ROCK REPORT

Mechanics & Tunnelling

Quarterly Newsletter of the Institute of Rock Mechanics and Tunnelling

01 Volume 3
April 2022

RMT

NAWI Graz
GEOZENTRUM

TU Graz
Graz University of Technology

MLGT
Machine Learning in Geotechnics

Content

Marcher's Column

Dear Friends of the Institute,

despite the never-ending and ever-changing crises that also significantly affects travel, we look forward to the visit of scholars from all over the world to our institute. So it gives me great pleasure to welcome Josephine Morgenroth, a PhD student from the York University, Canada. She will complete her PhD on machine learning technologies for underground structures this summer. A perfect complement to one of our research focuses. We have already made some plans for joint research collaboration. We are also pleased to welcome Mr. Vaibhav Shringi to our institute. We got in touch some time ago through the IAESTE programme. COVID-19 delayed the stay a bit, but finally Mr. Vaibhav Shringi made it and has now started a bachelor thesis at our institute. A great collaboration together with his home university, Birla Institute of Technology and Science (BITS-Pilani), in India.

It is the duty of all of us to contribute to the important goal of reducing the carbon footprint. One technical possibility is to use the geothermal potential. And this can also be used successfully in tunnel construction. Our "Project Focus" in the current Rock Report summarises the results of the "Thermocluster BBT" research project funded by the Austrian Research Promotion Agency FFG, which looked at the great potential of drainage water in long, deep seated tunnels.

Last but not least: I would like to announce that we are confident that we will be able to celebrate our traditional St. Barbara Institute celebration in 2022. On December 2nd we will have the opportunity to celebrate the 30th anniversary of our Institute. Together with our Emeritus Prof. Wulf Schubert, I am pleased to invite all our friends to Graz for this unique event.

Glück Auf and stay healthy!

thomas.marcher@tugraz.at

Title Picture:
View of ongoing drilling works at lot H71 at the Italian part of the BBT (Franzensfeste)
© Thomas Geisler (under approval of the BBT SE)

05. April 2022 – published
Manuel B. Winkler – editor in chief
tunnel@tugraz.at – contact

Project Focus I

ThermoCluster - BBT

The use of geothermal energy from engineering structures and tunnel buildings ("tunnel thermal energy") offers an environmentally friendly option for heating and cooling buildings in the proximity of a tunnel building [1].

Due to its proximity to the city of Innsbruck, the Brenner Base Tunnel offers the optimal boundary conditions to determine the effectiveness and application limits of tunnel thermal energy, to simulate its distribution in the city and thus to explore its technical and economic feasibility. In consideration of demographic change and the ever-increasing demand for energy and heat, future-oriented heat supply technologies, such as geothermal energy, represent key functions.

Long deep-seated railway tunnels are currently being built in alpine areas in particular. Due to the large overburden of these tunnels and the temperatures that prevail as a result, it is possible to extract the heat provided by the rock at a temperature level of over 20°C, which is higher than the temperature of conventional geothermal systems, and to use it for heat provision.

In existing tunnel systems, it is sometimes necessary, depending on the mass of the rock overburden and the associated temperature, to cool the tunnel drainage water with special systems before it can be discharged into the corresponding receiving streams. Since these large infrastructure projects primarily serve to improve the traffic and transit situation in the country, it is important to find possibilities and synergies between utilization in terms of traffic engineering, tunnel construction and geothermal energy.

Due to the above mentioned facts we were allowed to initiate and lead the project ThermoCluster BBT together with five other research and science partners - funded by the Austrian research Promotion Agency (FFG).

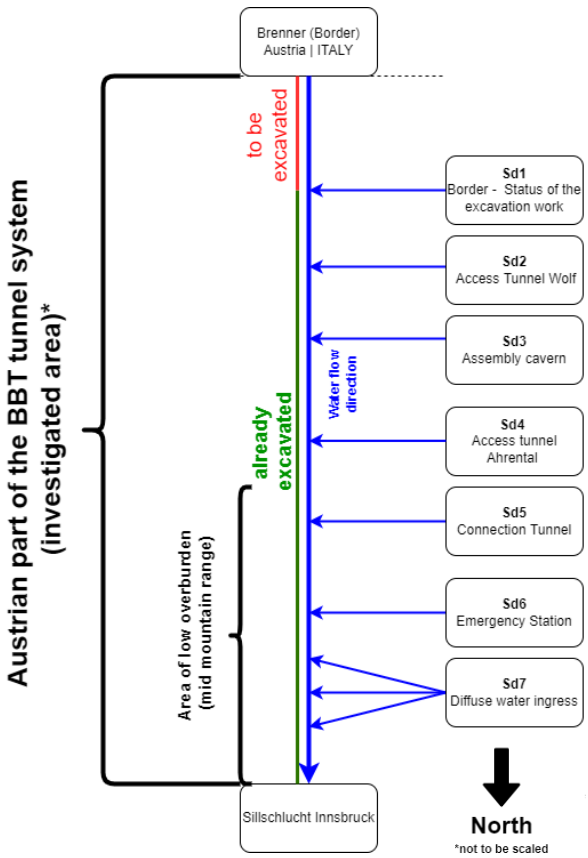


Figure 1. Tunnel water discharge system at the Austrian section of the BBT. [4]

At the BBT, the concept of sectional discharges is applied in addition to many individual discharge measurements. Part of this concept is that tunnel sections with homogeneous hydrological conditions and therefore homogenous properties sections are clustered and considered as unit system.

geisler@tugraz.at

Project Focus II

ThermoCluster - BBT

A single cluster is thus called sectional discharge (Sd) [2]. After completion of the BBT, a total of 7 sectional discharges will contribute to the total discharge at the tunnel portal in Innsbruck (Figure 1). Thus, the discharge rate as well as the temperature at the tunnel portal will be defined by these sectional discharges, as they are mixed within the tunnel drainage system. These are the two parameters (temperature and discharge) that are necessary to calculate the geothermal potential [3].

In addition to the basic determination of the geothermal potential, however, research was conducted on how to increase the geothermal potential. Two concepts were developed for this purpose:

- Separate discharge of colder partial flows [5].
- Heating of colder sectional discharges using absorbers

It can be stated in principle that a considerable geothermal potential exists in the drainage water of the Brenner Base Tunnel. However, optimization by separating colder sectional discharges is only possible to a limited extent. A real increase of the geothermal potential is only possible by installing absorbers in particularly warm rock areas and requires further modeling and research work. In order to successfully complete the important and required energy transition, the possibility of heat recovery from the tunnel water of the BBT can be a mosaic stone.

ThermoCluster Project Partners

- TU Graz | Institute of Rock Mechanics and Tunnelling
- Austrian Institute of Technology GmbH | Center for Energy
- BOKU | Institute of Applied Geosciences & Institute of Chemical and Energy Engineering
- Geologische Bundesanstalt | Department of Hydrogeology & Geothermal Energy
- Innsbrucker Kommunalbetriebe AG
- Brenner Basistunnel Gesellschaft BBT SE

References:

(1) Adam, D.; Markiewicz, R.; Oberhauser Andreas. Nachhaltige Nutzung von Erdwärme mittels innovativer Systeme im Ingenieurtiefbau und Tunnelbau. Departmentkongress Bautechnik & Naturgefahren Wien 2005

(2) Burger, U.; Geisler, T.; Lehner, F.; Cordes, T.; Marcher, T. Sectional discharges as geothermal potentials of deep tunnels. Geomechanics and Tunnelling 2022, doi:10.1002/geot.202100089.

(3) Rybach, L. Thermal waters in deep Alpine tunnels. Geothermics 1995, 24, 631–637, doi:10.1016/0375-6505(95)00029-1

(4) T. Geisler, K. Voit, U. Burger, T. Cordes, G. Götzl, M. Wolf, M. Thomas, Geothermal potential of the Brenner Base tunnel – initial evaluations. (to be published), Processes (2022).

(5) Geisler et al. Optimizing the geothermal potential of tunnelwater by separating colder sectional discharges - casestudy brenner base tunnel. (tob e publisched) Renewable Energy (2022)

geisler@tugraz.at

Research Focus I

Guest researcher – practical applications of machine learning in rock engineering

Dear colleagues,

My name is Josephine Morgenroth. I am a rock mechanics engineer and PhD candidate from York University in Toronto, Canada. I have worked and conducted research on mining and tunneling projects for the last 8 years and thought, “where better to visit during my PhD research than the motherland of tunnels – Austria!” My research focus is on practical machine learning applications to underground rock engineering problems. I endeavour to bridge the gap between theoretical research and practical engineering by developing accessible machine learning algorithms for active mining projects using real, messy geotechnical data.

I received my bachelor’s degree in Geological Engineering from Queen’s University in 2014, where I discovered my love for rock mechanics and rock engineering under the mentorship of Dr. Mark Diederichs. Through exposure to summer work in geotechnical engineering, I knew that this blend of interesting design challenges and field data collection was the career for me. One thing that struck me was how difficult it was to investigate all the available data in detail, especially when working within a project’s budget and schedule constraints.

For this reason, the topic of my master’s degree at the University of British Columbia focused on statistical decision making using tunnelling data from the Kemano hydropower project. I received the Einstein Memorial Scholarship from Tunnelling Association of Canada in 2015

© Josephine Morgenroth

for this work. I developed a Bayesian Belief Network (BBN) approach for evaluating geotechnical conditions to predict the support class needed ahead of the advancing face. Little did I know when I graduated from my master’s in 2016 that this topic was foreshadowing of my PhD research topic several years later. But first I took a job at Hatch as a geotechnical engineer in 2016. In this role I worked on hydropower, mining, and tunnelling projects in Canada, the United States, Australia, Columbia, and Honduras. I was involved in all stages of project maturity – prefeasibility design, geotechnical site investigation, geotechnical design and numerical modelling, and construction supervision. I learned invaluable professional skills and had the privilege to work with some extraordinary engineers and project managers. However, I had a yearning to answer questions in more depth than most project constraints would allow.

Research Focus II

Guest researcher – practical applications of machine learning in rock engineering

In 2018, I was enticed back to academia by Prof. Matthew Perras, and within the first months Prof. Usman Khan came onboard as my co-supervisor. I was newly initiated into the world of machine learning after completing a case study with my colleague Everett Snieder, which I presented at the 2019 ISRM conference in Foz do Iguassu, Brasil. This is where I made the acquaintance of Dr. Georg Erharter of the RMT Institute. This early research on developing an Artificial Neural Network (ANN) to compare to the BBN I developed in my master's earned me the Enbridge Graduate Student Award at York University as well as the Ontario Graduate Scholarship.

My PhD research took shape and found itself at the intersection of machine learning and rock engineering, earning me the joke "so, your algorithms are going to take my job??" at more conferences than I can count. As a rock mechanics engineer (not a data scientist!) I took it upon myself to formulate my thesis around "practical applications" of machine learning – in other words, machine learning that would be useful and accessible for geotechnical practitioners. In 2020 I received the prestigious Alexander Graham Bell Canada Graduate Scholarship (NSERC) for my research, which has only a 17% national success rate.

I am particularly interested in algorithm interpretability which includes transparency ("how does the model work?") and post-hoc interpretations ("what can we learn after the model is built?"). My thesis contains data from mining projects representing two end member rock deformation mechanisms – squeezing ground with high tunnel convergences, and spalling ground with high seismogenic risk. The former dataset, from Cigar Lake Mine in Saskatchewan, Canada, was used to develop a Convolutional Neural Network (CNN) to predict tunnel liner yield. The latter dataset, from Garson Mine near Sudbury, Canada, was used to develop a Long-Short Term Memory (LSTM) network to assist in the calibration of a complex FLAC3D model. The LSTM network uses microseismic event data to forecast the stress state in the FLAC3D model as mining operations advance.

I am looking forward to collaborating with colleagues at the RMT Institute, to share knowledge and experience, and to continue to push the frontier of this research forward together. Thank you to Dr. Marcher for inviting me for this opportunity, and to Dr. Erharter for making the connection.

© Josephine Morgenroth

Teaching Highlights I

X-Change Teaching TU Graz – Uni Innsbruck

Matthias Flora, a native of South Tyrol, was appointed Professor of Tunnel Information Modelling (TIM) in the IBT working group (Construction Management, Construction Operations and Tunnelling) at the University of Innsbruck in summer 2020. The main goals of the professorship in the coming years include establishing and expanding teaching and research excellence in the field of digital tools in infrastructure and underground construction. This will be achieved through the development of a holistic tunnel information model, a so-called digital twin, and its practical implementation and validation on major infrastructure projects in Europe. In addition, the research focuses on mechanized tunnelling technology, construction logistics, digitalization, automation and resource optimization of construction processes in tunnelling, as well as the design of fair and economically attractive contract models.

© Matthias Flora

This was the starting point for a cooperation between our institute and Prof. Matthias Flora. RMT is pushing research in digitalization in the field of data science and machine learning. With the research focus at Prof. Flora's research group, this perfectly complements their focus in the areas of Tunnel Information Modelling (TIM). In addition to this growing collaboration, potential for cooperation has also been recognised in teaching. In the winter semester 2021/2022, a teaching exchange was therefore started in which Prof. Flora and Prof. Marcher worked as distinguished lecturers. Prof. Marcher provided lecture units in Innsbruck in the lecture “Rock and Tunnel Mechanics” and Prof. Flora contributed to the lecture "TBM excavations" at the TU Graz with specific issues for TBM excavations and thus supplemented the established programme with the external lecturers DI Weber and DI Goliasch. It is planned to further expand this cooperation in both research and teaching.

thomas.marcher@tugraz.at

Teaching Highlights II

New lectures by RMT starting with WS22/23

“Analysis of Sensor Data in Rock Mechanics and Tunnelling”:

The course "Monitoring Data Interpretation (NATM)" was offered by Prof. Wulf Schubert until the last winter semester 2021/2022 as part of the English Master's programme GEHE. At this point, we would like to thank Wulf Schubert for continuing this very important lecture for 3 years after his retirement. We will also continue the topic of monitoring data in tunnelling in the future. Due to the increasing importance of recording, processing and interpreting additional sensor data in rock mechanics and tunnelling (in addition to the conventional geodetic measuring systems), including data from TBM excavations, we have decided to expand this course programme under the new VU title: "Analysis of Sensor Data in Rock Mechanics and Tunnelling". Topics that will be additionally covered in the future include new developments in machine and sensor technology, data acquisition techniques, preprocessing of data using examples from rock mechanics and tunnelling (TBM) and systematic analysis methods / postprocessing. This new course will be offered in the summer semester in future (for the first time in 2023).

Updated lecture “TBM excavations”:

The lecture course "TBM excavations" has been offered many years. Due to the increasing importance of mechanised tunnelling nationally and internationally and also due to the rapid development in this field, it was necessary to expand the course programme. In addition to the existing course part, in which our external lecturers DI Goliasch and DI Weber are involved in a proven manner, we were able to achieve an expansion with the following contents: on the one hand TIM (Tunnel Information Modelling) in the TBM planning and construction process & new developments in the machine and sensor technology held by Prof. Matthias Flora, University of Innsbruck, in the course of a teaching exchange programme (see RR p.7). On the other hand specific topics on advance exploration techniques, data acquisition in TBM tunnelling, real-time classification and forecast updates, data processing (pre-processing / systematic analysis methods / post-processing), as well as geotechnical modelling for rock stress redistribution processes in the course of the mechanized excavation and geotechnical criteria for the right choice of TBMs are provided by Prof. Marcher. This new lecture will start in the winter semester 2022/2023.

thomas.marcher@tugraz.at

Teaching Highlights III

Applied Data Science for Geotechnics - Official Course

The ever-increasing amount of data, that has to be dealt with within various research tasks, soon let us recognize that for our students, willing to work on a master's thesis, a more sophisticated education in data processing was required.

In 2019, our institute has therefore launched an initially extracurricular pilot course program on the topic of geotechnical data processing with Python to which all interested students could register. The course scheduled in late summer term has now already been held for the third time and we have received a lot of positive feedback for it.

We are proud to announce that the academic commission now officially accepted the course to become a regular lecture within the master program's curriculum. That means that besides the valuable knowledge, our students can now also gain 3 ECTS credits, which is going to increase the interest in the subject.

The upcoming starting date of the new lecture "Applied Data Science for Geotechnics" will be the 30.05.2022.The course comprises of theoretical and practical parts. During the theoretical part the principles of the data science will be presented. That includes:

- Data management
- Data preprocessing and cleaning
- Data driven modeling and knowledge discovery
- Data engineering and transformation
- Assessment and validation of results

The data science principles will be accompanied by examples from geosciences. Known limitation on data representation will be demonstrated. The concept of data dimensionality will be introduced, and a special attention will be given to the data mining for sparse datasets and rare event forecasting. The principles of machine learning will be introduced, as another type of data driven analytics.

The practical part will allow students to obtain hands-on experience on data processing and analysis using the Python language. The concepts of data types and structures used in Python will be presented. In-class exercises are followed by home assignments to ensure every student gained sufficient knowledge and developed an understanding and the necessary skills to use Python language for data manipulation. Upon completing the course, our students will be able to design and build their own pipelines for data exploration and analysis and present the results via neat visualizations.

alla.sapronova@tugraz.at

Teaching Highlights IV

Field Excursion Rock Mechanics

In March this year the annual lecture “Field Excursion Rock Mechanics” took again place. Thereby, interested students were given the opportunity to visit construction sites of the Brenner Base Tunnel (BBT) in person and obtain valuable impressions from practice.

This year, our first stop was at the “BBT Tunnel World“ in Steinach am Brenner, Tyrol. The exhibition gives an overview of the largest tunnel project in Europe and is even equipped with a real scale display tunnel, showing the different necessary construction steps. In the afternoon of the first day, we visited the construction lot H21 – Sill Gorge. Once finished, this 600 m long stretch of the BBT will provide the link between the BBT and the central station in Innsbruck. This diverse construction lot offers a lot to see, several different construction works are carried out in parallel: a supporting wall (200 meters long), a cut-and-cover tunnel (130 meters long), 2 railway bridges over the river Sill, the northern Portal of the BBT, as well as a subsequent tunnel stretch (120 meters long). In spite of the relatively short stretch, this construction lot gave us interesting insights into very complex construction activities.

The second day took us to the southernmost construction lot of the BBT – Lot H71, Isarco river underpass, linking the BBT with the existing Brenner line and the railway station in Fortezza. In this construction lot the BBT underpasses loose fluvioglacial sediments and the groundwater layer of the Isarco river, requiring specific ground consolidation procedures including ground freezing and jet grouting.

During this two-day field excursion, the students were able to gain firsthand insights and impressions on the construction process of the Brenner Base Tunnel, the future longest underground railway connection in the world.

A big “Thank you!” to all who made this field excursion possible.

© RMT - TUG

unterlass@tugraz.at

Site Reports

Citylink project in the Stockholm underground - A student's perspective by Christopher Mittasch

At the beginning of 2021, I was given the chance to start writing my Master's thesis in connection with a tunnelling project in Sweden. For this reason, I came to Stockholm at the end of July 2021 to work for the Citylink project. A tunnel, as part of the project, is exclusively excavated to host four new high-power cables that are supposed to support the electricity grid of the Swedish capital. On the way from Anneberg to Skanstull, six shafts are sunk in addition to the excavation of the 13.4 - kilometre long tunnel. The maximum overburden is between 50 and 100 meters. A large part of the route is located directly below the historic buildings of the Swedish capital. In particularly difficult geological environments, the tunnelling method is switched from continuous tunnelling to conventional tunnelling.

In the course of my thesis, I deal with pre-excavation grouting in TBM tunnelling. Continuous grouting attempts to control the water inflow into the tunnel. The aim of the work is to analyse the project's existing grouting concept and, if necessary, to optimize it. Current results of the analysis show indeed some points of relevance for the further progress of the project.

From my personal point of view, the period of the last eight months has been one of the most interesting of my life so far. This opinion is not diminished at all by the long working days and the little sunshine in the winter months that I faced up here in the north. While the study programme is very much characterized by theoretical input, on-site you can see exactly how the theoretical knowledge can be applied to practice. All in all, I can only recommend the step of collecting on-site experience to every of my fellow students.

By mid-March of 2022, my thesis got the finishing touches and has now been submitted.

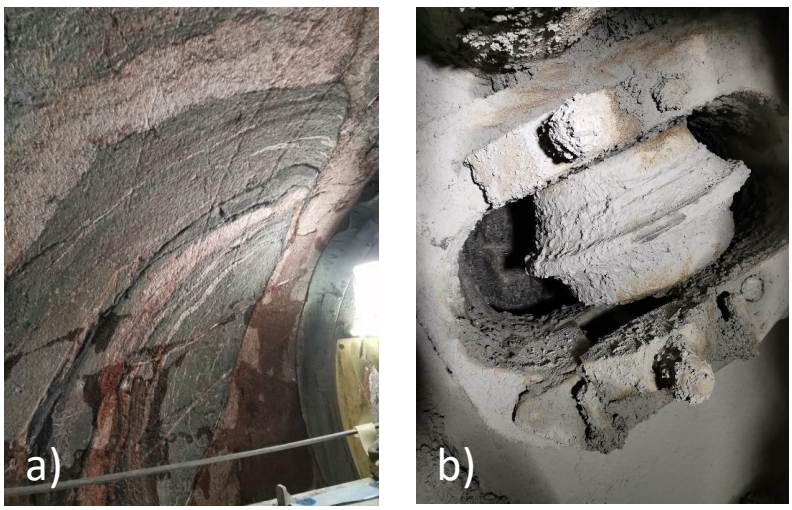


Figure: a) Sequence of lithologies at the AST, b) Close up of TBM Cutterdisk

winkler@tugraz.at

Publications & Presentations I

All publications of the institute are listed chronologically on our homepage. Selected papers and presentations are presented here.

Presentation "Chancen und Risiken der KI im Untertagebau" ("Chances and Risks of AI in Underground Construction") at WBI-Forum
Marcher, T., 23.03.2022, WBI GmbH, Weinheim, Germany

Artificial Intelligence, becoming increasingly powerful by the evolution of machine learning algorithms, will help us in future to deal with the interpretation of the enormous amounts of sensor data that are nowadays acquired at geotechnical construction sites and which can barely be processed by standard methods.

Associated with the use of AI are great opportunities for us – e.g. that it can improve the accuracy of geological forecasts in tunnel construction resulting in a reduction of the associated risks. However, in this context also the risks arising from the application of AI itself must be addressed since the results are not only highly influenced by the quality of data, but could also be maliciously fitted acc. to the entrusted parties' interests. Clear boundary conditions are therefore required, regulating the processes of data collection, data storage and data processing.

At the invitation of WBI GmbH company (Weinheim, Germany) Prof. Thomas Marcher gave a presentation on this interesting topic on the 23rd of March 2022 in the course of the WBI-Forum "Forschung und Praxis".

Prof. Thomas Marcher during his talk (Source: WBI-Forum, 23.03.2022, WBI GmbH)

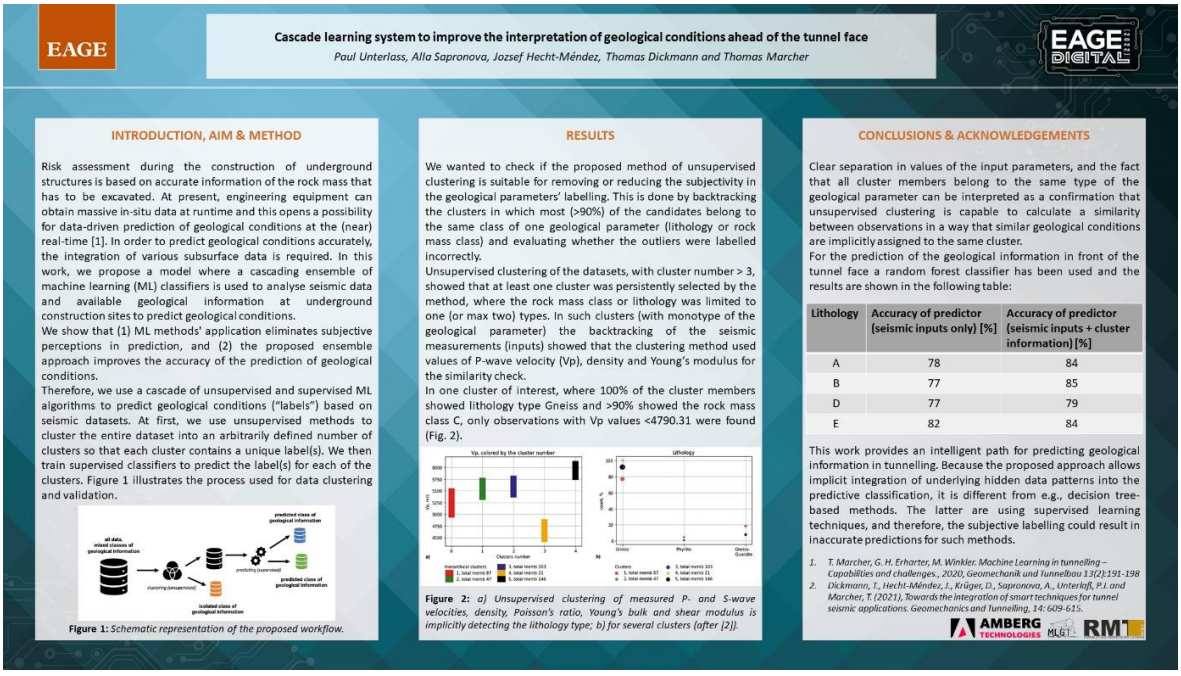
thomas.marcher@tugraz.at

Publications & Presentations II

All publications of the institute are listed chronologically on our homepage. Selected papers and presentations are presented here.

Conference poster on the topic of tunnel seismic prediction using Machine Learning techniques
Unterlass, P.J., Sapronova, A., Hecht-Mendez, J., Dickmann, T. and Marcher, T.
Presented at EAGE DIGITAL conference, March 23-25, 2022, Vienna

The research results from our ongoing cooperation with Amberg Technologies AG, where data analysis is used to predict rock mass conditions ahead of the tunnel face, were presented at the EAGE (European Association of Geoscientists and Engineers) DIGITAL conference held in Vienna, March 23-25, 2022. In this project, the tunnel seismic prediction (TSP) system collects seismic signals reflected by changes in the rock mass associated with discontinuities. The machine learning methods employed provide an improvement in the identification of rock mass classes and the lithology types.



Poster presented at the EAGE DIGITAL conference in Vienna, March 25-28, 2022

unterlass@tugraz.at

Faces

… today's students and alumni of the Institute of Rock Mechanics and Tunnelling

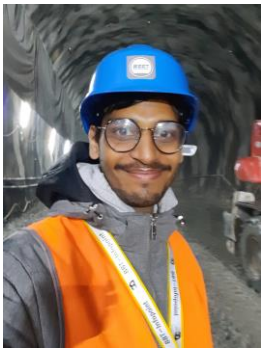
Günther M. Volkmann (Alumni)

After graduation in civil engineering at TUG, I worked as Research Assistant and Lecturer at the RMT-Institute. Here I started my Doctoral Thesis on the topic: "Function, Design, and Specifications for Pipe Umbrella Support Systems." At this time the evaluation of every minute measured deformations at the tunnel level ahead of the tunnel face with in-place chain inclinometers at Birgl Tunnel (Austria) and Trojane Tunnel (Slovenia) marked a great step forward in understanding this support system and stress transfer processes at the tunnel heading.

Since the second quarter of 2005 I am an employee of DSI Underground Austria GmbH. My responsibilities include research and development, business development tunneling worldwide, group internal and external adult education and being group expert for NATM product applications. Due to these responsibilities, I was involved in worldwide tunneling projects from design stage till construction and I was allowed to help shape the continuous development of the company from acting in mainly German speaking countries to a global player.

Vojtěch Anderle

When I started studying Civil Engineering at Czech Technical University in Prague in 2016, I wanted to focus in the structural design of buildings. However, after 1 year at university, I got a job in a company specializing in geotechnical monitoring and other geotechnical fields. While working on quite interesting projects of underground constructions in Prague I soon realized it is more interesting to me to deal with constructions beneath the ground rather than above the ground. With that in mind, I wrote my bachelor thesis on a geotechnical topic and after that changed my study program to Geotechnics and Transportation Engineering for my master studies. For my final semester I decided to study abroad and I have chosen TU Graz as my destination, mainly because of its reputation in tunnelling. During my time there, I finished my master thesis under supervision of Professor Thomas Marcher, head of the RMT institute. Besides that, I took several subjects relevant to my field of interest. The Knowledge and experience I have gained throughout my time at the RMT Institute I can now apply and implement on the projects I am working on in the future.



Vaibhav Shringi

The opportunity to pursue a bachelor thesis at a top-tier institution got me from India to Austria. I highly appreciate the efforts of IAESTE to introduce me to the Institute of Rock Mechanics and Tunnelling and turn my dream into a reality. Currently exploring the "Effects of the moment of ring closure in conventional tunnelling", RMT allows me to apply my previous knowledge while simultaneously learning new concepts. I am fortunate to find assistance from people of different expertise whenever I get stuck and socialize with them daily. A spark of interest in tunnels from the course "Fundamentals of Rock Mechanics" is really transforming into a passion with this experience. With such a cheerful and vibrant environment here, I am keen to remain associated with RMT and this beautiful city for as long as possible and looking forward to pursuing higher education at TU Graz.

Diary of Events

The Long Night of Research at TU Graz
Graz, Austria (2022/05/20)

Researchers all around Austria will allow a unique look behind the scenes and bring their research to life for one night. Our team will show some exciting tests in the rock mechanics laboratory. Registration via email addressed to tunnel@tugraz.at.
[additional information]

EURO:TUN 2021 goes SFB 873 & EURO:TUN 2022
Bochum, Germany (2022/06/22-24)

Due to the pandemic situation, EURO:TUN 21 was shifted to 22.-24.06.2022. The EURO:TUN conference focusing on Computational Methods and Information Models in Tunneling will take place in the Conference Centre of the Ruhr University Bochum (RUB). The conference will be combined with a workshop on Interactive Modeling in Mechanized Tunneling. More information on the conference can be found here: http://eurotun2021.rub.de

36. Christian Veder Kolloquium 2022
(2022/06/28-29)

Annual conference hosted by the Institute of Soil Mechanics, Foundation Engineering and Computational Geotechnics with the special topic of "Besondere Herausforderungen in Planung und Ausführung beim Bauen in weichen Böden". Conference is held in German without simultaneous translation. For further information see:
https://www.tugraz.at/institute/ibg/events/christian-veder-kolloquium/

Mini-Symposium "Rockfall Risk"
Schladming, Austria, (2022/12/01)

The symposium "Rockfall" will shed light on experiences and approaches to this topic from various disciplines. The spectrum ranges from engineering geology and rock mechanics to influences related to climate change, modern processing methods, possible further developments with the help of artificial intelligence, and legal liability issues. National and international experts will provide technical contributions and institutions will present their approaches (Further information - Link).

30th Anniversary Celebration of RMT followed by "Barbarafeier"
Graz, Austria (2022/12/02)

It has been 30 years since the Institute of Rock Mechanics and Tunnelling was founded in the year 1992. This must be celebrated and therefore a 30th anniversary celebration will take place at TU Graz on 2nd December 2022 (Start: 17:00 o'clock). After the anniversary celebration our yearly Barbarafeier will take place starting at 19:00 o'clock. Hope to see you there. Further information regarding the program and registration will follow on our website - Link.

3rd ATC²-Symposium 2023
Graz, Austria (2023/01/23)

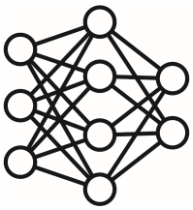
Symposium by the Austrian platform ATC² (Austrian Tunnel Competence Center), a collaboration of Graz University of Technology and Montanuniversität Leoben. The aim of the symposium is to transfer innovative ideas and know-how in tunnelling. In English. The topics of the upcoming events are: Shallow Tunnelling, Urban Tunnelling incl. Metro Tunnels and Stations. Further information can be found on the ATC² homepage (update in progress).
http://austrian-tunnel-competence-center.at

Have a look at our Master‘s Theses I

The institute has different research areas and offers numerous topics for a master thesis.

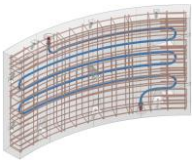
- **Artificial rock samples / Anisotropy (supervisor: M. Winkler)**

Rock is a complicated material, for example it is very often anisotropic making its’ deformational and strength characteristics dependent on the loading direction. To learn more about this phenomenon, numerical and experimental studies are carried out. Modern sand 3D-printing techniques aid in manufacturing of artificial rock samples which allow for the investigation of anisotropy without the influence of sample inhomogeneities.



- **Machine Learning (supervisor: G. Erharter, P. Unterlass)**

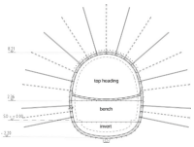
An exciting area of research is being led by the newly founded Machine Learning in Geotechnics (MLGT) Group. The research of this group focuses on machine learning, but the research topics are quite diverse, as one thesis deals with the application of Artificial Neural Networks (ANN) for the prediction of high resolution landslide monitoring data and another with the analysis and evaluation of geophysical data from Tunnel Seismic Points (TSP).



Moormann, C. (2010). GeoTU6 – a geothermal Research Project for Tunnels. Tunnel. 29. 14-21

- **Tunnel-thermal energy (supervisor: T. Geisler)**

You are interested in geology, tunnel construction and alternative forms of energy production? If so, this topic could be interesting for you. The main goal is the extraction of geothermal energy, by using (infrastructure) constructions, with the focus on deep-seated tunnels, so called “tunnel thermal energy”. This requires a symbiosis of geology, technical implementation possibilities and tunnel construction.



Schubert et al. 2014: Geotechnical and construction operational criteria for the selection of full or partial-face excavation

- **Ring closure (supervisor: A. Kluckner)**

In conventional tunnelling driving through weaker zones, it is common to excavate one round of volume in parts: e.g., top-heading, and bench and invert. Reduced displacements result. In very weak zones, partial excavation even might be the only way to cope with ground deformations. Anyway, the moment of ring closure determines the loading of the liner. If ring closure takes place too early, the loading might be too high. If it takes place too late, resulting displacements might be too high. A very interesting topic, especially in combination with the installation of yielding elements. Let’s investigate that.

Have a look at our Master‘s Theses II

© BBT SE (https://www.bbt-se.com/information/mediathek/#&gid=1&pid=28)

- **Aspects of steel – rock contacts in TBM tunneling** (supervisor: **G. Erharter**)

Tunnelling with Tunnel Boring Machines (TBM) becomes increasingly used also for difficult ground conditions. Many aspects of the interaction between TBM and the rock mass are not yet fully understood and one of them is the frictional contact between TBM shield and tunnel wall. Based on a currently ongoing study on this subject, this master's thesis should investigate in detail geometrical aspects of the TBM - tunnel contact as well as mineralogical aspects, with a focus on standard abrasivity estimations. The industry relevance of this topic is high, since new contractual developments also consider the effect of shield friction in TBM tunnelling.

- **Rock fall hazards (supervisor: A. Kluckner)**

Imagine a hiking trail or a cycle track in alpine regions. Rock slopes may surround the way. And imagine that you walk or drive along this way. Do you watch the rock slopes continuously? A rock block may fall down and endanger you! Or does the municipality the way is located in has to make sure that it is safe for you and others? Is the municipality in charge of for ALL trails and tracks in the mountains, all the time? The risk depends on many factors. The scope of site investigations, the geology, the climate conditions, etc. There is a need for research. Work on this topic with RMT and other cooperation partners.

- **Numerical modelling of underground caverns for hot water storage (supervisor: T. Marcher)**

For machine and transformer caverns in power plant construction, the installations such as pump turbines and hoisting cranes as well as transformer dimensions determine the sizes for the rock caverns. In headrace tunnel construction, the required flow rate defines the tunnel diameter. In traffic tunneling, the required clearance profile determines the dimensions of the excavation. For the storage of the heat storage medium water, the geometry is primarily relevant with regard to storage volume and, to a lesser extent, the storage surface and the resulting heat losses. Decisive for the application of storage caverns as large-scale heat storage facilities are storage costs per kWh.

In addition to these main research areas, further master theses are supervised, which can be found on the website. [overview of master's theses]

Cooperation

… please contact us in case we forgot you here