GRIMSEL TEST SITE (GTS)

NEWSLETTER

DECEMBER 2020 YEAR 2, VOL. 4

GTS nagra.

GUEST EDITOR: DR. IRINA GAUS

GTS NEWS AND CURRENT ACTIVITIES

GTS PROJECT UPDATES • GTC COURSES 2021

© Nagra / Grimsel Team, Switzerland

News and Activities . EDITOR'S NOTE

Dear colleagues and partners,

In what is becoming a bit of a tradition, we are very glad to send you the second and final Newsletter for this year, "just in time", on our last working day.

Right at the beginning I would like to thank my colleagues who have contributed to this newsletter. As for many of us, this year has evolved differently than planned. After the short-lived relief in the summer, the virus caught up again with us in the second half of the year. Given the impact of the COVID-19 pandemic, which has already caused much suffering and pushed social life to its limits, it is not that easy to distil the positive out of this year. Nevertheless, such challenges often reveal our strengths better than any other situation. We are very pleased to report that the Grimsel team has been able to maintain operations at the Grimsel Test Site and achieve the important milestones in this very challenging year. We believe that we have been able to meet our partners' expectations despite these circumstances. Some activities had to be postponed to next year, most notably the training programme of the Grimsel Training Centre, which could not be carried out as planned. After the short break and rest of the Christmas season, we will resume in 2021 with the same energy and enthusiasm that colleagues and partners know and expect from us.

For GTS, 2020 – especially the second half of it – was the year of the HotBENT experiment, which was started on schedule thanks to the tremendous efforts of an excellent international project team. Further information is given on the following pages.

Furthermore, we are pleased to welcome the Federal Office for the Safety of Nuclear Waste Management (BASE), the German regulator, which decided to participate in the GTS activities starting from this year.

Finally, I would also like to thank our colleague Irina Gaus - RD&D coordinator at Nagra - for her guest editorial contribution.

Yours sincerely,

Ingo Blechschmidt
Head of the Grimsel Test Site (GTS)

We are glad to provide you with our 4th newsletter with information on our activities at the GTS and to continue bringing the "**flavour of working underground**" closer to you at the end of this challenging year.

Stay healthy!

THE GRIMSEL TEST SITE (GTS)
INTERNATIONAL UNDERGROUND RESEARCH LABORATORY

✎ www.grimsel.com
Tel + 41 (0)56 437 1216
ingo.blechschmidt@nagra.ch

Guest Editorial

"Radioactive waste disposal RD&D is international and should be international."

The sheer uniqueness of the projects, the long-term horizons for implementing them and the societal need to develop solutions in many countries, each acting within their own cultural and regulatory framework, requires this. These solutions will serve the environmental and energy transition that our society is facing today.

Somewhat less visible than new policies and international agreements is the work on the ground – or also under ground – taking place in the various waste management organisations supported by a network of industrial partners and research institutes.

This work is constantly striving to finetune our safety cases as well as optimise the multibillion projects that disposal projects are. Underground research facilities are an essential part of that. It is here that concepts are validated, new equipment is being tested, 1:1 demonstrators are being constructed and new generations can get to grips with what is required for safe and optimised disposal of radioactive waste. Nagra has followed this international path already many decades ago and the Grimsel Test Site is an excellent example of what can be achieved to encourage and maintain international collaboration. It brings together radioactive waste programmes in all stages (from the generic stage to those actually constructing repositories) around experiments that capture the edge of science in various aspects. When I started at Nagra, I managed the FEBEX project for some years, taking over and learning from the vast experience of our Spanish colleagues and the international consortia that shaped it. The subsequent dismantling after 16 years and the current construction of the HotBENT makes this three-decade endeavour unique. It is now lead by a new generation of excellent scientists, incorporating the need for optimisation in our repository programmes, and continuing and enjoying the international spirit that is so important in our business.

Yours sincerely,

Irina Gaus

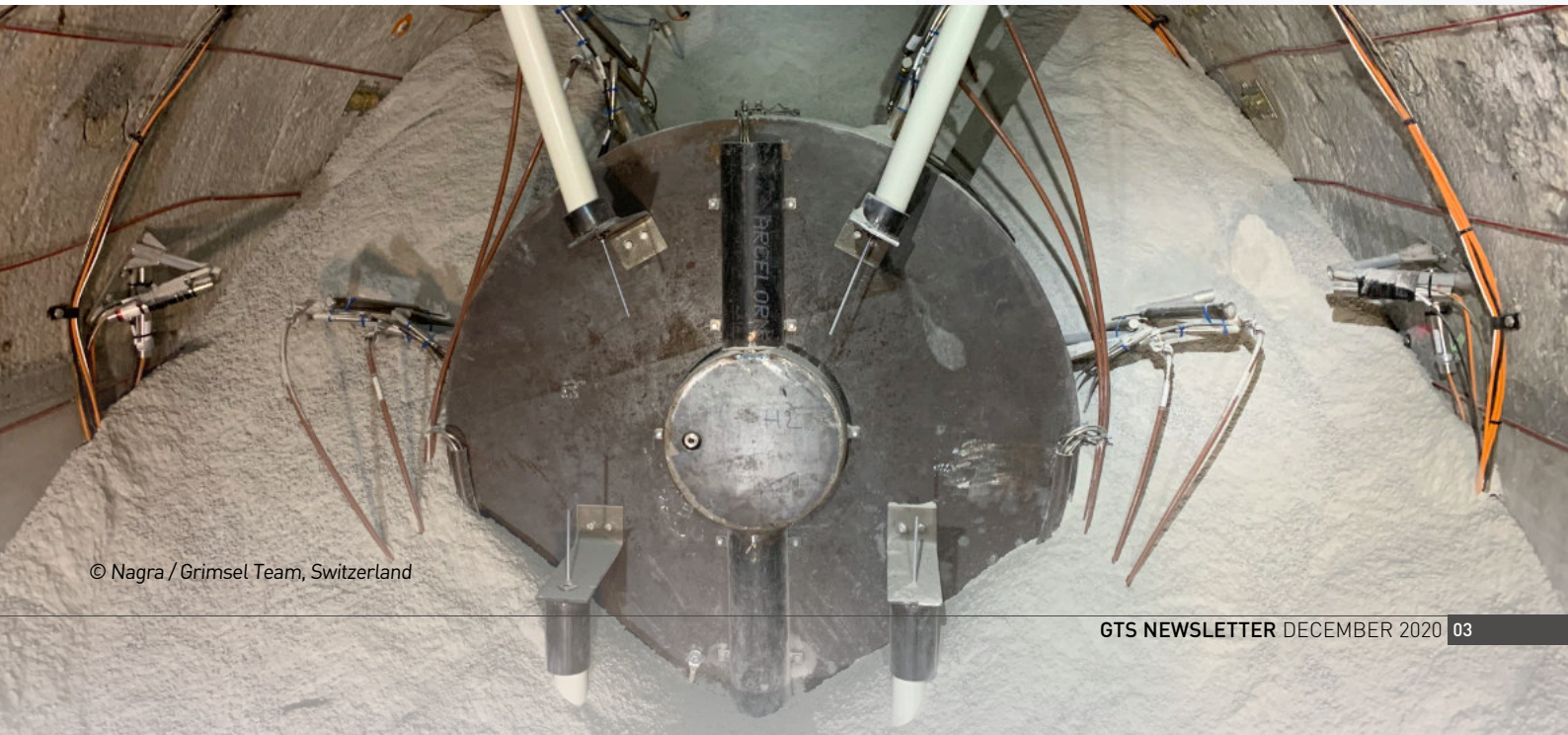
© Nagra / Grimsel Team, Switzerland

Dr. Irina Gaus

Dr. Irina Gaus is Head of Research and Development at Nagra, after holding the position of Project Manager Geosciences in the International Services and Projects Division for 7 years.

Trained as a geologist with a specialisation in hydrogeology at the University of Ghent (Belgium) Irina's expertise developed in the areas of coupled processes, conceptualisation of geological data, groundwater circulation, geostatistics as well as carbon capture and storage through employment with the British Geological Survey (BGS) and the French Geological Survey (BRGM). This expertise then expanded into various areas of radioactive waste management, including THMC behaviour of engineered and natural barrier systems and RD&D strategy and management.

Since 2019, Irina has served as Chair of the IGD-TP Executive Group (Implementing Geological Disposal of radioactive waste Technology Platform).



© Nagra / Grimsel Team, Switzerland

HotBENT

Bentonite at high temperatures

F. Kober

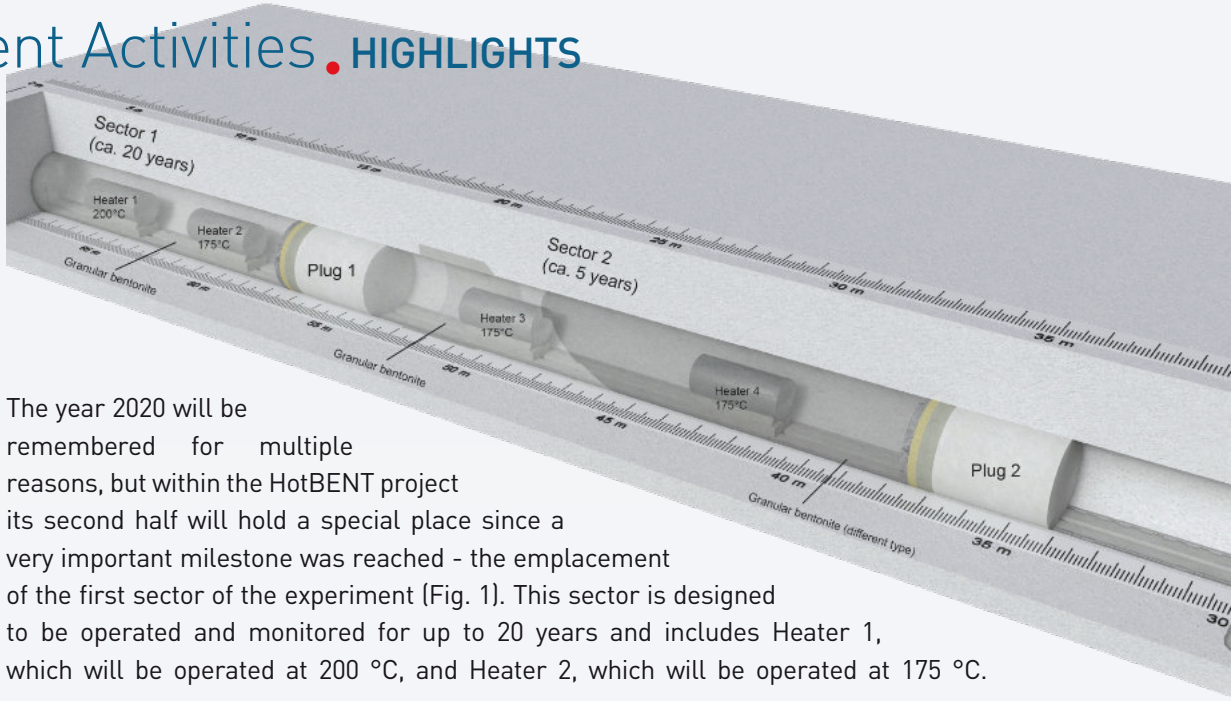


Fig. 1: General overview of HotBENT

The year 2020 will be remembered for multiple reasons, but within the HotBENT project its second half will hold a special place since a very important milestone was reached - the emplacement of the first sector of the experiment (Fig. 1). This sector is designed to be operated and monitored for up to 20 years and includes Heater 1, which will be operated at 200 °C, and Heater 2, which will be operated at 175 °C.

The entire HotBENT project is subdivided in work packages, four of which will be highlighted: preparatory works, bentonite material, auger, instrumentation. Work package 1 is dedicated to the site preparation works and was already introduced in the last newsletter with all activities related to the excavation of the HotBENT niche. Additionally, four enhanced geosphere pressurization boreholes were drilled subparallel to the gallery. They will be used to enhance the hydraulic pressure in the near field of the experiment. The preparatory works included also the concrete floor in the gallery and the rails (Fig. 2) along the whole tunnel length for the backfilling machine (Fig. 4).

Fig 2: Rail tracks for the auger machine in the emplacement gallery (left) and the niche (right)

© Nagra / Grimsel Team, Switzerland

Work package 2 consists of all activities related to the bentonite used in the experiment. Two different types of bentonite have been used. The majority of the experiment, namely 3 of the heaters, will be filled with Wyoming-type bentonite granular material (GBM), whereas the 4th heater will be backfilled with the Czech bentonite Černý Vrch (see Fig. 1). Heaters rest on pedestal made of rectangular blocks and curved blocks (Fig. 3) of the same material as the surrounding GBM.

The space between the tunnel wall and the heater and the bentonite blocks pedestals is filled with granular bentonite material using the Auger machine. A total of over 200 tons of GBM were produced and transported to the GTS. The backfilling of Sector 1 (Fig. 1) will be successfully achieved before Christmas.

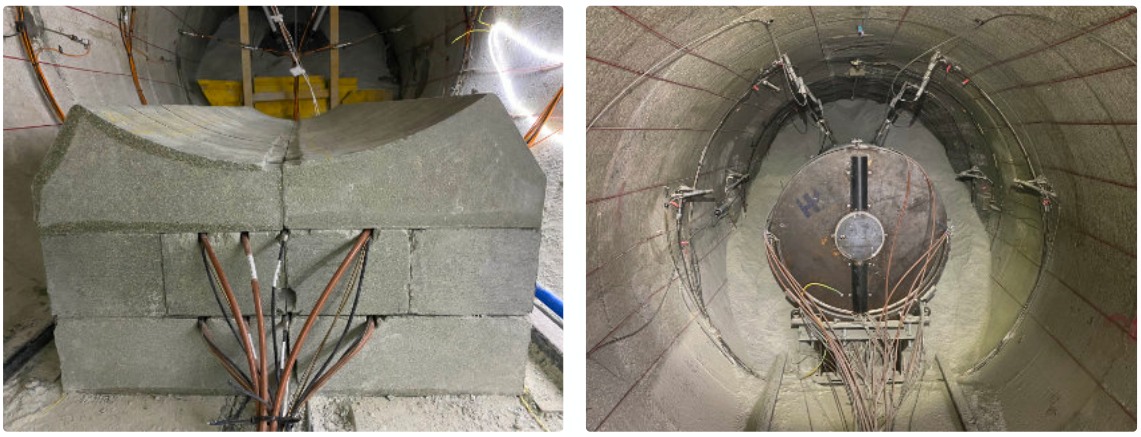


Fig. 3:
Pedestal 2 (left); heater 1 resting on the bentonite block pedestal partially backfilled with GBM and with mounted sensor installation at the tunnel wall and the heater in the front part (right)

© Nagra / Grimsel Team, Switzerland

Within the frame of the work package 3, the backfilling machine, which was initially constructed within the LUCOEX programme for the FE Experiment running in the Mont Terri underground research laboratory (www.mont-terri.ch), was adapted to the smaller diameter of the gallery at the GTS and tested. The backfilling machine consists of two parts. The front part consists of an independent unit of five screw conveyors (also referred to as auger machine) that transport the GBM into the slope being backfilled (Fig. 4, left). The rear part is the transport trolley that delivers the GBM in big bags to the auger machine and can also be alternatively used to transport the heater onto the pedestal (Fig. 4, right).

Fig. 4:
auger machine (left); transport trolley with the Heater 1 shortly before emplacement (right)

© Comet Photoshopping GmbH, Dieter Enz

The work package 4 is dedicated to the instrumentation of the entire experiment. In total, over 1300 sensors will be mounted, that will deliver monitoring data for the next 20 years on temperatures, relative humidity, total pressures and pore pressures, displacement, thermal conductivity, or gas compositions. The installation of the sensors occurs in instrumentation section to ensure the precise location of each measuring point (Fig. 5). As of writing of this newsletter about 550 sensors had been already installed.

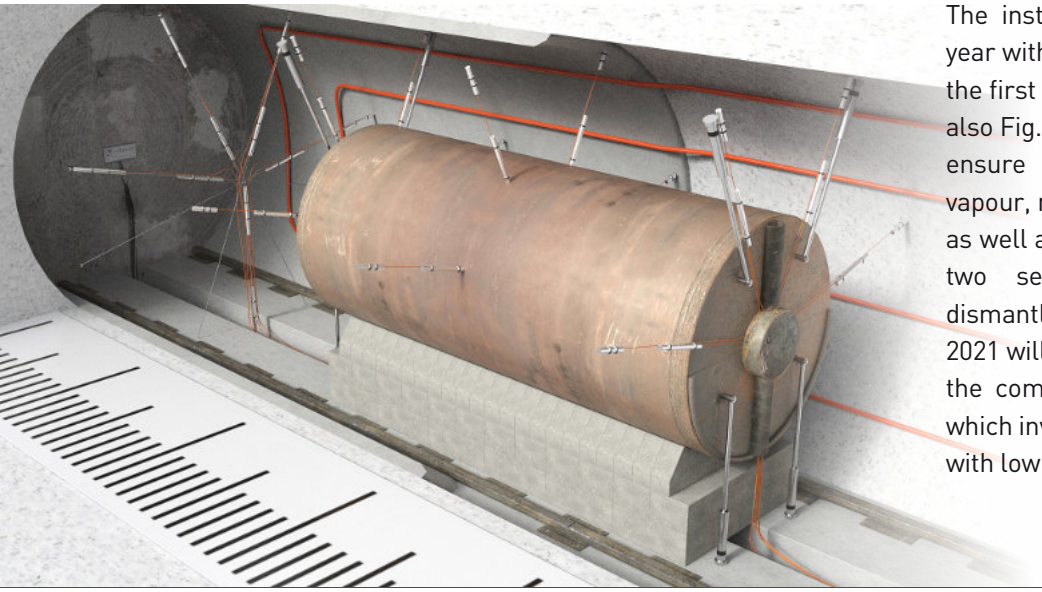


Fig. 5:
Visualization of heater 1 with various sensors

The installation works will be completed this year with the construction of a retaining wall, as the first component of the plug for Sector 1 (see also Fig.1). The two plugs have been designed to ensure a low transmissivity for water and vapour, mechanical confinement of each sector, as well as to minimise interactions between the two sectors during the planned partial dismantling in approximately 5 years. The year 2021 will start from a HotBENT perspective with the completion of the construction of Plug 1, which involves shotcreting a 2.5 m long segment with low pH shotcrete.

GTS Projects. UPDATES

For project objectives, and details please visit: www.grimsel.com

Project	Description
CFM i-BET In Situ Bentonite Erosion **I. Blechschmidt**	i-BET was implemented in mid-December 2018 and is now running for two years. The experimental focus lays on the observation of bentonite mass loss due to erosional processes. Positive pressures are recorded for the last hundred days, which indicate that the overall saturation of the bentonite rings is progressing and close to complete. However, the variance in the recorded data of the relative humidity sensors indicates that the saturation is heterogeneous. Analyses of the groundwater sampled from the near field of the experiment highlight differences between the near-field monitoring boreholes, especially in the sodium concentration. Current efforts are focusing on understanding the geochemical interactions occurring between the bentonite source and the Grimsel groundwater. Colloid concentration in the sampled groundwater were analysed by nanoparticle tracking analyse (NTA) by FSU Jena and showed largest average colloid size in the borehole beneath the bentonite source.
CFM LIT The Long-Term In-Situ Test **I. Blechschmidt**	The long-term in situ test after running for 4.5 years (circulation in the geosphere) was successfully overcored in early 2019. To sample the 300 mm diameter and 80 cm long core, a special saw was developed. After successful trials, the first test cuts were made on the LIT core in November and December 2020. These enabled the sampling of two slices in the bentonite source away from the MI shear zone. The resulting sample material (2 core discs crossing the granite and the outer bentonite rings) were sent to the KIT-INE and CIEMAT laboratories to test the sub-sampling procedure. Based on these tests the further sampling strategy in the "hot zone" of the LIT core will be carried out at the beginning of 2021. Within the CFM, a large number of tracer tests were performed in the MI shear zone. Because of this data set, a tracer test with an intermediate run time will be designed. At the MI site (radiation protection controlled area), maintenance work was performed to prepare the site for future hot-tracer experiments to be performed in the MI shear zone.
CIM C-14 and I-129 Migration **A. Martin**	The license application to handle and circulate C-14, I-129, Cl-36, Ba-133, Cs-134 and HTO in the in-situ test was approved by our regulator. PSI is currently preparing the radionuclide cocktail in their laboratory. The injection and start of radionuclide circulation is planned for the beginning of 2021. During 2020 monitoring and circulation of cementitious porewater solution in the borehole was continued. Hydrotests were also performed to characterise the hydraulics of the cementitious material in the vicinity of the injection/circulation interval.
GAST Gas-Permeable Seal Test **A. Reinicke**	The GAST partner meeting was held successfully in November 2020. This year the mini-GAST team from UPC (Universitat Politècnica de Catalunya) attended for the first time and presented the status of the mock-up experiment. The first dm-scale test has been kicked off after extensive pre-testing of the sand/bentonite material and checking of the system performance. The pressure and saturation homogenization of the GAST experiment progresses well with a pressure level of about 2.1 - 2.2 MPa in the filters. A recently conducted test campaign has indicated that the permeabilities at the interface between sand/bentonite (S/B) and granular bentonite (GB) in the head space have been decreased compared to 2018 while the saturation and stresses in the head space have been increased. This is a good evidence of ongoing swelling in the head space and sealing of the interface, both important for a successful execution of the Gas Flow Test (GFT). The TOUGH based prediction of homogenization pressures demonstrated that a sufficiently high and equalized pressure level in the S/B body can be reached within a couple of months from now. Consequently, the focus to kick-off the GFT by end of 2021 remains as the current plan and the corresponding preparations are ongoing.
HotBENT Bentonite at High Temperatures **F. Kober**	See highlight section.
LASMO Large Scale Monitoring **F. Kober**	Current LASMO activities in the GTS are restricted to the monitoring of hydraulic pressures in multiple borehole intervals throughout the entire laboratory. As the initial aim of LASMO was to monitor ongoing activities in the near and far field of GTS, the monitoring system is a valuable tool in observing variations to the hydraulic geosphere in general but also as response to new projects (for example LTD-GAM or HotBENT) and related activities such as borehole drillings or packer setup modifications.
LTD Long Term Diffusion **A. Martin**	Detailed preparation and site characterisation work is continuing at the former GAM site in the radiation controlled zone. Measured pressures in the GAM shear zone stabilised after fixing and/or redressing existing packer systems intersecting the shear zone. A preliminary migration test with non-radioactive tracers in the target flow channel (PT-1 dipole) is planned for January 2021. The dipole test will be used to finalise the design of the longer term ca. two-year migration test with radionuclides in PT-1.
MaCoTe Material Corrosion Test **A. Martin**	Detailed analysis of 4.5 years modules containing test metal specimens emplaced in bentonite is almost complete and will be distributed for evaluation to the MACOTE partners in the coming weeks. Analysis of carbon steel, stainless steel and copper coating in the 4.5 years module from the heated in-situ test is also ongoing. Additional modules containing candidate canister materials from NUMO (Japan), KIT (Germany) and KIGAM (South Korea) are currently being prepared in Jacobs' labs in Harwell, Oxfordshire, U.K. These new modules are planned to be inserted into the non-heated test borehole in April 2021.

GTC Grimsel Training Centre . COURSES 2021

GTC Grimsel Training Centre

www.grimsel.com

Date	Description
25.08.2021 to 27.08.2021 at the GTS 3 days	**From RD&D requirements to in-situ experiments - how to design and set up URL experiments** This course teaches 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). Each experiment is unique; there is no 'manual' that can be referred to. To this end, new techniques and/or procedures often have to be designed and developed to achieve the experimental goals. Lessons learned from designing and running URL experiments at the GTS will also be presented and discussed.
30.08.2021 to 01.09.2021 at the GTS 3 days	**Use of radioactive tracers in URL experiments (input to safety cases)** The GTS is one of only a few URLs where radioactive tracers can be used in tracer migration tests in the geosphere at activities requiring a license. This course aims to show how such in-situ tests can produce results that are more reliable and realistic than standard in-situ tests using non-radioactive tracers. Focus is on showing how results from laboratory based experiments, (the derived parameters of which are used as input to performance assessment calculations), are linked to field scale (1-10 m) in-situ tests, as well as improving process understanding of how radionuclides behave both in water conducting fault zones and in the rock matrix.
06.09.2021 to 10.09.2021 at the GTS 1 week	**Engineered Barrier System (EBS) Bentonite properties and applications** This course aims to provide an opportunity to exchange key information and ideas on clay barrier research in order to support engineering designs. Key physiochemical, geochemical and hydromechanical properties as well as relevant analytical techniques and conceptual models will be introduced. The course includes onsite discussion of the large-scale experiments at the GTS studying and demonstrating the performance of bentonite materials.

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

GTS The view from the GTS onsite team

HotBENT Internship at GTS of Paul-Magnus Andersson

Paul-Magnus Andersson is currently supporting the HotBENT Experiment installation works at GTS, foremost supervising and overlooking the QA/QM procedure of the instrumentation work package. Aside from this he is a helping hand at all ends of the emplacement works: be it backfilling, documentation, reporting and other tasks.

Paul has a background in Physics and recently completed the IDEA League Joint Master in Applied Geophysics, a degree offered jointly by the universities TU Delft, RWTH Aachen and ETH Zurich. The Master program provided him with a solid foundation across the Earth Sciences, which he is eager to put into practice during his internship at the GTS.


© Nagra / Grimsel Team, Switzerland

Most of Paul's usual working day is spent in the HotBENT tunnel and niche where he is overseeing the sensor installations and conducting/ overseeing quality controls, a formidable task considering the sheer number of sensors installed in the tunnel (eventually over 1300 sensors). If not in the HotBENT tunnel, he can be found in his office at the entrance of the GTS, jokingly called the "fishtank". He has grown fond of his team, as well as the local contractors, and is excited to continue supporting the HotBENT project into the next year.

Although Paul has worked in laboratory environments before, working at the GTS presents unique challenges hardly faced in any other workplace. Aside from the unusual route to work, working underground for most of the day and the sometimes-unpredictable weather conditions, Paul has had to adjust to life in a narrow valley where direct sunlight is a rare sight in winter. "Working underground for months on end can be difficult for some, however I see it as a challenge and a unique opportunity. It requires a somewhat intrepid personality. Being originally from Finland probably helps with dealing with the lack of sunlight as well!"

In his free time, Paul is keeping busy with sports and outdoor activities, such as kickboxing, hiking, skiing and even attending shooting practice with the on-site team member and soon-to-be-hunter Michael Treuthardt. It is fair to say that Paul has adapted well to his new surroundings.

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/grimsel-brochures
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/gts-information/grimsel-training-centre-gtc

SEASON'S GREETINGS

from the Grimsel Team!

AND

A HAPPY NEW YEAR

THE GRIMSEL TEST SITE (GTS)
International Underground Research Laboratory

GTS onsite
Grimsel Test Site
info@nagra.ch
Tel +41 (0)33 973 1225

General GTS enquiries
Andrea Wettstein - De Marco
andrea.wettstein@nagra.ch
Tel +41 (0)56 437 1310

Visits to the GTS facilities
Renate Spitznagel
renate.spitznagel@nagra.ch
Tel + 41 (0)56 437 1282