GRIMSEL TEST SITE (GTS)
NEWSLETTER

DECEMBER 2019 YEAR 1, VOL. 2

News and Activities . EDITOR'S NOTE

Dear colleagues and partners,

In June of this year, the annual meeting of the International Steering Committee (ISCO) of the Grimsel Test Site (GTS) took place in the nearby Hotel Handeck. As every year, the ISCO meeting was dedicated primarily to the scientific and financial governance of the entire GTS programme. All Grimsel partners are invited annually to learn about current projects and planned activities, to exchange ideas and to agree on the future strategy of joint research activities at the GTS.

In addition, 2019 was a special year as we celebrated the 35th anniversary of the GTS and launched the next 5-year programme. The success of the programme is also reflected in the long-standing relationship between organisations and individuals participating in the activities.

The Spanish Radioactive Waste Management Agency (ENRESA), one of the many partner organisations at the GTS, has been involved in our activities for many years and has contributed to the success of many projects. To commemorate this, we asked our long-time colleague Juan Carlos Mayor to contribute with a guest editorial message to this second edition of the GTS Newsletter.

Your sincerely,

Dr. Ingo Blechschmidt
Head of the Grimsel Test Site (GTS)

"We are glad to provide you with our 2nd newsletter with information on our major activities at the GTS and to continue bringing the "**flavour of working underground**" closer to you.

THE GRIMSEL TEST SITE (GTS)
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GTS Participating Countries

Fig. 1: ISCO Meeting 2019, Grimsel Test Site Phase VI, Hotel Handeck, Grimsel, Switzerland

Guest Editorial

Enresa, the Spanish Radioactive Waste Management Agency, started participating in the GTS programme in the mid-nineties with the planning and designing, and later installation and operation, of the Full-scale Engineered Barrier EXperiment (FEBEX), which was a demonstration test of the Spanish concept for waste disposal in granite.

Our participation throughout all these years in a generic laboratory such as the GTS has allowed us to achieve two main objectives:

- The acquisition of first-hand practical experience in the development of work methodologies, instrumentation techniques and test equipment that will be used during the underground characterisation of a granitic host rock.
- The generation of know-how in planning, execution and interpretation of in-situ and large-scale tests under repository-like conditions.

The GTS provides the necessary flexibility and cooperative spirit for achieving these objectives. Overall, it has been truly satisfactory to work here all these years.

After 35 years of activity, the GTS still has a bright future ahead; for more advanced programmes, continuing information exchange and keeping up to date with achieved know-how remain a must. For less advanced programmes, getting first-hand practical experience in underground testing is of paramount importance. In addition, the GTS could be "opened" to cooperation in other areas in applied geosciences (e.g. geothermal energy).

Your sincerely,

Juan Carlos Mayor

JUAN CARLOS MAYOR

MSc in Civil Engineering (Stanford University, USA) and Mining Engineer (Madrid School of Mines, Spain)

Juan has over 30 years working experience in the field of radioactive waste management. He is presently Senior Manager in charge of the R&D programme of the Site Engineering Dept. of the Spanish Radioactive Waste Management Agency (ENRESA) in the fields of Rock Mechanics and Hydrogeology.

Juan is a member of the Steering Committees of both the Mont Terri Project and the Grimsel Test Site in Switzerland, and deputy member of the Executive Group of the IGD-TP.

CFM LIT

The Long-Term In-Situ Test

I. Blechschmidt

The Long-Term In-Situ Test (LIT) was successfully overcored in 2019. The LIT was part of the CFM project investigating radionuclide and colloid transport behaviour in a natural flow system. The overcoring allows post-mortem analyses of the bentonite source and its interactions with the water-conducting structure as well as the diffusion path of the emplaced radionuclides (Ca-45, Se-75, Tc-99, Cs-137, Am-241, U-233, Pu-242, Np-237). As a first step of the post-mortem analysis, an X-ray CT scan of the core was performed. The acquired CT scans formed an ideal basis for the detailed planning of the sampling strategy as areas with different density (i.e. steel mandrel, Grimsel granodiorite, FEBEX bentonite, glass vials, etc) can be distinguished and accurately located.

The first impressions from the CT scans confirmed the known channelised fault architecture of the MI shear zone, verifying the macroscopic description from the tunnel wall mapping showing multiple channels filled with cohesionless gouge. Moreover, density contrasts at the contact between the MI shear zone and the bentonite might indicate bentonite erosion into the shear zone.

During the last CFM partner meeting held in October at the Institute of Geosciences of the Friedrich-Schiller-University Jena, Germany, it was decided to investigate, during the subsequent laboratory phase, zones that include the glass vial-bentonite interface, bentonite homogenisation, the bentonite-fracture interface, and the bentonite-steel mandrel interface.

Fig. 2: LIT core with CT scan image position.

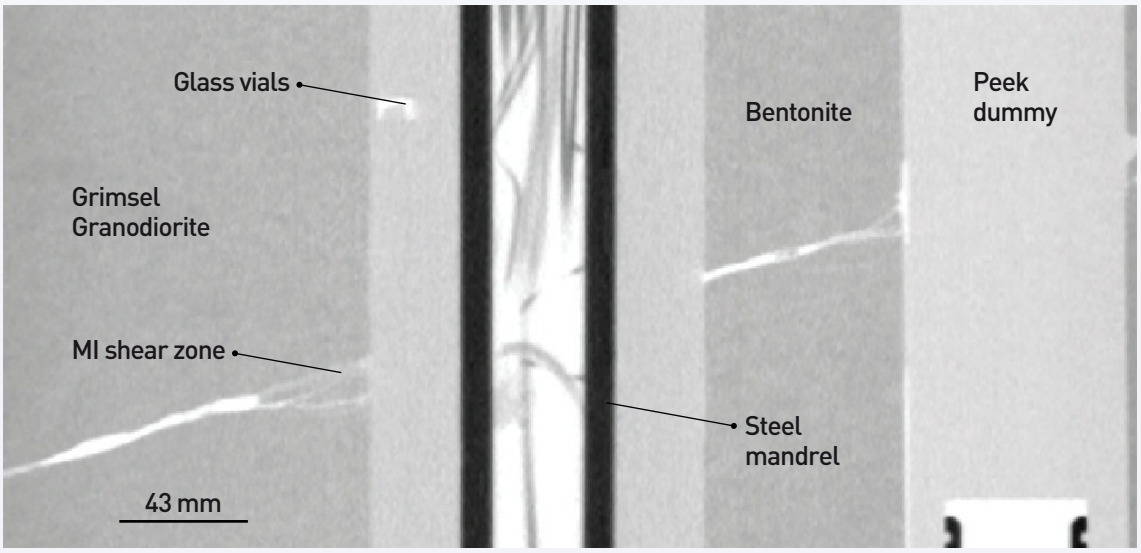


Fig. 3: LIT core CT scan between 6.65 and 6.90 mah (metres along hole) showing the central CFM 06.002 and CFM 11.002 boreholes.

CIM

C-14 and I-129 Migration

A. Martin

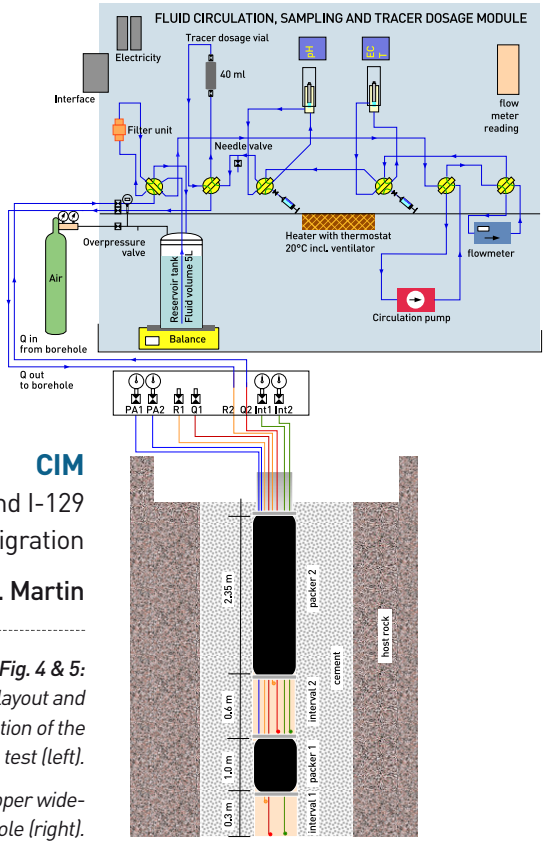
The CIM project is dedicated to the study of carbon-14 and iodine-129 retardation in aged cement represented in the field by a 14-year old cement (see Fig. 4). A large-diameter borehole (320 mm) was drilled to a depth of 2.60 m and a steel liner was installed. The drilling was performed off-centre of the backfilled HP 98.005 borehole. The steel liner acted as a guide for drilling both the central experiment borehole and one of the observation boreholes. This will also facilitate the overcoring that is planned in the final stage of the field investigations.

The porewater composition of cement samples was analysed to derive constraints on the initial cement chemistry of the circulation solution of the radionuclide cocktail. All borehole drilling, packer insertion and surface instrumentation was completed in November. The radionuclide cocktail will be circulated in a closed interval section between 5 and 6 mah of the central borehole (bottom interval in the figure below). All boreholes will be used to monitor temporal changes in radionuclide concentrations and water chemistry.

CIM

C-14 and I-129 Migration

A. Martin



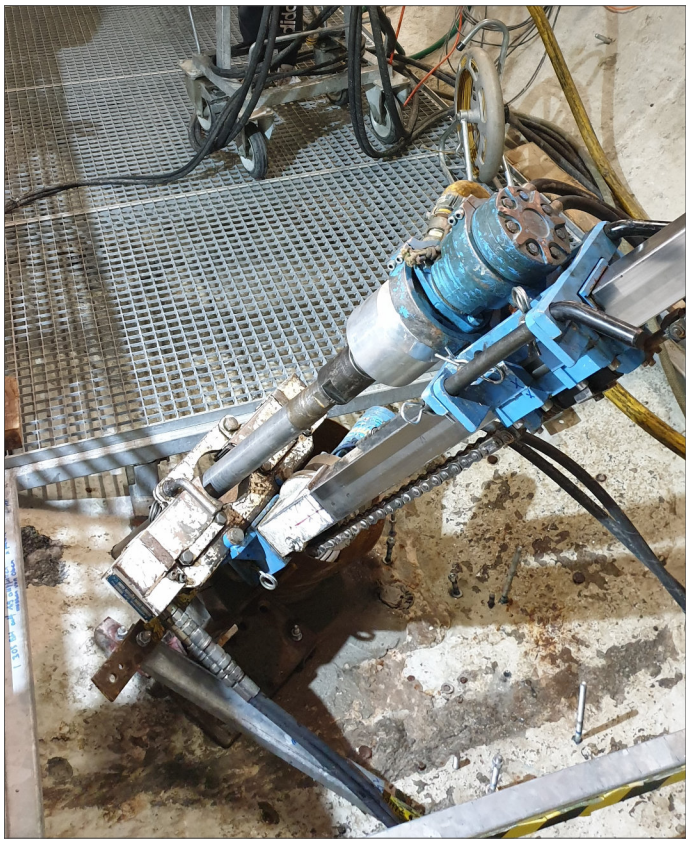


Fig. 4 & 5:
Borehole layout and instrumentation of the CIM in-situ test (left).

Drilling of the upper wide-diameter borehole (right).

Publication

of the new Nagra Report NTB 19-01

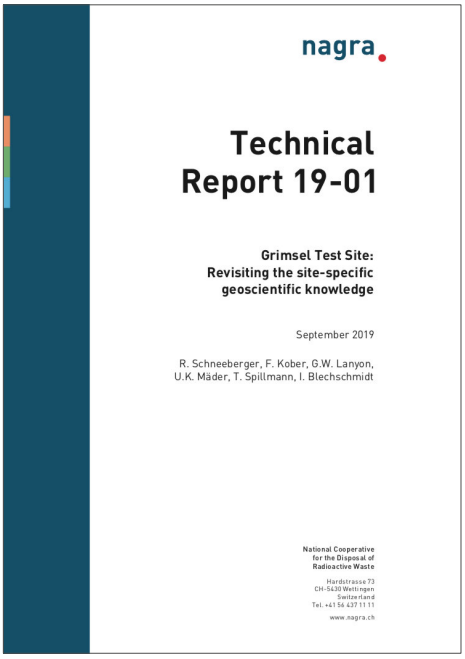
September 2019

NTB 19-01 • Grimsel Test Site: Revisiting the site-specific geoscientific knowledge

R. Schneeberger, F. Kober, G.W. Lanyon, U.K. Mäder, T. Spillmann, I. Blechschmidt

The most recent GTS technical report is NTB 19-01. It revisits the geoscientific knowledge related to site characterisation obtained so far from the many experiments performed during the last 35 years of GTS operation. The report shows that a profound knowledge of the rock mass surrounding the GTS has been obtained. On the one hand, the report provides an overview of the geological setting, characteristics, experiments and activities of the GTS and, on the other hand, will help in designing potential new experiments in an already well-characterised environment.

The report can be downloaded from Nagra's website ✎ www.nagra.ch



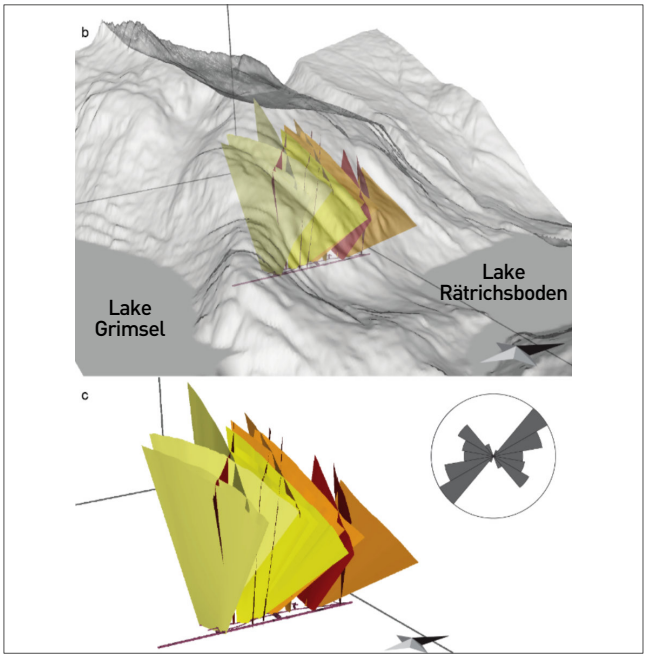


Fig. 6 & 7:
Cover page NTB 19-01 and a key figure from the report conceptualising the influence of geological control on water-conducting features.

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 successfully implemented at the end of 2018. Monitoring data have been acquired since then. Groundwater samples are taken from the near-field monitoring boreholes (CFM 18.001, 18.002, and 18.003) and from the far-field monitoring borehole (JGP 11.001). First groundwater samples indicate an increased concentration of colloids in the near-field as well as slightly decreased acidity of the groundwater. Monitoring data from the total pressure sensors indicate that the source is building up swelling pressure.
CFM LIT The Long-Term In-Situ Test **I. Blechschmidt**	Further details in Highlights.
CIM C-14 and I-129 Migration **A. Martin**	Further details in Highlights.
FEBEX-DP Full-Scale Engineered Barrier Experiment **F. Kober**	The last working report of the FEBEX-DP programme was completed (NAB 16-13, Gas-Water Analysis) and published, completing the series of 19 Nagra working reports related to the FEBEX-DP project. The overarching FEBEX/FEBEX-DP synthesis report has been drafted and is being prepared for review.
GAST Gas-Permeable Seal Test **A. Reinicke**	A report documenting the interpretation of the first gas injection test (from the first semester of 2018) has been drafted and finalisation is expected by the end of the year. The GAST experiment has reached the target hydraulic pressure (2 MPa) in the filters and pressure homogenisation is ongoing. Based on the understanding generated from the first gas injection test, the next phase of the GAST experiment has been planned. In this next phase, all relevant work focuses on the execution and evaluation of the full gas flow test. The full-scale experiment is newly accompanied by a mock-up experiment (half-metre scale), whose final cell design is currently under optimisation.
HotBENT Bentonite at High Temperatures **F. Kober**	Preparations for the experiment have continued: 1.) hydrotests were performed in previous FEBEX boreholes in order to test hydraulic gradients; 2.) the former auger machine used for emplacing granular bentonite in Nagra's FE Experiment in the Mont Terri Lab was evaluated for deployment in the smaller FEBEX tunnel, 3.) bentonite block and granular material production has been prepared and 4.) the HotBENT Experimental Plan was drafted and discussed at the 3rd HotBENT Detailed Design Partner Meeting (October) and is being finalised.
LASMO Large Scale Monitoring **F. Kober**	Analysis and interpretation of the data acquired are ongoing and results are to be published individually by the partners. A summary report of the geoscientific knowledge at the GTS is now available (see Highlights - NTB 19-01).
LTD Long Term Diffusion **A. Martin**	Samples taken from the second in-situ radionuclide solution circulation are being analysed in detail by the LTD partners. Results are expected in the near future. Detailed preparation and site characterisation work is being performed at the former GAM site at AU140 in the GTS. This is being evaluated as a candidate site for a follow-up experiment of the LTD dedicated to studying the influence of fracture heterogeneity on the sorption of radionuclides.
MaCoTe Material Corrosion Test **A. Martin**	Additional cast steel samples from NUMO were inserted into the non-heated test and the four-year samples were retrieved for analysis. The samples are currently being analysed by John Wood Plc on behalf of the MaCoTe partners and comparisons with the results of analyses of the one-year samples are expected in the coming year.
Modern – TEM Test and Evaluation of Monitoring Systems **A. Reinicke**	The final report documenting the status and results of the TEM experiment was produced and will be published as a deliverable as part of the Modern2020 EU project. In a nutshell, the wireless monitoring system performed exceptionally well and very reliably. However, the investigation of the mechanical stability of the shotcrete plug could not be executed as planned, because sufficent pressurisation could not be achieved due to limitations of the hydraulic system. Options to replace the hydraulic system to enable full saturation of the experiment have been considered and will be evaluated for a potential future extension.

GTC Grimsel Training Centre . COURSE RETROSPECT 2019

In 2019, three GTC courses were held. A tailor-made short course on "Bentonite used as Engineered Barrier System" was followed by "From geophysical field data to geological models – theory and hands-on workshop" in Wettingen in June and "Fundamentals in hydraulic testing in URLs – theory and hands-on workshop" at the GTS in September.

In the geophysical course (see Fig. 8), participants and students learned about the interpretation of 2D seismic lines, focusing on possible pitfalls, using real data from Nagra's 2D and 3D seismic investigations. The course was complemented by lectures on seismic acquisition, seismic processing, tomography and 3D geological modelling. Finally, the topic of uncertainty and how to communicate it was presented.

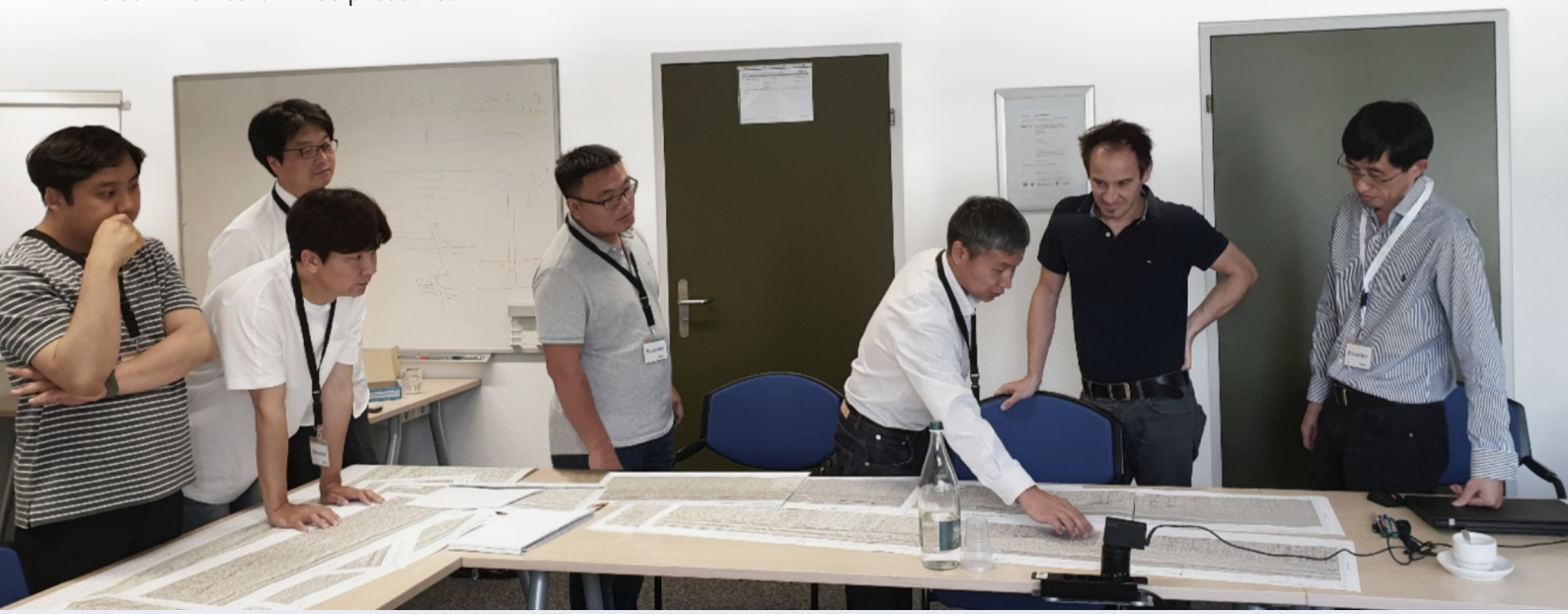


Fig. 8: "Hands-on" experience of interpreting seismic lines.

GTC Grimsel Training Centre . COURSES & 2020

GTC Grimsel Training Centre

www.grimsel.com

Date	Description
26.08.2020 to 28.08.2020 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, in a sense, unique and new techniques and/or procedures therefore often have to be designed and developed to achieve the goals of the experiments. Lessons learned from designing and running URL experiments at the GTS will also be presented and discussed.
31.08.2020 to 02.09.2020 at the GTS 3 days	**Use of radioactive tracers in URL experiments** The GTS is one of only a few URLs where radioactive tracers can be used in migration experiments in the rock itself for activities requiring a license. This course aims to show how such in-situ tests will contribute to the understanding of reliable and realistic radioactive tracer processes and phenomena. The focus is on showing how results from lab 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.
07.09.2020 to 11.09.2020 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 physico-chemical, geochemical and hydromechanical properties, as well as relevant analytical techniques and conceptual models, will also be introduced. The course includes on-site discussion of the implementation experiments at the GTS that study bentonite materials.

We are happy to discuss any needs for, and interest in, any course related to rad-waste, be it custom-made or general - please contact us.

GTS in numbers. 35th ANNIVERSARY

The GTS celebrated its 35th anniversary

The GTS celebrated its 35th anniversary this year. In light of this, some selected key figures for the URL:

- In 2018, 1,355 curious people visited the GTS (2019 will also likely be in this range).
- Approximately 3,000 cups of coffee were consumed in 2019 (or around 1 cup of coffee every 3 hours).
- Air ventilation provided healthy visiting and working conditions by bringing in approx. 3,400 m³/hour of fresh air.
- Despite the supply of fresh air from the outside, the temperature in the GTS is more or less constant throughout the year (around 14.04 ± 0.29 °C), which is notably above the 5°C annual average of the nearby Grimsel pass.
- Over the last 35 years, 170 peer-reviewed publications and 188 Nagra reports have been published *(source: Scopus, Nagra database)*. This is equivalent to approximately one publication every five metres of tunnel. The question of who was the most prolific author is of secondary interest. More important is that everyone who made the GTS what it is today, is gratefully acknowledged.

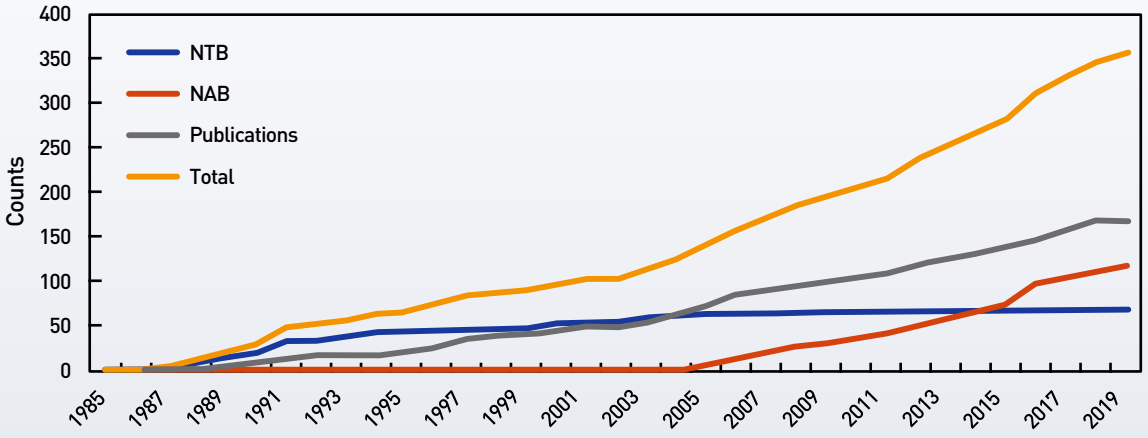


Fig. 9:
GTS publication report

GTS The view from the GTS onsite team

A surface assignment of the GTS team to study rock erodibility parameters in support of Nagra's site selection programme.

A drilling campaign was initiated during the summer of 2019 to sample multiple lithologies in Nagra's siting regions in Northern Switzerland. The samples are used to investigate the erosion properties of numerous rock units forming the stratigraphic column in Northern Switzerland. The GTS drilling team retrieved 15 cores of soft-sedimentary rocks of Switzerland's foreland during three days of daylight drilling. These cores will later be used in abrasion mill experiments in the laboratory in conjunction with rock-mechanical tests. The drill sites were mainly located in old quarries and were complemented by block samples taken during field work. They were subsequently prepared in the GTS to obtain the required sample geometry.

Fig 10 (left):
The Grimsel mobile drilling team drilling into the Beggingen Member in a quarry near Frick.

Fig 11 (right):
Cores (mostly 20-cm diameter) obtained in the Swiss foreland from sandstones, limestones and dolomitic rocks, which are relatively easy to drill compared to the hard Grimsel granitoid rocks.

SEASON'S GREETINGS

from the Grimsel Team!

AND

A HAPPY NEW YEAR





Part of the Grimsel team at a recent electrical safety instruction course at the GTS.

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/

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