely,
Lukáš Vondrovic

DR LUKÁŠ VONDROVIC (SÚRAO)

Lukáš Vondrovic holds a Ph.D. in Structural Geology awarded by the Charles University Faculty of Science in Prague. His professional experience is field-oriented geological research related both to geological mapping and the structural analysis of magmatic and metamorphic rocks before moving from the field to the office environment. In 2014 Lukáš Vondrovic became head of the Site Characterisation department at SÚRAO with responsibility for the construction and the early phase of operation of the Bukov Underground Research Facility since 2014. Since 2018, he has been responsible for the development of the future Czech deep geological repository programme and for providing support for the safety assessment of currently operational near-surface repositories. He is a member of both OECD-NEA and IGSC expert groups and a member of ISCO Steering Committee for GTS.



THE HOTBENT PROJECT – EMPLACEMENT

▷ F. KOBER

The HotBENT Experiment has been the focus of the activities at the Grimsel Test Site for the last two years. Here we report on the completion of the emplacement works in late August this year, review the objectives of HotBENT and let revue some major milestones from these last two years.

The main goal of HotBENT is to expand the understanding and databases of the behavior of clay-based technical barrier systems (EBS) at high temperatures (i.e. over 150 °C at the heater surface).

It is motivated by the efforts to optimize a repository (in terms of design, space and costs), for which supporting information is required. We are delighted to have completed the onsite works successfully, almost in time without any major incident.

HotBENT is an international GTS Partner Project jointly funded by the WMO's*: SÚRAO (CZ), NUMO (JP), RWM (GB), US-DOE (US), BGE (D), BGR (D), NWMO (CA), ENRESA (ES), and Nagra (CH) and supported by further organisations: BGR (D), Obayashi (JP).

**WMO = Waste Management Organisation*

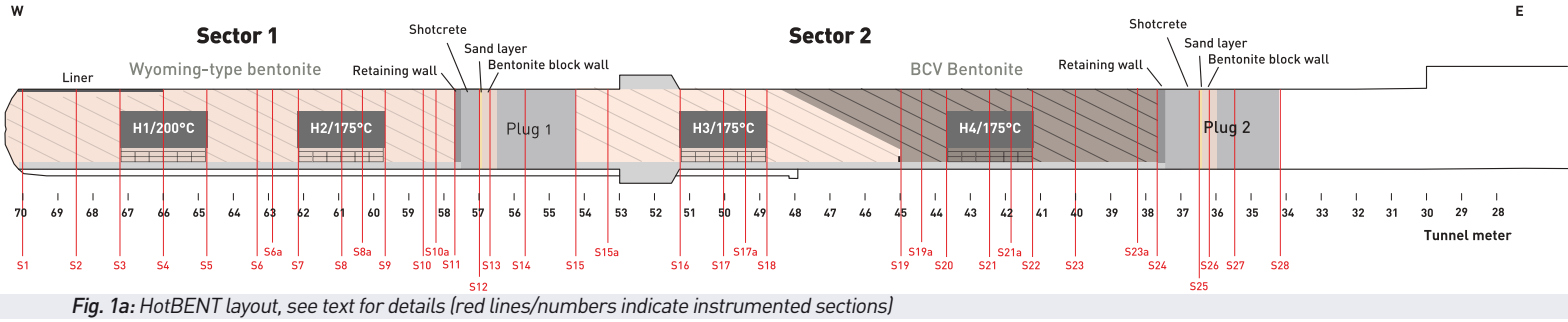


Fig. 1a: HotBENT layout, see text for details (red lines/numbers indicate instrumented sections)

HOTBENT WILL PROVIDE INFORMATION AND KNOWLEDGE BY

- studying the effects of high thermal loading (→ 175 / 200 °C) at a canister/heater's surface on the performance of bentonite and/or bentonite mixtures as buffer materials considering repository-relevant scales, gradients and in-situ conditions.
- investigating the chemical behaviour of an EBS that can be described with the models and data from existing, laboratory scale investigations at higher temperatures.
- enhancing the existing databases and the understanding of buffer performance under such high temperatures, in particular in terms of robustness with respect to assessing the effect on the generally agreed safety functions.
- scrutinizing current conceptual and numerical models have sufficient predictive power and describing the major prevailing processes.

The constructed HotBENT Experiment consists of 4 heaters in two sectors with an intermediate and a final sandwich plug as is shown in Fig. 1a layout and 1b for location. The construction of two sectors will allow a partial dismantling of Sector 2 (dismantling planned after 5 years of heating) without perturbation (hydration/saturation) of Sector 1, which is due for dismantling after a heating and hydration phase after about 20 years, as modelling indicated that these timescales are needed for investigating the THMC-objectives for the ambient conditions at GTS.

Currently, the temperature of the 4 heaters are ramped up to their planned target (surface) temperatures of 175 and 200°C.

Ramping is done in ~50°C steps to calibrate the heating management as well as to provide data for model calibrations.

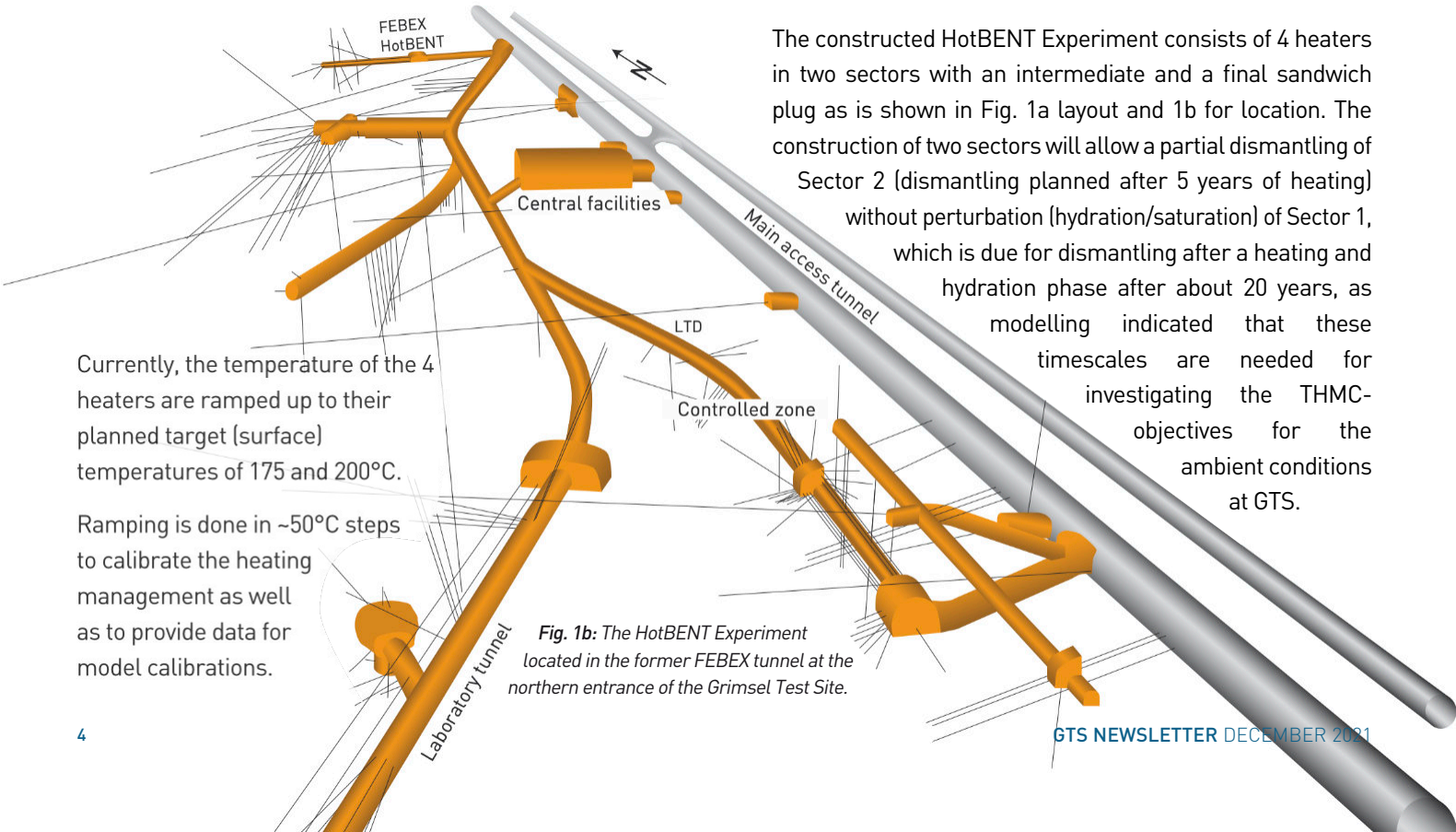


Fig. 1b: The HotBENT Experiment located in the former FEBEX tunnel at the northern entrance of the Grimsel Test Site.

ON-SITE ACTIVITIES OF THE LAST 2 YEARS OF THE HOTBENT INSTALLATION

▷ F. KOBER

DECEMBER 2019 TO FEBRUARY 2020

Removal of all remnants of FEBEX floor and concrete works in former FEBEX gallery.

MAY 2020 TO JUNE 2020

Drilling of 4, 40 m long, 86 mm diameter boreholes, parallel to the FEBEX drift in ~1m distance of the gallery. These boreholes will be used for regulating the geosphere background pressure (elevated pressures up to 2 MPa are considered) as well as monitoring the nearfield with sensors. Modelling has shown that elevated background pressures will subdue boiling phenomena within the buffer as well as it will reduce the time needed to full saturation.

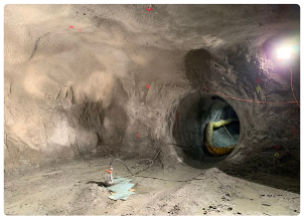







MARCH 2020 TO APRIL 2020

Construction of a HotBENT cavern using the drill-blast method. A cavern of ~ 140 m³ was excavated. The cavern was created for various purposes: start of the enhanced geosphere pressurization boreholes (EGPB), temporary transfer-site for emplacement machinery, location of the data acquisition system cabinets for the more than 1400 installed sensors.

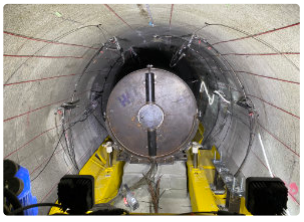



JULY 2020 TO AUGUST 2020

Low-pH - concrete works: a new floor within the gallery and the newly created cavern was constructed. Furthermore, a partially reinforced 8 cm thick shotcrete liner for experimental purposes at tunnel meter 66-70 was sprayed. Finally, all voids existing from former FEBEX constructions (e.g. former recess FEBEX plug) were filled.


SEPTEMBER 2020 TO DECEMBER 2020

Emplacement of Sector 1: This sector, comprising the backend of the experiment encompasses 2 modules, whereby a module consists of a heater resting on compacted Wyoming-type bentonite blocks that are surrounded by Wyoming-type granular bentonite material (GBM). While heater H1 will be managed at 200°C, heater H2, will be managed at 175°C – at the heaters surface. Sector 1 is anticipated to run for 20 years of heating – hydration conditions. Each module is instrumented with ~350 point measurement sensors including measured parameters such as temperature, relative humidity and various types of pressures. Sector 1 was closed prior to Christmas 2020 with a retaining wall.




ON-SITE ACTIVITIES OF THE LAST 2 YEARS OF THE HOTBENT INSTALLATION

▷ F. KOBER

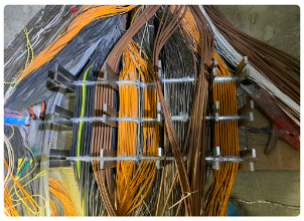
JANUARY 2021 TO MARCH 2021

In preparation of the sandwich plug construction for Sector 1, all cables (~700) were fed trough a resin-closed cable box. Following a first shotcrete layer installation, a sand layer and a bentonite block (the "sandwich" part of the plug) were constructed, after which another ~2 m of shotcrete were sprayed. Afterwards some additional cable channel cutting with in the gallery and cavern were performed, to ensure a proper cable housing to the data acquisition system (DAS) cabinets in the HotBENT cavern.



JULY 2021 TO AUGUST 2021

Similar to Plug 1 of Sector 1, all cables (now ~1400 cables from Sectors 1 & 2) had to be guided through a resin-filled cable box, which was constructed prior to shotcreting activities. Following this, the sequence of construction of shotcrete - sand layer - bentonite block wall and shotcrete layers as for Sector 1 was performed.



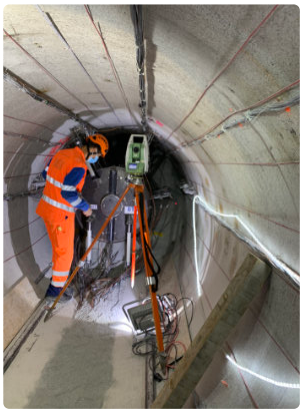

AUGUST 30th 2021

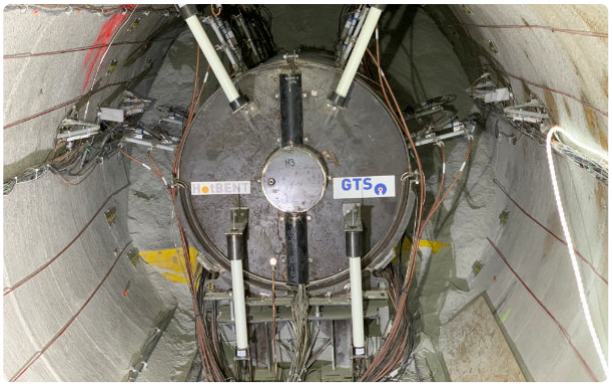
Finally, on August 30th, 2021, the Emplacement works were completed and shortly after, the last sensors (displacement sensors of Plug 2) were mounted.

APRIL 2021 TO JUNE 2021

Sector 2 was constructed in roughly 3 months, following the same procedures as for Sector 1. The only difference is that Module 3 (Heater 3) is a comparable module to Module 1 & 2 made of Wyoming bentonite blocks and Wyoming type granular bentonite material, which is different to module 4 (Heater 4), that was constructed by Czech BCV (Bentonite Černý Vrch) type compacted blocks and granular bentonite material. Sector 2 was also closed by erecting a retaining wall.





CARBON-14 AND IODINE-129 MIGRATION IN CEMENT (CIM) EXPERIMENT

▷ A. MARTIN

Calculated Carbon-14 and Iodine-129 released from L/ILW and TRU waste repositories typically contribute the most to dose rates over the long-term (10 ka to 100 ka). This is primarily due to the combination of (i) high solubility and (ii) low sorption properties of the chemical forms that the two radionuclides are expected to exist in. In the case of C-14, experimental work on the speciation of carbon during corrosion of activated and none-activated steel under anoxic conditions similar to that of an emplacement tunnel showed the formation of oxygenated and reduced hydrocarbons, including carboxylic acids and methane.

Methane is not expected to react with cementitious material or with the host rock. Uncertainties remain, however, on the retardation of carboxylic acids in clay and cementitious materials. In the case of formic acid, so far, no retardation is expected in near-neutral environments; however, laboratory experiments at PSI showed evidence of weak sorption of formic acid on cementitious material.

I-129 originates largely from reprocessed waste and is expected to occur mostly as iodide. Although large amounts of cementitious material will be used in L/ILW and TRU waste repositories, it is still not known whether cementitious materials retard I-129 and C-14 species under in-situ conditions, especially in naturally aged cement on the field scale.

THE MAIN AIMS OF THE EXPERIMENT

- Simulate the transport of C-14 and I-129 through aged cementitious backfill of a L/ILW or TRU waste repository and into the saturated host rock
- Provide confirmation on the effect of cementitious on material retarding C-14 and I-129
- Further improve the process understanding of the behaviour of C-14 and I-129 under real in-situ conditions
- Develop a method to upscale the results obtained from extensive laboratory-based migration studies to the field/disposal tunnel scale.

Radionuclide	Species
C-14	Formate HCOO$^-$
I-129	Iodide I$^-$
H-3	HTO
Cl-36	Cl$^-$
Cs-134	Cs$^+$
Ba-133	Ba^{2+}

Table 1: Radionuclides used in the CIM experiment

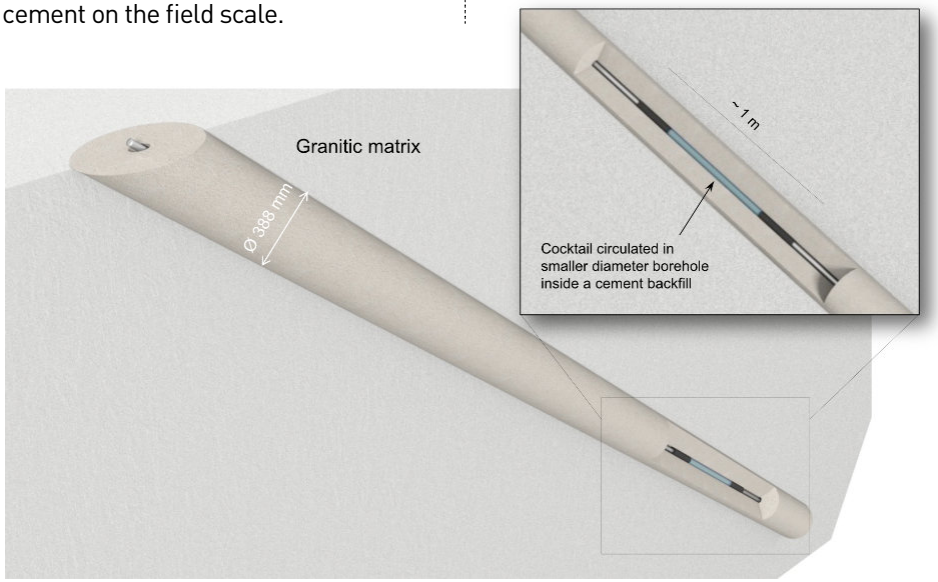


Fig. 1: Experimental concept of CIM

EXPERIMENT CONCEPT

A large diameter (388 mm) borehole backfilled with ordinary Portland cement mortar is being used as a proxy for cementitious material used as backfill and/or support material in L/ILW or TRU waste repositories. In the centre of the mortar backfill, a small diameter (56 mm) borehole (Figure 1) was drilled and equipped with a multi-packer system for the circulation of the radionuclide cocktail (Table 1).

CARBON-14 AND IODINE-129 MIGRATION IN CEMENT (CIM) EXPERIMENT

▷ A. MARTIN

Fig. 2 a, b: *CIM surface cabinet. The radionuclides are contained in the white tank in the bottom left of the photograph.*

The circulation interval is connected to surface equipment (Figure 2 a, b), allowing for continuous monitoring of the fluid composition by online sensors and sampling. Monitoring focuses on activities of the injected radionuclides, chemistry, and microbiology. Three monitoring boreholes drilled at relatively short distance (ca 15 cm) from the circulation borehole are used to monitor the progress of the weakest sorbing compounds in the rock.

The radionuclide cocktail was delivered to the GTS on 30th August 2021 (Figure 3) and circulation was started shortly afterwards. Samples taken after the first two months of circulation are currently being analysed at PSI.

Based on the results from the experiment monitoring and discussions between the partners (NUMO, RWM, SÚRAO, BASE and Nagra), the date for the over-coring of the in-situ experiment for the purpose of analysing diffusion profiles in the mortar and in the granite will be decided at the end of 2022.

Fig. 3: *Delivery of the radionuclide cocktail on 30th August 2021.*

PROJECT	DESCRIPTION
CFM i-BET Colloid Formation and Migration **I. Blechschmidt**	i-BET (in-situ Bentonite Erosion Test) was implemented in a fractured zone in granitic host rock for 2.5 years. The test is focused on erosion of bentonite in a natural environment. Saturation of the bentonite rings is ongoing, the total pressure cells that are part of the experimental setup record swelling pressures. Saturation of the bentonite blocks from formation water stemming is almost complete. However, the variance in the recorded data of the relative humidity sensors indicates that the saturation is heterogeneous. Current efforts are focusing on understanding the geochemical interactions occurring between the bentonite source and the surrounding Grimsel groundwater. Colloid concentrations in the sampled groundwater were/have been analysed by nanoparticle tracking analysis (NTA) by FSU Jena and showed largest average colloid size in the borehole beneath the bentonite source. Special recirculation tests were carried out to potentially mobilise larger grains in the monitoring intervals. Analyses of the re-mobilisation tests are ongoing.
CFM LIT Colloid Formation and Migration **I. Blechschmidt**	LIT (Long-term In-situ Test) after running for 4.5 years (radionuclide-spiked bentonite source intersecting a shear zone) was successfully overcored in early 2019 and subsampled to 5 cm thick 300 mm diameter slices (non-active). Those slices were further subsampled in two laboratories (KIT-INE and Ciemat) to test the subsampling strategy and give feedback to the optimal cutting strategy of the 300 mm diameter core (consisting of granite, carbon steel, bentonite + radionuclides and granite). Based on the experience of the first slices, the remaining slices were cut. One slice of 10 cm was cut containing the RN-spiked bentonite and one 7 cm thick slice containing the MI shear zone which will be sent soon for laboratory analysis to the partners. A larger maintenance of the CFM MI site is ongoing including the de-watering of the mega-packer and a thorough inspection of the resin seal of the shear zone and of all surface packers.
CIM ^{14}C and ^{129}I Migration **A. Martin**	See highlight section.
GAST GAs-permeable Seal Test **A. Reinicke**	The preparations for the Gas Flow Test (GFT) are far progressed. The GAST system is ready for gas injection and extraction including tracer placement and sampling of water and gas. A system has been designed that allows for detection of gas leakage as well as online sampling and detection of gas transported through the engineered barrier. As part of the preparations, phases of the GFT have been modelled to estimate parameters like gas breakthrough times, pumped volumes, and flow rates for the purpose of an appropriate test system design. Recently, the new THM modelling campaign has been kicked off delivering a numerical representation of GAST to assess the THM status before and during the gas test and derive information about the evolving gas path.
HotBENT High Temperature BENTonite **F. Kober**	See highlight section.
SET Borehole Sealing Test **T. Kunimaru (R. Schneeberger)**	The borehole sealing test (SET), led by NUMO, will study the performance of a Kunigel V1 based borehole seal at a realistic scale. The test aims at characterizing the saturation development, the swelling pressure and the hydraulic conductivity of the borehole seal in a vertical setting within crystalline bedrock. The field activities were initiated with the preparation (enlargement and drilling) of two vertical boreholes in the southern part of GTS. In the boreholes, which are accessible from both ends, a 1.0 m thick plug confined by a packer above and one below, will be emplaced and tested. Final design of the instrumentation and packer systems is on-going and manufacturing will start early next year. Installation of the seals and the system is planned in the first part of next year.
BAMODA (LASMO++) BAseline MOnitoring and DAta **R. Schneeberger**	Following the successful completion of the LASMO project (Large Scale Monitoring, see previous GTS newsletters or NTB 19-01), the baseline monitoring program of hydraulic pressure and geodetic data has continued. In the process, the GTS database is continuously expanded with the data from the baseline monitoring and the relevant data generated in the experiments. Furthermore, the data collection enables testing and updating of exiting models (e.g., hydrological, structural, geotechnical, etc.). Routine measurements are automated and carried out regularly, while there is also a constant effort to use or test new techniques and methods. The GTS partners are invited to discuss these possibilities with us and also to contribute their own ideas.
LTD Long Term Diffusion **A. Martin**	The design of the surface equipment of the in-situ radionuclide migration test was finalised and fabrication of the equipment has started. The first injection will be HTO and Na-22 at the beginning of 2022. Based on the results of the first injection, a second injection test involving HTO and possibly also Cl-36 will be carried out later in the year. Both injections will provide information on the hydraulic and channelling characteristics of the target fracture. A third and final injection will contain sorbing radionuclides (Ni-63, Cs-134 and Ba-133) which will be carried out a few weeks prior to overcoring in 2023.
MaCoTe Material Corrosion Test **A. Martin**	Detailed analysis of 4.5 year-modules are being finalised in both the non-heated and heated experiments. Throughout the year water samples were taken for microbial analysis by the Technical University of Liberec from all five boreholes of the heated experiment. Additional modules containing candidate canister materials from NUMO (Japan), KIT (Germany) and KIGAM (South Korea) were inserted into the non-heated test borehole on 2nd November 2021. During the insertion the 7-year module pair was retrieved and sent to the Jacobs Harwell labs for analysis.

DATE	DESCRIPTION

30.08.2021 to 01.09.2021
at the GTS
3 days

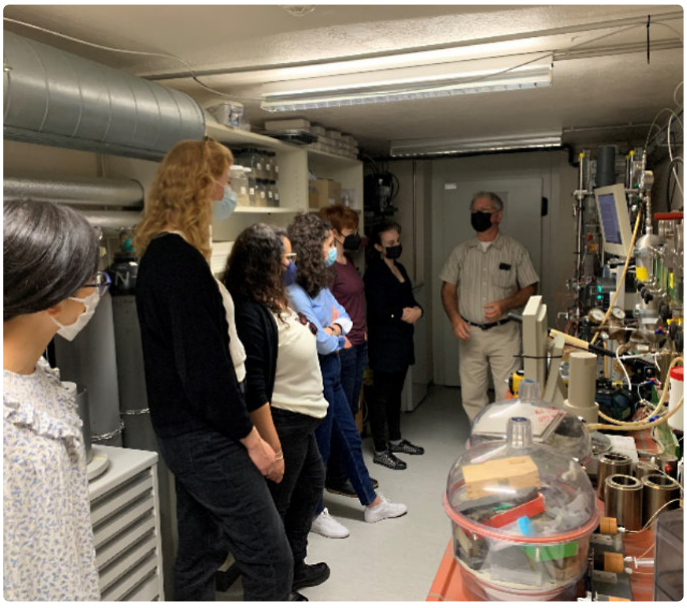
USE OF RADIOACTIVE TRACERS IN URL EXPERIMENTS (INPUT TO SAFETY CASES)

The course "Use of radioactive tracers in URL experiments (input to safety cases) was attended by participants from Europe. Tutors came from Spain and Switzerland. The first day provided an overview of the ongoing experiments using radionuclides at the Grimsel Test Site. The focus on the second day was on radiochemistry and how to select radionuclides and activities to be used in in-situ tests. There was a combination of lectures and group exercises. On the final day participants learned about radionuclide migration modelling used in safety assessment calculations. There was a lot to learn in three days, but students thoroughly enjoyed themselves.

06.09.2021 to 10.09.2021
at the GTS
1 week

ENGINEERED BARRIER SYSTEM (EBS) BENTONITE PROPERTIES AND APPLICATIONS

The course "Engineered Barrier System (EBS) Bentonite properties and applications" was attended by participants from different European countries, who were taught by international experts in the various fields of bentonite application in radioactive waste concepts. The lecture program was complemented by numerous visits to the various GTS experiments to link theory with practice. A laboratory visit to the University of Bern was extended with a cultural program and a tour of in the city of Bern; short excursions to the Grimsel region between modules provided nice breaks (and were very popular). It is planned to hold this course again in 2023.



DATE	DESCRIPTION
30.08.2022 to 01.09.2022 at the GTS 3 days	**FROM RD&D REQUIREMENTS TO IN-SITU EXPERIMENTS - HOW TO DESIGN AND SETUP URL EXPERIMENTS** This course will teach participants how to manage and design URL experiments ranging from relatively small experiments with one or two boreholes up to large scale experiments testing and demonstrating the performance of EBS component(s). The use of radioactive tracers in URL experiments (input for safety cases) will also be covered in the course, as well as lessons learned from designing and running URL experiments at Swiss URLs.
MODULE 1: **05.09.2022 to 07.09.2022** at the GTS 3 days MODULE 2: **08.09.2022 to 09.09.2022** at the GTS 2 days	This course is divided into two modules. Although both modules are linked, it is possible for participants to attend one module only. **SITE SELECTION OF DEEP GEOLOGICAL REPOSITORIES - PROCESSES AND METHODOLOGIES** This module (3 days) will familiarize students with the main approaches used for selecting sites for radioactive waste repositories. It will include an overview of Nagra's own experience and recent staged approach starting from a 'white' map. Site selection programmes developed in other countries from around the world will also be evaluated and compared from both technical and social-political points of views. Students will also learn about important lessons learned and key aspects to be considered when designing a site-selection programme. **GEOLOGICAL AND GEOPHYSICAL DATA COLLECTION** This module (2 days) will teach about data collection techniques mainly from surface based geophysics and borehole investigations.
19.09.2022 to 21.09.2022 at the GTS 3 days	**DATA MANAGEMENT** Data and data management tools are both expanding rapidly. The radioactive waste business is no exception. It is very important for scientists, engineers, and managers alike working in the radioactive waste management business to know how to handle large amounts of geological and geophysical data. This course will teach participants the basics of data management systems, the different data types used in radioactive waste management and the concept of metadata (including searchability, accessibility, localizability). Students will also gain familiarity by performing exercises using Nagra's data management tools.

A detailed course schedule for the above courses will be available in early 2022 and will be posted on the GTC website: www.grimsel.com/grimsel-training-centre-gtc

We are happy to discuss any needs and interests for additional courses or workshops be it custom made or general - please contact us.

Previous GTC course on Engineered Barrier System Bentonite properties and applications. © Nagra / Grimsel Team, Switzerland

ASCLEPIOS First Simulated Moon Walk

WHERE RADIOACTIVE WASTE DISPOSAL ASPECTS ARE BEING INVESTIGATED, "ASTRONAUTS" DARED THEIR FIRST SIMULATED MOON WALK IN MID-JULY

After long planning and preparation, the time had finally come on 12th July this year for 6 analog astronauts to move into the GTS for 8 days as part of the Asclepios I Analogue Space Mission (replication of Moon and Mars environments for the simulation of space missions). Asclepios is an international student project that is organised by the École polytechnique fédérale de Lausanne (EPFL) under the umbrella of the student organisation "Space@yourService", whose main goal is to popularise and promote space science.

The Asclepios I project involved over 100 students from a wide range of countries. The analogue astronauts were selected in advance according to a similar scheme as the astronauts of the European Space Agency (ESA) and trained over a longer period of time before the 6 selected moved into a simulated Moon base in the Grimsel Test Site area. The AU Gallery (southern part) in the rock laboratory was transformed by the GTS team into an impressive lunar habitat for the duration of the mission, so that the analogue astronauts could live and work under the most realistic conditions possible in isolation about 500 m below surface. At the same time, a mission control centre (MCC) was set up in the school of the municipality of Guttannen down the valley, where about 25 students worked in shifts to remotely guide and support the analogue moon mission around the clock.

Mission control centre (MCC). © Comet Photoshopping GmbH, Dieter Enz.

The experiments, that were selected during the project preparation as part of an international tender, involved for example, the production of bioplastics, the filtration of soil for future agriculture on Mars or the Moon, and geological mapping and geophysical investigations to explore unknown terrain. The astronauts themselves were also the focus of the scientific investigations. Their behaviour and well-being was constantly monitored and appropriate tests were carried out to gather knowledge about the effects of the isolation and the restricted working and living conditions. The mission also included simulated extra-vehicular activities (EVA) to conduct experiments outside the moon habitat and to train behaviour in a hostile environment. All activities during the 8 days followed a strict flight plan, which was constantly controlled and updated by the MCC.

Among many other organisations, the project was actively supported locally by the municipality of Guttannen, Grimsel Hydro and Nagra-GTS. Similar to the Grimsel projects, the cooperation of scientists from different countries and disciplines in the Asclepios projects is also the basis to meet the challenges of our time and to successfully achieve common goals.

Last advise by Claude Nicollier.

On the 20th of July, after a successful Asclepios 1-mission and numerous challenges - both planned and unplanned - the six astronauts were able to leave the lunar habitat on the Grimsel and celebrate the successful completion of the mission with a (car)landing in Guttannen together with all those involved.

For us, this project was another opportunity to open our underground laboratory to innovative projects and committed young scientists from outside our core topic of radioactive waste management and to pass on our many years of experience across disciplines while making our facilities accessible to a broader public.

- **ASCLEPIOS:** A student-led space mission analog simulating a mission on another celestial body, for educational and research purposes.
- **PARTNERS:** S@yS - EPFL

Test of air lock and space suits for the planned EVAs. © Elfie Roy, Asclepios I Project

GTS Newsletter

THE TEAM BEHIND IT

Since the launch of the GTS Newsletter in spring 2019, a team of 4 Nagra GTS colleagues has been editorially responsible for the newsletter. The aim of the GTS Newsletter is to "regularly report on important activities in GTS and to bring the flair of working underground" closer to the GTS community from all over the world.

We distribute the GTS Newsletter by e-mail, publish it at the GTS website (www.grimsel.com) as well as on various social media platforms, hoping to reach a wide audience.

The team behind the scenes tries to create the GTS Newsletter in an interesting, appealing and hopefully entertaining way every time.


Ingo Blechschmidt


Florian Kober


Raphael Schneeberger


Andrea Wettstein-De Marco


Cumhur Yörük

Since public relations is not part of our everyday core business, it is nevertheless an interesting and rewarding effort to bring the sometimes complex GTS projects and results closer to a wider audience in a simple and rather unconventional framework, not to mention some funny moments during the inspired phases of creating the newsletter. Fortunately, the product always ends up looking much better than the sometimes hectic, busy weeks leading up to the publication of a new issue would suggest.

Finally, we would like to thank all those who contribute to the content of the Newsletter, be it Nagra's internal colleagues or external colleagues who support us, for example, with regular guest contributions. At this point we would like to motivate the Grimsel community to contact us if there is interest in contributing a thematically appropriate article to one of our next newsletters. This would be very welcome.

GTS Information . MISCELLANEOUS

GTS Website	The GTS virtual tour was recently extended: www.grimsel.com/Virtual_Tours/
GTS Publications	Please visit our GTS publication area to find the most recent updates on reports and publications: www.grimsel.com/media-and-downloads/grimsel-test-site-publications-list
GTS Meetings	Planned upcoming GTS project meetings and GTC activities are online now.
GTS Links	News from the Swiss national programme: www.nagra.ch/en/
GTC Programme	The GTC programme is available under: www.grimsel.com/grimsel-training-centre-gtc

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